1. **PROGRAMME OUTCOMES (POs):**

   After going through the four years of study, our Chemical Engineering Graduates will exhibit ability to:

<table>
<thead>
<tr>
<th>Graduate attribute</th>
<th>Programme Outcome</th>
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<tbody>
<tr>
<td>PO1 Engineering knowledge</td>
<td>Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems</td>
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<tr>
<td>PO2 Problem analysis</td>
<td>Problem analysis Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.</td>
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<tr>
<td>PO3 Design / development of solutions</td>
<td>Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.</td>
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<tr>
<td>PO4 Conduct investigations of complex problems</td>
<td>Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.</td>
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<tr>
<td>PO5 Modern tool usage</td>
<td>Modern tool usage Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations</td>
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<tr>
<td>PO6 The Engineer and society</td>
<td>Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.</td>
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<tr>
<td>PO7 Environment and sustainability</td>
<td>Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development</td>
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<tr>
<td>PO8 Ethics</td>
<td>Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice</td>
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<tr>
<td>PO9 Individual and team work</td>
<td>Function effectively as an individual, and as a member or leader in diverse teams, and in</td>
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<td>PO11</td>
<td>Project management and finance</td>
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<td>PO12</td>
<td>Life-long learning</td>
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2. PROGRAM SPECIFIC OUTCOMES (PSOs):
   By the completion of Chemical Engineering Programme the student will have following Program-specific outcomes.

1. Graduates will have a strong foundation in engineering, science and current Chemical Engineering practices and will have experience in solving structured and unstructured problems using conventional and innovative solutions.
2. Graduates will be able to effectively describe the Chemical Engineering problem, analyze the data, develop potential solutions, evaluate these solutions, and present the results using their oral, written and electronic media skills.
3. Graduates will have an understanding of ethical and professional responsibilities of an engineer and the impact of engineering solutions on society and the global environment.
### 3. MAPPING OF COURSE OUTCOMES AND PROGRAMME OUTCOMES

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<th>COURSE NAME</th>
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### ANNA UNIVERSITY, CHENNAI
### NON-AUTONOMOUS COLLEGES AFFILIATED COLLEGES
### REGULATIONS 2021
### B.TECH. CHEMICAL ENGINEERING
### CURRICULUM AND SYLLABI FOR I TO VIII SEMESTERS

#### SEMESTER I

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$^*$ Skill Based Course

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# NCC Credit Course level 1 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.

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# NCC Credit Course level 2 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.

*Two weeks industrial training/internship carries one credit. Industrial training/internship during IV Semester Summer Vacation will be evaluated in V semester
### SEMESTER V

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* Mandatory Course-I is a Non-Credit Course (Student shall select one course from the list given under MC-I)

*Two weeks industrial training/Internship carries one credit. Industrial training/Internship during IV Semester Summer Vacation will be evaluated in V semester

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*Open Elective – I shall be chosen from the emerging technologies.

## Two weeks industrial training/Internship carries one credit. Industrial training/Internship during VI Semester Summer Vacation will be evaluated in VII semester

# Mandatory Course-II is a Non-Credit Course (Student shall select one course from the list given under MC-II)

# NCC Credit Course level 3 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.
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*If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII.

**Open Elective – II shall be chosen from the emerging technologies.

***Open Elective III and IV (Shall be chosen from the list of open electives offered by other Programmes

# Elective- Management shall be chosen from the Elective Management courses

## Two weeks industrial training/internship carries one credit. Industrial training/Internship during VI Semester Summer Vacation will be evaluated in VII semester.

### SELECTION VIII/VII

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<thead>
<tr>
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*If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII.

# 15 weeks of continuous Internship in an organization carries 10 credits.

### ELECTIVE – MANAGEMENT COURSES

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<tr>
<th>SL. NO.</th>
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TOTAL CREDITS: 166
### MANDATORY COURSES I*

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* Mandatory Courses are offered as Non–Credit Courses

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* Mandatory Courses are offered as Non–Credit Courses
### PROFESSIONAL ELECTIVE COURSES: VERTICALS

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<tr>
<th>Vertical I Petroleum Process Technology</th>
<th>Vertical II Energy Engineering</th>
<th>Vertical III Biochemical Engineering</th>
<th>Vertical IV Environmental and Safety Engineering</th>
<th>Vertical V Computational Chemical Engineering</th>
<th>Vertical VI Chemical Plant Design</th>
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<tbody>
<tr>
<td>Petroleum Chemistry and Refining Fundamentals</td>
<td>Bioenergy</td>
<td>Biochemistry</td>
<td>Air Pollution Engineering</td>
<td>Computational Techniques</td>
<td>Chemical Plant Design</td>
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<td>Primary Refining Technology</td>
<td>Renewable Energy Resources</td>
<td>Bioprocess Technology</td>
<td>Waste Water Treatment</td>
<td>Optimization of Chemical Processes</td>
<td>Plant Layout</td>
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<tr>
<td>Secondary Refining Technology</td>
<td>Pinch Technology</td>
<td>Fermentation and Bioprocessing</td>
<td>Solid waste Management</td>
<td>Process Modeling and Simulation</td>
<td>Design Safety</td>
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<tr>
<td>Petrochemical Technology</td>
<td>Non-Renewable Energy Sources</td>
<td>Bioreactor Design</td>
<td>Risk and HAZOP Analysis</td>
<td>Computational Fluid Dynamics</td>
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**Registration of Professional Elective Courses from Verticals:**

Refer to the regulations 2021, Clause 6.3. (Amended on 27.07.2023)
## PROFESSIONAL ELECTIVE COURSES : VERTICALS

### VERTICAL I: PETROLEUM PROCESS TECHNOLOGY

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### VERTICAL III: BIOCHEMICAL ENGINEERING

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### VERTICAL IV: ENVIRONMENTAL AND SAFETY ENGINEERING

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### VERTICAL V: COMPUTATIONAL CHEMICAL ENGINEERING

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### VERTICAL VI: CHEMICAL PLANT DESIGN

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OPEN ELECTIVES

(Students shall choose the open elective courses, such that the course contents are not similar to any other course contents/title under other course categories.)

OPEN ELECTIVE I AND II
(EMERGING TECHNOLOGIES)

To be offered other than Faculty of Information and Communication Engineering

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OPEN ELECTIVES – III

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**SUMMARY**

**B.TECH. CHEMICAL ENGINEERING**

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Enrollment for B.E. / B. Tech. (Honours) / Minor degree (Optional)

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E./B.Tech. (Honours) Minor degree.

For B.E. / B. Tech. (Honours), a student shall register for the additional courses (18 credits) from semester V onwards. These courses shall be from the same vertical or a combination of different verticals of the same programme of study only.

For minor degree, a student shall register for the additional courses (18 credits) from semester V onwards. All these courses have to be in a particular vertical from any one of the other programmes. Moreover, for minor degree the student can register for courses from any one of the following verticals also.

Complete details are available in clause 4.10 (Amendments) of Regulations 2021.

**VERTICALS FOR MINOR DEGREE (in additions to all the verticals of other programmes)**

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Choice of courses for Minor degree is to be made from any one vertical of other programmes or from anyone of the following verticals

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### VERTICAL II: ENTREPRENEURSHIP

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### VERTICAL III: PUBLIC ADMINISTRATION

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### VERTICAL V: ENVIRONMENT AND SUSTAINABILITY

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This is a mandatory 2 week programme to be conducted as soon as the students enter the institution. Normal classes start only after the induction program is over.

The induction programme has been introduced by AICTE with the following objective:

“Engineering colleges were established to train graduates well in the branch/department of admission, have a holistic outlook, and have a desire to work for national needs and beyond. The graduating student must have knowledge and skills in the area of his/her study. However, he/she must also have broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he/she would understand and fulfill his/her responsibility as an engineer, a citizen and a human being. Besides the above, several meta-skills and underlying values are needed.”

“One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character.”

Hence, the purpose of this programme is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program.

(i) Physical Activity
This would involve a daily routine of physical activity with games and sports, yoga, gardening, etc.

(ii) Creative Arts
Every student would choose one skill related to the arts whether visual arts or performing arts. Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it everyday for the duration of the program. These would allow for creative expression. It would develop a sense of aesthetics and also enhance creativity which would, hopefully, grow into engineering design later.

(iii) Universal Human Values
This is the anchoring activity of the Induction Programme. It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting stay in the hostel and department, be sensitive to others, etc. A module in Universal Human Values provides the base. Methodology of teaching this content is extremely important. It must not be through do's and dont's, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing.

Discussions would be conducted in small groups of about 20 students with a faculty mentor each. It would be effective that the faculty mentor assigned is also the faculty advisor for the student for the full duration of the UG programme.
(iv) Literary Activity
Literary activity would encompass reading, writing and possibly, debating, enacting a play etc.

(v) Proficiency Modules
This would address some lacunas that students might have, for example, English, computer familiarity etc.

(vi) Lectures by Eminent People
Motivational lectures by eminent people from all walks of life should be arranged to give the students exposure to people who are socially active or in public life.

(vii) Visits to Local Area
A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the under privileged.

(viii) Familiarization to Dept./Branch & Innovations
They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilities.

(ix) Department Specific Activities
About a week can be spent in introducing activities (games, quizzes, social interactions, small experiments, design thinking etc.) that are relevant to the particular branch of Engineering/Technology/Architecture that can serve as a motivation and kindle interest in building things (become a maker) in that particular field. This can be conducted in the form of a workshop. For example, CSE and IT students may be introduced to activities that kindle computational thinking, and get them to build simple games. ECE students may be introduced to building simple circuits as an extension of their knowledge in Science, and so on. Students may be asked to build stuff using their knowledge of science.

Induction Programme is totally an activity based programme and therefore there shall be no tests / assessments during this programme.

REFERENCES:
Guide to Induction program from AICTE

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OBJECTIVES:
- To improve the communicative competence of learners
- To learn to use basic grammatic structures in suitable contexts
- To acquire lexical competence and use them appropriately in a sentence and understand their meaning in a text
- To help learners use language effectively in professional contexts
- To develop learners’ ability to read and write complex texts, summaries, articles, blogs, definitions, essays and user manuals.
UNIT I  INTRODUCTION TO EFFECTIVE COMMUNICATION  
What is effective communication? (Explain using activities) Why is communication critical for excellence during study, research and work? What are the seven C’s of effective communication? What are key language skills? What is effective listening? What does it involve? What is effective speaking? What does it mean to be an excellent reader? What should you be able to do? What is effective writing? How does one develop language and communication skills? What does the course focus on? How are communication and language skills going to be enhanced during this course? What do you as a learner need to do to enhance your English language and communication skills to get the best out of this course?

INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION  
Reading - Reading brochures (technical context), telephone messages / social media messages relevant to technical contexts and emails. Writing - Writing emails / letters introducing oneself. Grammar - Present Tense (simple and progressive); Question types: Wh/ Yes or No/ and Tags. Vocabulary - Synonyms; One word substitution; Abbreviations & Acronyms (as used in technical contexts).

UNIT II  NARRATION AND SUMMATION  
Reading - Reading biographies, travelogues, newspaper reports, Excerpts from literature, and travel & technical blogs. Writing - Guided writing -- Paragraph writing Short Report on an event (field trip etc.) Grammar –Past tense (simple); Subject-Verb Agreement; and Prepositions. Vocabulary - Word forms (prefixes& suffixes); Synonyms and Antonyms. Phrasal verbs.

UNIT III DESCRIPTION OF A PROCESS / PRODUCT  
Reading – Reading advertisements, gadget reviews; user manuals. Writing - Writing definitions; instructions; and Product /Process description. Grammar - Imperatives; Adjectives; Degrees of comparison; Present & Past Perfect Tenses. Vocabulary - Compound Nouns, Homonyms; and Homophones, discourse markers (connectives & sequence words).

UNIT IV CLASSIFICATION AND RECOMMENDATIONS  
Reading – Newspaper articles; Journal reports –and Non Verbal Communication (tables, pie charts etc, .). Writing – Note-making / Note-taking (“Study skills to be taught, not tested); Writing recommendations; Transferring information from non verbal (chart, graph etc, to verbal mode) Grammar – Articles; Pronouns - Possessive & Relative pronouns. Vocabulary - Collocations; Fixed / Semi fixed expressions.

UNIT V  EXPRESSION  
Reading – Reading editorials; and Opinion Blogs; Writing – Essay Writing (Descriptive or narrative). Grammar – Future Tenses, Punctuation; Negation (Statements & Questions); and Simple, Compound & Complex Sentences. Vocabulary - Cause & Effect Expressions – Content vs Function words.

LEARNING OUTCOMES:
At the end of the course, learners will be able
- To use appropriate words in a professional context
- To gain understanding of basic grammatical structures and use them in right context.
- To read and interpret information presented in tables, charts and other graphic forms
- To write definitions, descriptions, narrations and essays on various topics

TEXT BOOKS :
1. English for Engineers & Technologists  Orient Blackswan Private Ltd. Department of English, Anna University, (2020 edition)
2. English for Science & Technology Cambridge University Press, 2021. Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.
REFERENCE BOOKS:

ASSESSMENT PATTERN
Two internal assessments and an end semester examination to test students’ reading and writing skills along with their grammatical and lexical competence.

CO-PO & PSO MAPPING

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1. 1-low, 2-medium, 3-high, "-" no correlation  
2. Note: The average value of this course to be used for program articulation matrix.

MA3151 MATRICES AND CALCULUS

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3 1 0 4

COURSE OBJECTIVES:
- To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
- To familiarize the students with differential calculus.
- To familiarize the student with functions of several variables. This is needed in many branches of engineering.
- To make the students understand various techniques of integration.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.

UNIT I MATRICES
9+3

UNIT II DIFFERENTIAL CALCULUS
9+3

UNIT III FUNCTIONS OF SEVERAL VARIABLES
9+3
Partial differentiation – Homogeneous functions and Euler’s theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor’s series for functions of
two variables – Applications: Maxima and minima of functions of two variables and Lagrange's method of undetermined multipliers.

UNIT IV INTEGRAL CALCULUS  9+3
Definite and Indefinite integrals - Substitution rule - Techniques of Integration: Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals - Applications: Hydrostatic force and pressure, moments and centres of mass.

UNIT V MULTIPLE INTEGRALS  9+3

TOTAL: 60 PERIODS

COURSE OUTCOMES:
At the end of the course the students will be able to
- Use the matrix algebra methods for solving practical problems.
- Apply differential calculus tools in solving various application problems.
- Able to use differential calculus ideas on several variable functions.
- Apply different methods of integration in solving practical problems.
- Apply multiple integral ideas in solving areas, volumes and other practical problems

TEXT BOOKS:
3. James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 8th Edition, New Delhi, 2015. [For Units II & IV - Sections 1.1, 2.2, 2.3, 2.5, 2.7 (Tangents problems only), 2.8, 3.1 to 3.6, 3.11, 4.1, 4.3, 5.1 (Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.1 - 7.4 and 7.8].

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PH3151 ENGINEERING PHYSICS

COURSE OBJECTIVES

- To make the students effectively to achieve an understanding of mechanics.
- To enable the students to gain knowledge of electromagnetic waves and its applications.
- To introduce the basics of oscillations, optics and lasers.
- Equipping the students to be successfully understand the importance of quantum physics.
- To motivate the students towards the applications of quantum mechanics.

UNIT I MECHANICS


UNIT II ELECTROMAGNETIC WAVES

The Maxwell’s equations - wave equation; Plane electromagnetic waves in vacuum, Conditions on the wave field - properties of electromagnetic waves: speed, amplitude, phase, orientation and waves in matter - polarization - Producing electromagnetic waves - Energy and momentum in EM waves: Intensity, waves from localized sources, momentum and radiation pressure - Cell-phone reception. Reflection and transmission of electromagnetic waves from a non-conducting medium-vacuum interface for normal incidence.

UNIT III OSCILLATIONS, OPTICS AND LASERS


UNIT IV BASIC QUANTUM MECHANICS

Photons and light waves - Electrons and matter waves – Compton effect - The Schrodinger equation (Time dependent and time independent forms) - meaning of wave function - Normalization – Free particle - particle in a infinite potential well: 1D,2D and 3D Boxes- Normalization, probabilities and the correspondence principle.

UNIT V APPLIED QUANTUM MECHANICS

The harmonic oscillator(qualitative)- Barrier penetration and quantum tunneling(qualitative)- Tunneling microscope - Resonant diode - Finite potential wells (qualitative)- Bloch’s theorem for particles in a periodic potential –Basics of Kronig-Penney model and origin of energy bands.

COURSE OUTCOMES

After completion of this course, the students should be able to

- Understand the importance of mechanics.
- Express their knowledge in electromagnetic waves.
- Demonstrate a strong foundational knowledge in oscillations, optics and lasers.
- Understand the importance of quantum physics.
- Comprehend and apply quantum mechanical principles towards the formation of energy bands.

TEXT BOOKS:

2. E.M.Purcell and D.J.Morin, Electricity and Magnetism, Cambridge Univ.Press, 2013.
REFERENCES:

CO's-PO's & PSO's MAPPING

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Note: the average value of this course to be used for program articulation matrix.

CY3151 ENGINEERING CHEMISTRY L T P C

COURSE OBJECTIVES:
- To inculcate sound understanding of water quality parameters and water treatment techniques.
- To impart knowledge on the basic principles and preparatory methods of nanomaterials.
- To introduce the basic concepts and applications of phase rule and composites.
- To facilitate the understanding of different types of fuels, their preparation, properties and combustion characteristics.
- To familiarize the students with the operating principles, working processes and applications of energy conversion and storage devices.

UNIT I WATER AND ITS TREATMENT

UNIT II NANO CHEMISTRY
Basics: Distinction between molecules, nanomaterials and bulk materials; Size-dependent properties (optical, electrical, mechanical and magnetic); Types of nanomaterials: Definition, properties and uses of – nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: sol-gel, solvothermal, laser ablation, chemical vapour deposition, electrochemical deposition and electro spinning. Applications of nanomaterials in medicine, agriculture, energy, electronics and catalysis.

UNIT III PHASE RULE AND COMPOSITES
Phase rule: Introduction, definition of terms with examples. One component system - water system; Reduced phase rule; Construction of a simple eutectic phase diagram - Thermal analysis; Two
component system: lead-silver system - Pattinson process.
Composites: Introduction: Definition & Need for composites; Constitution: Matrix materials (Polymer matrix, metal matrix and ceramic matrix) and Reinforcement (fiber, particulates, flakes and whiskers). Properties and applications of: Metal matrix composites (MMC), Ceramic matrix composites and Polymer matrix composites. Hybrid composites - definition and examples.

UNIT IV FUELS AND COMBUSTION
Fuels: Introduction: Classification of fuels; Coal and coke: Analysis of coal (proximate and ultimate), Carbonization, Manufacture of metallurgical coke (Otto Hoffmann method). Petroleum and Diesel: Manufacture of synthetic petrol (Bergius process), Knocking - octane number, diesel oil - cetane number; Power alcohol and biodiesel.
Combustion of fuels: Introduction: Calorific value - higher and lower calorific values, Theoretical calculation of calorific value; Ignition temperature: spontaneous ignition temperature, Explosive range; Flue gas analysis - ORSAT Method. CO₂ emission and carbon foot print.

UNIT V ENERGY SOURCES AND STORAGE DEVICES
Stability of nucleus: mass defect (problems), binding energy; Nuclear energy: light water nuclear power plant, breeder reactor. Solar energy conversion: Principle, working and applications of solar cells; Recent developments in solar cell materials. Wind energy; Geothermal energy; Batteries: Types of batteries, Primary battery - dry cell, Secondary battery - lead acid battery and lithium-ion-battery; Electric vehicles; working principles; Fuel cells: H₂-O₂ fuel cell, microbial fuel cell; Supercapacitors: Storage principle, types and examples.

TOTAL: 45 PERIODS

COURSE OUTCOMES
At the end of the course, the students will be able:
- To infer the quality of water from quality parameter data and propose suitable treatment methodologies to treat water.
- To identify and apply basic concepts of nanoscience and nanotechnology in designing the synthesis of nanomaterials for engineering and technology applications.
- To apply the knowledge of phase rule and composites for material selection requirements.
- To recommend suitable fuels for engineering processes and applications.
- To recognize different forms of energy resources and apply them for suitable applications in energy sectors.

TEXT BOOKS:

REFERENCES:
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**GE3151 PROBLEM SOLVING AND PYTHON PROGRAMMING**

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**OBJECTIVES:**
- To understand the basics of algorithmic problem solving.
- To learn to solve problems using Python conditionals and loops.
- To define Python functions and use function calls to solve problems.
- To use Python data structures - lists, tuples, dictionaries to represent complex data.
- To do input/output with files in Python.

**UNIT I COMPUTATIONAL THINKING AND PROBLEM SOLVING**

- Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

**UNIT II DATA TYPES, EXPRESSIONS, STATEMENTS**

- Python interpreter and interactive mode, debugging; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

**UNIT III CONTROL FLOW, FUNCTIONS, STRINGS**

- Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

**UNIT IV LISTS, TUPLES, DICTIONARIES**

- Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: simple sorting, histogram, Students marks statement, Retail bill preparation.

**UNIT V FILES, MODULES, PACKAGES**

- Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file, Voter’s age validation, Marks range validation (0-100).

**TOTAL : 45 PERIODS**
OUTCOMES:
Upon completion of the course, students will be able to
CO1: Develop algorithmic solutions to simple computational problems.
CO2: Develop and execute simple Python programs.
CO3: Write simple Python programs using conditionals and looping for solving problems.
CO4: Decompose a Python program into functions.
CO5: Represent compound data using Python lists, tuples, dictionaries etc.
CO6: Read and write data from/to files in Python programs.

TEXT BOOKS:

REFERENCES:
5. https://www.python.org/

COs- PO’s & PSO’s MAPPING

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GE3152 கதோபாகம்

L T P C 1 0 0 1

கல்லூற்றுக்குரிய செவ்வகப்பக்கம்
 nacional கல்லூற்றுக்குரிய செவ்வகப்பக்கம் - பிரபல கல்லூற்றுக்குரிய செவ்வகப்பக்கம் - பிரபல கல்லூற்றுக்குரிய செவ்வகப்பக்கம் - பிரபல கல்லூற்றுக்குரிய செவ்வகப்பக்கம் - பிரபல கல்லூற்றுக்குரிய செவ்வகப்பக்கம் - பிரபல கல்லூற்றுக்குரிய செவ்வகப்பக்கம் - பிரபல கல்லூற்றுக்குரிய செவ்வகப்பக்கம் - பிரபல கல்லூற்றுக்குரிய செவ்வகப்பக்கம் - பிரபல கல்லூற்றுக்குரிய செவ்வகப்பக்கம் - பிரபல கல்லூற்றுக்குரிய செவ்வகப்பக்கம்.
கலாச்சாரங்கள் பதிப்பு - மண்டலம் 3


கலாச்சாரங்கள் பதிப்பு - மண்டலம் 3


கலாச்சாரங்கள் பதிப்பு - மண்டலம் 3


TEXT-CUM-REFERENCE BOOKS
1. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
2. Historical Heritage of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies).
3. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
4. Keeladi - ‘Sangam City Civilization on the banks of river Vaigai’ (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
5. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
6. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
UNIT I LANGUAGE AND LITERATURE

UNIT II HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE

UNIT III FOLK AND MARTIAL ARTS
Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV THINAI CONCEPT OF TAMILS
Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

UNIT V CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE
Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India - Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS
1. கல்வியாட்டு மரபுருவு - மத்தியாம பாலகர்பகுதியில் - இந்தியா (பாலராஜி: கல்வியாட்டு மரபுருவு, மத்தியாம பாலகர்பகுதியில் இந்தியா).
3. சிவலிங்கம் - தீமாக சிவலிங்கம் சிவகாரூடு சிவகாரூடு (தீமாக சிவகாரூடு சிவகாரூடு).
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies).
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - “Sangam City Civilization on the banks of river Vaigai” (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)

32
OBJECTIVES:

- To understand the problem solving approaches.
- To learn the basic programming constructs in Python.
- To practice various computing strategies for Python-based solutions to real world problems.
- To use Python data structures - lists, tuples, dictionaries.
- To do input/output with files in Python.

EXPERIMENTS:

Note: The examples suggested in each experiment are only indicative. The lab instructor is expected to design other problems on similar lines. The Examination shall not be restricted to the sample experiments listed here.

1. Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same. (Electricity Billing, Retail shop billing, Sin series, weight of a motorbike, Weight of a steel bar, compute Electrical Current in Three Phase AC Circuit, etc.)
2. Python programming using simple statements and expressions (exchange the values of two variables, calculate the values of n variables, distance between two points).
3. Scientific problems using Conditionals and Iterative loops. (Number series, Number Patterns, pyramid pattern)
4. Implementing real-time/technical applications using Lists, Tuples. (Items present in a library/Components of a car/ Materials required for construction of a building — operations of list & tuples)
5. Implementing real-time/technical applications using Sets, Dictionaries. (Language, components of an automobile, Elements of a civil structure, etc. - operations of Sets & Dictionaries)
6. Implementing programs using Functions. (Factorial, largest number in a list, area of shape)
7. Implementing programs using Strings. (reverse, palindrome, character count, replacing characters)
8. Implementing programs using written modules and Python Standard Libraries (pandas, numpy, Matplotlib, scipy)
9. Implementing real-time/technical applications using File handling. (copy from one file to another, word count, longest word)
10. Implementing real-time/technical applications using Exception handling. (divide by zero error, voter's age validity, student mark range validation)
12. Developing a game activity using Pygame like bouncing ball, car race etc.

TOTAL: 60 PERIODS

OUTCOMES:

On completion of the course, students will be able to:
CO1: Develop algorithmic solutions to simple computational problems.
CO2: Develop and execute simple Python programs.
CO3: Implement programs in Python using conditionals and loops for solving problems.
CO4: Deploy functions to decompose a Python program.
CO5: Process compound data using Python data structures.
CO6: Utilize Python packages in developing software applications.

TEXT BOOKS:


REFERENCES:

5. https://www.python.org/

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BS3171 PHYSICS AND CHEMISTRY LABORATORY
PHYSICS LABORATORY: (Any Seven Experiments)

COURSE OBJECTIVES:
- To learn the proper use of various kinds of physics laboratory equipment.
- To learn how data can be collected, presented and interpreted in a clear and concise manner.
- To learn problem solving skills related to physics principles and interpretation of experimental data.
- To determine error in experimental measurements and techniques used to minimize such error.
- To make the student as an active participant in each part of all lab exercises.

LIST OF EXPERIMENTS
1. Torsional pendulum - Determination of rigidity modulus of wire and moment of inertia of regular and irregular objects.
2. Simple harmonic oscillations of cantilever.
3. Non-uniform bending - Determination of Young’s modulus.
5. Laser- Determination of the wave length of the laser using grating.
6. Air wedge - Determination of thickness of a thin sheet/wire.
7. a) Optical fibre - Determination of Numerical Aperture and acceptance angle
   b) Compact disc - Determination of width of the groove using laser.
8. Acoustic grating- Determination of velocity of ultrasonic waves in liquids.
9. Ultrasonic interferometer – determination of the velocity of sound and compressibility of liquids.
11. Photoelectric effect.
12. Michelson Interferometer.
13. Melde’s string experiment.
14. Experiment with lattice dynamics kit.

TOTAL: 30 PERIODS

OUTCOMES:
Upon completion of the course, the students should be able to
- Understand the functioning of various physics laboratory equipment.
- Use graphical models to analyze laboratory data.
- Use mathematical models as a medium for quantitative reasoning and describing physical reality.
- Access, process and analyze scientific information.
• Solve problems individually and collaboratively.

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- 1-Low, 2-Medium, 3-High, "-"--no correlation
- Note: the average value of this course to be used for program articulation matrix.

### CHEMISTRY LABORATORY: (Any seven experiments)

**OBJECTIVES:**
- To inculcate experimental skills to test basic understanding of water quality parameters, such as, acidity, alkalinity, hardness, DO, chloride and copper.
- To induce the students to familiarize with electroanalytical techniques such as, pH metry, potentiometry and conductometry in the determination of impurities in aqueous solutions.
- To demonstrate the analysis of metals and alloys.
- To demonstrate the synthesis of nanoparticles

**CHEMISTRY LABORATORY: (Any seven experiments to be conducted)**
1. Preparation of Na₂CO₃ as a primary standard and estimation of acidity of a water sample using the primary standard
2. Determination of types and amount of alkalinity in water sample.
3. Determination of total, temporary & permanent hardness of water by EDTA method.
4. Determination of DO content of water sample by Winkler’s method.
5. Determination of chloride content of water sample by Argentometric method.
6. Estimation of copper content of the given solution by Iodometry.
7. Estimation of TDS of a water sample by gravimetry.
8. Determination of strength of given hydrochloric acid using pH meter.
9. Determination of strength of acids in a mixture of acids using conductivity meter.
10. Conductometric titration of barium chloride against sodium sulphate (precipitation titration)
11. Estimation of iron content of the given solution using potentiometer.
13. Preparation of nanoparticles (TiO₂/ZnO/CuO) by Sol-Gel method.
14. Estimation of Nickel in steel
15. Proximate analysis of Coal

**TOTAL: 30 PERIODS**

**OUT COMES:**
- To analyse the quality of water samples with respect to their acidity, alkalinity, hardness and DO.
- To determine the amount of metal ions through volumetric and spectroscopic techniques.
- To analyse and determine the composition of alloys.
- To learn simple method of synthesis of nanoparticles.
- To quantitatively analyse the impurities in solution by electroanalytical techniques.

**TEXT BOOK:**
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- 1-low, 2-medium, 3-high, ““- no correlation

## GE3172 ENGLISH LABORATORY

### OBJECTIVES:
- To improve the communicative competence of learners
- To help learners use language effectively in academic /work contexts
- To develop various listening strategies to comprehend various types of audio materials like lectures, discussions, videos etc.
- To build on students’ English language skills by engaging them in listening, speaking and grammar learning activities that are relevant to authentic contexts.
- To use language efficiently in expressing their opinions via various media.

### UNIT I INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION 6
Listening for general information-specific details- conversation: Introduction to classmates - Audio / video (formal & informal); Telephone conversation; Listening to voicemail & messages; Listening and filling a form. Speaking - making telephone calls-Self Introduction; Introducing a friend; - politeness strategies- making polite requests, making polite offers, replying to polite requests and offers- understanding basic instructions (filling out a bank application for example).

### UNIT II NARRATION AND SUMMATION 6
Listening - Listening to podcasts, anecdotes / stories / event narration; documentaries and interviews with celebrities. Speaking - Narrating personal experiences / events-Talking about current and temporary situations & permanent and regular situations* - describing experiences and feelings- engaging in small talk- describing requirements and abilities.

### UNIT III DESCRIPTION OF A PROCESS / PRODUCT 6
Listening - Listen to product and process descriptions; a classroom lecture; and advertisements about products. Speaking – Picture description- describing locations in workplaces- Giving instruction to use the product- explaining uses and purposes- Presenting a product- describing shapes and sizes and weights- talking about quantities (large & small)-talking about precautions.

### UNIT IV CLASSIFICATION AND RECOMMENDATIONS 6
Listening – Listening to TED Talks; Listening to lectures - and educational videos. Speaking – Small Talk; discussing and making plans-talking about tasks-talking about progress- talking about positions and directions of movement-talking about travel preparations- talking about transportation-

### UNIT V EXPRESSION 6
Listening – Listening to debates/ discussions; different viewpoints on an issue; and panel discussions. Speaking – making predictions- talking about a given topic-giving opinions-understanding a website-describing processes

TOTAL : 30 PERIODS

### LEARNING OUTCOMES:
At the end of the course, learners will be able
- To listen to and comprehend general as well as complex academic texts information
• To listen to and understand different points of view in a discussion
• To speak fluently and accurately in formal and informal communicative contexts
• To describe products and processes and explain their uses and purposes clearly and accurately
• To express their opinions effectively in both formal and informal discussions

ASSESSMENT PATTERN
• One online / app based assessment to test listening /speaking
• End Semester ONLY listening and speaking will be conducted online.
• Proficiency certification is given on successful completion of listening and speaking internal test and end semester exam.

CO-PO & PSO MAPPING

| CO | PO | PSO | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
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| AVg.| 3  | 3   | 3  | 3 | 3  | 3  | 3  | 3  | 3  | 3  | 3  | 3  | 3  |

• 1-low, 2-medium, 3-high, "-"- no correlation
• Note: The average value of this course to be used for program articulation matrix.

HS3252 PROFESSIONAL ENGLISH-I

OBJECTIVES :
• To engage learners in meaningful language activities to improve their reading and writing skills
• To learn various reading strategies and apply in comprehending documents in professional context.
• To help learners understand the purpose, audience, contexts of different types of writing
• To develop analytical thinking skills for problem solving in communicative contexts
• To demonstrate an understanding of job applications and interviews for internship and placements

UNIT I MAKING COMPARISONS 6
Reading - Reading advertisements, user manuals, brochures; Writing – Professional emails, Email etiquette - Compare and Contrast Essay; Grammar – Mixed Tenses, Prepositional phrases

UNIT II EXPRESSING CAUSAL RELATIONS IN SPEAKING AND WRITING 6
Reading - Reading longer technical texts– Cause and Effect Essays, and Letters / emails of complaint, Writing - Writing responses to complaints. Grammar - Active Passive Voice transformations, Infinitive and Gerunds

UNIT III PROBLEM SOLVING 6
Reading - Case Studies, excerpts from literary texts, news reports etc. Writing – Letter to the Editor, Checklists, Problem solution essay / Argumentative Essay. Grammar – Error correction; If conditional sentences

UNIT IV REPORTING OF EVENTS AND RESEARCH 6
UNIT V THE ABILITY TO PUT IDEAS OR INFORMATION COGENTLY

Reading – Company profiles, Statement of Purpose, (SOP), an excerpt of interview with professionals; Writing – Job / Internship application – Cover letter & Resume; Grammar – Numerical adjectives, Relative Clauses.

TOTAL: 30 PERIODS

OUTCOMES:
At the end of the course, learners will be able
- To compare and contrast products and ideas in technical texts.
- To identify and report cause and effects in events, industrial processes through technical texts.
- To analyse problems in order to arrive at feasible solutions and communicate them in the written format.
- To present their ideas and opinions in a planned and logical manner.
- To draft effective resumes in the context of job search.

TEXT BOOKS:
3. Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

REFERENCE BOOKS:

ASSESSMENT PATTERN
Two internal assessments and an end semester examination to test students’ reading and writing skills along with their grammatical and lexical competence.

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• 1-low, 2-medium, 3-high, ‘-‘- no correlation
• Note: The average value of this course to be used for program articulation matrix.
OBJECTIVES:

- This course aims at providing the necessary basic concepts of a few statistical and numerical methods and give procedures for solving numerically different kinds of problems occurring in engineering and technology.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To introduce the basic concepts of solving algebraic and transcendental equations.
- To introduce the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.

UNIT I TESTING OF HYPOTHESIS 9+3
Sampling distributions - Tests for single mean, proportion and difference of means (Large and small samples) – Tests for single variance and equality of variances – Chi square test for goodness of fit – Independence of attributes.

UNIT II DESIGN OF EXPERIMENTS 9+3
One way and two way classifications - Completely randomized design – Randomized block design – Latin square design - $2^k$ factorial design.

UNIT III SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 9+3

UNIT IV INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION 9+3
Lagrange’s and Newton’s divided difference interpolations – Newton’s forward and backward difference interpolation – Approximation of derivatives using interpolation polynomials – Numerical single and double integrations using Trapezoidal and Simpson’s 1/3 rules.

UNIT V NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS 9+3

OUTCOMES:
Upon successful completion of the course, students will be able to:
- Apply the concept of testing of hypothesis for small and large samples in real life problems.
- Apply the basic concepts of classifications of design of experiments in the field of agriculture.
- Appreciate the numerical techniques of interpolation in various intervals and apply the numerical techniques of differentiation and integration for engineering problems.
- Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.
- Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.

TEXT BOOKS:
REFERENCES:

CO-PO & PSO MAPPING

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1-Low,2-Medium,3-High,”-“-no correlation
Note: the average value of this course to be used for program articulation matrix.

PH3258 PHYSICS OF MATERIALS L T P C

OBJECTIVES:
- To make the students to understand the basics of phase diagrams and various materials preparation techniques
- To equip the students to have a knowledge on different types of electron theory, basics of quantum mechanics and about superconductors
- To introduce the physics of semiconducting materials and applications of semiconductors in device fabrication
- To familiarize the students with the theory and applications of magnetic and dielectric materials
- To provide the students a sound platform towards learning about advanced materials and their applications.

UNIT I PREPARATION OF MATERIALS

UNIT II ELECTRICAL PROPERTIES OF MATERIALS
UNIT III SEMICONDUCTING PROPERTIES MATERIALS 9
Elemental Semiconductors - Compound semiconductors - Origin of band gap in solids (qualitative) -
carrier concentration in metals - carrier concentration in an intrinsic semiconductor (derivation) –
Fermi level – variation of Fermi level with temperature – electrical conductivity – band gap
determination – carrier concentration in n-type and p-type semiconductors (derivation) – variation of
Fermi level with temperature and impurity concentration – Hall effect – determination of Hall
coefficient – LED - Solar cells.

UNIT IV DIELECTRIC AND MAGNETIC MATERIALS 9
Dielectric, Paraelectric and ferroelectric materials - Electronic, Ionic, Orientational and space charge
polarization – Internal field and deduction of Clausius Mosotti equation – dielectric loss – different
types of dielectric breakdown – classification of insulating materials and their applications -
Ferroelectric materials - Introduction to magnetic materials - Domain theory of ferromagnetism,
Hysteresis, Soft and Hard magnetic materials – Anti-ferromagnetic materials – Ferrites, Giant
Magneto Resistance materials.

UNIT V NEW MATERIALS AND APPLICATIONS 9
Ceramics – types and applications – Composites: classification, role of matrix and reinforcement –
processing of fibre reinforced plastics and fibre reinforced metals – Metallic glasses – Shape
memory alloys – Copper, Nickel and Titanium based alloys – grapheme and its properties – Relaxor
ferroelectrics - Biomaterials – hydroxyapatite – PMMA – Silicone - Sensors: Chemical Sensors - Bio-
sensors – Polymer semiconductors – Photoconducting polymers.

TOTAL: 45 PERIODS

OUTCOMES:
On completion of the course, the students should be able to
• acquire knowledge of phase diagram, and thin film and nanomaterial preparation techniques
• familiarize with conducting materials, basic quantum mechanics, and properties and
applications of superconductors.
• gain knowledge on semiconducting materials based on energy level diagrams, its types,
temperature effect. Also, fabrication methods for semiconductor devices will be understood.
• realize with theories and applications of dielectric and ferromagnetic materials
• familiarize with ceramics, composites, metallic glasses, shape memory alloys, biomaterials  and
their important applications.

TEXT BOOKS:
Introduction for Engineers, 2011.

REFERENCES:

CO's-PO's & PSO's MAPPING

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1-Low,2-Medium,3-High,"-"=no correlation
Note: the average value of this course to be used for program articulation matrix.
OBJECTIVES:
- To introduce the basics of electric circuits and analysis
- To impart knowledge in domestic wiring
- To impart knowledge in the basics of working principles and application of electrical machines
- To introduce analog devices and their characteristics
- To introduce the functional elements and working of sensors and transducers.

UNIT I  ELECTRICAL CIRCUITS
DC Circuits: Circuit Components: Conductor, Resistor, Inductor, Capacitor – Ohm’s Law - Kirchhoff’s Laws – Simple problems- Nodal Analysis, Mesh analysis with Independent sources only (Steady state)
Introduction to AC Circuits and Parameters: Waveforms, Average value, RMS Value, Instantaneous power, real power, reactive power and apparent power, power factor – Steady state analysis of RLC circuits (Simple problems only), Three phase supply – star and delta connection – power in three-phase systems

UNIT II  MAGNETIC CIRCUITS AND ELECTRICAL INSTALLATIONS
Magnetic circuits-definitions-MMF, flux, reluctance, magnetic field intensity, flux density, fringing, self and mutual inductances-simple problems.
Domestic wiring , types of wires and cables, earthing ,protective devices- switch fuse unit- Miniature circuit breaker-moulded case circuit breaker- earth leakage circuit breaker, safety precautions and First Aid

UNIT III  ELECTRICAL MACHINES

UNIT IV  ANALOG ELECTRONICS

UNIT V  SENSORS AND TRANSDUCERS
Sensors, solenoids, pneumatic controls with electrical actuator, mechatronics, types of valves and its applications, electro-pneumatic systems, proximity sensors, limit switches, piezoelectric, hall effect, photo sensors,Strain gauge, LVDT, differential pressure transducer,optical and digital transducers, Smart sensors, Thermal Imagers.

OUTCOMES :
After completing this course, the students will be able to
- CO1: Compute the electric circuit parameters for simple problems
- CO2: Explain the concepts of domestics wiring and protective devices
- CO3: Explain the working principle and applications of electrical machines
- CO4: Analyze the characteristics of analog electronic devices
- CO5: Explain the types and operating principles of sensors and transducers

TEXT BOOKS:
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1-Low, 2-Medium, 3-High,”-“-no correlation
Note: the average value of this course to be used for program articulation matrix.

GE3251 ENGINEERING GRAPHICS

COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for:
   i. Drawing engineering curves.
   ii. Drawing freehand sketch of simple objects.
   iii. Drawing orthographic projection of solids and section of solids.
   iv. Drawing development of solids
   v. Drawing isometric and perspective projections of simple solids.

CONCEPTS AND CONVENTIONS (Not for Examination)
Importance of graphics in engineering applications — Use of drafting instruments — BIS conventions and specifications — Size, layout and folding of drawing sheets — Lettering and dimensioning.

UNIT I PLANE CURVES
Basic Geometrical constructions, Curves used in engineering practices: Conics — Construction of ellipse, parabola and hyperbola by eccentricity method — Construction of cycloid — construction of involutes of square and circle — Drawing of tangents and normal to the above curves.

UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACE
Orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces. Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT III PROJECTION OF SOLIDS AND FREEHAND SKETCHING
Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes and parallel to the other by rotating object method. Visualization concepts and Free Hand sketching: Visualization principles —Representation of Three Dimensional objects — Layout of views- Freehand sketching of multiple views from pictorial views of objects.
UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES
Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other — obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids — Prisms, pyramids cylinders and cones.

UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS
Principles of isometric projection — isometric scale — Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones - combination of two solid objects in simple vertical positions - Perspective projection of simple solids - Prisms, pyramids and cylinders by visual ray method.

OUTCOMES:
On successful completion of this course, the student will be able to
- Use BIS conventions and specifications for engineering drawing.
- Construct the conic curves, involutes and cycloid.
- Solve practical problems involving projection of lines.
- Draw the orthographic, isometric and perspective projections of simple solids.
- Draw the development of simple solids.

TEXT BOOKS:

REFERENCES:

Special points applicable to University Examinations on Engineering Graphics:
1. There will be five questions, each of either or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size.
4. The examination will be conducted in appropriate sessions on the same day.
CO's, PO's & PSO's MAPPING

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Low (1) ; Medium (2) ; High (3)

1-Low, 2-Medium, 3-High, "-"-no correlation

CH3251  INTRODUCTION TO CHEMICAL ENGINEERING  

OBJECTIVES:
To acquaint the students with the fundamentals of Chemical Engineering and to build their perspective in a wholesome manner

UNIT I  INTRODUCTION
Chemical Engineering in day to day life with examples, Origin and growth of chemical Engineers in chemical process industries, unit operations and unit processes concepts, scaling up or down, units and dimensions, application of mathematics in chemical Engg, recent developments in chemical process industries

UNIT II  INTRODUCTION TO MATERIAL AND ENERGY BALANCES
Basic concepts of material and energy balances, energy and mass transport, and kinetics of chemical reactions. Introduction to heat and mass transfer. Process flow sheeting and symbols.

UNIT III  FLUID FLOW

UNIT IV  CHEMICAL ENGINEERING COMPUTER SOFTWARE TOOLS AND APPLICATIONS
Introduction to Process Engineering Design Software (HYSYS and PRO II), Computations Using Microsoft Excel, Computer-Aided Design & Drafting, Piping and Equipment Design Software

UNIT V  CAREER DIVERSITIES IN CHEMICAL ENGINEERING
Career Development Leading to Specialization, Chemical Engineering Job Titles/Options, Chemical and Process Engineers, Commissioning Engineer, Process Control/Automation Engineer, Process Safety Engineer, Research & Development Engineer Pharmaceutical Engineer/Pharmaceutical Process Engineer, Pipeline Engineer Chemical Manufacturing Engineer, Environment Engineer.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon successful completion of the course, student should be able to:
CO1. Correlate day to day like with the principles of chemical Engineering.
CO2. Assess the mass and energy involved in any chemical plant.
CO3. Have an insight into areas where Chemical Engineering plays major role.
CO4. Carry out modelling and simulation using software tools.
CO5. Identify their right future.
CO6: Gain confidence and outline about the programme as a whole.
**TEXT BOOKS:**

**REFERENCES:**
## Course articulation matrix

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<td>Assess the mass and energy involved in any chemical plant.</td>
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</table>

1, 2, and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
TEXT-CUM-REFERENCE BOOKS

1. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
2. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies).
3. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
4. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
5. Keeladi - ‘Sangam City Civilization on the banks of river Vaigai’ (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

GE3252 TAMILS AND TECHNOLOGY

UNIT I WEAVING AND CERAMIC TECHNOLOGY
Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY
Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

UNIT III MANUFACTURING TECHNOLOGY

UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY
Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.

UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS
1. படிமங்கரை ஓருடன் - மக்களின் வாழ்க்கையில் – க.து.பி. பாணத்துக்குரு (பாணத்துக்குரு பாணத்துக்குரு: கூட்டமிட்டு மட்டும் கூட்டமிட்டும் என்னும் கூட்டமிட்டும்)
2. கல்வித்திக்குச் சேதியில் - மக்களின் வாழ்க்கையில் (சிவநிதீஸ்வரர்).
3. சிற்பம் - கூட்டம் நிதிக்கொண்டு கூட்டாகக் கூட்டாகக் கூட்டாகக் (சிவநிதீஸ்வரர் சிவநிதீஸ்வரர்)
4. விளக்கத்துக்குரு - நூற்றுக்குரு காலத்துக்குரு (சிவநிதீஸ்வரர் சிவநிதீஸ்வரர்)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
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11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

### NCC Credit Course Level 1*

**NX3251**  
**(ARMY WING) NCC Credit Course Level - I**  

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#### NCC GENERAL
- **NCC 1** Aims, Objectives & Organization of NCC  
- **NCC 2** Incentives  
- **NCC 3** Duties of NCC Cadet  
- **NCC 4** NCC Camps: Types & Conduct

#### NATIONAL INTEGRATION AND AWARENESS
- **NI 1** National Integration: Importance & Necessity  
- **NI 2** Factors Affecting National Integration  
- **NI 3** Unity in Diversity & Role of NCC in Nation Building  
- **NI 4** Threats to National Security

#### PERSONALITY DEVELOPMENT
- **PD 1** Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving  
- **PD 2** Communication Skills  
- **PD 3** Group Discussion: Stress & Emotions

#### LEADERSHIP
- **L 1** Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour ‘Code  
- **L 2** Case Studies: Shivaji, Jhasi Ki Rani

#### SOCIAL SERVICE AND COMMUNITY DEVELOPMENT
- **SS 1** Basics, Rural Development Programmes, NGOs, Contribution of Youth  
- **SS 2** Protection of Children and Women Safety  
- **SS 3** Road / Rail Travel Safety  
- **SS 4** New Initiatives  
- **SS 5** Cyber and Mobile Security Awareness

**TOTAL : 30 PERIODS**

### NCC Credit Course Level 1*

**NX3252**  
**(NAVAL WING) NCC Credit Course Level - I**  

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- **NI 3** Unity in Diversity & Role of NCC in Nation Building  
- **NI 4** Threats to National Security

**TOTAL : 30 PERIODS**
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TOTAL: 30 PERIODS

NCC Credit Course Level 1*

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**NATIONAL INTEGRATION AND AWARENESS**

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**PERSONALITY DEVELOPMENT**

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**LEADERSHIP**

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**SOCIAL SERVICE AND COMMUNITY DEVELOPMENT**

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<td>SS 7</td>
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TOTAL: 30 PERIODS
OBJECTIVES:
The main learning objective of this course is to provide hands on training to the students in:

1. Drawing pipe line plan; laying and connecting various pipe fittings used in common household plumbing work; Sawing; planing; making joints in wood materials used in common household wood work.
2. Wiring various electrical joints in common household electrical wire work.
3. Welding various joints in steel plates using arc welding work; Machining various simple processes like turning, drilling, tapping in parts; Assembling simple mechanical assembly of common household equipments; Making a tray out of metal sheet using sheet metal work.
4. Soldering and testing simple electronic circuits; Assembling and testing simple electronic components on PCB.

GROUP – A (CIVIL & ELECTRICAL)

PART I CIVIL ENGINEERING PRACTICES

PLUMBING WORK:
- a) Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and other components which are commonly used in household.
- b) Preparing plumbing line sketches.
- c) Laying pipe connection to the suction side of a pump
- d) Laying pipe connection to the delivery side of a pump.
- e) Connecting pipes of different materials: Metal, plastic and flexible pipes used in household appliances.

WOOD WORK:
- a) Sawing,
- b) Planing and
- c) Making joints like T-Joint, Mortise joint and Tenon joint and Dovetail joint.

Wood Work Study:
- a) Studying joints in door panels and wooden furniture
- b) Studying common industrial trusses using models.

PART II ELECTRICAL ENGINEERING PRACTICES

a) Introduction to switches, fuses, indicators and lamps - Basic switch board wiring with lamp, fan and three pin socket
b) Staircase wiring
c) Fluorescent Lamp wiring with introduction to CFL and LED types.
d) Energy meter wiring and related calculations/calibration
e) Study of Iron Box wiring and assembly
f) Study of Fan Regulator (Resistor type and Electronic type using Diac/Triac/quadrac)
g) Study of emergency lamp wiring/Water heater

GROUP – B (MECHANICAL AND ELECTRONICS)

PART III MECHANICAL ENGINEERING PRACTICES

WELDING WORK:
- b) Practicing gas welding.

BASIC MACHINING WORK:
- a) (simple)Turning.
- b) (simple)Drilling.
- c) (simple)Tapping.
ASSEMBLY WORK:
  a) Assembling a centrifugal pump.
  b) Assembling a household mixer.
  c) Assembling an air conditioner.

SHEET METAL WORK:
  a) Making of a square tray

FOUNDRY WORK:
  a) Demonstrating basic foundry operations.

PART IV ELECTRONIC ENGINEERING PRACTICES

SOLDERING WORK:
  a) Soldering simple electronic circuits and checking continuity.

ELECTRONIC ASSEMBLY AND TESTING WORK:
  a) Assembling and testing electronic components on a small PCB.

ELECTRONIC EQUIPMENT STUDY:
  a) Study an elements of smart phone.
  b) Assembly and dismantle of LED TV.
  c) Assembly and dismantle of computer/ laptop

OUTCOMES:
Upon completion of this course, the students will be able to:
  - Draw pipe line plan; lay and connect various pipe fittings used in common household plumbing work; Saw; plan; make joints in wood materials used in common household wood work.
  - Wire various electrical joints in common household electrical wire work.
  - Weld various joints in steel plates using arc welding work; Machine various simple processes like turning, drilling, tapping in parts; Assemble simple mechanical assembly of common household equipments; Make a tray out of metal sheet using sheet metal work.
  - Solder and test simple electronic circuits; Assemble and test simple electronic components on PCB.

CO’s, PO’s & PSO’s MAPPING

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Low (1) ; Medium (2) ; High (3)

TOTAL : 60 PERIODS

1-Low, 2-Medium, 3-High, "-"-no correlation

BE3272 BASIC ELECTRICAL, ELECTRONICS AND INSTRUMENTATION

ENGINEERING LABORATORY

OBJECTIVES:
  - To train the students in conducting load tests electrical machines
  - To gain practical experience in experimentally obtaining the characteristics of electronic devices and rectifiers
  - To train the students to measure three phase power and displacement
LIST OF EXPERIMENTS
1. Verification of ohms and Kirchhoff’s Laws.
2. Three Phase Power Measurement
3. Load test on DC Shunt Motor.
4. Load test on Self Excited DC Generator
5. Load test on Single phase Transformer
6. Load Test on Induction Motor
7. Characteristics of PN and Zener Diodes
8. Characteristics of BJT, SCR and MOSFET
9. Design and analysis of Half wave and Full Wave rectifiers
10. Measurement of displacement of LVDT

TOTAL: 60 PERIODS

OUTCOMES:
After completing this course, the students will be able to
CO1: Use experimental methods to verify the Ohm’s law and Kirchhoff’s Law and to measure three phase power
CO2: Analyze experimentally the load characteristics of electrical machines
CO3: Analyze the characteristics of basic electronic devices
CO4: Use LVDT to measure displacement

CO’s, PO’s & PSO’s MAPPING

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1-Low,2-Medium,3-High,”-”-no correlation

GE3272 COMMUNICATION LABORATORY

OBJECTIVES
• To identify varied group discussion skills and apply them to take part in effective discussions in a professional context.
• To analyse concepts and problems and make effective presentations explaining them clearly and precisely.
• To be able to communicate effectively through formal and informal writing.
• To be able to use appropriate language structures to write emails, reports and essays
• To give instructions and recommendations that are clear and relevant to the context

UNIT I
Speaking: Role Play Exercises Based on Workplace Contexts, - talking about competition-discussing progress toward goals-talking about experiences- talking about events in life- discussing past events-Writing: writing emails ( formal & semi-formal).

UNIT II
Speaking: discussing news stories-talking about frequency-talking about travel problems- discussing travel procedures- talking about travel problems- making arrangements-describing arrangements-discussing plans and decisions- discussing purposes and reasons- understanding common technology terms-Writing: - writing different types of emails.
UNIT III
12
Speaking: discussing predictions-describing the climate-discussing forecasts and scenarios- talking about purchasing-discussing advantages and disadvantages- making comparisons-discussing likes and dislikes-discussing feelings about experiences-discussing imaginary scenarios Writing: short essays and reports-formal/semi-formal letters.

UNIT IV
12
Speaking: discussing the natural environment-describing systems-describing position and movement-explaining rules-(example-discussing rental arrangements)-understanding technical instructions-Writing: writing instructions-writing a short article.

UNIT V
12
Speaking: describing things relatively-describing clothing-discussing safety issues-making recommendations-talking about electrical devices-describing controlling actions-Writing: job application(Cover letter + Curriculum vitae)-writing recommendations.

TOTAL: 60 PERIODS

LEARNING OUTCOMES
At the end of the course, learners will be able
- Speak effectively in group discussions held in a formal/semi formal contexts.
- Discuss, analyse and present concepts and problems from various perspectives to arrive at suitable solutions.
- Write emails, letters and effective job applications.
- Write critical reports to convey data and information with clarity and precision.
- Give appropriate instructions and recommendations for safe execution of tasks.

Assessment Pattern
- One online/app based assessment to test speaking and writing skills.
- Proficiency certification is given on successful completion of speaking and writing.

CO-PO & PSO MAPPING

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- 1-low, 2-medium, 3-high, "-"- no correlation.
- Note: The average value of this course to be used for program articulation matrix.

MA3356 DIFFERENTIAL EQUATIONS

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UNIT I  ORDINARY DIFFERENTIAL EQUATIONS  9+3
Higher order linear differential equations with constant coefficients – Particular integrals: Operator methods, Method of variation of parameters, Methods of undetermined coefficients– Cauchy’s and Legendre’s linear equations – Simultaneous first order linear equations with constant coefficients .

UNIT II  PARTIAL DIFFERENTIAL EQUATIONS  9+3
Formation of partial differential equations – Singular integrals -- Solutions of standard types of first order partial differential equations - Lagrange’s linear equation -- Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

UNIT III  NUMERICAL METHODS FOR ORDINARY DIFFERENTIAL EQUATIONS  9+3

UNIT IV  FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS  9+3
Laplace and Poisson’s equations in a rectangular region: Five point finite difference schemes, Leibmann’s iterative methods, Dirichlet and Neumann conditions – Laplace equation in polar coordinates: finite difference schemes.

UNIT V  FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL DIFFERENTIAL EQUATION  9+3
Parabolic equations: explicit and implicit finite difference methods, weighted average approximation - Dirichlet and Neumann conditions – First order hyperbolic equations – method of characteristics, different explicit and implicit methods; Wave equation: Explicit scheme- Stability of above schemes.

TOTAL : 60 PERIODS

OUTCOMES:
Upon successful completion of the course, students will be able to:
- Apply various methods of solving differential equation which arise in many application problems.
- Understand how to solve the given standard partial differential equations.
- Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.
- Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.
- Familiar with various methods to solve time dependent partial differential equations.

TEXT BOOKS:

REFERENCES:
CO’s, PO’s & PSO’s MAPPING

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1-Low, 2-Medium, 3-High, "-"-no correlation
COURSE OBJECTIVES:
- To impart knowledge on thermodynamics and thermal engineering power generating units such as engines and theory of machines

UNIT I  LAWS OF THERMODYNAMICS  9
Basic concepts and hints; Zeroth law; First Law of Thermodynamics - Statement and application; Steady flow energy equation-problems- Second law of Thermodynamics – Kelvin - Plank statement and Clausius statement- problems; Limitations; Heat Engine, Refrigerator and Heat Pump, Available energy, Third law of Thermodynamics - Statement.

UNIT II  HEATING AND EXPANSION OF GASES  9
Expressions for work done, Internal energy and heat transfer for Constant Pressure, Constant Volume, Isothermal, Adiabatic and Polytropic processes-Derivations and problems; Free expansion and Throttling process.

UNIT III  AIR STANDARD CYCLES  9
Carnot cycle; Stirlings cycle; Joule cycle; Otto cycle; Diesel cycle; Dual combustion Cycle- Derivations and problems.

UNIT IV  I.C. ENGINES, STEAM AND ITS PROPERTIES AND TEAM  9
Engine nomenclature and classification; SI Engine; CI Engine; Four Stroke cycle, Two stroke cycle; Performance of I.C.Engine; Brake thermal efficiency; Indicated Thermal Efficiency, Specific fuel consumption.
Steam - Properties of steam; Dryness fraction; latent heat; Total heat of wet steam; Dry steam; Superheated steam. Use of steam tables; volume of wet steam, volume of superheated steam; External work of evaporation; Internal energy; Entropy of vapour, Expansion of vapour, Rankine cycle. Steam turbines – Impulse and Reaction types - Principles of operation.

UNIT V  SIMPLE MECHANISM, FLY WHEEL, DRIVES AND BALNCING  9
Definition of Kinematic Links, Pairs and Kinematic Chains; Flywheel-Turning moment Diagram; Fluctuation of Energy. Belt and rope drives; Velocity ratio; slip; Creep; Ratio of tensions; Length of belt; Power Transmitted; gear trains-types. Balancing of rotating masses in same plane; Balancing of masses rotating in different planes.

COURSE OUTCOMES:
On Completion of the course, the students would
- Understand the basic concepts and Laws of thermodynamics and its applications.
- Understand the various processes with its derivation and gaining knowledge of various processes in Chemical Industries
- Understand the various thermodynamic cycles with its derivation
- Understand the thermal engineering equipments like IC engine etc with its performance, and rankine cycle
- Understand the drives used to transmit power from one shaft to another belt drive, chain drive, gear drive etc and flywheel.

TEXT BOOKS

REFERENCES
3. Kothandaraman and Dhomkundwar,“: A course in Thermal Engineering (SI Units)”, Dhanpat
### Course Articulation Matrix

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<tr>
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<td>Understand the thermal engineering equipments like IC engine etc with its performance, and rankine cycle</td>
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<td>Understand the drives used to transmit power from one shaft to another belt drive, chain drive, gear drive etc and flywheel.</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
COURSE OBJECTIVES:

- To impart knowledge on designing the support column, beams, pipelines, storage tanks and reaction columns and tanks after undergoing this course. This is precursor for the study on process equipment design and drawing.

UNIT I  STRESS, STRAIN AND DEFORMATION OF SOLIDS  9

UNIT II  TRANSVERSE LOADING ON BEAMS  9

UNIT III  DEFLECTIONS OF BEAMS  9

UNIT IV  STRESSES IN BEAMS  9

UNIT V  TORSION AND COLUMNS  9
Torsion of circular shafts – derivation of torsion equation (T/J = f_s/R = Cθ/L) – stress and deformation in circular and hollow shafts – stresses and deformation in circular and hollow shafts – stepped shafts – shafts fixed at both ends – stresses in helical springs – deflection of springs – spring constant. Axially loaded short columns – columns of unsymmetrical sections – Euler’s theory of long columns – critical loads for prismatic columns with different end conditions – effect of eccentricity.  

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- Upon completion of the course, the students would be able to
- Understand the basic concepts of stress, strain and deformation of solids
- Understand the concept of transverse loading on statistically deterministic beams and its
- Understand the concept of slope and deflection in beams through Double Integration,
- Understand the stress distribution concept like bending and shear stresses in beams and leaf springs
- Understand the stress and deformation in shafts, analysis of columns by Euler's theory and effect of eccentricity.

TEXT BOOKS:


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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
COURSE OBJECTIVES:
- To enable the students to acquire knowledge on laws of chemistry and its application to solution of mass and energy balance equations for single and network of units and introduce to process simulators.

UNIT I
Base and derived Units - Composition of Mixture and solutions - calculations of pressure, volume and temperature using ideal gas law. Use of partial pressure and pure component volume in gas calculations, applications of real gas relationship in gas calculation.

UNIT II
Stoichiometric principles, Application of material balance to unit operations like distillation, evaporation, crystallisation, drying etc., - Material balance with chemical reaction - Limiting and excess reactants - recycle - bypass and purging - Unsteady state material balances.

UNIT III
Calculation of absolute humidity, molal humidity, relative humidity and percentage humidity - Use of humidity in condensation and drying - Humidity chart, dew point.

UNIT IV
Heat capacity of solids, liquids, gases and solutions, use of mean heat capacity in heat calculations, problems involving sensible heat and latent heats, evaluation of enthalpy, Standard heat of reaction, heats of formation, combustion, solution, mixing etc., calculation of standard heat of reaction - Effect of pressure and temperature on heat of reaction - Energy balance for systems with and without chemical reaction - Unsteady state energy balances.

UNIT V
Determination of Composition by Orsat analysis of products of combustion of solid, liquid and gas fuels - Calculation of excess air from orsat technique, problems on sulphur and sulphur burning compounds - Application of Process simulators in energy and material balance problems.

COURSE OUTCOMES:
On completion of the course, the students would be able to
- Understand the concepts of dimensional consistency and effective application of units and dimensions.
- Analyze a problem statement and balance the material flowing through single and various operations
- Understand the gas behavior and its properties
- Understand general energy balance, simplify and apply to open and closed systems
- Write material and energy balance for unsteady state how material and energy balances are formulated for equation- and modular based flow sheeting codes

TEXT BOOKS:

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<td>CO4</td>
<td>Understand general energy balance, simplify and apply to open and closed systems</td>
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<tr>
<td>CO5</td>
<td>Write material and energy balance for unsteady state how material and energy balances are formulated for equation- and modular based flow sheeting codes</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
COURSE OBJECTIVES:
- To enable the students to acquire a sound knowledge on fluid properties, fluid statics, dynamic characteristics of fluid flow for through pipes and porous medium, flow measurement and fluid machineries

UNIT I
Methods of analysis and description - fluid as a continuum – Velocity and stress field - Newtonian and non-Newtonian fluids – Classification of fluid motion

UNIT II
Fluid statics – basic equation - equilibrium of fluid element – pressure variation in a static fluid - application to manometer – Differential analysis of fluid motion – continuity, equation of motions, Bernoulli equation and Navier-Stokes equation.

UNIT III
The principle of dimensional homogeneity – dimensional analysis, Rayleigh method and the Pi-theorem - non-dimensional action of the basic equations - similitude - relationship between dimensional analysis and similitude - use of dimensional analysis for scale up studies

UNIT IV
Reynolds number regimes, internal flow - flow through pipes – pressure drop under laminar and turbulent flow conditions – major and minor losses; Line sizing; External flows - boundary layer concepts, boundary layer thickness under laminar and turbulent flow conditions- Flow over a sphere – friction and pressure drag - flow through fixed and fluidized beds.

UNIT V
Flow measurement - Constant and variable head meters; Velocity measurement techniques; Types, characteristics and sizing of valves; Classification, performance characteristics and sizing of pumps, compressors and fans

OUTCOME OUTCOMES:
On completion of the course, the students would be able to
- Understand the fundamental properties of fluids, stress-strain relationship in fluids, and its characteristics under static conditions and establish force balance in static systems.
- Apply Bernoulli principle, Navier-Stokes equation and compute pressure variation in static fluid.
- Use of dimensional analysis to derive relationships among process or system variables. Further they would develop dimensionless groups that help in scale-up studies.
- Understand the different types of flow conditions in fixed bed and fluidized beds.
- Describe function of flow metering devices, apply Bernoulli equation to determine the performance of flow-metering devices and also analyze the performance aspects of fluid machinery such as pumps, compressors and valves.

TEXT BOOKS:

REFERENCES:
Course articulation matrix:

<table>
<thead>
<tr>
<th>Statements</th>
<th>PO1</th>
<th>PO2</th>
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<th>PO12</th>
<th>PSO1</th>
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<td>CO1 Understand the fundamental properties of fluids, stress-strain</td>
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<td>relationship in fluids, and its characteristics under static conditions and</td>
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<td>establish force balance in static systems.</td>
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<td>CO2 Apply Bernoulli principle, Navier - Stokes equation and compute</td>
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<td>pressure variation in static fluid.</td>
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<td>CO3 Use of dimensional analysis to derive relationships among process or</td>
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<td>system variables. Further they would develop dimensionless groups that</td>
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<td>help in scale-up studies.</td>
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<td>CO4 Understand the different types of flow conditions in fixed bed and</td>
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<td>fluidized beds.</td>
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<td>CO5 Describe function of flow metering devices, apply Bernoulli equation</td>
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<td>to determine the performance of flow-metering devices and also analyze</td>
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<td>the performance aspects of fluid machinery such as pumps, compressors and</td>
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<td>valves.</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
COURSE OBJECTIVES:
- To impart knowledge on various aspects of production engineering and make the student understand the practical methods of production in a chemical factory.

UNIT I SULFUR, SULFURIC ACID AND CEMENT
Sulfur, Raw materials Sources, Mining and production of Sulfur – Sulfuric acid, Methods of production of Sulfuric acid – Contact process – Chamber process. Cement – properties of Cement – Methods of production – Overall factors for Cement industry.

UNIT II FERTILIZER INDUSTRY
Major Components of Fertilizer industries – Nitrogen industries, ammonia, nitric acid, urea – Phosphorus industries, Phosphoric acid, Single Super Phosphate, DAP, MAP and NPK – Potassium chloride, Potassium Sulphate – Liquid Fertilizers – Bio Fertilizers.

UNIT III PULP, PAPER, SUGAR AND STARCH INDUSTRIES

UNIT IV PETROLEUM AND PETRO CHEMICAL INDUSTRIES

UNIT V FUEL AND INDUSTRIAL GASES

COURSE OUTCOMES:
On completion of the course, the students will be able to

- CO1 : Understand the various unit operations and processes with their symbols
- CO2 : Understand the various chemical reactions involved in the process
- CO3 : Students will know to draw the process Flow sheet and understand the major engineering problems encountered in the processes.
- CO4 : To learn manufacturing processes of organic and Inorganic Chemicals and its applications.
- CO5 : Students will understand the role of chemical Engineering in the process plants

TEXT BOOKS:

REFERENCE:
2. Srikumar Koyikkal, “Chemical Process Technology and Simulation”, PHI Learning Ltd
## Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statements</th>
<th>PO1</th>
<th>PO2</th>
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<th>PS O1</th>
<th>PS O2</th>
<th>PS O3</th>
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</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand the various unit operations and processes with their symbols</td>
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<td>CO2</td>
<td>Understand the various chemical reactions involved in the process</td>
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<tr>
<td>CO3</td>
<td>Students will know to draw the process Flow sheet and understand the major engineering problems encountered in the processes.</td>
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<tr>
<td>CO4</td>
<td>To learn manufacturing processes of organic and Inorganic Chemicals and its applications.</td>
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<tr>
<td>CO5</td>
<td>Students will understand the role of chemical Engineering in the process plants</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
COURSE OBJECTIVES:
The course is aimed to
- Impart practical knowledge in operating IC engines and conduct experiments.
- To make the students understand the test procedures in testing material for engineering applications

LIST OF EXPERIMENTS* 
1. Port timing diagram
2. Valve timing diagram
3. Study of 2,4 stroke I C Engines
4. Load test on 4-stroke petrol engine
5. Performance test on 4-stroke single cylinder diesel engine
6. Performance test on 4-stroke twin cylinder diesel engine
7. Heat balance test on diesel engines
8. Tension test
9. Compression test
10. Deflection test
11. Hardness test (Rockwell and Brinell)
12. Spring test
13. Torsion test
14. Impact test

COURSE OUTCOMES: 
On the completion of the course students are expected to
CO1: Determine Brake power, Indicated power and frictional power of single cylinder diesel engines.
CO2: Determine Brake power, Indicated power and frictional power of twin cylinder diesel engines.
CO3: Determine Brake power, Indicated power and frictional power of single cylinder petrol engines.
CO4: Evaluate the heat distribution from engine and preparing heat balancechart.
CO5: Estimate the engine performance with mechanical loading
CO6: Estimate the PTD and VTD of two and four stroke engines

TOTAL: 45 PERIODS
**Course Articulation Matrix:**

<table>
<thead>
<tr>
<th>Course Outcome</th>
<th>Statements</th>
<th>PO 1</th>
<th>PO 2</th>
<th>PO 3</th>
<th>PO 4</th>
<th>PO 5</th>
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<th>PO 10</th>
<th>PO 11</th>
<th>PO 12</th>
<th>PSO1</th>
<th>PSO2</th>
<th>PSO3</th>
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<td>Determine Brake power, Indicated power and frictional power of single cylinder diesel engines.</td>
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<tr>
<td>CO2</td>
<td>Determine Brake power, Indicated power and frictional power of twin cylinder diesel engines.</td>
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<tr>
<td>CO3</td>
<td>Determine Brake power, Indicated power and frictional power of single cylinder petrol engines.</td>
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<tr>
<td>CO4</td>
<td>Evaluate the heat distribution from engine and preparing heat balance chart.</td>
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<tr>
<td>CO5</td>
<td>Estimate the engine performance with mechanical loading</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
COURSE OBJECTIVES:
• To learn basic principles involved in estimation and characterization of industrially important materials.

Experiments:
I. Soap Analysis
   a. Estimation of total fatty acid
   b. Estimation of percentage alkali content
II. Oil Analysis
   a. Estimation of free acid
   b. Determination of Saponification value
   c. Determination of iodine value
III. Cement Analysis
   a. Estimation of Silica content
   b. Estimation of mixed oxide content
   c. Estimation of calcium oxide content
   d. Estimation of calcium oxide by rapid method
IV. Coal Analysis
   a. Estimation of Sulphur present in coal
   b. Ultimate analysis of coal
   c. Proximate analysis of coal
V. Analysis of Bleaching Powder
   a. Estimation of available chlorine
VI. Analysis of Glycerol
   Estimation of purity of glycerol
VII. Analysis of fuels
   a. Flash point
   b. Fire point
   c. Cloud point
   d. Pour point
   e. Aniline point.
### COURSE OUTCOMES:

<table>
<thead>
<tr>
<th>Course Outcome</th>
<th>Statements</th>
<th>Program Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand the estimation and analysis of Soap.</td>
<td>PO 1  3  3  2  2  2  3  2  3  2  2  3  2  3  2  2  3  3  2  -</td>
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<td>CO2</td>
<td>Understand the estimation and analysis of Cement Analysis</td>
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<tr>
<td>CO3</td>
<td>Understand the estimation and analysis of Coal Analysis</td>
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<tr>
<td>CO4</td>
<td>Understand the estimation and analysis of Analysis of Glycerol</td>
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<tr>
<td>CO5</td>
<td>Understand the estimation and analysis of Analysis of fuels</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVES:

To be proficient in important Microsoft Office tools: MS WORD, EXCEL, POWERPOINT.

- To be proficient in using MS WORD to create quality technical documents, by using standard templates, widely acceptable styles and formats, variety of features to enhance the presentability and overall utility value of content.
- To be proficient in using MS EXCEL for all data manipulation tasks including the common statistical, logical, mathematical etc., operations, conversion, analytics, search and explore, visualize, interlink, and utilizing many more critical features offered.
- To be able to create and share quality presentations by using the features of MS PowerPoint, including: organization of content, presentability, aesthetics, using media elements and enhance the overall quality of presentations.

MS WORD: 10 Hours

Create and format a document
Working with tables
Working with Bullets and Lists
Working with styles, shapes, smart art, charts
Inserting objects, charts and importing objects from other office tools
Creating and Using document templates
Inserting equations, symbols and special characters
Working with Table of contents and References, citations
Insert and review comments
Create bookmarks, hyperlinks, endnotes footnote
Viewing document in different modes
Working with document protection and security
Inspect document for accessibility

MS EXCEL: 10 Hours

Create worksheets, insert and format data
Work with different types of data: text, currency, date, numeric etc.
Split, validate, consolidate, Convert data
Sort and filter data
Perform calculations and use functions: (Statistical, Logical, Mathematical, date, Time etc.,)
Work with Lookup and reference formulae
Create and Work with different types of charts
Use pivot tables to summarize and analyse data
Perform data analysis using own formulae and functions
Combine data from multiple worksheets using own formulae and built-in functions to generate results
Export data and sheets to other file formats
Working with macros
Protecting data and Securing the workbook

MS POWERPOINT: 10 Hours

Select slide templates, layout and themes
Formatting slide content and using bullets and numbering
Insert and format images, smart art, tables, charts
Using Slide master, notes and handout master
Working with animation and transitions
Organize and Group slides
Import or create and use media objects: audio, video, animation
Perform slideshow recording and Record narration and create presentable videos

OUTCOMES:

On successful completion the students will be able to

- Use MS Word to create quality documents, by structuring and organizing content for their day to day technical and academic requirements

TOTAL: 30 PERIODS
• Use MS EXCEL to perform data operations and analytics, record, retrieve data as per
requirements and visualize data for ease of understanding
• Use MS PowerPoint to create high quality academic presentations by including common tables,
charts, graphs, interlinking other elements, and using media objects.

MA3451            TRANSFORM TECHNIQUES

OBJECTIVES:
• To acquaint the students with the concepts of vector calculus which naturally arises
in many engineering problems.
• To introduce Fourier series analysis which is central to many applications in engineering apart
from its use in solving boundary value problems.
• To acquaint the student with Fourier transform techniques used in wide variety of situations.
• To make the students appreciate the purpose of using transforms to create a new domain in
which it is easier to handle the problem that is being investigated.
• To introduce the effective mathematical tools for the solutions of partial differential equations that
model several physical processes and to develop Z transform techniques for discrete time
systems.

UNIT I       VECTOR CALCULUS
Gradient and directional derivative – Divergence and curl – Irrotational and solenoidal vector fields –
Line integral over a plane curve – Surface integral – Area of a curved surface – Volume integral –
Green’s, Gauss divergence and Stoke’s theorems – Verification and applications in evaluating line, 
surface and volume integrals.

UNIT II      FOURIER SERIES
Dirichlet’s conditions – General Fourier series – Odd and even functions – Half range sine series and
cosine series – Root mean square value – Parseval’s identity – Harmonic analysis.

UNIT III     FOURIER TRANSFORMS
Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and
and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval’s
identity.

UNIT IV    LAPLACE TRANSFORMS
Existence conditions – Transforms of elementary functions – Transform of unit step function and unit
impulse function – Basic properties – Shifting theorems – Transforms of derivatives and integrals – Initial
and final value theorems – Inverse transforms – Convolution theorem – Transform of periodic functions
– Application to solution of linear second order ordinary differential equations with constant coefficients.

UNIT V   Z - TRANSFORMS AND DIFFERENCE EQUATIONS
Z-transforms – Elementary properties – Convergence of Z-transforms – Initial and final value theorems
– Inverse Z-transform using partial fraction and Convolution theorem – Formation of difference
equations – Solution of difference equations using Z-transforms.

TOTAL: 60 PERIODS

OUTCOMES
Upon successful completion of the course, students should be able to:
• Calculate grad, div and curl and use Gauss, Stokes and Greens theorems to simplify calculations
of integrals.
• Solve differential equations using Fourier series analysis which plays a vital role in engineering
applications.
• Understand the mathematical principles on transforms and partial differential equations would
provide them the ability to formulate and solve some of the physical problems of engineering.
• Understand the mathematical principles on Laplace transforms and would provide them the
ability to formulate and solve some of the physical problems of engineering.
• Use the effective mathematical tools for the solutions of partial differential equations by using Z
transform techniques for discrete time systems.
TEXT BOOKS

REFERENCES
COURSE OUTCOMES:

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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
COURSE OBJECTIVES:
The course is aimed to enable the students
- Learn and determine mass transfer rates under laminar and turbulent conditions and apply these concepts in the design of humidification columns, dryers and crystallisers.

UNIT I  MOLECULAR DIFFUSION  9
Introduction to mass transfer operations. Molecular diffusion in gases, liquids and solids. Diffusivity measurement and prediction; multi-component diffusion.

UNIT II  CONVective TRANSFER AND INTERPHASE MASS TRANSFER  9
Eddy diffusion, concept of mass transfer coefficients, theories of mass transfer, different transport analogies, application of correlations for mass transfer coefficients, inter phase mass transfer, relationship between individual and overall mass transfer coefficients. NTU and NTP concepts, Stage-wise and differential contractors.

UNIT III  HUMIDIFICATION OPERATIONS  9
Humidification – Equilibrium, humidity chart, adiabatic and wet bulb temperatures; humidification operations; theory and design of cooling towers, dehumidifiers and humidifiers using enthalpy transfer unit concept.

UNIT IV  DRYING  9

UNIT V  CRYSTALLIZATION  9
Crystal geometry. Equilibrium, yield and purity of products, theory of super saturation, nucleation and crystal growth, classification of crystallizers, design of batch crystallizers and continuous crystallizers.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On the completion of the course students are expected to
CO1: Understand the fundamentals, types and mechanism of mass transfer operations
CO2: Understand the theories of mass transfer and the concept of inter-phase mass transfer
CO3: Understand the basics of humidification process and its application
CO4: Understand the concept and mechanism of drying operations
CO5: Understand the concept of crystallization process and identification of suitable crystallizer
And formulate to solve material balances for unit operations such as humidification, drying and crystallization operations...

TEXT BOOKS:

REFERENCES:
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<td>Understand the concept of crystallization process and identification of suitable crystallizer And formulate to solve material balances for unit operations such as humidification, drying and crystallization operations.</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
COURSE OBJECTIVES:
- To impact knowledge in the field of particle size reduction and also construction and working of equipment's used for mechanical operations.

UNIT I PARTICLE CHARACTERIZATION AND MEASUREMENT
General characteristics of solids, different techniques of size analysis- Static - Image analysis and Dynamic analysis - Light scattering techniques, shape factor, surface area determination, estimation of particle size. Advanced particle size analysis techniques. Screening methods and equipment, screen efficiency, ideal and actual screens.

UNIT II PARTICLE SIZE REDUCTION AND SIZE ENLARGEMENT
Laws of size reduction, energy relationships in size reduction, methods of size reduction, classification of equipments, crushers, grinders, disintegrators for coarse, intermediate and fine grinding, power requirement, work index; Advanced size reduction techniques - Nano particle fabrication - Top-down approach - Bottom-up approach. Size enlargement - Importance of size enlargement, principle of granulation, briquetting, palletization, and flocculation. Fundamentals of particle generation.

UNIT III PARTICLE SEPARATION (GAS-SOLID AND LIQUID-SOLID SYSTEM)
Gravity settling, sedimentation, thickening, elutriation, double cone classifier, rake classifier, bowl classifier. Centrifugal separation - continuous centrifuges, super centrifuges, design of basket centrifuges; industrial dust removing equipment, cyclones and hydro cyclones, electrostatic and magnetic separators, heavy media separations, floatation, jigging

UNIT IV FILTRATION AND FILTRATION EQUIPMENTS
Theory of filtration, Batch and continuous filters, Flow through filter cake and filter media, compressible and incompressible filter cakes, filtration equipments - selection, operation and design of filters and optimum cycle of operation, filter aids.

UNIT V MIXING AND PARTICLE HANDLING
Mixing and agitation - Mixing of liquids (with or without solids), mixing of powders, selection of suitable mixers, power requirement for mixing. Storage and conveying of solids - Bunkers, silos, bins and hoppers, transportation of solids in bulk, Powder hazards, conveyer selection, different types of conveyers and their performance characteristics.

TOTAL: 45 PERIODS

COURSE OUTCOME:
On completion of the course, the students will be able to
CO1: Understand and determine various properties of particulates
CO2: Gain Preliminary understanding on Size Reduction and Size Enlargement
CO3: Understand various separation and purification techniques employed in solid particles
CO4: Enhance their knowledge on Filtration Process
CO5: Understand Handling, Storage and Transportation of Solids and Obtain knowledge on various unit operations and their applications

TEXT BOOKS:

REFERENCES:
2. Christie J. Geankoplis, Transport processes and unit operations.
## COURSE ARTICULATION MATRIX

| Course Outcomes | Statements | P O1 | P O2 | P O3 | P O4 | P O5 | P O6 | P O7 | P O8 | P O9 | P O10 | P O11 | P O12 | PSO 1 | PSO2 | PSO 3 |
|-----------------|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO1             | Understand and determine various properties of particulates | 3    | 3    | 3    | 1    | 1    | 1    | -    | 3    | 3    | 3     | 2     | 3     | 1     |       |
| CO2             | Gain Preliminary understanding on Size Reduction and Size Enlargement | 3    | 2    | 2    | 2    | 1    | 1    | -    | 1    | 2    | 2     | 2     | 2     | 3     | 1     |
| CO3             | Understand various separation and purification techniques employed in solid particles | 3    | 2    | 2    | 3    | 3    | 1    | 3    | 2    | 1    | 2     | 3     | 2     | 3     | 3     |
| CO4             | Enhance their knowledge on Filtration Process | 2    | 2    | 2    | 1    | 1    | 1    | 2    | 1    | 1    | 1     | 1     | 1     | 2     | 1     |
| CO5             | Understand Handling, Storage and Transportation of Solids and Obtain knowledge on various unit operations and their applications | 2    | 2    | 3    | 2    | 1    | 2    | 3    | 1    | 1    | 2     | 2     | 1     | 1     | 3     |
| OVERALL CO      |            | 3    | 3    | 3    | 2    | 2    | 3    | 1    | 2    | 2    | 3     | 3     | 3     | 3     | 2     |

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
COURSE OBJECTIVES:
The course is aimed to enable the students to

- Learn PVT behaviour of fluids, laws of thermodynamics, thermodynamic property relations and their application to fluid flow, power generation and refrigeration processes.

UNIT I
Terminologies of thermodynamics, the variables and quantities of thermodynamics, characteristics of systems and processes, energy classifications, point and path functions, energy in transition work and heat. Zeroth law; temperature scales

UNIT II
The first law of thermodynamics, statements of first law for the flow and non-flow processes. PVT behaviour of fluids; Mathematical representation of PVT behaviour; generalized compressibility factor correlation; generalized equations of state

UNIT III
Joule’s experiment, energy balance for closed systems, mass and energy balance for open systems, Statements of the second law of thermodynamics, heat engine and refrigerator, Carnot theorems, thermodynamic temperature scale, entropy and its calculation, second law of thermodynamics for a control volume, Third law of thermodynamics, entropy from a microscopic point of view.

UNIT IV
Thermodynamic properties – internal energy, enthalpy, Helmholtz free energy, Gibbs free energy; thermodynamic property relations – Maxwell relations – partial derivatives and Jacobian method; residual properties; thermodynamic property tables and diagrams.

UNIT V
Thermodynamic aspects of compression, expansion processes and duct flow of compressible fluids, steam power plant.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On the completion of the course students are expected to

CO1: Understand the fundamental concepts of thermodynamics and its related functions
CO2: Relate PVT behaviour of fluids and understand the real gas behavior
CO3: Apply second law and analyse the feasibility of system/devices
CO4: Analyse the thermodynamic property relations and their application to fluid flow
CO5: Develop the significance of thermodynamic potentials and their use in the analysis of processes and formulate thermodynamic formulations and the working of compressors and expanders

TEXT BOOKS:

REFERENCES:
## COURSE ARTICULATION MATRIX

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<tr>
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<td>Apply second law and analyse the feasibility of system/devices</td>
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<td>Analyse the thermodynamic property relations and their application to fluid flow</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
CHAPTER 1

1.4 B.K. Dutta, Heat transfer principles and applications, PHI Learning


REFERENCES:


COURSE OBJECTIVES:
The course is aimed to
- Teach the fundamental concepts of heat transfer viz., conduction, convection, radiation, boiling and condensation and its application to the students

UNIT I
Importance of heat transfer in Chemical Engineering operations - Modes of heat transfer ; One dimensional steady state heat conduction through plane and composite walls, hollow cylinder and spheres - Thermal conductivity measurement-effect of temperature on thermal conductivity; Heat transfer in extended surfaces; Transient heat conduction

UNIT II
Concepts of heat transfer by convection - Natural and forced convection, Hydrodynamic and thermal Boundary layers; analogies between transfer of momentum and heat - Reynold’s analogy, Prandtl and Colburn analogy. Dimensional analysis in heat transfer, heat transfer coefficient for flow through a pipe, flow past flat plate.

UNIT III
Heat Exchangers – classification and design, overall and individual film coefficients, mean temperature difference, LMTD correction factor for multiple pass exchanger, NTU and efficiency of Heat exchangers

UNIT IV
Heat transfer to fluids with phase change - heat transfer from condensing vapours, drop wise and film wise condensation, Nusselt equation for vertical and horizontal tubes, condensation of superheated vapours, Heat transfer to boiling liquids - mechanism of boiling, nucleate boiling and film boiling

UNIT V
Evaporation- single and multiple effect operation, material and Energy balance in evaporators, boiling point elevation, Dühring’s rule. Radiation heat transfer - Black body radiation, Emissivity, Stefan - Boltzman law, Plank’s law, radiation between surfaces.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On the completion of the course students are expected to

CO1: Familiarize the students with the fundamental concepts of Heat Transfer. provide the student with knowledge about heat transfer by conduction in solids for steady state.

CO2: Understand convective heat transfer and use of heat transfer coefficients for laminar and turbulent flows

CO3: Students will be able to calculate and use overall heat transfer coefficients in designing heat exchangers

CO4: The course provides the student with knowledge about heat transfer with phase change (boiling and condensation) and evaporation

CO5: Students will understand radiative heat transfer including blackbody radiation and Kirchhoff’s law, and will be able to solve radiative problems apply knowledge of heat transfer to solve thermal engineering problems

TEXT BOOKS:


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## COURSE ARTICULATION MATRIX

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<td>familiarize the students with the fundamental concepts of Heat Transfer. provide the student with knowledge about heat transfer by conduction in solids for steady state.</td>
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<td>understand convective heat transfer and use of heat transfer coefficients for laminar and turbulent flows</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVES:

- To introduce the basic concepts of environment, ecosystems and biodiversity and emphasize on the biodiversity of India and its conservation.
- To impart knowledge on the causes, effects and control or prevention measures of environmental pollution and natural disasters.
- To facilitate the understanding of global and Indian scenario of renewable and nonrenewable resources, causes of their degradation and measures to preserve them.
- To familiarize the concept of sustainable development goals and appreciate the interdependence of economic and social aspects of sustainability, recognize and analyze climate changes, concept of carbon credit and the challenges of environmental management.
- To inculcate and embrace sustainability practices and develop a broader understanding on green materials, energy cycles and analyze the role of sustainable urbanization.

UNIT I

ENVIRONMENT AND BIODIVERSITY


UNIT II

ENVIRONMENTAL POLLUTION


UNIT III

RENEWABLE SOURCES OF ENERGY

Energy management and conservation, New Energy Sources: Need of new sources. Different types new energy sources. Applications of- Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.

UNIT IV

SUSTAINABILITY AND MANAGEMENT

Development, GDP, Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainable to sustainability-millennium development goals, and protocols- Sustainable Development Goals-targets, indicators and intervention areas Climate change- Global, Regional and local environmental issues and possible solutions-case studies. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry-A case study.

UNIT V

SUSTAINABILITY PRACTICES


TOTAL: 30 PERIODS

OUTCOMES:

- To recognize and understand the functions of environment, ecosystems and biodiversity and their conservation.
- To identify the causes, effects of environmental pollution and natural disasters and contribute to the preventive measures in the society.
- To identify and apply the understanding of renewable and non-renewable resources and contribute to the sustainable measures to preserve them for future generations.
- To recognize the different goals of sustainable development and apply them for suitable technological advancement and societal development.
- To demonstrate the knowledge of sustainability practices and identify green materials, energy cycles and the role of sustainable urbanization.
TEXT BOOKS:
5. Bradley, A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning.

REFERENCE BOOKS:

CO-PO & PSO MAPPING

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Avg. 2.8

1-low, 2-medium, 3-high, " "- no correlation

NCC Credit Course Level 2*

NX3451

(ARMY WING) NCC Credit Course Level - II

PERSONALITY DEVELOPMENT
PD 3 Group Discussion: Change your mindset, Time Management, Social Skills 6
PD 5 Public Speaking 3

LEADERSHIP
L 2 Case Studies: APJ Abdul Kalam, Deepa Malik, Maharana Pratap, N Narayan Murty, Ratan Tata, Rabindra Nath Tagore, Role of NCC cadets in 1965 7

DISASTER MANAGEMENT
DM 1 Disaster Management Capsule: Organisation, Types of Disasters, Essential Services, Assistance, Civil Defence Organisation 3
DM 2 Initiative Training, Organising Skills, Do's & Don’ts, Natural Disasters, Man Made Disasters 9
DM 3 Fire Service & Fire Fighting 1
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<tr>
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**TOTAL: 45 PERIODS**

**NCC Credit Course Level 2* (NAVAL WING) NCC Credit Course Level - II**

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<th>COURSE</th>
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<td>PERSONALITY DEVELOPMENT</td>
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<td>L 2 Case Studies: APJ Abdul Kalam, Deepa Malik, Maharana Pratap, N Narayan Murty, Ratan Tata, Rabindra Nath Tagore, Role of NCC cadets in 1965</td>
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<td>DISASTER MANAGEMENT</td>
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<td>DM 1 Disaster Management Capsule: Organisation, Types of Disasters, Essential Services, Assistance, Civil Defence Organisation</td>
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<td>DM 2 Initiative Training, Organising Skills, Do's &amp; Don't's, Natural Disasters, Man Made Disasters</td>
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<td>GA 1 General Knowledge</td>
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<td>AF 1 Armed Forces and Navy Capsule</td>
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<td>EEZ 1 EEZ Maritime Security and ICG</td>
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PD 5  Public Speaking 6

LEADERSHIP
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DISASTER MANAGEMENT
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DM 3  Fire Service & Fire Fighting 1

ENVIRONMENTAL AWARENESS & CONSERVATION
EA 1  Environmental Awareness and Conservation 3

GENERAL AWARENESS
GA 1  General Knowledge 4

GENERAL SERVICE KNOWLEDGE
GSK 1  Armed Forces & IAF Capsule 2
GSK 2  Modes of Entry in IAF, Civil Aviation 2
GSK 3  Aircrafts - Types, Capabilities & Role 2

ADVENTURE
AD 1  Introduction to Adventure Activities 1

BORDER & COASTAL AREAS
BCA 1  History, Geography & Topography of Border/Coastal areas 2

TOTAL: 45 PERIODS

CH3411  FLUID MECHANICS LABORATORY

COURSE OBJECTIVES:
- To enable the students to learn experimentally to calibrate flow meters, find pressure loss for fluid flows and determine pump characteristics.

LIST OF EXPERIMENTS
1. Viscosity measurement of non-Newtonian fluids
2. Calibration of constant and variable head meters
3. Calibration of weirs and notches
4. Open drum orifice and draining time
5. Flow through straight pipe
6. Flow through annular pipe
7. Flow through helical coil and spiral coil
8. Losses in pipe fittings and valves
9. Characteristic curves of pumps (Centrifugal / Gear / Reciprocating)
10. Pressure drop studies in packed column
11. Hydrodynamics of fluidized bed
12. Drag coefficient of solid particle
"Minimum 10 experiments shall be offered"

**COURSE OUTCOMES:**
On completion of the course, the students would be able to

CO1 Identify and characterize of flow patterns and regimes
CO2 Calibrate flow measurement devices
CO3 Correlate the difference between fixed and fluidized bed columns and its application.
CO4 Select pumps for the transportation of fluids based on process conditions/requirements and fluid properties
CO5 Compare the results of theoretical analytical models to the actual behavior of real fluid flows and draw sustainable conclusions

**Course Articulation Matrix:**

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<th>Course Outcomes</th>
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<td>Calibrate flow measurement devices</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
COURSE OBJECTIVES:
The course is aimed to
• Develop sound practical knowledge on different types of mechanical operations equipments.

LIST OF EXPERIMENTS*
1. Sieve analysis
2. Batch filtration studies using a Leaf filter
3. Batch filtration studies using a Plate and Frame Filter press
4. Characteristics of batch Sedimentation
5. Reduction ratio in Jaw Crusher
6. Reduction ratio in Ball mill
7. Separation characteristics of Cyclone separator
8. Reduction ratio of Roll Crusher
9. Separation characteristics of Elutriator
10. Reduction ratio of Drop weight crusher
11. Size separation using Sub-Sieving

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On the completion of the course students are expected to
CO1: Determine the size analysis in solid- solid separation systems
CO2: Capability to select different solid - fluid separation equipments.
CO3: Evaluate the size reduction and various crushing parameters
CO4: Estimate the separation characteristics
CO5: Understand the technical methods related to unit operations in process plant

Course Articulation Matrix:

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OVERALL CO

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVES:
To enable the students to
• Get connected with industry/ laboratory/research institute
• Get practical knowledge on production process in the industry and develop skills to solve related problems
• Develop skills to carry out research in the research institutes/laboratories

The students individually undergo training in reputed firms/ research institutes / laboratories for the specified duration. After the completion of training, a detailed report should be submitted within ten days from the commencement of next semester. The students will be evaluated as per the Regulations.

OUTCOMES:
On completion of the course, the student will know about
CO1: Plant layout, machinery, organizational structure and production processes in the firm or research facilities in the laboratory/research institute
CO2: Analysis of industrial / research problems and their solutions
CO3: Documenting of material specifications, machine and process parameters, testing parameters and results
CO4: Preparing of Technical report and presentation

UNIT I SOLUTION THERMODYNAMICS 6
Partial molar properties, ideal and non-ideal solutions, standard states definition and choice, Gibbs-Duhem equation, excess properties of mixtures, pure species and liquids.

UNIT II PHASE EQUILIBRIA 12
Phase equilibrium in ideal solution, excess Gibbs free energy models, Henry’s law, fugacity, Phase diagrams for homogeneous systems and for systems with a miscibility gap, effect of temperature and pressure on azeotrope composition, liquid-liquid equilibrium, ternary liquid-liquid equilibrium.

UNIT III CORRELATION AND PREDICTION OF PHASE EQUILIBRIA 12
Vapor-Liquid Equilibrium at low, moderate and high pressures; bubble and dew point calculation, thermodynamic consistency test of VLE data

UNIT IV CHEMICAL REACTION EQUILIBRIA 9
Chemical Reaction Equilibrium of single and multiple reactions, Standard Gibbs free change, equilibrium constant-effect of temperature; homogeneous gas and liquid phase reactions.

UNIT V REFRIGERATION 6

TOTAL: 45 PERIODS

OUTCOMES:
On the completion of the course students are expected to
CO1: Understand the systematic development of new class of properties to describe real mixtures
CO2: Develop the idea of chemical potential to derive the idea of phase equilibria
CO3: Understand the relationship connecting T, P and composition originating from the concept of
chemical potential and fugacity coefficient

CO4: Understand the principle of chemical reaction thermodynamics for the prediction of equilibrium conversion.

CO5: Analyze the ideal and actual vapor-compression refrigeration cycle and Evaluate the performance of Liquefaction processes

TEXT BOOKS:

REFERENCES

COURSE ARTICULATION MATRIX

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OVERALL CO 3 3 3 3 3 - - - - - 3 3 3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE:
The course is aimed to
- Impart knowledge on how certain substances undergo the change in composition, change in phases and exhibit their properties according to the changed environment. Also, to design absorber and stripper, distillation column, extraction and leaching equipment and adsorber.

UNIT I  ABSORPTION  9
Equilibrium and operating line concept in absorption calculations; types of contactors, design of packed and plate type absorbers; Operating characteristics of stage wise and differential contactors, concepts of NTU, HTU and overall volumetric mass transfer coefficients; multicomponent absorption; mechanism and model of absorption with chemical reaction; thermal effects in absorption process.

UNIT II  DISTILLATION  9
Vapour liquid equilibria - Raoult's law, vapor-liquid equilibrium diagrams for ideal and non-ideal systems, enthalpy concentration diagrams. Principle of distillation - flash distillation, differential distillation, steam distillation, multistage continuous rectification, Number of ideal stages by McCabe - Thiele method and Ponchan - Savart method, Total reflux, minimum reflux ratio, optimum reflux ratio. Introduction to multi-component distillation, azeotropic and extractive distillation

UNIT III  LIQUID-LIQUID EXTRACTION  9
Liquid - liquid extraction - solvent characteristics-equilibrium stage wise contact calculations for batch and continuous extractors- differential contact equipment-spray, packed and mechanically agitated contactors and their design calculations-packed bed extraction with reflux. Pulsed extractors, centrifugal extractors-Supercritical extraction

UNIT IV  LEACHING  9
Solid-liquid equilibria- leaching equipment for batch and continuous operations, calculation of number of stages - Leaching - Leaching by percolation through stationary solid beds, moving bed leaching, counter current multiple contact (shank's system), equipments for leaching operation, multi stage continuous cross current and countercurrent leaching, stage calculations, stage efficiency.

UNIT V  ADSORPTION, ION EXCHANGE AND MEMBRANE SEPARATION PROCESSES  9
Adsorption - Types of adsorption, nature of adsorbents, adsorption equilibria, effect of pressure and temperature on adsorption isotherms, Adsorption operations - stage wise operations, steady state moving bed and unsteady state fixed bed adsorbers, break through curves. Principle of Ion exchange, techniques and applications. Solid and liquid membranes; concept of osmosis; reverse osmosis; electro dialysis; ultrafiltration.

TOTAL: 45 PERIODS

OUTCOMES:
On the completion of the course students are expected to

CO1: Understand concept and determine the theoretical stages, number of transfer units and height requirements for a gas absorption process.

CO2: Identify the suitable distillation techniques, determine the number of trays for stage wise contact and determine the height of the packed tower.

CO3: Apply the ternary equilibrium diagram concepts to determine the number of stages required for separation of liquid-liquid extraction process.

CO4: Describe core principles of leaching, setting up mass balances, use graphical methods to estimate the number of ideal stages in leaching operation.

CO5: Understand the concept of adsorption techniques, various isotherms and ion exchange Process and Formulate to solve mass and energy balances for unit operations such as absorption, distillation, extraction, leaching, adsorption and other separation processes.

TEXT BOOKS:

REFERENCES:

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<td>CO4</td>
<td>Describe core principles of leaching, setting up mass balances, use graphical methods to estimate the number of ideal stages in leaching operation</td>
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<td>Understand the concept of adsorption techniques, various isotherms and ion exchange Process and Formulate to solve mass and energy balances for unit operations such as absorption, distillation, extraction, leaching, adsorption and other separation processes</td>
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OVERALL CO: 3 3 2 - - 1 1 1 - 1 - 3 3 2 2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE:
The course is aimed to

- Solve chemical engineering problems form core courses using Excel, MATLAB, Polymath / problem solving software tool and chemical process simulation software tool.

Suggested Exercises
1. Friction factor, pressure drop, minimum fluidization velocity calculations
2. Settling velocity, drag coefficient, Reynolds number estimations
3. Equation of state, activity coefficient, VLE data, equilibrium conversion calculations
4. Empirical equation in fluid flow, heat and mass transfer operations
5. Solving a simple flow sheet by simultaneous approach
6. One, two and three dimensional heat conduction equations
7. Differential equation for reactors in series, non isothermal reactors, dispersion models, gravity tank
8. Partial differential equation involved in heat transfer, mass transfer, reaction engineering
9. First order and second order system in control system
10. Simulation of heat exchangers, Distillation, Absorber, Extraction column, reactors.
11. Simulation of process plant/simple flow sheet

Specific examples
1. Solving chemical Engineering Numerical problems (fluid flow, mechanical operations, heat transfer, mass transfer, thermodynamics and reaction Engineering problems) using Goal seek, solver, Regression function of Microsoft office Excel.
2. Solve simultaneous equation in chemical engineering by Matrix method using Microsoft office Excel.
4. Solving simultaneous equations, linear and non linear equations and differential equations in Chemical Engineering using problem solving software tool/Polymath.
5. Solving Simultaneous equations, Differential equations and Partial differential Equations in Chemical Engineering using MATLAB.
6. Apply MATLAB Simulink tool to simulate Chemical process control systems with suitable examples.
7. Predictions thermodynamics properties using PROCESS SIMULATION SOFTWARE TOOL.
8. Steady state simulation of Heat Exchanger using PROCESS SIMULATION SOFTWARE TOOL.
9. Steady state simulation of different types of Reactor using PROCESS SIMULATION SOFTWARE TOOL.
10. Steady state simulation of Distillation Column using PROCESS SIMULATION SOFTWARE TOOL.
11. Steady state simulation of an Absorption column using PROCESS SIMULATION SOFTWARE TOOL.
12. Dynamic simulation of Heat Exchanger using PROCESS SIMULATION SOFTWARE TOOL.
13. Dynamic simulation of different types of Reactor using PROCESS SIMULATION SOFTWARE TOOL.
14. Dynamic simulation of Distillation Column using PROCESS SIMULATION SOFTWARE TOOL.

OUTCOMES:
On the completion of the course students are expected to

CO1: Solving chemical engineering problems using different tools available in the excel software.
CO2: Solving simultaneous equation and differential equation using polymath.
CO3: Solving simultaneous equation and differential equation using Matlab.
CO4: Simulation of simple chemical process with controller using simulink tool.
CO5: Estimation of fluid property and understand the unit operation simulation using process simulation tool.
TEXT BOOKS

REFERENCES
1. Pradeep Ahuja Introduction to Numerical Methods in Chemical Engineering PHI New delhi, 2010
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE:
The course is aimed to
- Develop sound practical knowledge for students on different types of heat transfer equipments

LIST OF EXPERIMENTS*
1. Measurement of Thermal Conductivity of metal rod
2. Performance studies on Cooling Tower
3. Batch drying kinetics using Tray Dryer
4. Heat transfer in Open Pan Evaporator
5. Boiling Heat Transfer
6. Heat Transfer through Packed Bed
7. Heat Transfer in a Double Pipe Heat Exchanger
8. Heat Transfer in a Bare and Finned Tube Heat Exchanger
9. Heat Transfer in a Vertical and Horizontal Condenser
10. Heat Transfer in Helical Coils
11. Heat Transfer in Agitated Vessels
12. Heat transfer studies in Stefan - Boltzmann apparatus

OUTCOMES:
On the completion of the course students are expected to

CO1: Apply the concepts of heat transfer and fluid dynamics to the operation of heat transfer equipments.

CO2: Estimate the heat transfer rate and heat transfer co-efficient

CO3: To perform heat transfer operation and to compare observed with predicted performance.

CO4: Evaluate the performance/calculate the parameters in heat transfer equipments.

CO5: Collect and analyse the heat transfer data practically and Conduct experiments to solve complex engineering problems effectively as an individual as well as team work
## COURSE ARTICULATION MATRIX:

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<th>Statements</th>
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<td>Collect and analyse the heat transfer data practically and Conduct experiments to solve complex engineering problems effectively as an individual as well as team work</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE:
The course is aimed to
☐ Develop sound practical knowledge for students on different types of mass transfer equipment's

LIST OF EXPERIMENTS*
1. Separation of binary mixture using Simple distillation
2. Separation of binary mixture using Steam distillation
3. Separation of binary mixture using Packed column distillation
4. Measurement of diffusivity
5. Liquid-liquid extraction
6. Drying characteristics of forced draft dryer
7. Adsorption studies
8. Cross current leaching studies
9. Surface evaporation
10. Wetted wall column
11. Solid Liquid mass transfer studies
12. Water purification using ion exchange columns
13. Mass transfer characteristics of Rotating disc contactor
14. Estimation of mass/heat transfer coefficient for cooling tower
15. Demonstration of Gas – Liquid absorption

TOTAL: 45 PERIODS

OUTCOMES:
On the completion of the course students are expected to
CO1: Determine the diffusivity practically and compare the results with the empirical correlations.
CO2: Estimate the mass transfer rate and mass transfer co-efficient
CO3: Evaluate the performance/calculate the parameters in different distillation processes
CO4: Evaluate the performance/calculate the parameters in leaching and extraction operations
CO5: Estimate the drying characteristics
### COURSE ARTICULATION MATRIX:

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<th>Course Outcomes</th>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE:
The course is aimed to
   □ Learn reaction kinetics, types of reactors, design of reactors, understand the isothermal, non-isothermal operation of reactors and gain knowledge about non ideal reactors.

UNIT I
Rate equation, elementary, non-elementary reactions, theories of reaction rate and Prediction; Design equation for constant and variable volume batch reactors, analysis of experimental kinetics data, integral and differential analysis. Half-life calculation. Temperature dependent rate expression.

UNIT II
Ideal reactor classification. Design of continuous reactors - stirred tank and tubular flow reactor, recycle reactors, combination of reactors, and size comparison of reactors.

UNIT III
Design of reactors for multiple reactions - consecutive, parallel and mixed reactions - factors affecting choice, optimum yield and conversion, selectivity, reactivity and yield.

UNIT IV
Non-isothermal homogeneous reactor systems, adiabatic reactors, rates of heat exchanges for different reactors, design for constant rate input and constant heat transfer coefficient, operation of batch and continuous reactors, optimum temperature progression.

UNIT V
The residence time distribution for chemical reactors, residence time functions and relationship between them in reactor; Models for non-ideal reactors, conversion in non-ideal reactors.

TOTAL: 45 PERIODS

OUTCOMES:
On the completion of the course students are expected to
CO1: Understand the kinetics of homogenous reaction.
CO2: Develop performance equation and determine the conversion for different reactors.
CO3: Understand the reactor arrangement in series and parallel configuration.
CO4: Understand the design of reactor for multiple reactions.
CO5: Understand the non-isotherm operation of the reactor and gain knowledge on the residence time distribution function and analyze the non-ideality in the reactor.

TEXT BOOKS:

REFERENCES:
1. L.K Doraiswamy, DenizUner, Chemical Reaction Engineering Beyond the fundamentals, CRC Press, 2013
**COURSE ARTICULATION MATRIX:**

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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE:
The course is aimed to
- Determine possible control objectives, input variables (manipulated variables and disturbances), model the dynamic behavior of a process, design PID controllers, frequency response and analyze stability of closed loop and open loop systems.

UNIT I

UNIT II
Open-loop systems, first order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics; transportation lag, FOPDT Model, Skogestad's rule for FOPDT and SOPDT, Lead-Lag systems

UNIT III
Closed loop control systems, development of block diagram for feed-back control systems, servo and regulatory problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers, control valves, transient response of closed-loop control systems and their stability, Root locus diagram.

UNIT IV
Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, stability criterion, tuning of controller settings, Nyquist Stability Criterion

UNIT V
Introduction to advanced control systems, cascade control, feed forward control, Controllers for Inverse response Smith predictor controller, control of distillation towers and heat exchangers, introduction to computer control of chemical processes.

TOTAL: 45 PERIODS

OUTCOMES:
On the completion of the course students are expected to
CO1: Understand the need to develop mathematical description of a chemical process as a Prerequisite to process design and to control the process.
CO2: Develop transient models for chemical processes using material and/or energy balance equations by incorporating constitutive relationships and seek their solution using Laplace Transforms.
CO3: Represent a physical system using FOPDT model and estimate parameters in FOPDT model.
CO4: Convert a process and instrumentation diagram to a control block diagram
CO5: Understand Frequency response of control systems and tune the PID controllers and appreciate the performance augmentation of PID controllers by using advanced control strategies such as Cascade, Feed forward, Dead time compensation.

TEXT BOOKS:
REFERENCES:
# COURSE ARTICULATION MATRIX

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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
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<td>Study of Battles - Indo Pak War 1965, 1971 &amp; Kargil</td>
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<td>MH 4</td>
<td>Boat Pulling Instructions</td>
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<td>FIRE FIGHTING FLOODING &amp; DAMAGE CONTROL</td>
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<td>FI 1</td>
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<td>AM 1</td>
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<td>Forces acting on Aircraft</td>
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<td>E 1</td>
<td>Introduction and types of Aero Engine</td>
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<td>E 2</td>
<td>Aircraft Controls</td>
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**TOTAL : 45 PERIODS**
OBJECTIVE:
The course is aimed to
- Develop sound practical knowledge for students on different types of reactors.

LIST OF EXPERIMENTS*
1. Kinetic studies in a Batch reactor
2. Kinetic studies in a Plug flow reactor
3. Kinetic studies in a CSTR
4. Kinetic studies in a Packed bed reactor
5. Kinetic studies in a PFR followed by a CSTR
6. RTD studies in a PFR
7. RTD studies in a Packed bed reactor
8. RTD studies in a CSTR
9. Studies on micellar catalysis
10. Study of temperature dependence of rate constant using CSTR.
11. Kinetic studies in Sono chemical reactor
12. Studies on Cascade CSTR
13. Kinetics of photochemical reaction
14. Demonstration of heterogeneous catalytic reaction
15. Demonstration of gas-liquid reaction
16. Kinetics study in Adiabatic reactor
17. Determination of Activation Energy of a reaction
18. Kinetic study in semi batch reactor

TOTAL: 45 PERIODS

OUTCOMES:
On the completion of the course students are expected to
CO1: Determine the rate constant experimentally in a batch reactor.
CO2: Determine the conversion of a reaction in different reactors (batch, CSTR, PFR)
CO3: Study of temperature dependence of rate constant.
CO4: Determine the non-ideal behaviour and residence time distribution in PFR and CSTR.
CO5: Determine the conversion of reactor arranged in series and the rate constant using sono and photo chemical reactors.
COURSE ARTICULATION MATRIX

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statements</th>
<th>PO1</th>
<th>PO2</th>
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<th>PSO2</th>
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<td>Determine the rate constant experimentally in a batch reactor.</td>
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<tr>
<td>CO2</td>
<td>Determine the conversion of a reaction in different reactors (batch, CSTR, PFR)</td>
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<td>CO3</td>
<td>Study of temperature dependence of rate constant.</td>
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<tr>
<td>CO4</td>
<td>Determine the non-ideal behaviour and residence time distribution in PFR and CSTR.</td>
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<tr>
<td>CO5</td>
<td>Determine the conversion of reactor arranged in series and the rate constant using sono and photocatalytic reactors.</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE:
- Students learn to do in detail process and mechanical design and engineering drawing of different chemical engineering equipments

UNIT I
Heat Exchangers, Condensers, Evaporators

UNIT II
Cooling Tower, Dryers

UNIT III
Absorption column, Distillation Column, Extraction Column, Adsorption column

UNIT IV
Packed bed Reactors, Pressure Vessel, Storage Vessel

UNIT V
Design of Plant Layout, Pipe Lines and Pipe Layouts, Schematics and Presentation
Materials of Construction and Selection of process equipments

TOTAL : 45 PERIODS

OUTCOMES:
CO1: Design double pipe and shell and tube heat exchangers according to standards such as BIS, TEMA
CO2: Design Cooling towers and evaporators and design evaporators and crystallizer
CO3: Process and Equipment Design of separation equipments such as absorbers, distillation column, extractors
CO4: Calculate the design specifications of packed bed reactor and storage vessels, bins and silos
CO5: Determine sizes, materials, and capital and operating costs of equipment commonly used in the chemical processing industries and the essential elements of a chemical engineering process (equipment sizes, material & energy balances, economics, environmental, safety)

COURSE ARTICULATION MATRIX:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Program Outcomes</th>
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<tbody>
<tr>
<td>Statements</td>
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<tr>
<td>CO1</td>
<td>Design double pipe and shell and tube heat exchangers according to standards such as BIS, TEMA</td>
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<tr>
<td>CO2</td>
<td>Design Cooling towers and evaporators and design evaporators and crystallizer</td>
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<tr>
<td>CO3</td>
<td>Process and Equipment Design of separation equipments such as absorbers, distillation column, extractors</td>
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### OUTCOMES:

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<th>No.</th>
<th>OUTCOME</th>
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<td>1</td>
<td>Calculate the design specifications of packed bed reactor and storage vessels, bins and silos</td>
</tr>
<tr>
<td>2</td>
<td>Determine sizes, materials, and capital and operating costs of equipment commonly used in the chemical processing industries and the essential elements of a chemical engineering process (equipment sizes, material &amp; energy balances, economics, environmental, safety)</td>
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</table>

**OVERALL CO**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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**CH3712**  
**INDUSTRIAL TRAINING / INTERNSHIP II**

**OBJECTIVES:**

To enable the students to

- Get connected with industry/ laboratory/research institute
- Get practical knowledge on production process in the industry and develop skills to solve related problems
- Develop skills to carry out research in the research institutes/laboratories

The students individually undergo training in reputed firms/ research institutes / laboratories for the specified duration. After the completion of training, a detailed report should be submitted within ten days from the commencement of next semester. The students will be evaluated as per the Regulations.

**No. of Weeks: 02**

**OUTCOMES:**

On completion of the course, the student will know about

- CO1: Plant layout, machinery, organizational structure and production processes in the firm or research facilities in the laboratory/research institute
- CO2: Analysis of industrial / research problems and their solutions
- CO3: Documenting of material specifications, machine and process parameters, testing parameters and results
- CO4: Preparing of Technical report and presentation

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**CH3701**  
**CHEMICAL REACTION ENGINEERING II**

**OBJECTIVE:**

The course is aimed to

- Learn gas solid non catalytic, gas solid catalytic and fluid- fluid reaction and apply the knowledge for the reactor design.

**UNIT I**

Gas solid non catalytic reaction. Reaction kinetics, Shrinking Core Model and Progressive conversion model, Controlling resistances (diffusion through gas film, ash layer and chemical reaction controlling), rate controlling steps; time for Complete Conversion for Single
and Mixed Sizes, design of fluid –particle reactors.

UNIT II  

UNIT III  

UNIT IV  
Diffusion within Catalyst Particle, Mass and Heat Transfer Within Catalyst Pellets, Effectiveness Factor, Thiele Modulus, Effectiveness factor for non isothermal condition.

UNIT V  
Fluid Fluid reaction. Kinetics and design of Fluid- Fluid Reactions. Rate equation, Kinetic regimes for absorption combined with chemical reaction. Various cases of mass transfer with chemical reaction .Factors to select the contactor, Tower Reactor Design.

TOTAL: 45 PERIODS

OUTCOMES:  
On the completion of the course students are expected to  
CO1: Understand the gas solid non catalytic reaction and different models for non catalytic reaction.  
CO2: Understand catalyst, catalyst preparation, property estimation and isotherm study.  
CO3: Understand the gas solid catalytic reaction and their mechanism  
CO4: Design of catalytic reactor for gas solid reaction.  
CO5: Understand the concepts of effectiveness factor, Thiele modulus and the concept of Mass Transfer and Mass transfer with reaction for fluid reaction and tower design

TEXT BOOKS:  

REFERENCES:  
2. L.K Doraiswamy, DenizUner, Chemical Reaction Engineering Beyond the fundamentals, CRC Press , 2013  
### COURSE ARTICULATION MATRIX

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<th>Course Outcomes</th>
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<td>CO1</td>
<td>Understand the gas solid non catalytic reaction and different models for non catalytic reaction.</td>
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<td>CO2</td>
<td>Understand catalyst, catalyst preparation, property estimation and isotherm study</td>
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<td>CO3</td>
<td>Understand the gas solid catalytic reaction and their mechanism</td>
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<td>CO4</td>
<td>Design of catalytic reactor for gas solid reaction.</td>
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<tr>
<td>CO5</td>
<td>Understand the concepts of effectiveness factor, Thiele modulus and the concept of Mass Transfer and Mass transfer with reaction for fluid reaction and tower design</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE:
The course is aimed to
- Describe mass, momentum and energy transport at molecular, microscopic and macroscopic level to determine velocity, temperature and concentration profiles.

UNIT I  MOMENTUM TRANSPORT
Viscosity, temperature and pressure effect on viscosity of gases and liquids, Newton’s law, mechanism of momentum transport, shell momentum balance method, Shear stress and velocity distributions in falling film, circular tube, annulus, slit.

UNIT II  ENERGY TRANSPORT
Thermal conductivity, temperature and pressure effect on thermal conductivity of gases and liquids, Fourier’s law, mechanism of energy transport, shell energy balance method, Energy flux and temperature distribution in solids and laminar flow with electrical, nuclear, viscous, chemical heat source, heat conduction through composite walls, cylinders, spheres, fins, slits.

UNIT III  MASS TRANSPORT
Diffusivity, temperature and pressure effect on diffusivity, Fick’s law, mechanism of mass transport, shell mass balance method, Mass flux and concentration distribution in solids and in laminar flow: stagnant gas film, heterogeneous and homogeneous chemical reaction systems, falling film, porous catalyst.

UNIT IV  EQUATIONS OF CHANGE AND THEIR APPLICATIONS

UNIT V  TRANSPORT IN TURBULENT FLOWS AND ANALOGIES
Comparison of laminar and turbulent flows, time-smoothed equations of change, empirical expressions. Comparison of laminar and turbulent hydrodynamics, thermal and concentration boundary layer and their thicknesses. Development and applications of analogies between momentum, heat and mass transfer.

TOTAL: 45 PERIODS

OUTCOMES:
On the completion of the course students are expected to
CO1: Understand the mechanisms of momentum, heat and mass transfer each at molecular, micro and macro levels.
CO2: Develop mathematical models to determine transfer fluxes and velocity, temperature and concentration distribution for flow channels, heat sources and systems involving diffusion and reactions.
CO3: Determine the interrelationship between the molecular, microscopic and macroscopic descriptions of transport processes and compare the various coordinate systems to formulate equations of change.
CO4: Apply the equation of change for different coordinate systems and solve of momentum, mass and heat transport problems.
CO5: Apply the concepts of dimensional analysis and scale factors for equation of change for different coordinate systems and analyze the analogy between the transports and understand the turbulence and boundary layer concept in heat and mass transport.

TEXT BOOKS:
REFERENCES:

### COURSE ARTICULATION MATRIX:

| Course Outcomes | Statements                                                                 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | P | PSO2 | PSO3 |
|-----------------|-----------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------| |   |      |
| CO1             | Understand the mechanisms of momentum, heat and mass transfer each at molecular, micro and macro levels. | 3   | 2   | 1   | -   | -   | -   | -   | -   | -   | -    | 1    | 3    | 3 | -    |      |
| CO2             | Develop mathematical models to determine transfer fluxes and velocity, temperature and concentration distribution for flow channels, heat sources and systems involving diffusion and reactions. | 3   | 3   | 3   | 2   | 2   | -   | -   | -   | -   | -    | 1    | -    | - | 1    | 3    |
| CO3             | Determine the interrelationship between the molecular, microscopic and macroscopic descriptions of transport processes and compare the various coordinate systems to formulate equations of change | 3   | 3   | 3   | 1   | 1   | -   | -   | -   | -   | -    | 1    | -    | - | 1    | 3    |
| CO4             | Apply the equation of change for different coordinate systems and solve of momentum, mass and heat transport problems. | 3   | 3   | 3   | 2   | 1   | -   | -   | -   | -   | -    | 1    | -    | - | 1    | 3    |
| CO5             | Apply the concepts of dimensional analysis and scale factors for equation of change for different coordinate systems and analyze the analogy between the transports and understand the turbulence and boundary layer concept in heat and mass transport. | 3   | 3   | 3   | 2   | 1   | -   | -   | -   | -   | -    | 1    | -    | - | 1    | 3    |
| OVERALL CO      |                                                                                          | 3   | 3   | 3   | 2   | 1   | -   | -   | -   | -   | 1    | -    | - | 1    | 3    |

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
COURSE DESCRIPTION
This course aims to provide a broad understanding about the modern values and ethical principles that have evolved and are enshrined in the Constitution of India with regard to the democratic, secular and scientific aspects. The course is designed for undergraduate students so that they could study, understand and apply these values in their day to day life.

COURSE OBJECTIVES:
- To create awareness about values and ethics enshrined in the Constitution of India
- To sensitize students about the democratic values to be upheld in the modern society.
- To inculcate respect for all people irrespective of their religion or other affiliations.
- To instill the scientific temper in the students’ minds and develop their critical thinking.
- To promote sense of responsibility and understanding of the duties of citizen.

UNIT I  DEMOCRATIC VALUES  6
Reading Text: Excerpts from John Stuart Mills’ On Liberty

UNIT II  SECULAR VALUES  6
Understanding Secular values – Interpretation of secularism in Indian context - Disassociation of state from religion – Acceptance of all faiths – Encouraging non-discriminatory practices.
Reading Text: Excerpt from Secularism in India: Concept and Practice by Ram Puniyani

UNIT III  SCIENTIFIC VALUES  6
Reading Text: Excerpt from The Scientific Temper by Antony Michaelis

UNIT IV  SOCIAL ETHICS  6
Application of ethical reasoning to social problems – Gender bias and issues – Gender violence – Social discrimination – Constitutional protection and policies – Inclusive practices.
Reading Text: Excerpt from 21 Lessons for the 21st Century by Yuval Noah Harari

UNIT V  SCIENTIFIC ETHICS  6
Transparency and Fairness in scientific pursuits – Scientific inventions for the betterment of society - Unfair application of scientific inventions – Role and Responsibility of Scientist in the modern society.

TOTAL: 30 PERIODS

REFERENCES:
COURSE OUTCOMES

Students will be able to

CO1: Identify the importance of democratic, secular and scientific values in harmonious functioning of social life.
CO2: Practice democratic and scientific values in both their personal and professional life.
CO3: Find rational solutions to social problems.
CO4: Behave in an ethical manner in society.
CO5: Practice critical thinking and the pursuit of truth.

CH3711 PROCESS CONTROL LABORATORY

OBJECTIVE:

- To determine experimentally the methods of controlling the processes including measurements using process simulation techniques.

LIST OF EXPERIMENTS

1. Response of first order system
2. Response of second order system
3. Response of Non-Interacting level system
4. Response of Interacting level system
5. Open loop study on a thermal system
6. Closed loop study on a level system
7. Closed loop study on a flow system
8. Closed loop study on a thermal system
9. Tuning of a level system
10. Tuning of a pressure system
11. Tuning of a thermal system
12. Flow co-efficient of control valves
13. Characteristics of different types of control valves
14. Closed loop study on a pressure system
15. Tuning of pressure system
16. Closed loop response of cascade control system
17. Optimum Controller Tuning using Ziegler Nichols method

*Minimum 10 experiments shall be offered.

TOTAL: 45 PERIODS

OUTCOME:

On completion of the course, the students will be able to

CO1: Able to determine the response of a first order and second order system for various input
CO2: Able to determine the response of an interacting and non-interacting system for various input
CO3: Understand the difference between an open loop and closed loop system
CO4: Understand the concept of three classical controller P, PI, PID controller
CO5: Understand the concept of stability and tuning of a system
## Course Articulation matrix

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statements</th>
<th>PO 1</th>
<th>PO 2</th>
<th>PO 3</th>
<th>PO 4</th>
<th>PO 5</th>
<th>PO 6</th>
<th>PO 7</th>
<th>PO 8</th>
<th>PO 9</th>
<th>PO 10</th>
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<th>P S O 2</th>
<th>P S O 3</th>
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<td>CO1</td>
<td>Able to determine the response of a first order and second order system for various input</td>
<td>3</td>
<td>3</td>
<td>2</td>
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<td>3</td>
<td>1</td>
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<tr>
<td>CO2</td>
<td>Able to determine the response of a interacting and non-interacting system for various input</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
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<td>1</td>
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<td>2</td>
<td>3</td>
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<tr>
<td>CO3</td>
<td>Understand the difference between an open loop and closed loop system</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1</td>
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<td>3</td>
</tr>
<tr>
<td>CO4</td>
<td>Understand the concept of three classical controller P, PI, PID controller</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1</td>
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<td>2</td>
<td>3</td>
</tr>
<tr>
<td>CO5</td>
<td>Understand the concept of stability and tuning of a system</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1</td>
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<td>2</td>
<td>3</td>
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</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

### CH3811 PROJECT WORK / INTERNSHIP

**OBJECTIVES:**
To train the students in
- Identifying problem and developing the structured methodology to solve the identified problem in the industry or research problem at research Institution or college.
- Conducting experiments, analyze and discuss the test results, and make conclusions.
- Preparing project reports and presentation

The students shall individually / or as group work on a specific topic approved by the Department. The student can select any topic which is relevant to his/her specialization of the programme. The student should continue the work on the selected topic as per the formulated methodology. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work, results and discussion, conclusion and references should be prepared as per the format prescribed by the University and submitted to the Head of the department. The students will be evaluated based on the report and viva-voce examination by a panel of examiners as per the Regulations.

**OUTCOMES:**
At the end of the project, the student will be able to
- CO1: Formulate and analyze problem / create a new product/ process.
- CO2: Design and conduct experiments to find solution
- CO3: Analyze the results and provide solution for the identified problem, prepare project report and make presentation.

**TOTAL: 300 PERIODS**
PEC- Petroleum Process Technology

CH3001 PETROLEUM CHEMISTRY AND REFINING FUNDAMENTALS L T P C 3 0 0 3

OBJECTIVE
The course is aimed
1) To enable the students to learn the fundamental and methodologies in the petroleum refining processes.
2) To enable students to examine how each refinery process works
3) To enable students to express the objectives of petroleum refining and classify the processes used in petroleum refining
4) To enable students learn how physical and chemical principles are applied to achieve the objectives of each refinery process

UNIT I CRUDE CHEMISTRY AND PRODUCTS 9
Origin, Formation and Evaluation of Crude Oil - Indian petroleum industries- types of Hydrocarbon -composition of crude oil (PONA,S,N2 etc) -Thermo-physical and physical properties of crude oil- petroleum standards- chemical analysis data- Testing methods of petroleum products-Chemical quality of products-Types of crude-Crude assay- selection of crude based on product yield.

UNIT II BASICS FOR REFINING 9

UNIT III PETROLEUM THERMODYNAMICS AND CALCULATION 9

UNIT IV REFINERY UNIT OPERATIONSAND CALCULATION 9
Distillation-types-column internals-multi component distillation-relative volatility- azeotropic mixture- absorption- desorption- adsorption- refrigeration - extraction- drying curve-humification principle- crystallization-stripping operation-boiling curve- application of all operation in refinery and its basic design calculations.

UNIT V REFINERY PROCESSES AND CATALYST FUNDAMENTAL 9

OUTCOMES:
On completion of the course, the students will be able to
CO1: Understand the classification, composition and testing methods of crude petroleum and its products. Learn the mechanism of refining process.
CO2: Understand the insights of primary treatment processes to produce the precursors.
CO3: Study the secondary treatment processes cracking, vis-breaking and coking to produce more petroleum products.
CO4: Appreciate the need of treatment techniques for the removal of sulphur and other impurities from petroleum products.
CO5: Understand the societal impact of petrochemicals and learn their manufacturing processes and Learn the importance of optimization of process parameters for the high yield of
petroleum products.

TEXT BOOKS
1. Fundamentals of Petroleum Refining, M.A. Fahim, T.A. Al-sahhaf, A.S. Elkilani; Elsevier Science and Technology
3. The Chemistry and technology of Petroleum, James G. Speight, CRC Press, taylor& Francis Group
5. Jean vidal, Thermodynamics Application in chemical Engineering and the petroleum industry, Institute Francaisupetrolepublications,France 2003.

REFERENCES
### COURSE ARTICULATION MATRIX:

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<tr>
<td>CO1</td>
<td>Understand the classification, composition and testing methods of crude petroleum and its products. Learn the mechanism of refining process.</td>
<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO10  PO11  PO12  PSO1  PSO2  PSO3</td>
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<tr>
<td>CO2</td>
<td>Understand the insights of primary treatment processes to produce the precursors.</td>
<td>2  1  1  1  2  1  1  2  1  1  1  1  2  2  1  1</td>
</tr>
<tr>
<td>CO3</td>
<td>Study the secondary treatment processes cracking, vis-breaking and coking to produce more petroleum products.</td>
<td>1  1  2  1  2  1  -  1  1  1  1  1  1  2  1  1</td>
</tr>
<tr>
<td>CO4</td>
<td>Appreciate the need of treatment techniques for the removal of sulphur and other impurities from petroleum products</td>
<td>1  2  2  2  1  1  2  2  2  1  2  1  2  2  2  2</td>
</tr>
<tr>
<td>CO5</td>
<td>Understand the societal impact of petrochemicals and learn their manufacturing processes. Learn the importance of optimization of process parameters for the high yield of petroleum products</td>
<td>1  2  2  1  1  1  1  2  2  -  1  1  2  1  2  2</td>
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<tr>
<td>Overall CO</td>
<td>1  1  2  1  1  1  1  1  2  1  1  1  2  1  1  1</td>
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</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE
The course is aimed

1) To enable the students to learn the methodologies in the primary petroleum refining processes like crude preparation, atmospheric and vacuum distillation, Lube, asphalt and wax processing.
2) To enable students to examine how each refinery process works
3) To enable students learn each operating variables are applied to achieve the objectives of each refinery process

UNIT I FEED PREPARATION 9
Pipelines from port to tank farm - safety and regulations - storage techniques in crude oil - impurities removal - measuring by dipping - spiking techniques - types of salts in crude - desalting process - electric desalter - preheating train and design - furnace and its operation.

UNIT II ATMOSPHERIC DISTILLATION 9
Operation and process description of ADU-design characteristics of ADU tower-cutpoints-degree of fractionation-over flash-column pressure and overhead temperature- Preflash system- overhead system-side streams-intermediate pump around and reflux systems- Refinery off gas - LPG treatment-Naphtha stabilizer and splitter-side stripping sections-operating variables

UNIT III VACUUM DISTILLATION 9
Operation of VDU- Need of vacuum- ejectors and its types/principle- Overhead ejector system- flash zone- draw off temperature- internal flow in VDU- light/middle/heavy cuts- routing to secondary units- lube based treatments-packing section tower loading of VDU

UNIT IV LUBE OIL BASE STOCKS 9
Viscosity index calculation and pour point - LOBS processing by solvent treatment and hydro treatment- solvent selection-solvent extraction by NMP, furfural, MEK solvent dewaxing/- refrigerating and filtration -hydro finishing- types of LOBS based on VI- types or groups of lube processing-spindle/LN/IN/HN/BN processing and blending.

UNIT V ASPHALT AND WAX TECHNOLOGY 9
Vacuum residue properties- propane deasphalting-asphalt processing and types-chemical structure-air blowing of bitumen- slack wax processing- wax and types/properties- wax deoiling-unit operations in wax plants- refrigerating and filtration/ hydro treating of wax- molding and storage

COURSE OUTCOMES:
On completion of the course, the students will be able to

CO1: Understand the methodologies in the primary petroleum refining processes like crude preparation, atmospheric and vacuum distillation, Lube, asphalt and wax processing.
CO2: understand how each refinery process works
CO3: learn the operating variables which are applied to achieve the objectives of each refinery process
CO4: Understand the methodologies of processing and blending
CO5: Apply the concepts in asphalt processing and wax treatment technology

TEXT BOOKS:

TOTAL: 45 PERIODS
5) Fundamentals of Petroleum Refining, M.A. Fahim, T.A. Al-sahhaf, A.S. Elkilani; Elsevier Science and Technology

REFERENCES
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<td></td>
<td></td>
<td>PO1</td>
</tr>
<tr>
<td>CO1</td>
<td>Understand the methodologies in the primary petroleum refining processes like crude preparation, atmospheric and vacuum distillation, Lube, asphalt and wax processing.</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>understand how each refinery process works</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>learn the operating variables which are applied to achieve the objectives of each refinery process</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>Understand the methodologies of processing and blending</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>Apply the concepts in asphalt processing and wax treatment technology</td>
<td>2</td>
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<td>Overall CO</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE
The course is aimed

1. To enable the students to learn the methodologies in the secondary petroleum refining or upgrading processes like thermal cracking, coking, catalytic cracking, hydrocracking, hydro treating, reforming, isomerization, alkylation and sulfur finishing processes.
2. To enable students to learn refinery operation on FCC, Vis breaker, DCU, Reformer, etc. and operation on utilities like steam, cooling water, instrument air, H2, N2 etc.
3. To enable students learn each operating variables of all units.

UNIT I THERMAL CRACKING AND COKING 9

UNIT II CATALYTIC CRACKING 9

UNIT III HYDROGEN AND HYDROCONVERSION 9
H2 requirements-steam reforming and shift conversion-operation and thermodynamics of reformer and NI catalyst-Hydro treatment processes- catalyst and reaction chemistry- Naphtha/Diesel/lube/wax/gasoline hydro treatment-Hydrocracking process- Typical hydrocracker in refinery- catalyst/severity/conversion/Temperature profile for yield pattern-reaction kinetics of hydrocracker- Operation and variables.

UNIT IV REFORMING/ISOMERISATION/ALKYLATION 9

UNIT V FINISHING PROCESSES AND UTILITIES 9
Sources of sulfur in refinery-types of sulfur compounds in crude-sweetening processes- various sulfur treatment process in products-H2S properties and removal by physical and chemical process- Amine selection-amine absorption and regeneration-sour water stripping- Merox process- Sulfur recovery from H2S by Claus /super Claus/ modified Claus technology/SCOT Process/CS2 process; Electricity and steam generation by Gas turbine/boiler-Cooling tower operation-Fuel oil-Cryogenic distillation of air to N2 and O2 production- Instrument air operation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On completion of the course, the students will be able to

CO1 – acquires knowledge on different methodologies in the secondary petroleum refining processes like thermal cracking, coking, catalytic cracking, hydrocracking.
CO2 – understand the operation on FCC, Vis breaker, DCU, Reformer.
CO3 - helps to understand the operation on utilities like steam, cooling water, instrument air, H2, N2.
CO4 – understand the basic knowledge on isomerisation, alkylation and reforming process.
CO5 – gather some knowledge in the finishing processes and their operations in refining industries.
TEXT BOOKS:
5. Fundamentals of Petroleum Refining, M.A. Fahim, T.A. Al-sahhaf, A.S. Elkilani; Elsevier Science and Technology

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<tr>
<td></td>
<td></td>
<td>PO1</td>
</tr>
<tr>
<td>CO1</td>
<td>acquires knowledge on different methodologies in the secondary petroleum refining processes like thermal cracking, coking, catalytic cracking, hydrocracking</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>understand the operation on FCC, Vis breaker, DCU, Reformer.</td>
<td>1</td>
</tr>
<tr>
<td>CO3</td>
<td>helps to understand the operation on utilities like steam, cooling water, instrument air, H2, N2.</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>understand the basic knowledge on isomerisation, alkylation and reforming process.</td>
<td>1</td>
</tr>
<tr>
<td>CO5</td>
<td>gather some knowledge in the finishing processes and their operations in refining industries</td>
<td>1</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE
The course is aimed
- To enable the students to learn the advanced techniques, automation, units integration and instrumentation techniques in refinery.
- To enable students to understand the environmental regulations, safety and government policies on refinery
- To enable students learn the energy saving techniques and refinery economics.

UNIT I  ENVIRONMENTAL REGULATION AND GOVERNMENT POLICIES 9
Classes of petroleum based on flash point- storage tank design- GAS/LIQUID/SOLID wastes form refinery units-environmental standards on air and water pollution and control-Solid waste management- Sludge conditioning and treatment and disposal- Effluent treatment plant-TTP-greenhouse gases-Bharat stages and its regulations- Recent modification for BS-6- Policies on biofuel-EBP-Bio-diesel

UNIT II  CORROSION AND SAFETY 9
Corrosion- reaction and types- refinery corrosion tests- controlling parameters- corrosion control in equipment and pipelines-Types of fire- Safety triangle- Firefighting equipment-PPE- HAZOP studies- Petroleum disasters case study- process safety protocol- pressure relief systems- flare systems- CBD/OWS- MSDS for units- oil spilling and skimming

UNIT III  ADVANCEMENTS IN REFINERY 9
Instrumentation- Flow/pressure/temperature/level transmitter-Control systems and logics – controller types- mode of controllers- cascade, split range, ratio etc. - P/Pi/PID controllers and control tuning-process optimization by APC/DMC- DCS/PLC systems

UNIT IV  REFINERY UNIT INTEGRATION AND RECENT TRENDS 9
.Overall modern refinery flow sheet- products routing- naphtha utilization route up and integration- Diesel/gasoline/ATF/kerosene route up to blending header- Blending processes-line blending- Blending of diesel and MS calculation- LP model for blending operation- Recent trends in ADU with pre flash- RFCC-OHCU-Prime G+-catalytic dewaxing- PSA technology-DWC technology- Blue H2 process-Pre reforming- moving bed in CRU and isom-Advanced lube processing

UNIT V  ENERGY SAVING AND REFINERY ECONOMICS 9

OUTCOMES:
On completion of the course, the students will be able to
CO1 – understanding the regulations and government policies in refining industries.
CO2 – acquire some knowledge on advanced techniques, automation and instrumentation techniques.
CO3 – understand the different controllers and automated control systems in refineries.
CO4 – gathers knowledge on unit integrations in refineries.
CO5 – understand the basis on energy saving techniques and refinery economics

TEXTBOOKS:
3. Fundamentals of Petroleum Refining, M.A. Fahim, T.A. Al-sahhaf, A.S. Elkilani; Elsevier Science and Technology

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<tbody>
<tr>
<td>CO1</td>
<td>understanding the regulations and government policies in refining industries.</td>
<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO10  PO11  PO12  PSO1  PSO2  PSO3</td>
</tr>
<tr>
<td>CO2</td>
<td>acquire some knowledge on advanced techniques, automation and instrumentation techniques</td>
<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO10  PO11  PO12  PSO1  PSO2  PSO3</td>
</tr>
<tr>
<td>CO3</td>
<td>understand the different controllers and automated control systems in refineries.</td>
<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO10  PO11  PO12  PSO1  PSO2  PSO3</td>
</tr>
<tr>
<td>CO4</td>
<td>gathers knowledge on unit integrations in refineries.</td>
<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO10  PO11  PO12  PSO1  PSO2  PSO3</td>
</tr>
<tr>
<td>CO5</td>
<td>understand the basis on energy saving techniques and refinery economics.</td>
<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO10  PO11  PO12  PSO1  PSO2  PSO3</td>
</tr>
<tr>
<td>Overall CO</td>
<td></td>
<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO10  PO11  PO12  PSO1  PSO2  PSO3</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE:
- To study and analyze suitable equipment for particular reservoir conditions.

UNIT I
Casing program, casing and tubing design, principles of cementing, completion added skin, well perforating, hydraulic fracturing. DRILL BIT DESIGN. ROLLER CONE BITS. PDC DRILL BITS. NOMENCLATURE AND IADC CODES for drill bits. BHA (Bottom hole assembly). ESP (Electrical submersible pumps). SRP (Sucker rod pumping) unit design.

UNIT II
Design of Surface Facilities - Design of production and processing equipment, including separation problems, treating, and transmission systems.

UNIT III
Capstone design in the areas of geology, reservoir engineering, production, drilling and well completions to practical design problems based on real field data with all of the associated shortcomings and uncertainties. Use of commercial software.

UNIT IV

UNIT V
Refinery Equipment Design-atmospheric distillation column Design and construction of on/ offshore pipelines, Fields Problems in pipeline, Hydrates, scaling & wax etc and their mitigation.

OUTCOME:
On completion of the course, the students will be able to
- CO1 Understand the drill bit fundamentals, codes and standards
- CO2 Understand design of production and processing equipment
- CO3 Understand the Capstone design in reservoir engineering.
- CO4 Understand the design of Oil and Gas Treatment Equipment
- CO5 Understand the design of pipe systems.

TEXT BOOKS:
1. Petroleum Exploration Hand Book by Moody, G.B.
2. Wellsite Geological Techniques for petroleum Exploration by Sahay.B et al

REFERENCE:
Course Articulation matrix:

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<td>CO1</td>
<td>Understand the drill bit fundamentals, codes and standards</td>
<td>P O 1 P O 2 P O 3 P O 4 P O 5 P O 6 P O 7 P O 8 P O 9 P O 10 P O 11 P O 12 P S O 1 P S O 2 P S O 3 P S O 4</td>
</tr>
<tr>
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<td></td>
<td>3 2 2 - 2 - 2 - 2 - 2 - - 3 - 3 - - - 2</td>
</tr>
<tr>
<td>CO2</td>
<td>Understand design of production and processing equipment.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 2 3 3 2 - 3 - - - - - - - 3 - 2 2</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand the Capstone design in reservoir engineering.</td>
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<tr>
<td></td>
<td></td>
<td>3 2 3 - 2 2 - 2 - 2 - - 3 1 - - 3</td>
</tr>
<tr>
<td>CO4</td>
<td>Understand the design of Oil and Gas Treatment Equipment</td>
<td></td>
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<tr>
<td></td>
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<td>3 2 3 2 - - 3 - - - - 1 - 3 - - 2</td>
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<tr>
<td>CO5</td>
<td>Understand the design of pipeline systems.</td>
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<td>3 3 3 - 3 2 - - - - - - - 3 - - 3</td>
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<td>Overall CO</td>
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<td>3 2 3 2 2 - 2 2 - 2 3 - 3 1 2 2</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE
The course is aimed
- To enable the students to learn the operation and methodologies in petrochemical industries
- To enable students to learn the application of petrochemicals in all process fields
- To enable students learn each products of petrochemical industries and its application with production techniques in detail.

UNIT I PETROCHEMICALS EVOLUTION 9

UNIT II INTERMEDIATES FOR PETROCHEMICALS INDUSTRIES 9
Production Methods - Reforming and cracking of feed stocks; Sources: Chemicals from synthesis gas, olefins and aromatics. Ethylene, Propylene, C4 hydrocarbons, higher olefins, Benzene, Toluene, Xylene and their derivatives

UNIT III COMPLEX PETROCHEMICAL PRODUCTS 9
Acrylonitrile, Acrylic acid, dimethyl terephtalate, ethanol, ethylene glycol, linear alkyl benzene, methyl tertiary butyl ether, vinyl acetate, vinyl chloride, Maleic and phthalic anhydride, ethyl benzene, Phenol, Cumene, Styrene, Bisphenol, Aniline – Process flow scheme- various technology- advantages-yield pattern-process variables

UNIT IV POLYMERS 9

UNIT V GLOBAL CHEMICALS 9
Petrochemicals-Lubricants, additives, adhesives, agrochemicals, cosmetics raw materials, electronic chemicals, detergents, paint, healthcare and pharmaceuticals, Fertilizers-Ammonia, Urea, NPK etc.

TOTAL: 45 PERIODS

OUTCOMES:
On completion of the course, the students will be able to
CO1 – able to understand the basic knowledge on petrochemical industry and their growth, history.
CO2 – understand the different methods of production in petrochemical products and their derivatives.
CO3 – gather knowledge on the production of complex petrochemical products
CO4 - able to understand the petrochemical industries and its application with production techniques in polymers.
CO5 – to understand the application of petrochemicals in all process fields

TEXTBOOKS
REFERENCES
## COURSE ARTICULATION MATRIX:

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<td>able to understand the basic knowledge on petrochemical industry and their growth, history.</td>
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<td>CO2</td>
<td>understand the different methods of production in petrochemical products and their derivatives</td>
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<td>CO3</td>
<td>gather knowledge on the production of complex petrochemical products</td>
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<tr>
<td>CO4</td>
<td>able to understand the petrochemical industries and its application with production techniques in polymers.</td>
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<tr>
<td>CO5</td>
<td>to understand the application of petrochemicals in all process fields</td>
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</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
UNIT I
Biomass sources and classification; Biomass characteristics & preparation; Chemical composition and properties of biomass; Size reduction, Briquetting of loose biomass, Drying, Storage and handling of biomass.

UNIT II
Biogas technology: Feedstock for producing biogas; Microbial and biochemical aspects and operating parameters for biogas production, Kinetics and mechanism. Dry and wet fermentation, Digestors for rural application-High rate digesters for industrial waste water treatment.

UNIT III

UNIT IV

UNIT V

TOTAL: 45 PERIODS

OUTCOMES:
On completion of the course, the students will be able to
CO1- understand the fundamental knowledge on classification, characterization and sources of biomass
CO2- learn the production of biogas
CO3- gather knowledge on the operations of incineration, pyrolysis.
CO4- understand the process in gasification of biomass
CO5- knowledge on the types of combustion of biomass.

TEXT BOOKS

REFERENCE BOOKS
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<td>CO3</td>
<td>gather knowledge on the operations of incineration, pyrolysis.</td>
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<td>CO4</td>
<td>understand the process in gasification of biomass</td>
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<tr>
<td>CO5</td>
<td>knowledge on the types of combustion of biomass</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
UNIT I

UNIT II

UNIT III

UNIT IV

UNIT V

OUTCOMES:
On completion of the course, the students will be able to
CO1- understand the fundamental knowledge on history, consumption of energy
CO2- learn the production of solar energy
CO3- gather knowledge on the geothermal and bio energy
CO4- understand the production of wind energy and their utilization
CO5- knowledge on the production and utilization of tidal energy

TEXT BOOKS

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<td>CO1</td>
<td>understand the fundamental knowledge on history, consumption of energy</td>
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<tr>
<td>CO2</td>
<td>learn the production of solar energy</td>
<td>1</td>
</tr>
<tr>
<td>CO3</td>
<td>gather knowledge on the geothermal and bio energy</td>
<td>1</td>
</tr>
<tr>
<td>CO4</td>
<td>understand the production of wind energy and their utilization</td>
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<tr>
<td>CO5</td>
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</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
UNIT I
Thermodynamic review of the process, Pinch Concept, significance of pinch, pinch in grid representation, Threshold problems, capital cost implication of the pinch.

UNIT II
Targeting: Heat exchanger networks, energy targeting, area targeting, unit targeting, shell targeting, cost targeting, super targeting, continuous targeting.

UNIT III

UNIT IV
Pinch Design and Optimization: Networks for maximum energy recovery, Pinch design method, Flexibility criteria of the pinch, C_p table, heuristics, optimization of heat exchanger network: optimality for a minimum area network.

UNIT V

OUTCOMES:
On completion of the course, the students will be able to
CO1. Understand the pinch concept and process thermodynamics
CO2. Identify minimum energy targets
CO3. Classify different choices and constraint during heat exchange networking
CO4. Apply strategies for retrofitting existing process plant, integration of energy demands of multiple processes
CO5: Analyze the concepts in various chemical processes.

TEXT BOOKS

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<tr>
<td>CO1</td>
<td>Understand the pinch concept and process thermodynamics</td>
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<tr>
<td>CO2</td>
<td>Identify minimum energy targets</td>
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<tr>
<td>CO3</td>
<td>Classify different choices and constraint during heat exchange networking</td>
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<tr>
<td>CO4</td>
<td>Apply strategies for retrofitting existing process plant, integration of</td>
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<td>energy demands of multiple processes</td>
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<tr>
<td>CO5</td>
<td>Analyze the concepts in various chemical processes.</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVES

- To create awareness about alternate clean fuel available. To familiarize the students with the concepts and chemistry of fuel cell

UNIT I INTRODUCTION 9
Overview of fuel cells: Low and high temperature fuel cells; Fuel cell thermodynamics - heat, work Potentials, prediction of reversible voltage, fuel cell efficiency, Types of fuel cells.

UNIT II FUEL CELL KINETICS 9
Fuel cell reaction kinetics - electrode kinetics, overvoltage, Tafel equation, charge transfer reaction, exchange currents, electro catalysis - design, activation kinetics, Fuel cell charge and mass transport - flow field, transport in electrode and electrolyte.

UNIT III CHARACTERIZATION TECHNIQUES 9
Fuel cell characterization - in-situ and ex-situ characterization techniques, i-V curve, frequency response analysis; Fuel cell modeling and system integration: - 1D model – analytical solution and CFD models.

UNIT IV RENEWABLE SOURCES 9
Balance of plant; Hydrogen production from renewable sources and storage; safety issues, cost expectation and life cycle analysis of fuel cells.

UNIT V APPLICATIONS OF FUEL CELL 9
Fuel cell power plants: fuel processor, fuel cell power section (fuel cell stack), power conditioner; automotive applications, portable applications

TOTAL: 45 PERIODS

OUTCOME
On completion of the course, the students will be able to
CO 1: aware of alternate energy sources and its importance of it.
CO2 : understand the fuel cell kinetics
CO3: able to understand the characterization techniques
CO4: Analyze the renewable sources and storage
CO5: Understand the applications of fuel cells in various fields.

TEXTBOOKS

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<td>aware of alternate energy sources and its importance of it.</td>
<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO10  PO11  PO12  PSO1  PSO2  PSO3</td>
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<tr>
<td>CO2</td>
<td>understand the fuel cell kinetics</td>
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</tr>
<tr>
<td>CO3</td>
<td>able to understand the characterization techniques</td>
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<td>2  2  2  3  3  2  2  2  1  2  1  2  2  2  2</td>
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<tr>
<td>CO4</td>
<td>Analyze the renewable sources and storage</td>
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<tr>
<td>CO5</td>
<td>Understand the applications of fuel cells in various fields</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
CH3010  POWER PLANT ENGINEERING  L T P C
UNIT I  9
Power Plants - Features, Components and Layouts - Working of Power Plants, Power Plant Economics.

UNIT II  9
Boiler Classification - Boiler Types - Fire Tube & Water Tube Boilers - Fluidized Bed Boilers - Positive Circulation Boilers - Thermal Liquid Heaters & Vaporizers

UNIT III  9
Steam Turbines: Classification - Features - Working – Performance; Losses in Steam Turbines - Trouble Shooting

UNIT IV  9
Gas Turbines: Classification and Comparison of Different Types Gas Turbine Power Plants Components - Economics & Future of Combined Cycles

UNIT V  9

TOTAL:45 PERIODS

OUTCOMES:
On completion of the course, the students will be able to
CO1- understand the fundamental knowledge on components, layouts and working of power plants
CO2- learn the types, classification and usage of boilers
CO3- gather knowledge on classification and usage of steam turbines
CO4- understand the types of gas turbines
CO5- knowledge on the application of integration of various process in power plants

TEXT BOOKS

REFERENCE BOOKS
2. Arora and Domkundwar, A course in Power Plant Engineering, Dhanpat Ra, N.Delhi.2003
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<td>CO1</td>
<td>understand the fundamental knowledge on components, layouts and working of power plants</td>
<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO10  PO11  PO12  PSO1  PSO2  PSO3</td>
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<tr>
<td>CO2</td>
<td>learn the types, classification and usage of boilers</td>
<td>2    2    2    2    2    2    2    2    1    1    1    2    1    2    2    2    2</td>
</tr>
<tr>
<td>CO3</td>
<td>gather knowledge on classification and usage of steam turbines</td>
<td>2    2    2    2    2    2    2    2    1    1    1    1    1    2    2    2    2</td>
</tr>
<tr>
<td>CO4</td>
<td>understand the types of gas turbines</td>
<td>2    2    2    2    2    2    2    2    2    1    -    1    2    2    2    2    2</td>
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<tr>
<td>CO5</td>
<td>knowledge on the application of integration of various process in power plants</td>
<td>2    2    2    2    2    2    3    2    1    1    1    1    2    2    2    2    2</td>
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<tr>
<td>Overall CO</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
CH3011 NON-RENEWABLE ENERGY SOURCES

UNIT I
Origin of Petroleum, Composition, Extraction of Petroleum. Products of Petroleum refining: Diesel; Gasoline; LPG; Fuel oil; Tar; and Bitumen. Environmental Issues associated with petroleum resources.

UNIT II
Types of coal; Composition of coal; Oxygen content, Proximate and Ultimate Analysis of coal; Carbonization, Coal for generation of electricity, coal liquefaction, coal blending. Environmental Issues associated with usage of coal.

UNIT III NATURAL GAS
Resources of for Natural Gas, Properties and classification of natural gas, transporation of natural gas, products from natural gas, liquefied natural gas, chemicals from natural gas, shale gas; Environmental Issues associated with usage of coal.

UNIT IV NUCLEAR ENGINEERING FUNDAMENTALS
Nuclear models, binding energy, Radio activity, half-life, mechanism of nuclear fission and fusion, decay chains, neutron reactions. Nuclear Fuels; Nuclear fuel reserves of Uranium and Thorium, Nuclear fuel cycles, characteristics, production and purification, other fuels Zirconium, Beryllium.

UNIT V NUCLEAR ENERGY
Nuclear reactors and classification, boiling water reactors (BWR), pressurized heavy water reactor (PHWR), fast breeder reactor (FBR), basics of nuclear fusion reactor. Nuclear Power Plant - Waste Management and Safety

OUTCOMES:
On completion of the course, the students will be able to
CO1- understand the fundamental knowledge on petroleum and its products
CO2- learn the usage of coal, types and its composition
CO3- gather knowledge on the properties, classification and products of natural gas
CO4- understand the fundamentals of nuclear engineering
CO5- knowledge on the usage of nuclear reactors, nuclear waste management and safety usage.

TEXT BOOKS
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<td>CO1</td>
<td>understand the fundamental knowledge on petroleum and its products</td>
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<tr>
<td>CO2</td>
<td>learn the usage of coal, types and its composition</td>
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<tr>
<td>CO3</td>
<td>gather knowledge on the properties, classification and products of natural gas</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>understand the fundamentals of nuclear engineering</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>knowledge on the usage of nuclear reactors, nuclear waste management and safety usage.</td>
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<td>Overall CO</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
PEC- Biochemical Engineering

BT3392   BIOCHEMISTRY        L T P C
                     3 0 0 3

OBJECTIVE
To enable students learn the fundamentals of Biochemical Processes and Biomolecules

UNIT I   INTRODUCTION TO BIOMOLECULES - CARBOHYDRATES:
Basic principles of organic chemistry, role of carbon, types of functional groups, chemical, nature of water, pH and biological buffers, bio molecules structure and properties of Carbohydrates (mono, di, oligo & polysaccharides) Proteoglycans, glucosaminoglycans. mutarotation, glycosidic bond, reactions of monosaccharides, reducing sugars. Starch, glycogen, cellulose and chitin. Proteoglycans, glycosaminoglycans. hyaluronic acid, chondroitin sulfate

UNIT II  STRUCTURE AND PROPERTIES OF OTHER BIOMOLECULES
Structure and properties of Important Biomolecules.
Lipids: fatty acids, glycerol, saponification, iodination, hydrogenation, phospholipids, glycolipids, sphingolipids, cholesterol, steroids, prostaglandins.
Protein: Amino Acids, Peptides, Proteins, measurement, structures, hierarchy of organization primary, secondary, tertiary and quaternary structures, glycoproteins, lipoproteins. Determine of primary structure.
Nucleic acids: purines, pyrimidines, nucleoside, nucleotide, RNA, DNA-Watson-Crick structure of DNA, reactions, properties, measurement, nucleoprotein complexes

UNIT III  METABOLISM CONCEPTS AND CARBOHYDRATE METABOLISM

UNIT IV   INTERMEDIARY METABOLISM AND REGULATION
Fatty acid synthesis and oxidation, reactions of amino acids, deamination, transamination and decarboxylation, urea cycle, Bioenergetics - High energy compounds, electronegative potential of compounds, respiratory chain, ATP cycle, calculation of ATP yield during oxidation of glucose and fatty acids.

UNIT V    PROTEIN TRANSPORT AND DEGRADATION
Protein targeting, signal sequence, secretion; Folding, Chaperone and targeting of organelle proteins, Protein degradation, receptor-mediated endocytosis, turnover.

TOTAL: 45 PERIODS

OUTCOMES
On completion of the course, the students will be able to
CO1 – understand the basic concepts on carbohydrates.
CO2 – learn the concepts of proteins
CO3 – gather knowledge on importance of nucleic acids
CO4 – understand the knowledge on lipids
CO5 – gather knowledge on intermediary metabolism and their pathways

TEXT BOOKS
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<td>understand the basic concepts on carbohydrates.</td>
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<tr>
<td>CO2</td>
<td>learn the concepts of proteins</td>
<td>2 1 2 2 2 1 1 2 2</td>
</tr>
<tr>
<td>CO3</td>
<td>gather knowledge on importance of nucleic acids</td>
<td>2 1 2 2 2 1 1 2 2</td>
</tr>
<tr>
<td>CO4</td>
<td>understand the knowledge on lipids</td>
<td>2 1 2 2 2 1 1 2 2</td>
</tr>
<tr>
<td>CO5</td>
<td>gather knowledge on intermediary metabolism and their pathways</td>
<td>2 1 1 2 1 2 2 2 2</td>
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*Overall CO* 2 1 1 1 1 1 2 1 2 2 2 2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
COURSE OBJECTIVES:

- To understand the fundamentals of bioprocesses
- To understand the production process of biomolecules
- To have a strong foundation in bioreactors.

UNIT I  INTRODUCTION TO BIOPROCESS

Biologists and Engineers, comparison of chemical and biochemical processing overview of biological basics, About cells and its growth, the stoichiometry of microbial growth and product Bioprocesses: Regulatory Constraints

UNIT II  MEDIA FORMULATION AND DEVELOPMENT

Media formulation, Media Sterilization: Methods of heat sterilization of media, thermal death kinetics, design criteria, batch and continuous sterilization. Air Sterilization: Methods of air sterilization, mechanism of air sterilization, solid and liquid handling. Industrially fermented broth

UNIT III  UNDERSTANDING BIOREACTORS

Purpose and importance of bioreactors. Classification of bioreactors, bioreactors for animal cells, bioreactors for plant cells, bioreactors for immobilized cells, operations of bioreactors, stirred tank reactor, plug flow reactor (PFR), fluidized bed reactor, bubble column, airlift reactor, Agitation, and Aeration: Mechanical agitation, power consumption in agitation, bubble aeration, bioreactors for waste management

UNIT IV  TRANSPORT PROCESSES


UNIT V  BIOETHICS AND BIOSAFETY

Introduction to Bioethics. Social and ethical issues, the process of biotechnology involved in generating new forms of life for informed decision making, Definition of Biosafety. Biosafety for human health and environment. Social and ethical issues. Use of genetically modified organisms and their release into the environment.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students will be able to

CO1- understand the fundamental knowledge on bioprocess technology
CO2- learn the the production process of biomolecules
CO3- gather knowledge on the operations of bioreactors and their purposes
CO4- understand the transportation processes in reactors and their behaviors
CO5- knowledge on the biosafety and information on bioethics.

TEXT BOOKS:


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<td>understand the fundamental knowledge on bioprocess technology</td>
<td>PO1</td>
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<tr>
<td>CO2</td>
<td>learn the production process of biomolecules</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>gather knowledge on the operations of bioreactors and their purposes</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>understand the transportation processes in reactors and their behaviors</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>knowledge on the biosafety and information on bioethics</td>
<td>2</td>
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<tr>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
COURSE OBJECTIVES:

- To understand fermentation and its kinetics
- To understand structural, functional properties of microbes
- To design fermenter with auxiliaries

UNIT I  FERMENTATION PROCESSES  9
Importance of fermentation, Fermentation and redox potential, solid-liquid fermentation, solid state fermentation, Kinetics of fermentations, Biosensors for fermentations, Production processes in fermentation.

UNIT II  MICROBIAL GROWTH KINETICS  9
Diversity of patterns of microbial growth in situ and ex situ, Microbial growth under homogeneous conditions, Heterogeneous microbial growth, Growth kinetics, Derivation of mathematical models, and identification

UNIT III  DESIGN OF FERMENTERS  9
fermentation processes, Fermentation processes and microorganisms, Kinetics and stoichiometry, Mass balances and design for batch, continuous and fed-batch reactors, Comparison of batch, continuous and fed-batch reactors, Heat generation and heat balances, examples of industrial fermentation processes

UNIT IV  INSTRUMENTATION AND CONTROL  9

UNIT V  FERMENTATION AND COMMODITY PRODUCTS  9
Engineering of Secretory Pathways, production of heterologous proteins, fungal, yeast fermentation of industrial products.

OUTCOMES:
On completion of the course, the students will be able to
CO1- understand the structural, functional properties of microbes
CO2- learn the growth kinetics of microorganisms
CO3- understand the basic concepts in designing of fermenters
CO4- gather knowledge on the operation of control systems in fermentation and bioprocess industry
CO5- acquire knowledge on the commodity, fermentation production and their production pathways

TOTAL : 45PERIODS

TEXTBOOKS:

REFERENCES:
## COURSE ARTICULATION MATRIX:

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<th>Statements</th>
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<td>CO2</td>
<td>learn the growth kinetics of microorganisms</td>
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<td>CO3</td>
<td>understand the basic concepts in designing of fermenters</td>
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<td>2</td>
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<td>CO4</td>
<td>gather knowledge on the operation of control systems in fermentation and bioprocess industry</td>
<td>1</td>
<td>2</td>
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<td>3</td>
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<td>CO5</td>
<td>acquire knowledge on the commodity, fermentation production and their production pathways</td>
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<td>2</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
COURSE OBJECTIVES:

- To learn the fundamentals of bio separations
- To design unit operations steps for various downstream purification steps
- To gain knowledge on theory, design, and application of bioprocessing.

UNIT I  INTRODUCTION
Introduction to By-products and Bioseparation: Range and characteristics of bio products, Characteristics of Fermentation Broth, Selection of unit operation with due consideration of the physical, chemical and biochemical aspects of biomolecules. Stages of Downstream Processing

UNIT II  CENTRIFUGATION AND FILTRATION
Primary Separation: Removal of insoluble and Biomass (and particulate debris) separation techniques, Flocculation and sedimentation, Centrifugation-Ultracentrifugation, Gradient centrifugation, Filtration: Theory of Filtration, Pre-treatment of Fermentation Broth, Filter Media and Equipment, Conventional and Cross-flow Filtration, Continuous Filtration, Filter cake resistance, specific cake resistance, Washing and dewatering of filter cakes

UNIT III  ABSORPTION
Gas Absorption: Solubility of gases in liquids, Effect of temperature and pressure on solubility, Ideal and Non-ideal solutions, Choice of solvent for gas absorption, absorption factor, stripping factor, minimum gas liq ratio, Single stage gas absorption Cross Current, Co-current, Countercurrent, Multistage Counter current Operation, Absorption with Chemical Reactions, Related problems

UNIT IV  EXTRACTION
Liquid-Liquid Separation Process: Single Stage Operation, Equipments for liquid-liquid extraction. Types of extraction processes: Reactive extraction, Aqueous two-phase systems, Reverse micellar extraction, solid-liquid extraction, Supercritical fluid Extraction. Different types of extractors and designing of extractors. Distillation: Simple, Steam and Equilibrium distillation, Fractionation, McCabe Thiele method, azotropes

UNIT V  CHROMATOGRAPHY AND MEMBRANE SEPARATION
Theory of chromatography, Shape and yield of a chromatographic peak, Binary chromatography, Hydrodynamic chromatography. Membrane-based bioseparation - Classification of membrane processes, Ultrafiltration, Microfiltration, Dialysis, Liquid membrane processes, Membrane chromatography, Electrophoresis, Affinity ultrafiltration, Field-flow fractionation

OUTCOMES:
On completion of the course, the students will be able to
CO1- understand the basic concept of bioseparation processes
CO2- acquire knowledge on theory, design, and application of bioprocessing
CO3- to understand the basic concepts absorption and their problems in bioprocessing
CO4- gather knowledge on extraction of bioproducts using different methods
CO5- acquire knowledge on chromatography techniques and their analysis, membrane separation process

TEST BOOKS:
2. Roger G. Harrison, Paul Todd, ScottR. Rudge, Demetri P. Petrides, Bioseparations Science and Engineering, Oxford University Press
REFERENCES:
4. Separation and purification techniques in biotechnology, Fredreich Dechow, 1989
5. T. Schepler et al, Biotreatment, Downstream Processing and Modeling (Advances in Biochemical Engineering /Biotechnology, Vol 56) by Springer Verlag
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<tr>
<td>CO2</td>
<td>acquire knowledge on theory, design, and application of bioprocessing</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>to understand the basic concepts absorption and their problems in bioprocessing</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>gather knowledge on extraction of bioproducts using different methods</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>acquire knowledge on chromatography techniques and their analysis, membrane separation process</td>
<td>2</td>
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CH3015 ENZYME IMMOBILISATION TECHNOLOGY

COURSE OBJECTIVES:

- To understand Enzymes, homogeneity, and heterogenicity
- To understand structural, functional properties, and metabolic pathways
- To learn immobilization procedures, and types.
- To design enzyme reactors

UNIT I INTRODUCTION

Catalysis and biocatalysis, Enzyme classification and nomenclature, enzyme structure, functionality and relationship, enzyme activity, enzyme sources, synthesis, recovery and purification, enzymes as process catalysts.

UNIT II HOMOGENEOUS ENZYME KINETICS

Hypothesis of enzyme kinetics, rapid equilibrium and steady-state hypothesis, determination of kinetic parameters, various types of kinetic inhibition, reactions with more than one substrate, effect of environmental variables - pH, temperature, and ionic strength.

UNIT III BASICS OF IMMOBILISATION

Immobilisation – Functional properties, Classification of Immobilisation techniques – Adsorption, matrix entrapment, crosslinking, covalent binding - advantages & disadvantages of each method, selection and characterisation of matrices for immobilisation, effect of physico chemical parameters on immobilised enzymes.

UNIT IV HETEROGENEOUS ENZYME KINETICS

Mass transfer effects in heterogeneous biocatalysis, partition effects, Immobilised enzyme kinetics - external (film) diffusion, internal (pore) diffusional kinetics, Thiele modulus and Effectiveness factor. Effects of electrostatic potential of the micro environment.

UNIT V ENZYME REACTORS & APPLICATION OF IMMOBILISED ENZYMES

Design of reactors with immobilised enzymes, Design of advanced immobilized enzyme systems, Application of immobilised enzymes in food industry, textile industry, Pharmaceutical industry & in medicine, in the production of biofuels, detergent industry, production of various bio-products, as biosensors.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students will be able to

CO1 – understand the basic knowledge on classification of enzymes and their nomenclature
CO2 - understand Enzymes, homogeneity, and heterogenicity
CO3 - understand structural, functional properties, and metabolic pathways of enzymes
CO4 - learn immobilization procedures, and their different types.
CO5 – knowledge on designing enzyme reactors.

TEXT BOOKS:


REFERENCE BOOKS:

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<tr>
<td>CO2</td>
<td>understand Enzymes, homogeneity, and heterogenicity</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>understand structural, functional properties, and metabolic pathways of enzymes</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>learn immobilization procedures, and their different types.</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>knowledge on designing enzyme reactors.</td>
<td>2</td>
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<tr>
<td>Overall CO</td>
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</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
COURSE OBJECTIVES:
- To understand the fundamentals of bioreactor design
- To design single and multiple bioreactors
- To design a bioprocess system.

UNIT I BIOREACTOR DESIGN & MEDIA REQUIREMENTS 9
Microbial growth and product formation kinetics, Bioreactor Selection, Reactor operational mode and selection.

UNIT II DESIGN EQUATIONS FOR BIOREACTORS 9

UNIT III BIOREACTOR REQUIREMENTS 9
Process-General requirements; Basic design and construction of bioreactors and their ancillaries; Material of construction, Vessel geometry, Bearing Assemblies, Motor drives, Aseptic seals; Flow measuring devices, Valves, Agitator and Sparger Design, Sensors, Non-isothermal homogeneous reactor systems. Adiabatic reactors, batch and continuous reactors, optimum temperature progression.

UNIT IV DESIGN OF BIOREACTORS 9
Process and mechanical design of Bioreactors, volume, sparger, agitator-type, size and motor power, heat transfer calculations for coil and jacket, sterilization system, scale-up, scale down, bioinstrumentation and control.

UNIT V NOVEL BIOREACTORS DESIGN 9
Design of Immobilized enzyme packed bed Reactor. Fluidized bed reactors, Slurry Reactors, Airlift & Loop reactors, Packed bed and Hollow fiber membrane bioreactors, Bioreactors for waste treatment processes; SSF bioreactors. bioreactor design considerations for plant and animal cell cultures.

TOTAL : 45 PERIODS

COURSE OUTCOMES:
On completion of the course, the students will be able to
CO1: Compare kinetics and reaction rates for various bioreactor designs, based on operational mode and type of substrate. 
CO2: Differentiate and estimate productivity in commercial bioreactors- packed bed, fed batch reactors
CO3: Helps to understand various requirements such as material of construction, valves, agitator, sensors etc
CO4: Understanding the mechanical design and heat transfer calculations for various type of bioreactor
CO5: Analyze immobilization techniques in reactors and use it for various applications

TEXT BOOKS:

REFERENCE:
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<tr>
<td>CO2</td>
<td>Differentiate and estimate productivity in commercial bioreactors- packed bed, fed batch reactors</td>
<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO10  PO11  PO12  PSO1  PSO2  PSO3</td>
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<tr>
<td>CO3</td>
<td>Helps to understand various requirements such as material of construction, valves, agitator, sensors etc</td>
<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO10  PO11  PO12  PSO1  PSO2  PSO3</td>
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</tr>
<tr>
<td>CO4</td>
<td>Understanding the mechanical design and heat transfer calculations for various type of bioreactor</td>
<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO10  PO11  PO12  PSO1  PSO2  PSO3</td>
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</tr>
<tr>
<td>CO5</td>
<td>Analyze immobilization techniques in reactors and use it for various applications</td>
<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO10  PO11  PO12  PSO1  PSO2  PSO3</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
PEC- Environmental and safety engineering

CH3017 AIR POLLUTION ENGINEERING L T P C 3 0 0 3

OBJECTIVE:
• To enable the students to learn about Air Pollution, effects of air pollution, Global effects, Sampling of pollutants, Meteorology and air pollution, Atmospheric stability, Plume rise and dispersion and Prediction of air quality.

UNIT I INTRODUCTION
Introduction to Air Quality; An Overview of the Clean Air Act Amendments; Air Pollution Regulatory Framework - Regulatory System – Laws and Regulations – Clean air Act – Provisions for Recent Developments. Ambient Air Quality Standards in India; Properties of Air Pollutants; Sources and effects of air pollution, emission standards, Air Quality Index

UNIT II GASEOUS POLLUTANTS

UNIT III PARTICULATE AIR POLLUTION
Particle Collection mechanisms– Fluid particle Dynamics – Particle size Distribution – Efficiency – Gravity Settling chambers Cyclones- Electrostatic precipitators and Bag houses

UNIT IV AIR POLLUTION CONTROL
Principles of Pollution Prevention- Characteristics and control of VOCs and HCs, Characteristics and control of sulphur oxides and nitrogen oxides, Control of mobile source pollutants - Control of particulate matters – Techniques of air pollution control - equipments

UNIT V AIR POLLUTION MODELLING
Meteorology and winds- Stability of the atmosphere, lapse rates & inversions- Air pollution dispersion models, Gaussian equation and variation, Industrial Air Pollution Sources and Prevention

TOTAL: 45 PERIODS

OUTCOME:
On completion of the course, the students will be able to
CO1 Understand the nature and characteristics of air pollutants, and basic concepts of air quality management.
CO2: Identify, formulate and solve air pollution problems using air pollution control devices to meet applicable standards
CO3: Understand the knowledge about particulate air pollutants and control devices.
CO4: Relate the air quality behaviour and its measurement
CO5: Control the air pollution in industries using various models.

TEXT BOOKS:

REFERENCE BOOKS
## COURSE ARTICULATION MATRIX:

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<td>PO1</td>
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<td>CO1</td>
<td>Understand the nature and characteristics of air pollutants, and basic concepts of air quality management</td>
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<tr>
<td>CO2</td>
<td>Identify, formulate and solve air pollution problems using air pollution control devices to meet applicable standards</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand the knowledge about particulate air pollutants and control devices.</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>Relate the air quality behaviour and its measurement</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>Control the air pollution in industries using various models.</td>
<td>2</td>
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<tr>
<td>Overall CO</td>
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</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE:
• To focus on the wastewater transport system and the theory and design technique for the wastewater treatment process.

UNIT I WASTE WATER TREATMENT AN OVERVIEW
Terminology – Regulations – Health and Environment Concerns in waste water management – Constituents in waste water; inorganic, Organic and heavy metal constituents.

UNIT II CHEMICAL UNIT PROCESSES
Role of unit processes in waste water treatment- Principles of Chemical treatment – Coagulation - flocculation– Precipitation–flotation – solidification and stabilization – disinfection

UNIT III BIOLOGICAL TREATMENT

UNIT IV TREATMENT METHODS
Activated Sludge process and variations, Sequencing Batch reactors, Membrane Biological Reactors-Trickling Filters- RBC-Moving Bed Reactors- fluidized bed reactors, aerated lagoons, waste stabilization ponds- Design of units – UASB, up flow filters, Fluidized beds MBR, septic tank and disposal

UNIT V ADVANCED WASTE WATER TREATMENT
Technologies used in advanced treatment – Classification of technologies- Removal of Colloids and suspended particles– Membrane Filtration – Ion Exchange – Advanced oxidation process – Zero liquid Discharge.- Software Applications

OUTCOME:
On completion of the course, the students will be able to
CO1: Understand the Physical and chemical Characteristics of wastewater and their measurement. 
CO2: Understand the various pollutant treatment techniques.
CO3: Understand the concepts using biological treatment methods
CO4: Analyze the reactors used for various treatment techniques
CO5: Understand the membrane based electrochemical process for pollutant treatment.

TEXT BOOKS:

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<td>Understand the Physical and chemical Characteristics of wastewater and their measurement.</td>
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<tr>
<td>CO2</td>
<td>Understand the various pollutant treatment techniques.</td>
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</tr>
<tr>
<td>CO3</td>
<td>Understand the concepts using biological treatment methods</td>
<td>2     2     2     3     2     2     2     2     2     2     2     2     2     2     1</td>
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<tr>
<td>CO4</td>
<td>Analyze the reactors used for various treatment techniques</td>
<td>2     2     2     3     2     2     2     2     2     2     2     2     2     2     1</td>
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<tr>
<td>CO5</td>
<td>Understand the membrane based electrochemical process for pollutant treatment.</td>
<td>2     3     2     2     3     2     2     2     2     2     2     2     2     2     1</td>
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<td>Overall CO</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE:
• To make the students conversant with the types, sources, generation, storage, collection, transport, processing and disposal of municipal solid waste.

UNIT I SOURCES AND CHARACTERISTICS

UNIT II SOURCE REDUCTION, WASTE STORAGE AND RECYCLING

UNIT III COLLECTION AND TRANSFER OF WASTES
Methods of Residential and commercial waste collection – Collection vehicles – Manpower – Collection routes – Analysis of waste collection systems; Transfer stations –location, operation and maintenance; options under Indian conditions – Field problems- solving.

UNIT IV PROCESSING OF WASTES
Objectives of waste processing – Physical Processing techniques and Equipment; Resource recovery from solid waste composting and bio meth nation; Thermal processing options – case studies under Indian conditions.

UNIT V WASTE DISPOSAL

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On completion of the course, the students will be able to
CO1: State solid waste characteristics and its sources.
CO2: Identify and analyze different methods of treatment of solid waste.
CO3: Illustrate Industrial practices in solid waste management.
CO4: Discuss the significance of recycling reuse and reclamation of solid wastes.
CO5: Assess the relationships between environmental guidelines, human activities and quality of impacted soil, water and air.

TEXTBOOKS:

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</tr>
<tr>
<td>CO2</td>
<td>Identify and analyze different methods of treatment of solid waste.</td>
<td>2</td>
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<tr>
<td>CO3</td>
<td>Illustrate industrial practices in solid waste management.</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>Discuss the significance of recycling reuse and reclamation of solid wastes.</td>
<td>2</td>
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<tr>
<td>CO5</td>
<td>Assess the relationships between environmental guidelines, human activities and quality of impacted soil, water and air</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVES:
- To impart the knowledge and skills to identify, assess and mitigate the environmental and social impacts of developmental projects

UNIT I  INTRODUCTION

UNIT II  ENVIRONMENTAL ASSESSMENT
Screening and Scoping in EIA – Drafting of Terms of Reference, Baseline monitoring, Prediction and Assessment of Impact on land, water, air, noise, flora and fauna - Matrices – Networks – Checklist Methods - Mathematical models for Impact prediction.

UNIT III  ENVIRONMENTAL MANAGEMENT PLAN

UNIT IV  SOCIO ECONOMIC ASSESSMENT
Baseline monitoring of Socio economic environment – Identification of Project Affected Personal – Rehabilitation and Resettlement Plan- Economic valuation of Environmental impacts – Cost benefit Analysis

UNIT V  MONITORING STUDIES AND APPLICATIONS
Environmental monitoring - guidelines - policies - planning of monitoring programmes; Environmental Management Plan- Post project audit ; Case studies of EIA of developmental projects in Food, Fertilizer and Petrochemical industry.

COURSE OUTCOMES:
On completion of the course, the students will be able to
CO1:Understand the concept of environmental Impact assessment
CO2: Know various components and assessment techniques of EIA.
CO3:Understand Environmental management plan
CO4: Understand socio economic assessment plans
CO5: gain knowledge about EIA monitoring studies through various industrial exposure

TEXT BOOKS:

REFERENCE BOOKS:
**COURSE ARTICULATION MATRIX:**

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statements</th>
<th>Program Outcomes</th>
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<td>CO1</td>
<td>Understand the concept of environmental impact assessment</td>
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<tr>
<td>CO2</td>
<td>Know various components and assessment techniques of EIA.</td>
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<tr>
<td>CO3</td>
<td>Understand Environmental management plan</td>
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<tr>
<td>CO4</td>
<td>Understand socio economic assessment plans</td>
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<tr>
<td>CO5</td>
<td>gain knowledge about EIA monitoring studies through various industrial exposure</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
CH3021  PROCESS SAFETY MANAGEMENT  L T P C  3 0 0 3

UNIT I  PROCESS SAFETY INFORMATION  9
Safety vs Process Safety, Importance of Process Safety, Elements of Process safety - Overview; Process Safety Information (PSI) – Importance of Process Safety Information; Types of PSI, Collection of PSI, familiarization of formats for capturing PSI, Challenges

UNIT II  SAFETY PROGRAMMES AND PROCEDURES  9
Need for safety in industries; Safety Programmes – components and realization; Potential hazards – extreme operating conditions, toxic chemicals; safe handling-Implementation of safety procedures – periodic inspection and replacement; Standard Operating Procedure – Overview and its importance, how to write effective operating procedure, Types of Procedures, Standard operating conditions and consequence of deviation; Emergency planning

UNIT III  ACCIDENT ANALYSIS  9
Accidents – identification and prevention, promotion of industrial safety. Process Safety Incident reporting and Investigation – Element overview, reporting and its importance; Process safety incident classification, Root cause analysis, making recommendations; Past accident analysis - Fiyoborough-Mexico- Chernobyl nuclear disaster-Bhopal gas analysis- process safety indicators

UNIT IV  PROCESS HAZARD ANALYSIS  9
Hazard identification- safety audits, checklist, what if analysis, vulnerability models- event tree analysis- fault tree analysis. Asset Integrity Process Hazard Analysis - Introduction to PHA, Overview of PHA Techniques, Selection of PHA techniques Implementation of recommendation – Key Aspects. Cyclic PHA /Revalidation; Review of PHA methodology (Prerequisites, Team Composition and their attributes)

UNIT V  SAFETY MANAGEMENT  9

TOTAL: 45 PERIODS

OUTCOMES:
On completion of the course, the students will be able to
CO1 - Understand the chemical process safety, safety codes
CO2 – safe handling of chemicals and plant inspection
CO3 – learn the different analysis to overcome the accidents in process industry
CO4 – understand the hazard analysis in process industry
CO5 – knowledge on safety management in different process industry

TEXT BOOKS:

REFERENCE BOOKS:
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
UNIT I  RISK ANALYSIS
Risk analysis introduction, quantitative risk assessment, rapid risk analysis – comprehensive risk analysis – identification, evaluation and control of risk

UNIT II  RISK ASSESSMENT
Risk assessment – introduction and available methodologies, Risk assessment steps- Quantitative risk analysis-event tree, fault tree, consequence analysis and layer of protection analysis- Bow tie analysis -

UNIT III  EMERGENCY PLANNING
Overall risk analysis–emergency planning-on site & off site emergency planning, risk management ISO 14000, EMS models case studies- marketing terminal, gas processing complex ; Risk due to Radiation, explosion due to over pressure, jet fire-fire ball.

UNIT IV  HAZARD
Hazard - Hazard identification – methods: Process Hazard Analysis - Introduction to PHA, Overview of PHA Techniques, Selection of PHA techniques Implementation of recommendation – Key Aspects. Cyclic PHA /Revalidation; Review of PHA methodology (Prerequisites, Team Composition and their attributes)

UNIT V  HAZOP
Introduction to HAZOP-Significance of HAZOP -HAZOP procedure –HAZOP Analysis -Computer usage in HAZOP- softwares employed - Limitations of HAZOP – case studies.

COURSE OUTCOMES:
On completion of the course, the students will be able to
CO1: Understand the knowledge of types of risks arising in working environment
CO2: Perform Risk Assurance and Assessment
CO3: Design Risk management systems and planning
CO4: Analyze the effect of process hazard
CO5: hazop and its consequences and to create hazard free working premises

TEXT BOOKS:

REFERENCES:
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<td>Understand the knowledge of types of risks arising in working environment</td>
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UNIT I NUMERICAL METHODS FOR SYSTEM OF LINEAR ALGEBRAIC EQUATIONS

UNIT II NUMERICAL METHODS FOR NON LINEAR ALGEBRAIC EQUATIONS
Introduction, Root finding methods for solution on non-linear algebraic equations: Bisection, Newton-Raphson and Secant methods, System of Non-linear Equations, Chemical Engineering problems involving solution of non-linear equations

UNIT III INTERPOLATION AND NUMERICAL INTEGRATION
Interpolation and Approximation, Newton's polynomials and Lagrange polynomials, spline interpolation, linear regression, polynomial regression, least square regression, Numerical integration: Trapezoidal rule, Simpson's rule, integration with unequal segments, Chemical engineering problems involving numerical differentiation and integration.

UNIT IV NUMERICAL METHODS FOR ODES
Euler method – explicit and implicit, Runge-Kutta method – 2nd and 4th order, Boundary value problems – shooting method, Chemical engineering problems involving single and system of ODEs.

UNIT V NUMERICAL METHODS FOR PDES
Introduction to Partial Differential Equations: Characterization of PDEs, parabolic, elliptic and first order hyperbolic equations, explicit and implicit methods, Chemical engineering problems involving the three types of PDEs.

TOTAL: 45 PERIODS

OUTCOMES
On completion of the course, the students will be able to
CO1 - Understand the numerical methods for linear algebraic equations.
CO2 – Identify numerical methods for non linear algebraic equations
CO3 - Identify different methods for interpolation and numerical integration
CO4 – knowledge on the numerical methods for ordinary differential equations
CO5 – understand the basic methods for partial differential equations

TEXT BOOKS

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</table>

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CH3024 OPTIMIZATION OF CHEMICAL PROCESSES  L T P C
3 0 0 3

UNIT I PROBLEM FORMULATION & CLASSIFICATION
Introduction; formulation of objective functions; fitting models to data; classification of functions; necessary and sufficient conditions for optimum; unimodal, multimodal functions; analytical methods

UNIT II LINEAR PROGRAMMING
Review on basic concepts of LP formulations; Simplex methods; Big-M method, two phase method and Duality in linear programming.

UNIT III NON-LINEAR PROGRAMMING
The Lagrange multiplier method, Integer, quadratic, geometric and dynamic programming.

UNIT IV NUMERICAL METHODS
Unimodal functions; Newton, quasi Newton, secant methods; region elimination methods, polynomial approximation; quadratic and cubic interpolation techniques for optimum. Multimodal functions; direct methods; Powell's technique; indirect methods; gradient and conjugate gradient methods; secant method

UNIT V APPLICATIONS
Heat transfer and energy conservation; separation processes; fluid flow systems; reactor design and operation; large scale systems.

TOTAL: 45 PERIODS

OUTCOMES:
On completion of the course, the students will be able to
CO1: be familiar on the basic problem formulation and optimization.
CO2: Understand mathematical characteristics of Linear programming
CO3: Learn computational solution techniques for nonlinear unconstrained optimization.
CO4: Understand various techniques used in constrained optimization
CO5: Apply the optimal and dynamic optimization.

TEXT BOOKS

REFERENCE BOOKS
### COURSE ARTICULATION MATRIX:

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<td>CO1</td>
<td>be familiar on the basic problem formulation and optimization.</td>
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<td>CO2</td>
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<tr>
<td>CO3</td>
<td>Learn computational solution techniques for nonlinear unconstrained optimization</td>
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<tr>
<td>CO4</td>
<td>Understand various techniques used in constrained optimization</td>
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<tr>
<td>CO5</td>
<td>Apply the optimal and dynamic optimization</td>
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</tbody>
</table>

Overall CO  
1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
UNIT I 
INTRODUCTION AND FIRST PRINCIPLES

UNIT II 
LUMPED SYSTEMS
Simple Hydraulic Tank, Variable flow hydraulic tank, Enclosed tank, Adiabatic compression in gas space, Mixing vessel, Mixing with reaction, Reversible reaction, Steam jacketed vessel, Continuous flow boiling system.

UNIT III 
STAGED OPERATIONS AND DISTRIBUTED SYSTEMS
Staged Operations: Counter current extraction, Distillation columns - Binary distillation. Distributed systems: Counter current Heat exchanger, Membrane separation process, tubular reactor and evaporators.

UNIT IV 
FITTING MODEL TO DATA
Fitting Linear Model, Multi-Linear Models, Matrix representation of Multi Linear Model, Fitting Quadratic Model, Cubic Model and Polynomial model using Regression, Power Law models. Performance Criteria to check quality of model, Co-efficient of Determination (R²)

UNIT V 
SIMULATION OF BASIC MODELS
MATLAB/Simulink - Introduction, Basic components, Operational Blocks, Examples - Gravity flow tank, Three CSTR's in series, Numerical solution of model using RK4, Euler's explicit and implicit techniques, Introduction to ODE 45 solver, Dynamic simulation of simple tank, variable flow tank, enclosed tank with isothermal compression, mixing vessel, mixing vessel with reaction using ODE 45 solver.

OUTCOMES:
On completion of the course, the students will be able to
CO1: Understand the fundamentals of modeling and their applications to transport/energy equations, chemical and phase equilibria kinetics
CO2: Associate the model with constitutive relations such as phenomenological laws, rate equations, equations of state, property estimation methods
CO3: Create the mathematical models for different unit operations equipments
CO4: Analyze the principles of steady state/unsteady state lumped systems and steady state/ unsteady state distributed systems
CO5: Apply relevant solution methods for the mathematical models with relevant initial and/or boundary conditions

TEXT BOOKS

REFERENCE BOOKS
### CO’s, PO’s & PSO’s MAPPING

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<td>Associate the model with constitutive relations such as phenomenological laws, rate equations, equations of state, property estimation methods</td>
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<td>Create the mathematical models for different unit operations equipments</td>
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<td>Analyze the principles of steady state/unsteady state lumped systems and steady state/unsteady state distributed systems</td>
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<td>CO5</td>
<td>Apply relevant solution methods for the mathematical models with relevant initial and/or boundary conditions</td>
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</table>

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UNIT I INTRODUCTION
Pinch analysis, process synthesis, pinch point, composite curves, energy targeting: problem table algorithm, shifted composite curve, capital cost, total cost targeting, process modification.

UNIT II TARGETING
Heat exchanger networks, energy targeting, area targeting, unit targeting, shell targeting, cost targeting, super targeting, and continuous targeting.

UNIT III PINCH ANALYSIS
Identification of streams, temperature, enthalpy diagram, minimum temperature difference, construction of composite curves, energy cost target, optimum target, design of heat exchanger network.

UNIT IV PINCH DESIGN AND OPTIMIZATION
Networks for maximum energy recovery, Pinch design method, flexibility criteria of the pinch, optimization of heat exchanger network, optimality for a minimum area network, Sensitivity analysis.

UNIT V ENERGY AND RESOURCE ANALYSIS OF VARIOUS PROCESSES
Batch process, flexible process, distillation process, evaporation process, reaction process, process using mass separating agent, heat pipes and heat pumps.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On completion of the course, the students will be able to
CO1. Understand the pinch concept and process thermodynamics
CO2. Identify minimum energy targets
CO3: Understand the knowledge of diagrams and energy cost target
CO4. Identify different choices and constraint during heat exchange networking
CO5. Apply strategies for retrofitting existing process plant, integration of energy demands of multiple processes

TEXT BOOKS

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<td>CASE STUDIES</td>
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**OUTCOMES:**

- CO1 – understand the basic concept in preparation of flowsheet
- CO2 – knowledge on preparing networks
- CO3 – understand different approach in flowsheeting
- CO4 – to learn the flowsheet preparation by equation solving methods
- CO5 – Evaluate the case studies using flowsheeting software.

**TEXT BOOKS**

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<tr>
<td>CO2</td>
<td>knowledge on preparing networks</td>
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<tr>
<td>CO3</td>
<td>understand different approach in flowsheeting</td>
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<td>CO4</td>
<td>to learn the flowsheet preparation by equation solving methods</td>
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<td>CO5</td>
<td>Evaluate the case studies using flowsheeting software</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
UNIT I  GOVERNING EQUATIONS  9
Governing equations of fluid flow and heat transfer - Navier-Stokes equations for a Newtonian fluid, Classification of physical behaviour, Classification of fluid flow equations, Auxiliary conditions for viscous fluid flow equations.

UNIT II  TURBULENCE AND ITS MODELLING  9
Transition from laminar to turbulent flow, Effect of turbulence on time-averaged Navier-Stokes equations, Characteristics of simple turbulent flows, free turbulent flows, flat plate boundary layer and pipe flow, Turbulence models, mixing length model, The k-omega model, Reynolds stress equation model, algebraic stress equation model.

UNIT III  FINITE VOLUME METHOD FOR DIFFUSION PROBLEMS  9
Introduction to finite volume method, one-dimensional steady state diffusion, two-dimensional diffusion, discretised equations for diffusion problems.

UNIT IV  FINITE VOLUME METHOD FOR CONVECTION-DIFFUSION PROBLEMS  9
Steady one-dimensional convection and diffusion, the central differencing scheme, properties of discretisation schemes - conservativeness, boundedness, transportiveness, Assessment of the central differencing scheme for convection-diffusion problems, The upwind differencing scheme, hybrid differencing scheme, power-law scheme, higher order differencing schemes, quadratic upwind differencing scheme.

UNIT V  FINITE VOLUME METHOD FOR UNSTEADY FLOWS  9
One-dimensional unsteady heat conduction, transient convection-diffusion equation, solution procedure for unsteady flow calculations. Implementation of inlet, outlet and wall boundary conditions, constant pressure boundary condition.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On completion of the course, the students will be able to
CO1: Understand the basics of CFD and governing equations for conservation of mass momentum and energy
CO2: Understand mathematical characteristics of partial differential equations
CO3: learn computational solution techniques for time integration of ordinary differential equations
CO4 gain knowledge in various discretization techniques used in CFD
CO5: Understand flow field computation techniques for steady and unsteady flows

TEXT BOOKS

REFERENCE BOOKS
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<th>Statements</th>
<th>PO1</th>
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<td>CO5</td>
<td>Understand flow field computation techniques for steady and unsteady flows</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
PEC- CHEMICAL PLANT DESIGN

CH3028 CHEMICAL PLANT DESIGN L T P C 3 0 0 3

COURSE OBJECTIVES:
- To understand the intricacies in equipment sizing and selection amongst options therein
- To leverage lessons learnt in designing chemical process unit with safety as paramount

UNIT I ROTARY EQUIPMENT

Pumps: Various types: Centrifugal, Reciprocating & Other Positive displacement types – Plunger, Piston, Diaphragm, Gear, Screw, Lobe, Vane, etc.; Compressors: Various types: Axial, Centrifugal, Reciprocating, and other positive displacement type such as Rotary Screw, Scroll, etc. Further, compressors are classified into two namely Oil free and Oil flooded lubricated; Fans: Various types: Axial fans (including Propeller, Tube-axial, and Vane-axial) and Centrifugal fans. Further fans are classified as Induced draft and Forced draft types; Steam Turbines: Various types: Back Pressure and Condensing Types with and without extraction, Impulse & Reaction types; Gas Turbines: Various types: Turbojet, Turboprop, Turbofan and Turboshaft Engines; Motor: Various types: AC motors (Synchronous & Asynchronous motors), DC motors (brushed and brushless), Variable Frequency and Variable Speed motors and Special purpose motors; Generator: Various types: AC and DC generator; Other Special Equipment: Various types: Power Recovery Turbines, Heat Pumps, Ejector pump, NASH vacuum pump

Case Studies – From Industries on operations and maintenance aspects viz. Trouble shooting, Energy improvement, Capacity augmentation, Design tips, Equipment safety, Catastrophic incidents, etc.

UNIT II STATIC EQUIPMENT - HEAT TRANSFER EQUIPMENT

Heat Exchangers – Shell and Tube, Double Pipe, Plate & Frame type, Tube in tube Scraped surface, and Fin tube, Coolers, Condensers, Fin Fan Coolers; Fired Heaters & Boilers – With or without air preheaters, Balanced draft or simply natural draft or even only forced draft, With and without waste heat generation, Refrigeration & Air Conditioning – HVAC (Heating, Ventilation, and Air Conditioning); Miscellaneous – Chilled water system with vapour compression refrigeration, Ejector refrigeration system, direct contact heat exchanger (such as cooling towers, Jet condensers, direct contact feed), Incinerator. Case Studies – From Industries on operations and maintenance aspects viz. Fouling control, Pinch study for energy recovery, Capacity creep, Design tips, Equipment safety, Catastrophic incidents, etc.

UNIT III STATIC EQUIPMENT - MASS TRANSFER

Mass Transfer Operations: Multi Component Distillation columns, Extractive distillation, Reactive Distillation, Azeotropic distillation, Divided wall columns, Dryers, Adsorption Isotherm, Pressure Swing Adsorption, Importance of recycles and Optimization needs, Absorption processes & operating variables, Liquid – Liquid Solvent Extraction; Humidification & dehumidification, Evaporation, Precipitation, Crystallizers, Membrane filtration; Reactors – CSTR, Slurry phase reactor, Tubular, Trickle Bed Reactor, etc., thermodynamically controlled reaction and kinetically controlled reaction, Reaction Kinetics, Importance of Reactor internals. Case Studies – From industries across life cycle such as Trouble shooting, enhance conversion & selectivity, IoT use, Debottlenecking, Design tips, Safety Incidents “Fit - For Purpose” Assessment, etc.

UNIT IV EQUIPMENT ANCILLARIES

Special equipment – Static Mixer, Agitators, Jet Mixing, Ejectors, Eductors, Structured Packing, Grid Packing and Random Packing, Demisters, Vortex Breaker, Calming Baffles, Schoepfetoeter, Vapour horn device, Cyclone separators; Package units – Inert gas generators, Feed stream filters (Mechanical, Chemical), Scrubbers, Spray Nozzles, Guard beds, Flare stack, Ground Flare, Flame arrestors, Strainers, Spring supports, Expansion joints, Electrostatic Precipitators; Steam Traps – Thermodynamic, Inverted Bucket type, Thermostatic – Float, Bimetallic type, etc., Case Studies – From Industries on operations & maintenance aspects viz. Trouble shooting, Efficiency / Effectiveness tracking, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.
UNIT V  STATIC EQUIPMENT - PRESSURE VESSELS, INTERNALS & SAFETY VALVES

Pressure Vessels – Vertical / Horizontal, Knock Out Drums, Steam and Blow down drum, Cold & Hot Separators, Surge drum, Deaerators, Water Seal Pot, Molecular seals, Shock Absorbers, Pressure snubber, Silencer, Slug Catcher, Desalter, Coke drum; Vessel & Columns - associated structural accessories such as Platforms, Ladders, Staircase etc. Internals – Column internals such as Trays (Sieve, Valve, Bubble Cap, Baffle, Dual flow, Multi down comer, Chimney tray etc.), Packings (structured, grid, random, etc.), Packed tower internals – Bed support plates, Liquid distributors, Bed limiters etc.; Mist eliminators, Demisters, Coalescing pads, Vortex breakers etc. Safety Valves: Normal, balanced bellows, pilot operated, etc., Rupture Discs, and Design codes governing Safety valve design, Case Studies– From industrial operations & maintenance activities– ASME codes, Trouble shooting, Efficiency tracking, Use of IoT, Debottlenecking, and Design tips, Safety & Environmental Incidents, etc.

TOTAL: 45 PERIODS

OUTCOMES:
On completion of the course, the students will be able to
CO1 – understand the basic on designing chemical process unit for rotary equipment
CO2 – learn the operations of boilers, heat exchangers, refrigeration and air conditioners.
CO3 – knowledge on operations of reactors, humidifiers and mass transfer operations
CO4 – learn the different types of equipments in process industries
CO5 – understand the knowledge on usage of different valves such as pressure, safety and internal.

TEXTBOOKS
2. Heat Transfer – D.Q. Kern
5. Fluid Mechanics, Heat Transfer, and Mass Transfer (Chemical Engineering Practice) – KSN Raju

REFERENCE BOOKS
## COURSE ARTICULATION MATRIX:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
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<td>PO1</td>
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<tr>
<td>CO1</td>
<td>understand the basic on designing chemical process unit for rotary equipment</td>
<td>2</td>
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<tr>
<td>CO2</td>
<td>learn the operations of boilers, heat exchangers, refrigeration and air conditioners</td>
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</tr>
<tr>
<td>CO3</td>
<td>knowledge on operations of reactors, humidifiers and mass transfer operations</td>
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<tr>
<td>CO4</td>
<td>learn the different types of equipments in process industries</td>
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<td>CO5</td>
<td>understand the knowledge on usage of different valves such as pressure, safety and internal.</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
COURSE OBJECTIVES:

- To understand the importance of plant layout in mitigating risk on people, plant, planet
- To apply knowledge in placing equipment for ease of operability & maintainability

UNIT I  STANDARDS FOR AREA CLASSIFICATION  9
Standards for area classification—Electrical Area classifications, OSHA (Occupational Safety and Health Administration) regulations, National Fire Protection Association (NFPA), Petroleum Hazards Classification, IP15 Petroleum classification based on flash point, OISD standards (Oil Industry Safety Directorate), API Codes (American Petroleum Institute), PESO (Petroleum and Explosives Safety Organization) guidelines, Investigations Reports & Best practices data Chemical Safety Board, USA

Case Studies – From Industries on Lessons from Incidents from Environmental Protection Agency (EPA), Safety & Environmental Incidents, etc.

UNIT II  INTER UNIT DISTANCES  9
Distance between plants, substation, centralized control room, utilities sections / captive power plants; Inter-distance between adjacent Columns, Storage tanks, Tank dykes; Flare stack location (based on Prevailing up-wind direction), Design to keep it smokeless, Sterile zone/area – Governing API /OISD Standards, Field cabins. Access to firefighting facilities, Fire tank capacity, Foam need assessment, Design to tackle simultaneous fire incidents, Protection of fire network and ensuring availability on demand, Risk evaluation (arising from inventory of flammable liquid, potential formation of explosive mixture, operation above auto-ignition temperature, toxic release, etc.) based on credible scenario;3D models used in equipment & piping isometric, Maintenance accessibility, Safe work place specially at elevated platform, Ease of emergency evacuation; Bow Tie Analysis to mitigate risk right at design stage, Blast proof design of control room, Minimize employee occupancy at a given time in risk zone. Case Studies – From Industries on operations & maintenance aspects viz. Trouble shooting, Efficiency / Effectiveness tracking, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.

UNIT III  STORAGE TANKS  9
Storage Tanks – Fixed or Floating roof, Mounded Bullet tanks, Cryogenic storage tanks & their special design requirements, Special designs along with breather systems, Lightening arrestors, Earth pits, other appurtenances –Manways for roofs or tank sidewalls, Catwalks, Roof vents, Roof hatches, Nozzles, Roofs (flat-style, knuckle-style, or pitched), Aluminium geodesic domes, Ladders, etc. Comfort factors Vs Inventory carrying cost, Safe operation of floating roof travel, breather sizing, steam coils design, rainwater drains, dyke capacity, inter tank distance based on product hazard classification, tank inspection schedule, ease of cleaning, confined place entry, water spray and other firefighting feature, fugitive emission control, etc. Case Studies – From Industries on operations & maintenance aspects viz. Trouble shooting, Water traps and roof collapse, safe filling height, Design tips, Safety & Environmental Incidents, etc.

UNIT IV  AT RISK SYSTEMS AND EQUIPMENT  9
At-risk systems and equipment: Fuel gas systems, Fuel oil network, Hydrogen gas for generator cooling in power plants; Plant battery systems, Ammonia systems, Solid handling of coal and coke dust, Sulphur yard, Toxic gas loss of containment, etc, MSDS of every stream being handled / processed, Spent catalyst safe disposal ;Safe at Risk Assessment: Overall risk assessment using credible scenario along with preventive measures & systems to be in place to eliminate / minimize loss of containment. Case Studies – From Industries on operations & maintenance aspects viz. Trouble shooting, Process Control, Early event detection, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.

UNIT V  BASIC ENGINEERING DESIGN PACKAGE  9
Basic Engineering Design Package (BEDP): First document to be prepared and approved between Process Engineering Team and Owner’s representative. It shall cover not limited to – Site Conditions (weather, wind rose, seismic activity, water table, etc.); System of measurement (in
FPS or MKS for flow of gas / liquid / steam, temperature, pressure, heat duty, inferential properties, etc.), Design considerations and margins, Design philosophies such as Operating & Control philosophy, Vent & Drain philosophy, Isolation philosophy, sparing philosophy etc. Raw material details (Capacity, conditions, logistics including receipt modes & storage criteria) Product offtake plans and modes of distribution, environmental norms, Levels of power & utilities that would be available for safe and hassle free operations; Green belt cover, use of renewables, zero liquid discharge, maximum air cooling / condensing, storm water channel considerations, rain water harvesting; Flare gas recovery, flight path and tall structures in industry premises, MIQA (mechanical integrity and quality assurance) considerations, equipment designed life; Feed definition / variability / flexibility, product mix & swings, product quality, custody transfer design basis, turnaround plans; Energy & loss targets and best in class design considerations, criteria for smooth and faster start-up, onstream factor, spinning margin, applicable codes, built in features for continual improvement, advanced process control and other s/w deployment for SCM (Supply Chain Mgt) and O&M (Operation and Maintenance) excellence. Case Studies – Lessons learnt from Industries viz. examples of regret investment, deviations from original design & impact thereof, market forces & design adaptability, challenges in product quality, etc.

TOTAL: 45 PERIODS

OUTCOMES:
On completion of the course, the students will be able to
CO1 – understand the importance of plant layout in mitigating risk on people, plant, planet
CO2 – understand the knowledge in placing equipment for ease of operability & maintainability
CO3 – understand the storage tanks operation and usage at safety level
CO4 – knowledge on usage of equipment at safety levels and their risk assessment
CO5 – understand the basic engineering design package

TEXTBOOKS
1. Chemical Engineering Design Principles, Practice and Economics of Plant and Process Design
   - GAVIN TOWLER and RAY SINNOTT

REFERENCE BOOKS
1. OISD Guideline on Plant Layout - OISD-STD-118
2. OSHA Guidelines on Plant Layout
3. API Guidelines on Plant layout
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<td>understand the knowledge in placing equipment for ease of operability &amp; maintainability</td>
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<td>understand the storage tanks operation and usage at safety level</td>
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COURSE OBJECTIVES:

- To understand the process safety systems both to prevent incident & to minimize loss
- To apply the principles ‘safe at risk’ to assess likely unsafe conditions in unit operation

UNIT I  SAFETY SYSTEMS

Safety systems: Deployment of sensors (Toxic, HC and Thermal) at critical locations, Fire network including elevated fire monitors, Egress system, Escape route and Assembly point, Water curtain, eye wash requirement, Clean and cooler water supply ;Dovetail Early Event Detections system to forecast and forewarn on ‘unsafe’ conditions emerging in process units, Cause & Effect diagram, Alarm rationalization, Partial or Total Plant Trips review; Setting up IOW (Integrity Operating Window), Utility stations at strategic locations in process units (for supply of LP steam, Nitrogen, Industrial Air, Service water), Fire Proofing of structures, ROVs (Remote Operated Valves), EIVs (Emergency Isolation Valves), Redundancy in trips (1 oo 1; 2 oo 3) and avoidance of spurious trips ;SIL (Safety Integrity Level) in process safety, HIPS (High Integrity Protection System),Shutdown system reset – Field or Controlled room, Centralized Vs Decentralized Control centre, Need of Chemical filter in Control Room Air conditioning, Cyber-attack prevention, Mutual aid plan. Case Studies – From Peer Industries on Performance Benchmark, Process safety Management, Safety Culture, Asset Integrity, Litigations, Safety & Environmental Incidents, etc.

UNIT II  ELECTRICAL SYSTEMS

Power systems – KV level, 3 phase and single phase, LT, HT generation and distribution network systems, MCC / PCC (motor control centre and power control centre) substations, Electrical Energy Audits, Exergy analysis, Cogen design aspects ; Emergency Power needs based on process criticalities (including power back up for fire water and plant safe shut down), Load shedding, Essential and Non- essential power load ;Uninterrupted Power System (UPS), Load assessment for UPS, Battery bank ;Earth pit design and maintenance aspects, Earth – Neutral Differential & impacts of stray voltage, Fault Level and its relevance in industry, Start-up load, Power from two independent Sources, Relay / Fuse Coordination. Electrical load distribution and its influence on safety relief / flare load in an industrial complex, Interphase with DCS (Distributed Control System), PLCs (programmable logic controls), I/P (Current to Pneumatic transmission) convertor failures ;An overview on electrical failures viz. cable fault, over load, over voltage due to surges, lightning strokes, aging of conductor, internal & external stresses on the conductors, spike in power banks, etc., Case Studies – Industries experiences on Steam – Power balance for efficiency enhancement, smart debottlenecking to minimize cable routing & MCC / PCC use, Safety & Environmental Incidents, etc.

UNIT III  FLARE SYSTEM

LP, HP, LLP and H2S flares, Types – Single Point Flares (Sonic & Subsonic), Multi Point Flares, Coanda Flares, Vent Tips, Enclosed Flares and Air Assisted Gas Flares ;Pilot gas system, Electronic ignition, Flare tip design, Flare noise reduction, Fire Ball prevention, Smokeless flare at worst weather conditions, Radiation impact zone, Flare release scenarios (fire, blocked mode, partial and total power failure), Nitrogen purge, flare header network design; Safety margins in design, Assessing flare loss in a multi units complex where metering individual headers is near impossible ;Flare gas recovery and Zero Flare release, Flare gas quality tracking and hydrogen management in refineries & petrochemicals. Case Studies – Industries experiences viz. Flare tips & header maintenance, Trouble shooting, Smart debottlenecking of units to limit flare load within capacity, Safety & Environmental Incidents, etc.

UNIT IV  RISK MITIGATION MEASURES

HAZOP (Hazard and Operability Study), HAZID (Hazard identification), HAZAN (Hazard Analysis), EERA (Emergency escape route analysis), SIL (Safety Integrity levels) study, QRA (Quantitative Risk Assessment)and Dispersion studies ;Trip reset (Field and Control Room) and MSDS (Material Safety Data Sheet) for all streams being handled, Bow Tie Analysis, Risk Evaluation using 8 x 8 Matrix, FMEA (Failure Modes And Effects Analysis), Insurance premium assessment and measures to minimize ;Best practices – Updated documentation, SOPs (Standard Operating Procedures),
SMPs (Standard Maintenance Procedures), PSM audits, Competency mapping and enhancement, employee loyalty programme, etc. Business risk – Risk in transportation of feed and products especially in sea routes (marine pollution); HSE norms non-compliance; Act of force majeure; etc. **Case Studies** – Industries experiences such as Trouble shooting, Efficiency / Effectiveness tracking, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.

**UNIT V  PROCESS CONTROL & INSTRUMENTATION**

Pneumatic (analogue controls) to DCS journey, Single loop Vs Multi loop controls, I/O cards, Graphic design & grouping to minimize user latency in process control ;Designed for safety through redundancy right from dedicated impulse lines to card level, PLC (Programmable Logic Controls), Cascaded Control, Process Historian, Online reporting by exception, Inferential predictions ;Use of AI / ML in controlling plant within best operating zone, QMI (Quality Measuring Instruments), Alarm rationalization, Operator Fatigue ;Functional designs in delayed (by a few seconds) trip, Machine monitoring viz. signature analysis (vibration and axial displacement), surge control with differing mol wt of process gas, tribology analysis ;Emphasis on lab instrumentation to get “tell-tale” indications on existence of unsafe conditions, hand held instrumentations to work in confined space, communication system (field & control room, etc.) etc. CCTV at select places to monitor and alert well in advance. Centralized fire control panel for the whole premises by way of wired network of safety sensors. **Case Studies** – From Industries on operations & maintenance aspects viz. Trouble shooting, Efficiency / Effectiveness tracking, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.

**OUTCOMES:**

On completion of the course, the students will be able to
CO1: learn the safety systems both to prevent incident & to minimize loss
CO2: understand the safety in electrical systems
CO3: knowledge on flare systems and their safety
CO4: get thorough knowledge on risk analysis and mitigation
CO5: knowledge on the control systems and their safety usage in different process industries

**TOTAL: 45 PERIODS**

**TEXTBOOKS**
2. Fundamentals of Process Safety Engineering - **Samarendra Kumar Biswas**

**REFERENCE BOOKS**
1. Chemical Process Safety - **Aarti Kashyap**
2. Process Safety - **Klein James A and Bruce K Vaughan**
**COURSE ARTICULATION MATRIX:**

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statements</th>
<th>PO1</th>
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<th>PSO1</th>
<th>PSO2</th>
<th>PSO3</th>
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<td>learn the safety systems both to prevent incident &amp; to minimize loss</td>
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<td>knowledge on flare systems and their safety</td>
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<td>get thorough knowledge on risk analysis and mitigation</td>
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<td>CO5</td>
<td>knowledge on the control systems and their safety usage in different process industries</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
COURSE OBJECTIVES:
- To understand various degradation mechanism that engineers face in chemical plants
- To mitigate with right choice metallurgy or chemical solution or operational changes

UNIT I  CORROSION
Different Degradation Mechanism as seen in various Chemical process industries, Corrosion (wet \(H_2S\), Naphthenic acid bearing Crude Processing, \(CO_2\) stress corrosion cracking, polythionic acid formation potential, amine stress corrosion cracking, microbiologically induced corrosion, corrosion under insulation, galvanic corrosion, caustic embrittlement, introduction & diffusion of hydrogen, Chloride stress corrosion cracking, etc.) ;Monitoring and prevention, NACE (National Association of Corrosion Engineers) guidelines, Life Cycle Cost Optimization and right MOC (Material of construction), Trade-off between MOC Vs Chemical inhibitors / Additives Solutions ;‘NO HARM’ requirements in chemical solutions, Operation within ‘best operating zone’, Corrosion coupons and test methods in lab, Need & challenges in asset Integrity management, Coatings, Leak Detection & Repair. Case Studies – From Industries on operational excellence viz. Trouble shooting, Efficacy of chemicals, Processing different feedstocks with confidence, Design tips, Safety & Environmental Incidents, etc.

UNIT II  ASSETS RELIABILITY ENHANCEMENT & INCIDENT ELIMINATION
Risk envelope, Inputs on FERT (Fire, Explosivity, Reactivity and Toxicity), Quantification of unplanned interruption viz. impact on Safety, Environment and Loss of properties / business erosion, Early Event Detection using AI / ML, Surface Chemistry, Advanced Lab Techniques (SEM - Scanning Electron Microscopy, Corrosion probes, Field Signature Method, Non-intrusive techniques, Ultimate Analysis, Atomic ratios on debris, Tell-Tale Indications, etc.), Case Studies – From Industries on process / equipment reliability viz. Asset integrity, Asset sweating within safe operating window, Design errors, Safety & Environmental Incidents, Human factors, etc.

UNIT III  FLOW AND ACOUSTIC INDUCED VIBRATION IN PIPES
Flow Induced Vibration in pipes: Flow regimes – Slug flow, plug flow, annular, dispersed, etc. Flows in Vertical and Horizontal pipes, Design criticalities in two phase (gas & liquid) and slurry flow (solid and liquid), Handling of steam condensate& prevention of water hammering, Piping Configurations for symmetrical flow distribution, Use CFD (Computational Fluid Dynamics) to assess - selective erosion in some section of pipes, cycling pattern of vibration, heat flux or fluid film temperature variation in heater tubes, etc., Suitability of Material of Constructions for different operating severity and feed stocks including changes in process conditions during start up, shut down, catalyst pre-sulphating, etc. Acoustic induced vibrations in pipes due to high velocity gas streams in pipes (Near sonic velocity conditions). Case Studies – From Industries on operations & maintenance aspects viz. Trouble shooting and controlling flow regimes to avoid vibration, Design tips, Safety & Environmental Incidents, etc.

UNIT IV  FOULING AND COKING
Asphaltenes precipitation, Wax deposits, Gum formation, Ageing of hydrocarbon on prolonged storage and filter plugging ;Dewatering and prevention of ingress of corrosion products leading to fouling, dead zone (stagnant) prevention, Inserting storage tanks to avoid oxidation induced feed / product degradation, Incompatibility of mixing, Shear stress assessment, Assessment of Coke precursors and elimination / removal during processing ;Chemical (anti-foulant) additives to mitigate fouling / coking, process variables impacting fouling specially in exchangers, heater pipes and column internals, Methods of decoking – steam-air decoking, mechanical, pigging and spalling ;Use of quench oil in gas / naphtha cracker heaters to keep asphaltenes in suspension, polymerisation prevention, hypothesis on coking viz. pyrolytic coke, filamentous coke, amorphous coke formation, etc. Case Studies – From Industries on operational excellence viz. Trouble shooting, Efficacy of chemicals, Processing different feedstocks with confidence, Design tips, Safety & Environmental Incidents, etc.
Academy to list the course content including use of graphene, metal organic framework, superconductors, replacement of Lithium for battery making, etc. In addition, Nano materials, there are lot more efforts needed to minimize dependence on import for some of the metals used in catalyst, defence needs, etc. which can only be substituted with effective end application needs and metallurgy and or alloy use. Case Studies – From market and strategic needs.

OUTCOMES:
On completion of the course, the students will be able to
CO1 – understand the basic concept on corrosion and their types in chemical industry
CO2 – know the degradation mechanism that engineers’ face in chemical plants
CO3 – recognize the different flows in pipes and their acoustic induced vibrations
CO4 - gain knowledge in the concept of fouling in pipes and different methods of decoking
CO5 – gather some knowledge on advancement in material science usage.

TEXTBOOKS
1. Corrosion Mechanisms (Chemical Industries) - Florian Mansfeld

REFERENCE BOOKS
1. NACE documents - American Petroleum Institute (API) 571 standards
## COURSE ARTICULATION MATRIX:

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<tr>
<th>Course Outcomes</th>
<th>Statements</th>
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<td>know the degradation mechanism that engineers' face in chemical plants</td>
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<td>CO5</td>
<td>gather some knowledge on advancement in material science usage</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
COURSE OBJECTIVES:

- To understand the purpose of competitive edge within the regulatory systems set
- To leverage learning to become SMART manufacturer within norms of responsive care

UNIT I PEOPLE AND PROCESS SAFETY

Factory Act, IBR (Indian Boiler Regulations), Weights & Measures, Power Connection from State Electricity Board, Labour Legislation, Compensation, Fines, Litigations, Image, etc. and other commercial approvals like company registration, GST Registration, IT act, Excise Regulations etc. For operations under EOU (Export oriented units) or SEZ (Special Economic Zones), take additional approval from Export Processing Zone (EPZ) and SEBI. **Case Studies** – Assess the number of days taken for all such approval and apply LEAN to crunch time.

UNIT II ENVIRONMENTAL REGULATIONS

Water act, Air act, for highly polluting industry category EIA (Environment Impact Assessment) is mandatory, Environmental Protection Act, Licence needed for 'Drugs & Pharmaceuticals' from State Drug Controller, Hazardous substance management, Waste Management rules, Pollution Control Boards / Consent to operate (State and Union Government) specially for Industries Requiring Water and Affecting Effluent Disposal… **Case Studies** – Assess the number of days taken for all such approval and apply LEAN to crunch time. Additionally, benchmark on HSE norms to compare with peer industries for improvement options.

UNIT III CUSTOMER CARE

Customer definition, Kano Model, CRM, PFABFS model (Property, Feature, Advantage, Benefit and Savings both monetary and emotional value); Product Supply Specification based on end use applications with competitive edge over peer industries; Quality Cost, Custody transfer precision, Wing to Wing co-operation with customers / suppliers to enhance value chain returns; Development of new products and services – Ideation, proof of concept, pilot run & commercialization. **Case Studies** – Products & Services that made difference, Companies that disappeared when changes were not picked up in time, Point of Sale tips for lasting impression, Cycle time to launch new product.

UNIT IV INTERNSHIP PREPARATION AND DO’S & DON’TS

Safety Contact, Mandatory use of PPE, Assembly points, Alarm station, Mock drills, Firefighting apparatus use on demand, know the escape routes; Shadow the trainer, learning objective – pick any one viz. Catalysis – past say three to five catalyst change, the conversion variation, generation of low value side reactions, sintering & loss of margin, H₂ loss, any tell-tale indications from apple core tests of spent catalyst, Deep dive into design of say, heat exchangers network with a view to achieve O&M excellence, Asset reliability – O&M efforts to continuously track PSM critical equipment, Energy benchmarking. Overall processing margins against best in class peer industries, Inventory management and assessment of revenue by blocked investment, Water management, etc. **Case studies** – In nearby cluster of industries at Tamil Nadu, assess O&M gaps and work to bridge the gap, learn about competencies gaps, past LFIs with RCA initiated, etc.

UNIT V SUSTAINABILITY REPORTING

Understanding aspects like 'Net Zero Concept', Green House Gases release reduction, ZLD (zero Liquid discharge), Benefits to the society, Concepts of linear economy and circular economy, Life Cycle Analysis, Think Global and Act Local, learn on 17 Sustainable Development Goals as per UN charter, Use Global Reporting Initiative (GRI) formats for Sustainability reporting. **Project assignment** – Work on Sustainability reporting for nearby cluster of industries in Tamil Nadu

OUTCOMES:

On completion of the course, the students will be able to

- **CO1** – understand the basis on different acts and their regulations
- **CO2** – basic knowledge in different ACT on water, air and environmental protection
- **CO3** – knowledge on the preparation of Kano model, CRM, PFABFS
CO4 – gain the knowledge on Do’s and Don’ts in an internship program
CO5 – understand the concepts of ZLD, GHG release and circular economy

TEXTBOOKS
2. Competitive Advantage: Creating and Sustaining Superior performance – Michael E. Porter

REFERENCE BOOKS
1. Sustainability What Everyone Needs to Know - Paul B. Thompson, Patricia E. Norris
**Course Articulation matrix:**

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statements</th>
<th>Program Outcomes</th>
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<tbody>
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<td>PO1</td>
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<tr>
<td>CO1</td>
<td>understand the basis on different acts and their regulations</td>
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<tr>
<td>CO2</td>
<td>basic knowledge in different ACT on water, air and environmental protection</td>
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<tr>
<td>CO3</td>
<td>knowledge on the preparation of Kano model, CRM, PFABFS</td>
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<td>CO4</td>
<td>gain the knowledge on Do’s and Don’ts in an internship program</td>
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<td>CO5</td>
<td>understand the concepts of ZLD, GHG release and circular economy</td>
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</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
COURSE OBJECTIVES:
- To understand the design and management of utilities system in any chemical industry
- To apply energy conservation techniques right at design and strive net zero emission

UNIT I BASIC UTILITIES
Air (Industrial Service and Instrument), Cold Box air Liquification Plant, Nitrogen, Inert gas generation; Water (Potable, Service, Utility, Cooling Boiler Feed water, DM water, Desal water, RO permeate, etc.); Steam (High Pressure, Medium, Low and Very Low-pressure system), Condensate Polishing, Hot oil system, Thermic fluids for energy supply to Process equipment. Associated control equipment to monitor and prevent Water Pollution, Air Pollution control equipment, Solid waste storage area as per Waste management Rules. Also, discuss about the need to control slop generation in chemical industries. Case Studies – From Industries on operations & maintenance aspects viz. Trouble shooting, Efficiency / Effectiveness tracking, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.

UNIT II POWER GENERATION & DISTRIBUTION
Power Generation & Distribution: Gas turbines (types of fuel Vs operational reliability), Open and closed cycle, Steam Turbine generators, Power Recovery Turbo generators, IC Engines Power Generators, Renewables Power – Solar, Wind, Waves, Geo thermal, Biomass, Fuel Gas / Fuel Oil network, Impacts of utility failures (partial and or full). Case Studies – From Industries on operations & maintenance aspects viz. Trouble shooting, Efficiency / Effectiveness tracking, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.

UNIT III WASTEWATER TREATMENT
Wastewater Treatment: Bioremediation, WWTP (Wastewater Treatment Plants along with separation system and biochemical processes to reduce BOD / COD (Biochemical Oxygen Demand and Chemical Oxygen Demand), Recalcitrant material adding to COD, Considerations in deployment of RO Membrane and reuse of treated water. Case Studies – From Industries on operations & maintenance aspects viz. Trouble shooting, Efficiency / Effectiveness tracking, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.

UNIT IV GAS PROCESSING
LNG/ CNG, Refinery Gas Treating, Sour Gas Processing, Amine Absorption and Regeneration Processes, Sulphur Recovery & Removal, Gas dehydra and Dew pointing. Case Studies – From Industries on operations & maintenance aspects viz. Trouble shooting, Efficiency / Effectiveness tracking, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.

UNIT V COOLING WATER SYSTEM
Cooling water System: Cooling towers (CT), Wet and Dry Bulb and its relation to CT performance, Induced Vs Natural Draft CT, COC (Cycle of Concentration), Minimize / eliminate drift loss, CW network, assessment of cooling effectiveness in multiple parallel exchangers with availability of combined flow. Case Studies – From Industries on operations & maintenance aspects viz. Trouble shooting, Efficiency / Effectiveness tracking, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.

TOTAL: 45 PERIODS

OUTCOMES:
On completion of the course, the students will be able to
CO1: gain knowledge in the importance of process plant utilities
CO2: Understand the Requisites of Industrial Water and treatment methodologies
CO3: be familiar on various types of steam generators and boiler corrosion
CO4: Understand the concept of refrigeration used in industries
CO5: Learn the classification of compressors and humidification equipments
TEXTBOOKS
2. Plant Utilities - D. B. DHONE Publisher Nirali Prakashan, 2018

REFERENCE BOOKS
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<tr>
<th>Course Outcomes</th>
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<td>gain knowledge in the importance of process plant utilities</td>
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<td>Understand the Requisites of Industrial Water and treatment methodologies</td>
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<td>be familiar on various types of steam generators and boiler corrosion</td>
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<td>Learn the classification of compressors and humidification equipments</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
COURSE OBJECTIVES:
- Sketch the Evolution of Management.
- Extract the functions and principles of management.
- Learn the application of the principles in an organization.
- Study the various HR related activities.
- Analyze the position of self and company goals towards business.

UNIT I INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS

UNIT II PLANNING

UNIT III ORGANISING

UNIT IV DIRECTING

UNIT V CONTROLLING
System and process of controlling – Budgetary and non - Budgetary control techniques – Use of computers and IT in Management control – Productivity problems and management – Control and performance – Direct and preventive control – Reporting.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: Upon completion of the course, students will be able to have clear understanding of managerial functions like planning, organizing, staffing, leading & controlling.
CO2: Have same basic knowledge on international aspect of management.
CO3: Ability to understand management concept of organizing.
CO4: Ability to understand management concept of directing.
CO5: Ability to understand management concept of controlling.

TEXT BOOKS:

REFERENCES:

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TOTAL QUALITY MANAGEMENT

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COURSE OBJECTIVES:
- Teach the need for quality, its evolution, basic concepts, contribution of quality gurus, TQM framework, Barriers and Benefits of TQM.
- Explain the TQM Principles for application.
- Define the basics of Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.
- Describe Taguchi’s Quality Loss Function, Performance Measures and apply Techniques like QFD, TPM, COQ and BPR.
- Illustrate and apply QMS and EMS in any organization.

UNIT I

INTRODUCTION

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of product and service quality –Definition of TQM-- Basic concepts of TQM - Gurus of TQM (Brief introduction) -- TQM Framework- Barriers to TQM –Benefits of TQM.

UNIT II

TQM PRINCIPLES


UNIT III

TQM TOOLS & TECHNIQUES I


UNIT IV

TQM TOOLS & TECHNIQUES II

Quality circles – Quality Function Deployment (QFD) - Taguchi quality loss function – TPM – Concepts, improvement needs – Performance measures- Cost of Quality - BPR.

UNIT V

QUALITY MANAGEMENT SYSTEM

Introduction-Benefits of ISO Registration-ISO 9000 Series of Standards-Sector-Specific Standards - AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements-Implementation-Documentation- Internal Audits-Registration-ENVIRONMENTAL MANAGEMENT SYSTEM:

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: Ability to apply TQM concepts in a selected enterprise.
CO2: Ability to apply TQM principles in a selected enterprise.
CO3: Ability to understand Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.
CO4: Ability to understand Taguchi's Quality Loss Function, Performance Measures and apply QFD, TPM, COQ and BPR.
CO5: Ability to apply QMS and EMS in any organization.

TEXT BOOK:

REFERENCES:

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GE3753 ENGINEERING ECONOMICS AND FINANCIAL ACCOUNTING

COURSE OBJECTIVES:
- Understanding the concept of Engineering Economics.
- Implement various micro economics concept in real life.
- Gaining knowledge in the field of macro economics to enable the students to have better understanding of various components of macro economics.
- Understanding the different procedures of pricing.
- Learn the various cost related concepts in micro economics.

UNIT I DEMAND & SUPPLY ANALYSIS
Managerial Economics - Relationship with other disciplines - Firms: Types, objectives and goals - Managerial decisions - Decision analysis. Demand - Types of demand - Determinants of demand - Demand function – Demand elasticity - Demand forecasting - Supply - Determinants of supply - Supply function - Supply elasticity.

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UNIT II PRODUCTION AND COST ANALYSIS 9
Production function - Returns to scale - Production optimization - Least cost input - Isoquants - Managerial uses of production function.

UNIT III PRICING 9
Determinants of Price - Pricing under different objectives and different market structures - Price discrimination - Pricing methods in practice.

UNIT IV FINANCIAL ACCOUNTING (ELEMENTARY TREATMENT) 9
Balance sheet and related concepts - Profit & Loss Statement and related concepts - Financial Ratio Analysis - Cash flow analysis - Funds flow analysis - Comparative financial statements - Analysis & Interpretation of financial statements.

UNIT V CAPITAL BUDGETING (ELEMENTARY TREATMENT) 9
Investments - Risks and return evaluation of investment decision - Average rate of return - Payback Period - Net Present Value - Internal rate of return.

TOTAL: 45 PERIODS

COURSE OUTCOMES: Students able to
CO1: Upon successful completion of this course, students will acquire the skills to apply the basics of economics and cost analysis to engineering and take economically sound decisions
CO2: Evaluate the economic theories, cost concepts and pricing policies
CO3: Understand the market structures and integration concepts
CO4: Understand the measures of national income, the functions of banks and concepts of globalization
CO5: Apply the concepts of financial management for project appraisal

TEXT BOOKS:

REFERENCES:
5. Dr. S. N. Maheswari and Dr. S.K. Maheshwari: Financial Accounting, Vikas, 2009

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OBJECTIVE:
- To provide knowledge about management issues related to staffing,
- To provide knowledge about management issues related to training,
- To provide knowledge about management issues related to performance
- To provide knowledge about management issues related to compensation
- To provide knowledge about management issues related to human factors consideration and compliance with human resource requirements.

UNIT I  INTRODUCTION TO HUMAN RESOURCE MANAGEMENT  9

UNIT II  HUMAN RESOURCE PLANNING  9

UNIT III  TRAINING AND EXECUTIVE DEVELOPMENT  9
Types of training and Executive development methods – purpose – benefits.

UNIT IV  EMPLOYEE COMPENSATION  9

UNIT V  PERFORMANCE EVALUATION AND CONTROL  9

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: Students would have gained knowledge on the various aspects of HRM
CO2: Students will gain knowledge needed for success as a human resources professional.
CO3: Students will develop the skills needed for a successful HR manager.
CO4: Students would be prepared to implement the concepts learned in the workplace.
CO5: Students would be aware of the emerging concepts in the field of HRM

TEXT BOOKS:

REFERENCES:

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GE3755 KNOWLEDGE MANAGEMENT  L T P C  3 0 0 3

COURSE OBJECTIVES:
The student should be made to:
Learn the Evolution of Knowledge management.
• Be familiar with tools.
• Be exposed to Applications.
• Be familiar with some case studies.

UNIT I INTRODUCTION
Introduction: An Introduction to Knowledge Management - The foundations of knowledge management- including cultural issues- technology applications organizational concepts and processes- management aspects- and decision support systems. The Evolution of Knowledge management: From Information Management to Knowledge Management - Key Challenges Facing the Evolution of Knowledge Management - Ethics for Knowledge Management.

UNIT II CREATING THE CULTURE OF LEARNING AND KNOWLEDGE SHARING

UNIT III KNOWLEDGE MANAGEMENT-THE TOOLS
Telecommunications and Networks in Knowledge Management - Internet Search Engines and Knowledge Management - Information Technology in Support of Knowledge Management - Knowledge Management and Vocabulary Control - Information Mapping in Information Retrieval - Information Coding in the Internet Environment - Repackaging Information.

UNIT IV KNOWLEDGE MANAGEMENT APPLICATION
Components of a Knowledge Strategy - Case Studies (From Library to Knowledge Center, Knowledge Management in the Health Sciences, Knowledge Management in Developing Countries).

UNIT V FUTURE TRENDS AND CASE STUDIES
Advanced topics and case studies in knowledge management - Development of a knowledge management map/plan that is integrated with an organization's strategic and business plan - A case study on Corporate Memories for supporting various aspects in the process life -cycles of an organization.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of the course, the student should be able to:
CO1: Understand the process of acquirey knowledge from experts
CO2: Understand the learning organization.
CO3: Use the knowledge management tools.
CO4: Develop knowledge management Applications.
CO5: Design and develop enterprise applications.

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TEXT BOOK:

REFERENCE:

GE3792 INDUSTRIAL MANAGEMENT

COURSE OBJECTIVES
- To study the basic concepts of management; approaches to management; contributors to management studies; various forms of business organization and trade unions function in professional organizations.
- To study the planning; organizing and staffing functions of management in professional organization.
- To study the leading; controlling and decision making functions of management in professional organization.
- To learn the organizational theory in professional organization.
- To learn the principles of productivity and modern concepts in management in professional organization.

UNIT – I INTRODUCTION TO MANAGEMENT
Management: Introduction; Definition and Functions – Approaches to the study of Management – Mintzberg’s Ten Managerial Roles – Principles of Taylor; Fayol; Weber; Parker – Forms of Organization: Sole Proprietorship; Partnership; Company (Private and Public); Cooperative – Public Sector Vs Private Sector Organization – Business Environment: Economic; Social; Political; Legal – Trade Union: Definition; Functions; Merits & Demerits.

UNIT – II FUNCTIONS OF MANAGEMENT - I
Planning: Characteristics; Nature; Importance; Steps; Limitation; Planning Premises; Strategic Planning; Vision & Mission statement in Planning – Organizing: Organizing Theory; Principles; Types; Departmentalization; Centralization and Decentralization; Authority & Responsibility – Staffing: Systems Approach; Recruiting and Selection Process; Human Resource Development (HRD) Concept and Design.

UNIT – III FUNCTIONS OF MANAGEMENT - II
Directing (Leading): Leadership Traits; Style; Morale; Managerial Grids (Blake-Mounton, Reddin) – Communication: Purpose; Model; Barriers – Controlling: Process; Types; Levels; Guidelines; Audit (External, Internal, Merits); Preventive Control – Decision Making: Elements; Characteristics; Nature; Process; Classifications.

UNIT – IV ORGANIZATION THEORY
Organizational Conflict: Positive Aspects; Individual; Role; Interpersonal; Intra Group; Inter Group; Conflict Management – Maslow’s hierarchy of needs theory; Herzberg’s motivation-hygiene theory; McClelland’s three needs motivation theory; Vroom’s valence-expectancy theory – Change Management: Concept of Change; Lewin’s Process of Change Model; Sources of Resistance; Overcoming Resistance; Guidelines to managing Conflict.

UNIT – V PRODUCTIVITY AND MODERN TOPICS
Productivity: Concept; Measurements; Affecting Factors; Methods to Improve – Modern Topics (concept, feature/characteristics, procedure, merits and demerits): Business Process Reengineering (BPR); Benchmarking; SWOT/SWOC Analysis; Total Productive Maintenance; Enterprise Resource Planning (ERP); Management of Information Systems (MIS).

TOTAL: 45 PERIODS
COURSE OUTCOMES:
At the end of the course the students would be able to
CO1 Explain basic concepts of management; approaches to management; contributors to management studies; various forms of business organization and trade unions function in professional organizations.
CO2 Discuss the planning; organizing and staffing functions of management in professional organization.
CO3 Apply the leading; controlling and decision making functions of management in professional organization.
CO4 Discuss the organizational theory in professional organization.
CO5 Apply principles of productivity and modern concepts in management in professional organization.

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MANDATORY COURSES I

MX3081 INTRODUCTION TO WOMEN AND GENDER STUDIES

COURSE OUTLINE

UNIT I CONCEPTS
Sex vs. Gender, masculinity, femininity, socialization, patriarchy, public/private, essentialism, binaryism, power, hegemony, hierarchy, stereotype, gender roles, gender relation, deconstruction, resistance, sexual division of labour.

UNIT II FEMINIST THEORY
Liberal, Marxist, Socialist, Radical, Psychoanalytic, postmodernist, ecofeminist.

UNIT III WOMEN’S MOVEMENTS: GLOBAL, NATIONAL AND LOCAL
Rise of Feminism in Europe and America.
Women’s Movement in India.

UNIT IV GENDER AND LANGUAGE
Linguistic Forms and Gender.
Gender and narratives.

UNIT V GENDER AND REPRESENTATION
Advertising and popular visual media.
Gender and Representation in Alternative Media.
Gender and social media.

TOTAL : 45 PERIODS

MX3082 ELEMENTS OF LITERATURE

OBJECTIVE:
- To make the students aware about the finer sensibilities of human existence through an art form. The students will learn to appreciate different forms of literature as suitable modes of expressing human experience.

1. COURSE CONTENTS
   Introduction to Elements of Literature
   
   1. Relevance of literature
      a) Enhances Reading, thinking, discussing and writing skills.
      b) Develops finer sensibility for better human relationship.
      c) Increases understanding of the problem of humanity without bias.
      d) Providing space to reconcile and get a cathartic effect.

   2. Elements of fiction
      a) Fiction, fact and literary truth.
      b) Fictional modes and patterns.
      c) Plot character and perspective.
3. Elements of poetry
   a) Emotions and imaginations.
   b) Figurative language.
   c) (Simile, metaphor, conceit, symbol, pun and irony).
   d) Personification and animation.
   e) Rhetoric and trend.

4. Elements of drama
   a) Drama as representational art.
   b) Content mode and elements.
   c) Theatrical performance.
   d) Drama as narration, mediation and persuasion.
   e) Features of tragedy, comedy and satire.

3. READINGS:

3.1 Textbook:
3.2 *Reference Books:: To be decided by the teacher and student, on the basis of individual student so as to enable him or her to write the term paper.

4. OTHER SESSION:
   4.1*Tutorials:
   4.2*Laboratory:
   4.3*Project: The students will write a term paper to show their understanding of a particular piece of literature

5. ASSESSMENT:
   5.1HA:
   5.2Quizzes-HA:
   5.3Periodical Examination: one
   5.4Project/Lab: one (under the guidance of the teachers the students will take a volume of poetry, fiction or drama and write a term paper to show their understanding of it in a given context; sociological, psychological, historical, autobiographical etc.
   5.5Final Exam:

OUTCOME OF THE COURSE:
- Students will be able to understand the relevance of literature in human life and appreciate its aspects in developing finer sensibilities.
In this course on film appreciation, the students will be introduced broadly to the development of film as an art and entertainment form. It will also discuss the language of cinema as it evolved over a century. The students will be taught as to how to read a film and appreciate the various nuances of a film as a text. The students will be guided to study film joyfully.

**Theme - A: The Component of Films**
- A-1: The material and equipment
- A-2: The story, screenplay and script
- A-3: The actors, crew members, and the director
- A-4: The process of film making… structure of a film

**Theme - B: Evolution of Film Language**
- B-1: Film language, form, movement etc.
- B-2: Early cinema… silent film (Particularly French)
- B-3: The emergence of feature films: Birth of a Nation
- B-4: Talkies

**Theme - C: Film Theories and Criticism/Appreciation**
- C-1: Realist theory; Auteurists
- C-2: Psychoanalytic, Ideological, Feminists
- C-3: How to read films?
- C-4: Film Criticism / Appreciation

**Theme – D: Development of Films**
- D-1: Representative Soviet films
- D-2: Representative Japanese films
- D-3: Representative Italian films
- D-4: Representative Hollywood film and the studio system

**Theme - E: Indian Films**
- E-1: The early era
- E-2: The important films made by the directors
- E-3: The regional films
- E-4: The documentaries in India

**READING:**
A Reader containing important articles on films will be prepared and given to the students. The students must read them and present in the class and have discussion on these.

**MX3084 DISASTER RISK REDUCTION AND MANAGEMENT**

**COURSE OBJECTIVE**
- To impart knowledge on concepts related to disaster, disaster risk reduction, disaster management
- To acquaint with the skills for planning and organizing disaster response

**UNIT I HAZRADS, VULNERABILITY AND DISASTER RISKS**
Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Types of Disasters: Natural, Human induced, Climate change induced –Earthquake, Landslide, Flood, Drought, Fire etc – Technological disasters- Structural collapse, Industrial accidents, oil spills -Causes, Impacts including social, Economic, political, environmental, health, psychosocial, etc.- Disaster vulnerability profile of India and Tamil Nadu - Global trends in disasters: urban disasters, pandemics, Complex emergencies, - -, Inter relations between Disasters and Sustainable development Goals
UNIT II  DISASTER RISK REDUCTION (DRR)  
Sendai Framework for Disaster Risk Reduction, Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community Based DRR, Structural- nonstructural measures, Roles and responsibilities of community, Panchayati Raj Institutions / Urban Local Bodies (PRIs/ULBs), States, Centre, and other stakeholders- Early Warning System – Advisories from Appropriate Agencies.- Relevance of indigenous Knowledge, appropriate technology and Local resources.

UNIT III  DISASTER MANAGEMENT  
Components of Disaster Management – Preparedness of rescue and relief, mitigation, rehabilitation and reconstruction- Disaster Risk Management and post disaster management – Compensation and Insurance- Disaster Management Act (2005) and Policy - Other related policies, plans, programmers and legislation - Institutional Processes and Framework at State and Central Level- (NDMA –SDMA-DDMA-NRDF- Civic Volunteers)

UNIT IV  TOOLS AND TECHNOLOGY FOR DISASTER MANAGEMENT  

UNIT V  DISASTER MANAGEMENT: CASE STUDIES  
Discussion on selected case studies to analyse the potential impacts and actions in the contest of disasters-Landslide Hazard Zonation: Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.- Field work-Mock drill -

TOTAL : 45 PERIODS

TEXT BOOKS:
1 Taimpo (2016), Disaster Management and Preparedness, CRC Publications

REFERENCES

COURSE OUTCOME:
CO1: To impart knowledge on the concepts of Disaster, Vulnerability and Disaster Risk reduction (DRR)
CO2: To enhance understanding on Hazards, Vulnerability and Disaster Risk Assessment prevention and risk reduction
CO3: To develop disaster response skills by adopting relevant tools and technology
CO4: Enhance awareness of institutional processes for Disaster response in the country and
CO5: Develop rudimentary ability to respond to their surroundings with potential Disaster response in areas where they live, with due sensitivity
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MANDATORY COURSES II
MX3085 WELL-BEING WITH TRADITIONAL PRACTICES-YOGA, AYURVEDA AND SIDDHA

COURSE OBJECTIVES:
- To enjoy life happily with fun filled new style activities that help to maintain health also
- To adapt a few lifestyle changes that will prevent many health disorders
- To be cool and handbill every emotion very smoothly in every walk of life
- To learn to eat cost effective but healthy foods that are rich in essential nutrients
- To develop immunity naturally that will improve resistance against many health disorders

UNIT I HEALTH AND ITS IMPORTANCE 2+4

Health: Definition - Importance of maintaining health - More importance on prevention than treatment
Ten types of health one has to maintain - Physical health - Mental health - Social health - Financial health - Emotional health - Spiritual health - Intellectual health - Relationship health - Environmental health - Occupational/Professional health.


Causes of the above diseases / disorders - Importance of prevention of illness - Takes care of health - Improves quality of life - Reduces absenteeism - Increase satisfaction - Saves time

Simple lifestyle modifications to maintain health - Healthy Eating habits (Balanced diet according to age) Physical Activities (Stretching exercise, aerobics, resisting exercise) - Maintaining BMI-Importance and actions to be taken

UNIT II DIET 4+6

Role of diet in maintaining health - energy one needs to keep active throughout the day - nutrients one needs for growth and repair - helps one to stay strong and healthy - helps to prevent diet-related illness, such as some cancers - keeps active and - helps one to maintain a healthy weight - helps to reduce risk of developing lifestyle disorders like diabetes – arthritis – hypertension
– PCOD – infertility – ADHD – sleeplessness -helps to reduce the risk of heart diseases - keeps the teeth and bones strong.


**Food additives and their merits & demerits** - Effects of food additives - Types of food additives - Food additives and processed foods - Food additives and their reactions

**Definition of BMI and maintaining it with diet**
Importance - Consequences of not maintaining BMI - different steps to maintain optimal BM

**Common cooking mistakes**
Different cooking methods, merits and demerits of each method

**UNIT III ROLE OF AYURVEDA & SIDDHA SYSTEMS IN MAINTAINING HEALTH** 4+4

**AYUSH systems and their role in maintaining health** - preventive aspect of AYUSH - AYUSH as a soft therapy.

**Secrets of traditional healthy living** - Traditional Diet and Nutrition - Regimen of Personal and Social Hygiene - Daily routine (Dinacharya) - Seasonal regimens (Ritucharya) - basic sanitation and healthy living environment - Sadvritta (good conduct) - for conducive social life.

**Principles of Siddha & Ayurveda systems** - Macrocosm and Microcosm theory - Pancheekarana Theory / (Five Element Theory) 96 fundamental Principles - Uyir Thathukkal (Tri-Dosha Theory) - Udal Thathukkal

**Prevention of illness with our traditional system of medicine**
Primary Prevention - To decrease the number of new cases of a disorder or illness - Health promotion/education, and - Specific protective measures - Secondary Prevention - To lower the rate of established cases of a disorder or illness in the population (prevalence) - Tertiary Prevention - To decrease the amount of disability associated with an existing disorder.

**UNIT IV MENTAL WELLNESS** 3+4

**Emotional health** - Definition and types - Three key elements: the subjective experience - the physiological response - the behavioral response - Importance of maintaining emotional health - Role of emotions in daily life - Short term and long term effects of emotional disturbances - Leading a healthy life with emotions - Practices for emotional health - Recognize how thoughts influence emotions - Cultivate positive thoughts - Practice self-compassion - Expressing a full range of emotions.


**Sleep** - Sleep and its importance for mental wellness - Sleep and digestion.

**Immunity** - Types and importance - Ways to develop immunity

**UNIT V YOGA** 2+12

**Definition and importance of yoga** - Types of yoga - How to Choose the Right Kind for individuals according to their age - The Eight Limbs of Yoga - Simple yogasanas for cure and prevention of health disorders - What yoga can bring to our life.

**TOTAL : 45 PERIODS**

**TEXT BOOKS:**
1. Nutrition and Dietetics - Ashley Martin, Published by White Word Publications, New York, NY 10001, USA
2. Yoga for Beginners_ 35 Simple Yoga Poses to Calm Your Mind and Strengthen Your Body, by Cory Martin, Copyright © 2015 by Althea Press, Berkeley, California
REFERENCES:

2. The Mindful Self-Compassion Workbook, Kristin Neff, Ph.D Christopher Germer, Ph.D, Published by The Guilford Press A Division of Guilford Publications, Inc.370 Seventh Avenue, Suite 1200, New York, NY 10001

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4799645/
2. Simple lifestyle modifications to maintain health https://www.niddk.nih.gov/health-information/diet-nutrition/changing-habits-better-health#:~:text=Make%20your%20new%20healthy%20habit,t%20have%20time%20to%20cook.
3. Read more: https://www.legit.ng/1163909-classes-food-examples-functions.html
7. BMI https://www.hsph.harvard.edu/nutritionsource/healthy-weight/
https://www.who.int/europe/news-room/fact-sheets/item/a-healthy-lifestyle---who-recommendations
8. Yoga https://www.healthifyme.com/blog/types-of-yoga/
https://yogamedicine.com/guide-types-yoga-styles/
Ayurveda : https://vikaspedia.in/health/ayush/ayurveda-1/concept-of-healthy-living-in-ayurveda
10. CAM : https://www.hindawi.com/journals/ecam/2013/376327/
11. Preventive herbs : https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3847409/

COURSE OUTCOMES:
After completing the course, the students will be able to:
- Learn the importance of different components of health
- Gain confidence to lead a healthy life
- Learn new techniques to prevent lifestyle health disorders
- Understand the importance of diet and workouts in maintaining health

MX3086 HISTORY OF SCIENCE AND TECHNOLOGY IN INDIA

UNIT-I CONCEPTS AND PERSPECTIVES
Meaning of History
Objectivity, Determinism, Relativism, Causation, Generalization in History; Moral judgment in history
Extent of subjectivity, contrast with physical sciences, interpretation and speculation, causation verses evidence, concept of historical inevitability, Historical Positivism.
Science and Technology-Meaning, Scope and Importance, Interaction of science, technology & society, Sources of history on science and technology in India.

UNIT-II HISTORIOGRAPHY OF SCIENCE AND TECHNOLOGY IN INDIA
Introduction to the works of D.D. Kosambi, Dharmpal, Debiprasad Chattopadhyay, Rehman, S. Irfan Habib, Deepak Kumar, Dhruv Raina, and others.
UNIT-III SCIENCE AND TECHNOLOGY IN ANCIENT INDIA
Technology in pre-historic period
Beginning of agriculture and its impact on technology
Science and Technology during Vedic and Later Vedic times
Science and technology from 1st century AD to C-1200.

UNIT-IV SCIENCE AND TECHNOLOGY IN MEDIEVAL INDIA
Legacy of technology in Medieval India, Interactions with Arabs
Development in medical knowledge, interaction between Unani and Ayurveda and alchemy
Astronomy and Mathematics: interaction with Arabic Sciences
Science and Technology on the eve of British conquest

UNIT-V SCIENCE AND TECHNOLOGY IN COLONIAL INDIA
Science and the Empire
Indian response to Western Science
Growth of techno-scientific institutions

UNIT-VI SCIENCE AND TECHNOLOGY IN A POST-INDEPENDENT INDIA
Science, Technology and Development discourse
Shaping of the Science and Technology Policy
Developments in the field of Science and Technology
Science and technology in globalizing India
Social implications of new technologies like the Information Technology and Biotechnology
TOTAL: 45 PERIODS

MX3087 POLITICAL AND ECONOMIC THOUGHT FOR A HUMANE SOCIETY

Pre-Requisite: None. (Desirable: Universal Human Values 1, Universal Human Values 2)

OBJECTIVES:
• This course will begin with a short overview of human needs and desires and how different political-economic systems try to fulfill them. In the process, we will end with a critique of different systems and their implementations in the past, with possible future directions.

COURSE TOPICS:
Considerations for humane society, holistic thought, human being’s desires, harmony in self, harmony in relationships, society, and nature, societal systems. (9 lectures, 1 hour each)

(Refs: A Nagaraj, M K Gandhi, JC Kumarappa)
Capitalism – Free markets, demand-supply, perfect competition, laissez-faire, monopolies, imperialism. Liberal democracy. (5 lectures)

(Refs: Adam smith, J S Mill)
Fascism and totalitarianism. World war I and II. Cold war. (2 lectures)
Communism – Mode of production, theory of labour, surplus value, class struggle, dialectical materialism, historical materialism, Russian and Chinese models.

(Refs: Marx, Lenin, Mao, M N Roy) (5 lectures)
Welfare state. Relation with human desires. Empowered human beings, satisfaction. (3 lectures)
Gandhian thought. Swaraj, Decentralized economy & polity, Community. Control over one’s lives. Relationship with nature. (6 lectures)

(Refs: M K Gandhi, Schumacher, Kumarappa)

Essential elements of Indian civilization. (3 lectures)

(Refs: Pt Sundarlal, R C Mazumdar, Dharampal)

Technology as driver of society, Role of education in shaping of society. Future directions. (4 lectures) (Refs: Nandkishore Acharya, David Dixon, Levis Mumford)

Conclusion (2 lectures)

Total lectures: 39

Preferred Textbooks: See Reference Books

Reference Books: Authors mentioned along with topics above. Detailed reading list will be provided.

GRADING:

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<td>Term paper</td>
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TOTAL: 45 PERIODS

OUTCOME:

- The students will get an understanding of how societies are shaped by philosophy, political and economic system, how they relate to fulfilling human goals & desires with some case studies of how different attempts have been made in the past and how they have fared.

MX3088 STATE, NATION BUILDING AND POLITICS IN INDIA L T P C 3 0 0 0

OBJECTIVE:
The objective of the course is to provide an understanding of the state, how it works through its main organs, primacy of politics and political process, the concept of sovereignty and its changing contours in a globalized world. In the light of this, an attempt will be made to acquaint the students with the main development and legacies of national movement and constitutional development in India, reasons for adopting a Parliamentary-federal system, the broad philosophy of the Constitution of India and the changing nature of Indian Political System. Challenges/ problems and issues concerning national integration and nation-building will also be discussed in the contemporary context with the aim of developing a future vision for a better India.

TOPICS:
Understanding the need and role of State and politics.

Development of Nation-State, sovereignty, sovereignty in a globalized world.

Organs of State – Executive, Legislature, Judiciary. Separation of powers, forms of government-unitary-federal, Presidential-Parliamentary,
The idea of India.
1857 and the national awakening.

1885 Indian National Congress and development of national movement – its legacies. Constitution making and the Constitution of India. 
Goals, objective and philosophy.
Why a federal system?
National integration and nation-building.

Challenges of nation-building – State against democracy (Kothari)
New social movements.
The changing nature of Indian Political System, the future scenario.
What can we do?

OUTCOME OF THE COURSE:

It is expected that this course will make students aware of the theoretical aspect of the state, its organs, its operationalization aspect, the background and philosophy behind the founding of the present political system, broad streams and challenges of national integration and nation-building in India. It will equip the students with the real understanding of our political system/ process in correct perspective and make them sit up and think for devising ways for better participation in the system with a view to making the governance and delivery system better for the common man who is often left unheard and unattended in our democratic setup besides generating a lot of dissatisfaction and difficulties for the system.

SUGGESTED READING:


TOTAL: 45 PERIODS

MX3089  INDUSTRIAL SAFETY  L T P C
3 0 0 0

OBJECTIVES

- To Understand the Introduction and basic Terminologies safety.
- To enable the students to learn about the Important Statutory Regulations and standards.
- To enable students to Conduct and participate the various Safety activities in the Industry.
- To have knowledge about Workplace Exposures and Hazards.
- To assess the various Hazards and consequences through various Risk Assessment Techniques.

UNIT I  SAFETY TERMINOLOGIES

Hazard-Types of Hazard- Risk-Hierarchy of Hazards Control Measures-Lead indicators- lag Indicators-Flammability- Toxicity Time-weighted Average (TWA) - Threshold LimitValue (TLV) - Short Term Exposure Limit (STEL)- Immediately dangerous to life or health (IDLH)- acute and chronic Effects- Routes of Chemical Entry-Personnel Protective Equipment- Health and Safety Policy-Material Safety Data Sheet MSDS
UNIT II    STANDARDS AND REGULATIONS

UNIT III    SAFETY ACTIVITIES

UNIT IV    WORKPLACE HEALTH AND SAFETY
Noise hazard- Particulate matter- musculoskeletal disorder improper sitting poster and lifting Ergonomics RULE & REBA- Unsafe act & Unsafe Condition- Electrical Hazards- Crane Safety- Toxic gas Release

UNIT V    HAZARD IDENTIFICATION TECHNIQUES
Job Safety Analysis-Preliminary Hazard Analysis-Failure mode and Effects Analysis- Hazard and Operability- Fault Tree Analysis- Event Tree Analysis Qualitative and Quantitative Risk Assessment- Checklist Analysis- Root cause analysis- What-If Analysis- and Hazard Identification and Risk Assessment

COURSE OUTCOMES
Course outcomes on completion of this course the student will be able:
- Understand the basic concept of safety.
- Obtain knowledge of Statutory Regulations and standards.
- Know about the safety Activities of the Working Place.
- Analyze on the impact of Occupational Exposures and their Remedies
- Obtain knowledge of Risk Assessment Techniques.

TEXTBOOKS
2. L. M. Deshmukh Industrial Safety Management: Hazard Identification and Risk Control McGraw-Hill Education

REFERENCES
5. Society of Safety Engineers, USA

ONLINE RESOURCES
## CO’s, PO’s & PSO’s MAPPING

<table>
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<tr>
<th>Course Outcomes</th>
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<td>Obtain knowledge of Risk Assessment Techniques.</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVES:
The main objectives of this course are to:
1. Understand the importance, principles, and search methods of AI
2. Provide knowledge on predicate logic and Prolog.
3. Introduce machine learning fundamentals
4. Study of supervised learning algorithms.
5. Study about unsupervised learning algorithms.

UNIT I  INTELLIGENT AGENT AND UNINFORMED SEARCH  6
Introduction - Foundations of AI - History of AI - The state of the art - Risks and Benefits of AI -
Intelligent Agents - Nature of Environment - Structure of Agent - Problem Solving Agents -
Formulating Problems - Uninformed Search - Breadth First Search - Dijkstra's algorithm or uniform-cost search - Depth First Search - Depth Limited Search

UNIT II  PROBLEM SOLVING WITH SEARCH TECHNIQUES  6
Informed Search - Greedy Best First - A* algorithm - Adversarial Game and Search - Game theory - Optimal decisions in game - Min Max Search algorithm - Alpha-beta pruning - Constraint Satisfaction Problems (CSP) - Examples - Map Coloring - Job Scheduling - Backtracking Search for CSP

UNIT III  LEARNING  6
Machine Learning: Definitions – Classification - Regression - approaches of machine learning models - Types of learning - Probability - Basics - Linear Algebra – Hypothesis space and inductive bias; Evaluation. Training and test sets, cross validation, Concept of over fitting, under fitting, Bias and Variance - Regression: Linear Regression - Logistic Regression

UNIT IV  SUPERVISED LEARNING  6
Neural Network: Introduction, Perceptron Networks – Adaline - Back propagation networks -
Decision Tree: Entropy – Information gain - Gini Impurity - classification algorithm - Rule based Classification - Naïve Bayesian classification - Support Vector Machines (SVM)

UNIT V  UNSUPERVISED LEARNING  6
Unsupervised Learning – Principle Component Analysis - Neural Network: Fixed Weight Competitive Nets - Kohonen Self-Organizing Feature Maps – Clustering: Definition - Types of Clustering – Hierarchical clustering algorithms – k-means algorithm

TOTAL : 30 PERIODS

PRACTICAL EXERCISES: 30 PERIODS
Programs for Problem solving with Search
1. Implement breadth first search
2. Implement depth first search
3. Analysis of breadth first and depth first search in terms of time and space
4. Implement and compare Greedy and A* algorithms.

Supervised learning
5. Implement the non-parametric locally weighted regression algorithm in order to fit data points.
   Select appropriate data set for your experiment and draw graphs
6. Write a program to demonstrate the working of the decision tree based algorithm.
7. Build an artificial neural network by implementing the back propagation algorithm and test the same using appropriate data sets.
8. Write a program to implement the naïve Bayesian classifier.
**Unsupervised learning**
9. Implementing neural network using self-organizing maps
10. Implementing k-Means algorithm to cluster a set of data.
11. Implementing hierarchical clustering algorithm.

Note:
- Installation of gnu-prolog, Study of Prolog (gnu-prolog).
- The programs can be implemented in using C++/JAVA/ Python or appropriate tools can be used by designing good user interface
- Data sets can be taken from standard repositories (https://archive.ics.uci.edu/ml/datasets.html) or constructed by the students.

**OUTCOMES:**
CO1: Understand the foundations of AI and the structure of Intelligent Agents
CO2: Use appropriate search algorithms for any AI problem
CO3: Study of learning methods
CO4: Solving problem using Supervised learning
CO5: Solving problem using Unsupervised learning

**TOTAL PERIODS: 60**

**TEXT BOOK**
2. S.N.Sivanandam and S.N.Deepa, Principles of soft computing-Wiley India.3 rd ed,

**REFERENCES**

**OCS352 IOT CONCEPTS AND APPLICATIONS**

**OBJECTIVES:**
- To apprise students with basic knowledge of IoT that paves a platform to understand physical and logical design of IoT
- To teach a student how to analyse requirements of various communication models and protocols for cost-effective design of IoT applications on different IoT platforms.
- To introduce the technologies behind Internet of Things(IoT).
- To explain the students how to code for an IoT application using Arduino/Raspberry Pi open platform.
- To apply the concept of Internet of Things in real world scenario.

**UNIT I INTRODUCTION TO INTERNET OF THINGS**

**UNIT II COMPONENTS IN INTERNET OF THINGS**
Functional Blocks of an IoT Ecosystem – Sensors, Actuators, and Smart Objects – Control Units - Communication modules (Bluetooth, Zigbee,Wifi, GPS, GSM Modules)

**UNIT III PROTOCOLS AND TECHNOLOGIES BEHIND IOT**
UNIT IV OPEN PLATFORMS AND PROGRAMMING


UNIT V IOT APPLICATIONS

Business models for the internet of things, Smart city, Smart mobility and transport, Industrial IoT, Smart health, Environment monitoring and surveillance – Home Automation – Smart Agriculture

PRACTICAL EXERCISES: 30 PERIODS
1. Introduction to Arduino platform and programming
2. Interfacing Arduino to Zigbee module
3. Interfacing Arduino to GSM module
4. Interfacing Arduino to Bluetooth Module
5. Introduction to Raspberry Pi platform and python programming
6. Interfacing sensors to Raspberry Pi
7. Communicate between Arduino and Raspberry Pi using any wireless medium
8. Setup a cloud platform to log the data
9. Log Data using Raspberry Pi and upload to the cloud platform
10. Design an IOT based system

OUTCOMES:
CO 1: Explain the concept of IoT.
CO 2: Understand the communication models and various protocols for IoT.
CO 3: Design portable IoT using Arduino/Raspberry Pi /open platform
CO 4: Apply data analytics and use cloud offerings related to IoT.
CO 5: Analyze applications of IoT in real time scenario.

TOTAL PERIODS: 60

TEXTBOOKS

REFERENCES
1. Perry Lea, “Internet of things for architects”, Packt, 2018

OCS353 DATA SCIENCE FUNDAMENTALS L T P C 2 0 2 3

COURSE OBJECTIVES:
- Familiarize students with the data science process.
- Understand the data manipulation functions in Numpy and Pandas.
- Explore different types of machine learning approaches.
● Understand and practice visualization techniques using tools.
● Learn to handle large volumes of data with case studies.

UNIT I  INTRODUCTION
Data Science: Benefits and uses – facets of data - Data Science Process: Overview – Defining research goals – Retrieving data – data preparation - Exploratory Data analysis – build the model – presenting findings and building applications - Data Mining - Data Warehousing – Basic statistical descriptions of Data

UNIT II  DATA MANIPULATION

UNIT III  MACHINE LEARNING
The modeling process - Types of machine learning - Supervised learning - Unsupervised learning - Semi-supervised learning- Classification, regression - Clustering – Outliers and Outlier Analysis

UNIT IV  DATA VISUALIZATION

UNIT V  HANDLING LARGE DATA
Problems - techniques for handling large volumes of data - programming tips for dealing with large data sets- Case studies: Predicting malicious URLs, Building a recommender system - Tools and techniques needed - Research question - Data preparation - Model building – Presentation and automation.

PRACTICAL EXERCISES:

LAB EXERCISES:
1. Download, install and explore the features of Python for data analytics.
2. Working with Numpy arrays
3. Working with Pandas data frames
4. Basic plots using Matplotlib
5. Statistical and Probability measures
   a) Frequency distributions
   b) Mean, Mode, Standard Deviation
   c) Variability
   d) Normal curves
   e) Correlation and scatter plots
   f) Correlation coefficient
   g) Regression

6. Use the standard benchmark data set for performing the following:
   a) Univariate Analysis: Frequency, Mean, Median, Mode, Variance, Standard Deviation, Skewness and Kurtosis.
   b) Bivariate Analysis: Linear and logistic regression modelling.
7. Apply supervised learning algorithms and unsupervised learning algorithms on any data set.
8. Apply and explore various plotting functions on any data set.

Note: Example data sets like: UCI, Iris, Pima Indians Diabetes etc.
COURSE OUTCOMES:
At the end of this course, the students will be able to:
- **CO1**: Gain knowledge on data science process.
- **CO2**: Perform data manipulation functions using Numpy and Pandas.
- **CO3**: Understand different types of machine learning approaches.
- **CO4**: Perform data visualization using tools.
- **CO5**: Handle large volumes of data in practical scenarios.

**TOTAL: 60 PERIODS**

TEXT BOOKS

REFERENCES

CCS333 AUGMENTED REALITY/VIRTUAL REALITY

**OBJECTIVES:**
- To impart the fundamental aspects and principles of AR/VR technologies.
- To know the internals of the hardware and software components involved in the development of AR/VR enabled applications.
- To learn about the graphical processing units and their architectures.
- To gain knowledge about AR/VR application development.
- To know the technologies involved in the development of AR/VR based applications.

**UNIT I** INTRODUCTION

**UNIT II** VR MODELING

**UNIT III** VR PROGRAMMING
VR Programming – Toolkits and Scene Graphs – World ToolKit – Java 3D – Comparison of World ToolKit and Java 3D

**UNIT IV** APPLICATIONS
UNIT V AUGMENTED REALITY

Introduction to Augmented Reality—Computer vision for AR—Interaction—Modelling and Annotation—Navigation—Wearable devices

PRACTICAL EXERCISES:

1. Study of tools like Unity, Maya, 3DS MAX, AR toolkit, Vuforia and Blender.
2. Use the primitive objects and apply various projection types by handling camera.
3. Download objects from asset store and apply various lighting and shading effects.
4. Model three dimensional objects using various modelling techniques and apply textures over them.
5. Create three dimensional realistic scenes and develop simple virtual reality enabled mobile applications which have limited interactivity.
6. Add audio and text special effects to the developed application.
7. Develop VR enabled applications using motion trackers and sensors incorporating full haptic interactivity.
8. Develop AR enabled applications with interactivity like E learning environment, Virtual walkthroughs and visualization of historic places.
10. Develop simple MR enabled gaming applications.

TOTAL: 60 PERIODS

OUTCOMES:
On completion of the course, the students will be able to:
CO1: Understand the basic concepts of AR and VR
CO2: Understand the tools and technologies related to AR/VR
CO3: Know the working principle of AR/VR related Sensor devices
CO4: Design of various models using modeling techniques
CO5: Develop AR/VR applications in different domains

TEXTBOOKS:
1. Charles Palmer, John Williamson, “Virtual Reality Blueprints: Create compelling VR experiences for mobile”, Packt Publisher, 2018

CO’s – PO’s & PSO’s MAPPING

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<thead>
<tr>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OPEN ELCTIVE III

OHS351 ENGLISH FOR COMPETITIVE EXAMINATIONS

Course Description:
Students aspiring to take up competitive exams of which the English language is a vital component will find this course useful. Designed for students in the higher semesters, the course will help students to familiarise themselves with those aspects of English that are tested in these examinations.

OBJECTIVES:
- To train the students in the language components essential to face competitive examinations both at the national (UPSC, Banking, Railway, Defence) and the international level (GRE, TOEFL, IELTS).
- To enhance an awareness of the specific patterns in language testing and the respective skills to tackle verbal reasoning and verbal ability tests.
- To inculcate effective practices in language-learning in order to improve accuracy in usage of grammar and coherence in writing.
- To improve students’ confidence to express their ideas and opinions in formal contexts.
- To create awareness of accuracy and precision in communication.

UNIT I

UNIT II

UNIT III

UNIT IV

UNIT V

Learning Outcomes:
At the end of the course, learners will be able
- expand their vocabulary and gain practical techniques to read and comprehend a wide range of texts with the emphasis required
- identify errors with precision and write with clarity and coherence

TOTAL: 45 PERIODS
• understand the importance of task fulfilment and the usage of task-appropriate vocabulary
• communicate effectively in group discussions, presentations and interviews
• write topic based essays with precision and accuracy

### CO-PO & PSO MAPPING

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Note: The average value of this course to be used for program articulation matrix.

### Teaching Methods:
Instructional methods will involve discussions, taking mock tests on various question papers – Objective, multiple-choice and descriptive. Peer evaluation, self-check on improvement and peer feedback. Practice sessions on speaking assessments, interview and discussion – Using multimedia.

### Evaluative Pattern:
Internal Tests – 50%
End Semester Exam - 50%

### TEXTBOOKS:

### REFERENCE BOOKS:

### WEBSITES
- [http://civilservicesmentor.com/](http://civilservicesmentor.com/)
- [http://www.educationobserver.com](http://www.educationobserver.com)

### COURSE OBJECTIVES
• to understand the importance of sustainable development
• to acquire a reasonable knowledge on the legal frameworks pertaining to pollution control and environmental management
• to comprehend the role of NGOs in attaining sustainable development

### UNIT I: ENVIRONMENTAL CONCERNS
Introduction to sustainable development goals, Global responsibility of environmental concern, Importance of environmental preservation, Environmental threats, Pollution and its types, Effects of Pollution, Pollution control, Treatment of wastes
UNIT II  ROLE OF NGOS  9
Role of NGO’s in national development, NGO’s and participatory management, Challenges and limitations of NGO’s, Community Development programmes, Role of NGO’s in Community Development programmes, Participation of NGO’s in environment management, Corporate Social responsibility, NGO’s and corporate social responsibility

UNIT III  SUSTAINABLE DEVELOPMENT  9
Issues and Challenges of Sustainable Development, Bioenergy, Sustainable Livelihoods and Rural Poor in Sustainable Development, Protecting ecosystem services for sustainable development, Non-renewable sources of energy and its effect, Renewable sources of energy for sustainability, Nuclear resources and Legal Regulation of Hazardous Substances, Sustainable Development: Programme and Policies, Sustainability assessment and Indicators

UNIT IV  NGO’S FOR SUSTAINABILITY  9
Civil Society Initiatives in Environment Management, Civil Society Initiatives for Sustainable Development, Global Initiatives in Protecting Global Environment, World Summit on Sustainable Development (Johannesburg Summit 2002), Ecological economics, Environmental sustainability, Social inclusion, Health for all, education for all, Food security and Water security, NGOs and Sustainable Development strategies

UNIT V  LEGAL FRAMEWORKS  9
Need for a Legal framework and its enforcement, Legal measures to control pollution, Environmental Legislations in India, Mechanism to implement Environmental Laws in India, Legal Protection of Forests Act 1927, Legal Protection of Wild Life, Role of NGO’s in implementing environmental laws, Challenges in the implementation of environmental legislation

OUTCOMES
Upon completion of this course, the student will:
CO1 Have a thorough grounding on the issues and challenges being faced in attaining sustainable development
CO2 have a knowledge on the role of NGOs towards sustainable development
CO 3 present strategies for NGOs in attaining sustainable development
CO 4 recognize the importance of providing energy, food security and health equity to all members of the society without damaging the environment
CO 5 understand the environmental legislations

REFERENCE BOOKS

OCE353  LEAN CONCEPTS, TOOLS AND PRACTICES  L T P C
3 0 0 3

OBJECTIVE:
- To impart knowledge about the basics of lean principles, tools and techniques, and implementation in the construction industry.

UNIT I  INTRODUCTION  9
Introduction and overview of the construction project management - Review of Project Management & Productivity Measurement Systems - Productivity in Construction - Daily Progress
Report - The state of the industry with respect to its management practices - construction project phases - The problems with current construction management techniques.

UNIT II LEAN MANAGEMENT
Introduction to lean management - Toyota’s management principle - Evolution of lean in construction industry - Production theories in construction - Lean construction value - Value in construction - Target value design - Lean project delivery system - Forms of waste in construction industry - Waste Elimination.

UNIT III CORE CONCEPTS IN LEAN
Concepts in lean thinking - Principles of lean construction - Variability and its impact - Traditional construction and lean construction - Traditional project delivery - Lean construction and workflow reliability - Work structuring - Production control.

UNIT IV LEAN TOOLS AND TECHNIQUES

UNIT V LEAN IMPLEMENTATION IN CONSTRUCTION INDUSTRY
Lean construction implementation - Enabling lean through information technology - Lean in design - Design Structure - BIM (Building Information Modelling) - IPD (Integrated Project Delivery) - Sustainability through lean construction approach.

OUTCOME:
On completion of this course, the student is expected to be able to

CO1 Explains the contemporary management techniques and the issues in present scenario.

CO2 Apply the basics of lean management principles and their evolution from manufacturing industry to construction industry.

CO3 Develops a better understanding of core concepts of lean construction tools and techniques and their importance in achieving better productivity.

CO4 Apply lean techniques to achieve sustainability in construction projects.

CO5 Apply lean construction techniques in design and modeling.

REFERENCES:
OMG353  DEMOCRACY AND GOOD GOVERNANCE  L T P C  3 0 0 3

UNIT-I
Structure and Process of Governance: Indian Model of Democracy, Parliament, Party Politics and Electoral Behaviour, Federalism, the Supreme Court and Judicial Activism, Units of Local Governance

UNIT-II
Regulatory Institutions – SEBI, TRAI, Competition Commission of India,

UNIT-III
Lobbying Institutions: Chambers of Commerce and Industries, Trade Unions, Farmers Associations, etc.

UNIT- IV
Contemporary Political Economy of Development in India: Policy Debates over Models of Development in India, Recent trends of Liberalisation of Indian Economy in different sectors, E-governance

UNIT-V
Dynamics of Civil Society: New Social Movements, Role of NGO’s, Understanding the political significance of Media and Popular Culture.

TOTAL 45 : PERIODS

REFERENCES:
4. Saima Saeed: Screening the Public Sphere: Media and Democracy in India, 2013

CME365  RENEWABLE ENERGY TECHNOLOGIES  L T P C  3 0 0 3

COURSE OBJECTIVES
1. To know the Indian and global energy scenario
2. To learn the various solar energy technologies and its applications.
3. To educate the various wind energy technologies.
4. To explore the various bio-energy technologies.
5. To study the ocean and geothermal technologies.

UNIT – I  ENERGY SCENARIO
Indian energy scenario in various sectors – domestic, industrial, commercial, agriculture, transportation and others – Present conventional energy status – Present renewable energy status-Potential of various renewable energy sources-Global energy status-Per capita energy consumption - Future energy plans

UNIT – II  SOLAR ENERGY
UNIT – III  WIND ENERGY  

UNIT – IV  BIO-ENERGY  

UNIT – V  OCEAN AND GEOTHERMAL ENERGY  

TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course the students would be able to
 Discuss the Indian and global energy scenario.
 Describe the various solar energy technologies and its applications.
 Explain the various wind energy technologies.
 Explore the various bio-energy technologies.
 Discuss the ocean and geothermal technologies.

TEXT BOOKS:

REFERENCES:

CO’s, PO’s & PSO’s MAPPING

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Low (1) ;     Medium (2) ;       High (3)
1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVES:
The course aims to
- Introduce tools & techniques of design thinking for innovative product development
- Illustrate customer-centric product innovation using on simple use cases
- Demonstrate development of Minimum usable Prototypes
- Outline principles of solution concepts & their evaluation
- Describe system thinking principles as applied to complex systems

UNIT I DESIGN THINKING PRINCIPLES 9
Exploring Human-centered Design - Understanding the Innovation process, discovering areas of opportunity, Interviewing & empathy-building techniques, Mitigate validation risk with FIR [Forge Innovation rubric] - Case studies

UNIT II ENDUSER-CENTRIC INNOVATION 9
Importance of customer-centric innovation - Problem Validation and Customer Discovery - Understanding problem significance and problem incidence - Customer Validation. Target user, User persona & user stories. Activity: Customer development process - Customer interviews and field visit

UNIT III APPLIED DESIGN THINKING TOOLS 9
Concept of Minimum Usable Prototype [MUP] - MUP challenge brief - Designing & Crafting the value proposition - Designing and Testing Value Proposition; Design a compelling value proposition; Process, tools and techniques of Value Proposition Design

UNIT IV CONCEPT GENERATION 9
Solution Exploration, Concepts Generation and MUP design- Conceptualize the solution concept; explore, iterate and learn; build the right prototype; Assess capability, usability and feasibility. Systematic concept generation; evaluation of technology alternatives and the solution concepts

UNIT V SYSTEM THINKING 9
System Thinking, Understanding Systems, Examples and Understandings, Complex Systems

COURSE OUTCOMES
At the end of the course, learners will be able to:
- Define & test various hypotheses to mitigate the inherent risks in product innovations.
- Design the solution concept based on the proposed value by exploring alternate solutions to achieve value-price fit.
- Develop skills in empathizing, critical thinking, analyzing, storytelling & pitching
- Apply system thinking in a real-world scenario

TEXT BOOKS
1. Steve Blank, (2013), The four steps to epiphany: Successful strategies for products that win, Wiley.
REFERENCES
1. https://www.ideou.com/pages/design-thinking#process
6. https://blog.forgeforward.in/star-tup-failure-is-like-true-lie-7812cdfe9b85

MF3003 REVERSE ENGINEERING LT P C 3 0 0 3

COURSE OBJECTIVES:
- The main learning objective of this course is to prepare students for:
- Applying the fundamental concepts and principles of reverse engineering in product design and development.
- Applying the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
- Applying the concept and principles of material identification and process verification in reverse engineering of product design and development.
- Analysing the various legal aspect and applications of reverse engineering in product design and development.
- Understand about 3D scanning hardware & software operations and procedure to generate 3D model

UNIT I INTRODUCTION & GEOMETRIC FORM 9 Hours

UNIT II MATERIAL CHARACTERISTICS AND PROCESS IDENTIFICATION 9 Hours

UNIT III DATA PROCESSING 9 Hours

UNIT IV 3D SCANNING AND MODELLING 9 Hours

UNIT V INDUSTRIAL APPLICATIONS 9 Hours

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
- Apply the fundamental concepts and principles of reverse engineering in product design
and development.

- Apply the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
- Apply the concept and principles of material identification and process verification in reverse engineering of product design and development.
- Apply the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development.
- Analyze the various legal aspect
- Applications of reverse engineering in product design and development.

TEXT BOOKS:

REFERENCES:

OPR351 SUSTAINABLE MANUFACTURING

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COURSE OBJECTIVES:
- To be acquainted with sustainability in manufacturing and its evaluation.
- To provide knowledge in environment and social sustainability.
- To provide the student with the knowledge of strategy to achieve sustainability.
- To familiarize with trends in sustainable operations.
- To create awareness in current sustainable practices in manufacturing industry.

UNIT – I ECONOMIC SUSTAINABILITY

UNIT – II SOCIAL AND ENVIRONMENTAL SUSTAINABILITY
Social sustainability – Introduction-Work management -Human rights - Societal commitment - Customers -Business practices -Modelling and assessing social sustainability. Environmental issues pertaining to the manufacturing sector: Pollution - Use of resources -Pressure to reduce costs - Environmental management: Processes that minimize negative environmental impacts - environmental legislation and energy costs - need to reduce the carbon footprint of manufacturing Operations-Modelling and assessing environmental sustainability

UNIT – III SUSTAINABILITY PRACTICES
Sustainability awareness - Measuring Industry Awareness-Drivers and barriers -Availability of sustainability indicators -Analysis of sustainability practicing -Modeling and assessment of sustainable practicing -Sustainability awareness -Sustainability drivers and barriers - Availability of sustainability indicators- Designing questionnaires- Optimizing Sustainability Indexes-Elements –Cost and time model.
UNIT – IV MANUFACTURING STRATEGY FOR SUSTAINABILITY
Concepts of competitive strategy and manufacturing strategies and development of a strategic improvement programme - Manufacturing strategy in business success strategy formation and formulation - Structured strategy formulation - Sustainable manufacturing system design options - Approaches to strategy formulation - Realization of new strategies/system designs.

UNIT – V TRENDS IN SUSTAINABLE OPERATIONS

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
CO1: Discuss the importance of economic sustainability.
CO2: Describe the importance of sustainable practices.
CO3: Identify drivers and barriers for the given conditions.
CO4: Formulate strategy in sustainable manufacturing.
CO5: Plan for sustainable operation of industry with environmental, cost consciousness.

CO’s, PO’s & PSO’s MAPPING

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1-Low,2-Medium,3-High,”-“-no correlation

TEXT BOOKS:

REFERENCES:
COURSE OBJECTIVES:
The objective of this course is to prepare the students to know about the general aspects of Electric and Hybrid Vehicles (EHV), including architectures, modelling, sizing, and sub system design and hybrid vehicle control.

UNIT I DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES

UNIT II ENERGY SOURCES

UNIT III MOTORS AND DRIVES
Types of Motors- DC motors- AC motors, PMSM motors, BLDC motors, Switched reluctance motors working principle, construction and characteristics.

UNIT IV POWER CONVERTERS AND CONTROLLERS
Solid state Switching elements and characteristics – BJT, MOSFET, IGBT, SCR and TRIAC - Power Converters – rectifiers, inverters and converters - Motor Drives - DC, AC motor, PMSM motors, BLDC motors, Switched reluctance motors – four quadrant operations –operating modes

UNIT V HYBRID AND ELECTRIC VEHICLES
Main components and working principles of a hybrid and electric vehicles, Different configurations of hybrid and electric vehicles. Power Split devices for Hybrid Vehicles - Operation modes - Control Strategies for Hybrid Vehicle - Economy of hybrid Vehicles - Case study on specification of electric and hybrid vehicles.

COURSE OUTCOMES:
At the end of this course, the student will be able to
1. Understand the operation and architecture of electric and hybrid vehicles
2. Identify various energy source options like battery and fuel cell
3. Select suitable electric motor for applications in hybrid and electric vehicles.
4. Explain the role of power electronics in hybrid and electric vehicles
5. Analyze the energy and design requirement for hybrid and electric vehicles.

TEXT BOOKS:

REFERENCES:
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OAS352 SPACE ENGINEERING

OBJECTIVES:
- Use the standard atmosphere tables and equations.
- Find lift and drag coefficient data from NACA plots.
- Apply the concept of static stability to flight vehicles.
- Describe the concepts of stress, strain, Young’s modulus, Poisson’s ratio, yield strength.
- Demonstrate a basic knowledge of dynamics relevant to orbital mechanics.

UNIT I STANDARD ATMOSPHERE
History of aviation – standard atmosphere - pressure, temperature and density altitude.

UNIT II AERODYNAMICS
Aerodynamic forces – Lift generation Viscosity and its implications - Shear stress in a velocity profile - Lagrangian and Eulerian flow field - Concept of a streamline – Aircraft terminology and geometry - Aircraft types - Lift and drag coefficients using NACA data.

UNIT III PERFORMANCE AND PROPULSION
Viscous and pressure drag - flow separation - aerodynamic drag - thrust calculations -thrust/power available and thrust/power required.

UNIT IV AIRCRAFT STABILITY AND STRUCTURAL THEORY

UNIT V SPACE APPLICATIONS
History of space research - spacecraft trajectories and basic orbital manoeuvres - six orbital elements - Kepler’s laws of orbits - Newtons law of gravitation.

TOTAL: 45 PERIODS

OUTCOMES:
- Illustrate the history of aviation & developments over the years
- Ability to identify the types & classifications of components and control systems
- Explain the basic concepts of flight & Physical properties of Atmosphere
- Identify the types of fuselage and constructions.
- Distinguish the types of Engines and explain the principles of Rocket

TEXT BOOKS:
REFERENCE:

OIM351 INDUSTRIAL MANAGEMENT  L T P C
3 0 0 3

COURSE OBJECTIVES:
- To introduce fundamental concepts of industrial management
- To understand the approaches to the study of Management
- To learn about Decision Making, Organizing and leadership
- To analyze the Managerial Role and functions
- To know about the Supply Chain Management

UNIT I INTRODUCTION  9

UNIT II FUNCTIONS OF MANAGEMENT  9

UNIT III ORGANIZATIONAL BEHAVIOUR  9

UNIT IV GROUPDYNAMICS  9

UNIT V MODERN CONCEPTS  9
Management by Objectives (MBO) - Management by Exception (MBE), Strategic Management - Planning for Future direction - SWOT Analysis - Evolving development strategies, information technology in management Decisions support system - Management Games Business Process Re-engineering (BPR) - Enterprises Resource Planning (ERP) - Supply Chain Management (SCM) - Activity Based Management (AM) - Global Perspective - Principles and Steps Advantages and disadvantage

TOTAL: 45 PERIODS
COURSE OUTCOMES:
CO1: Understand the basic concepts of industrial management
CO2: Identify the group conflicts and its causes.
CO3: Perform swot analysis
CO4: Analyze the learning curves
CO5: Understand the placement and performance appraisal

REFERENCES:

CO’s, PO’s & PSO’s MAPPING

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OIE354 QUALITY ENGINEERING

COURSE OBJECTIVES
- Developing a clear knowledge in the basics of various quality concepts.
- Facilitating the students in understanding the application of control charts and its techniques.
- Developing the special control procedures for service and process-oriented industries.
- Analyzing and understanding the process capability study.
- Developing the acceptance sampling procedures for incoming raw material.

UNIT I INTRODUCTION

UNIT II CONTROL CHARTS
Chance and assignable causes of process variation, statistical basis of the control chart, control charts for variables- X, R and S charts, attribute control charts - p, np, c and u- Construction and application.

UNIT III SPECIAL CONTROL PROCEDURES
Warning and modified control limits, control chart for individual measurements, multi-vari chart, X chart with a linear trend, chart for moving averages and ranges, cumulative-sum and exponentially weighted moving average control charts.

UNIT IV STATISTICAL PROCESS CONTROL
Process stability, process capability analysis using a Histogram or probability plots and control chart. Gauge capability studies, setting specification limits.

UNIT V ACCEPTANCE SAMPLING
The acceptance sampling fundamental, OC curve, sampling plans for attributes, simple, double, multiple and sequential, sampling plans for variables, MIL-STD-105D and MIL-STD-414E & IS2500 standards.

TOTAL: 45 PERIODS
COURSE OUTCOMES:
Students will be able to:

CO1: Control the quality of processes using control charts for variables in manufacturing industries.

CO2: Control the occurrence of defective product and the defects in manufacturing companies.

CO3: Control the occurrence of defects in services.

CO4: Analyzing and understanding the process capability study.

CO5: Developing the acceptance sampling procedures for incoming raw material.

**CO’s, PO’s & PSO’s MAPPING**

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1-Low, 2-Medium, 3-High, "-"-no correlation

OSF351 FIRE SAFETY ENGINEERING L T P C 3 0 0 3

COURSE OBJECTIVES
- To enable the students to acquire knowledge of Fire and Safety Studies
- To learn about the effect of fire on materials used for construction, the method of test for non-combustibility & fire resistance
- To learn about fire area, fire stopped areas and different types of fire-resistant doors
- To learn about the method of fire protection of structural members and their repair due to fire damage.
- To develop safety professionals for both technical and management through systematic and quality-based study programmes

UNIT I INHERENT SAFETY CONCEPTS 9
Compartment fire-factors controlling fire severity, ventilation controlled and fuel controlled fires; Spread of fire in rooms, within building and between buildings. Effect of temperature on the properties of structural materials- concrete, steel, masonry and wood; Behavior of non-structural materials on fire- plastics, glass, textile fibres and other house hold materials.

UNIT II PLANT LOCATIONS 9
Compartment temperature-time response at pre-flashover and post flashover periods; Equivalence of fire severity of compartment fire and furnace fire; Fire resistance test on structural elements-standard heating condition, Indian standard test method, performance criteria.

UNIT III WORKING CONDITIONS 9
Fire separation between building- principle of calculation of safe distance. Design principles of fire resistant walls and ceilings; Fire resistant screens- solid screens and water curtains; Local barriers; Fire stopped areas-in roof, in fire areas and in connecting structures; Fire doors- Low combustible, Non-combustible and Spark-proof doors; method of suspension of fire doors; Air-tight sealing of doors;

UNIT IV FIRE SEVERITY AND REPAIR TECHNIQUES 9
Fabricated fire proof boards-calcium silicate, Gypsum, Vermiculite, and Perlite boards; Fire
protection of structural elements - Wooden, Steel and RCC. Reparability of fire damaged structures- Assessment of damage to concrete, steel, masonry and timber structures, Repair techniques- repair methods to reinforced concrete Columns, beams and slabs, Repair to steel structural members, Repair to masonry structures.

UNIT V WORKING AT HEIGHTS 9

TOTAL PERIODS: 45

COURSE OUTCOMES
On completion of the course the student will be able to
CO1: Understand the effect of fire on materials used for construction
CO2: Understand the method of test for non-combustibility and fire resistance; and will be able to select different structural elements and their dimensions for a particular fire resistance rating of a building.
CO3: To understand the design concept of fire walls, fire screens, local barriers and fire doors and able to select them appropriately to prevent fire spread.
CO4: To decide the method of fire protection to RCC, steel, and wooden structural elements and their repair methods if damaged due to fire.
CO5: Describe the safety techniques and improve the analytical and intelligence to take the right decision at right time.

TEXT BOOKS

REFERENCES:

CO's- PO's & PSO's MAPPING

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1-Low, 2-Medium, 3-High,"-"no correlation
INTRODUCTION TO NON-DESTRUCTIVE TESTING

COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for:

- Understanding the basic importance of NDT in quality assurance.
- Imbibing the basic principles of various NDT techniques, its applications, limitations, codes and standards.
- Equipping themselves to locate a flaw in various materials, products.
- Applying the testing methods for inspecting materials in accordance with industry specifications and standards.
- Acquiring the knowledge on the selection of the suitable NDT technique for a given application.

UNIT I  INTRODUCTION TO NDT & VISUAL TESTING  
Concepts of Non-destructive testing-relative merits and limitations-NDT Versus mechanical testing, Fundamentals of Visual Testing – vision, lighting, material attributes, environmental factors, visual perception, direct and indirect methods – mirrors, magnifiers, boroscopes and fibrosopes – light sources and special lighting.

UNIT II  LIQUID PENETRANT & MAGNETIC PARTICLE TESTING  
Liquid Penetrant Inspection: principle, applications, advantages and limitations, dyes, developers and cleaners, Methods & Interpretation.
Magnetic Particle Inspection: Principles, applications, magnetization methods, magnetic particles, Testing Procedure, demagnetization, advantages and limitations, – Interpretation and evaluation of test indications.

UNIT III  EDDY CURRENT TESTING & THERMOGRAPHY  
Thermography- Principle, Contact & Non-Contact inspection methods, Active & Passive methods, Liquid Crystal – Concept, example, advantages & limitations. Electromagnetic spectrum, infrared thermography- approaches, IR detectors, Instrumentation and methods, applications.

UNIT IV  ULTRASONIC TESTING & AET  
Ultrasonic Testing: Types of ultrasonic waves, characteristics, attenuation, couplants, probes, EMAT. Inspection methods-pulse echo, transmission and phased array techniques, types of scanning and displays, angle beam inspection of welds, time of flight diffraction (TOFD) technique, Thickness determination by ultrasonic method, Study of A, B and C scan presentations, calibration.

UNIT V  RADIOGRAPHY TESTING  
Sources-X-rays and Gamma rays and their characteristics-absorption, scattering. Filters and screens, Imaging modalities-film radiography and digital radiography (Computed, Direct, Real Time, CT scan). Problems in shadow formation, exposure factors, inverse square law, exposure charts, Penetrameters, safety in radiography.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
After completion of this course, the students will be able to

1. Realize the importance of NDT in various engineering fields.
2. Have a basic knowledge of surface NDE techniques which enables to carry out various inspection in accordance with the established procedures.
3. Calibrate the instrument and inspect for in-service damage in the components by means of Eddy current testing as well as Thermography testing.
4. Differentiate various techniques of UT and AET and select appropriate NDT methods for better evaluation.
5. Interpret the results of Radiography testing and also have the ability to analyse the influence of various parameters on the testing.

TEXT BOOKS:

REFERENCES:

CO’s, PO’s & PSO’s MAPPING

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OMR351 MECHATRONICS L T P C 3 0 0 3

COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for:
1. Selecting sensors to develop mechatronics systems.
2. Explaining the architecture and timing diagram of microprocessor, and also interpret and develop programs.
3. Designing appropriate interfacing circuits to connect I/O devices with microprocessor.
4. Applying PLC as a controller in mechatronics system.
5. Designing and develop the apt mechatronics system for an application.

UNIT – I INTRODUCTION AND SENSORS

UNIT – II 8085 MICROPROCESSOR
UNIT – III PROGRAMMABLE PERIPHERAL INTERFACE

UNIT – IV PROGRAMMABLE LOGIC CONTROLLER
Introduction – Architecture – Input / Output Processing – Programming with Timers, Counters and Internal relays – Data Handling – Selection of PLC.

UNIT – V ACTUATORS AND MECHATRONICS SYSTEM DESIGN

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
CO1: Select sensors to develop mechatronics systems.
CO2: Explain the architecture and timing diagram of microprocessor, and also interpret and develop programs.
CO3: Design appropriate interfacing circuits to connect I/O devices with microprocessor.
CO 4: Apply PLC as a controller in mechatronics system.
CO 5: Design and develop the apt mechatronics system for an application.

TEXT BOOKS

REFERENCES

Mapping of COs with POs and PSOs

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1 – Slight, 2 – Moderate, 3 – Substantial
COURSE OBJECTIVES:
1. To study the kinematics, drive systems and programming of robots.
2. To study the basics of robot laws and transmission systems.
3. To familiarize students with the concepts and techniques of robot manipulator, its
   kinematics.
4. To familiarize students with the various Programming and Machine Vision application in
   robots.
5. To build confidence among students to evaluate, choose and incorporate robots in
   engineering systems.

UNIT – I  FUNDAMENTALS OF ROBOT  9
Robot – Definition – Robot Anatomy – Co-ordinate systems, Work Envelope, types and
classification – specifications – Pitch, yaw, Roll, Joint Notations, Speed of Motion, Pay Load –
Robot Parts and their functions – Need for Robots – Different Applications.

UNIT – II  ROBOT KINEMATICS  9
Forward kinematics, inverse kinematics and the difference: forward kinematics and inverse
Kinematics of Manipulators with two, three degrees of freedom (in 2 dimensional), four degrees
of freedom (in 3 dimensional) – derivations and problems. Homogeneous transformation
matrices, translation and rotation matrices.

UNIT – III  ROBOT DRIVE SYSTEMS AND END EFFECTORS  9
Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C. Servo
Motors, Stepper Motor, A.C. Servo Motors – Salient Features, Applications and Comparison of
All These Drives. End Effectors – Grippers – Mechanical Grippers, Pneumatic and Hydraulic
Grippers, Magnetic grippers, vacuum grippers, internal grippers and external grippers, selection
and design considerations of a gripper

UNIT – IV  SENSORS IN ROBOTICS  9
Force sensors, touch and tactile sensors, proximity sensors, non-contact sensors, safety
considerations in robotic cell, proximity sensors, fail safe hazard sensor systems, and
compliance mechanism. Machine vision system - camera, frame grabber, sensing and
digitizing image data – signal conversion, image storage, lighting techniques, image processing
and analysis – data reduction, segmentation, feature extraction, object recognition, other
algorithms, applications – Inspection, identification, visual serving and navigation.

UNIT – V  PROGRAMMING AND APPLICATIONS OF ROBOT  9
Teach pendant programming, lead through programming, robot programming languages – VAL
programming – Motion Commands, Sensors commands, End-Effector Commands, and simple
programs - Role of robots in inspection, assembly, material handling, underwater, space and
medical fields.

TOTAL: 45 PERIODS

COURSE OUTCOMES
At the end of the course, students will be able to:
CO1: Interpret the features of robots and technology involved in the control.
CO2: Apply the basic engineering knowledge and laws for the design of robotics.
CO3: Explain the basic concepts like various configurations, classification and parts of end
effectors compare various end effectors and grippers and tools and sensors used in robots.
CO4: Explain the concept of kinematics, degeneracy, dexterity and trajectory planning.
CO5: Demonstrate the image processing and image analysis techniques by machine vision
system.
Mapping of COs with POs and PSOs

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Average: 1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS:

REFERENCES:

OAE352 FUNDAMENTALS OF AERONAUTICAL ENGINEERING L T P C
3 0 0 3

OBJECTIVES:
- To acquire the knowledge on the Historical evaluation of Airplanes
- To learn the different component systems and functions
- To know the concepts of basic properties and principles behind the flight
- To learn the basics of different structures & construction
- To learn the various types of power plants used in aircrafts

UNIT I HISTORY OF FLIGHT
Balloon flight-ornithopter-Early Airplanes by Wright Brothers, biplanes and monoplanes, Developments in aerodynamics, materials, structures and propulsion over the years.

UNIT II AIRCRAFT CONFIGURATIONS AND ITS CONTROLS
Different types of flight vehicles, classifications-Components of an airplane and their functions- Conventional control, powered control- Basic instruments for flying-Typical systems for control actuation.

UNIT III BASICS OF AERODYNAMICS

UNIT IV BASICS OF AIRCRAFT STRUCTURES
UNIT V    BASICS OF PROPULSION
Basic ideas about piston, turboprop and jet engines – use of propeller and jets for thrust production- Comparative merits, Principle of operation of rocket, types of rocket and typical applications, Exploration into space.

OUTCOMES:
- Illustrate the history of aircraft & developments over the years
- Ability to identify the types & classifications of components and control systems
- Explain the basic concepts of flight & Physical properties of Atmosphere
- Identify the types of fuselage and constructions.
- Distinguish the types of Engines and explain the principles of Rocket

TEXT BOOKS

REFERENCE

OGI351    REMOTE SENSING CONCEPTS

OBJECTIVES:
- To introduce the concepts of remote sensing processes and its components.
- To expose the various remote sensing platforms and sensors and to introduce the elements of data interpretation

UNIT I    REMOTE SENSING AND ELECTROMAGNETIC RADIATION

UNIT II    EMR INTERACTION WITH ATMOSPHERE AND EARTH MATERIAL

UNIT III    ORBITS AND PLATFORMS
Motions of planets and satellites – Newton’s law of gravitation - Gravitational field and potential - Escape velocity - Kepler’s law of planetary motion - Orbit elements and types – Orbital perturbations and maneuvers – Types of remote sensing platforms - Ground based, Airborne platforms and Space borne platforms – Classification of satellites – Sun synchronous and Geosynchronous satellites – Lagrange Orbit.

UNIT IV    SENSING TECHNIQUES
Classification of remote sensors – Resolution concept : spatial, spectral, radiometric and temporal
resolutions - Scanners - Along and across track scanners – Optical-infrared sensors – Thermal sensors – microwave sensors – Calibration of sensors - High Resolution Sensors - LIDAR , UAV – Orbital and sensor characteristics of live Indian earth observation satellites

UNIT V DATA PRODUCTS AND INTERPRETATION
Photographic and digital products – Types, levels and open source satellite data products — selection and procurement of data– Visual interpretation: basic elements and interpretation keys - Digital interpretation – Concepts of Image rectification, Image enhancement and Image classification

TOTAL:45 PERIODS

COURSE OUTCOMES:
On completion of the course, the student is expected to
CO 1 Understand the concepts and laws related to remote sensing
CO 2 Understand the interaction of electromagnetic radiation with atmosphere and earth material
CO 3 Acquire knowledge about satellite orbits and different types of satellites
CO 4 Understand the different types of remote sensors
CO 5 Gain knowledge about the concepts of interpretation of satellite imagery

TEXTBOOKS:

REFERENCES:

CO-PO MAPPING

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OBJECTIVES:

- To introduce the students the principles of agricultural crop production and the production practices of crops in modern ways.
- To delineate the role of agricultural engineers in relation to various crop production practices.

UNIT I  INTRODUCTION  9
Benefits of urban agriculture - economic benefits, environmental benefits, social and cultural benefits, educational, skill-building and job training benefits, health, nutrition and food accessibility benefits.

UNIT II  VERTICAL FARMING  9

UNIT III  SOIL LESS CULTIVATION  9
Hydroponics, aeroponics, aquaponics: merits and limitations, costs and Challenges, backyard gardens- tactical gardens- street landscaping- forest gardening, greenhouses, urban beekeeping

UNIT IV  MODERN CONCEPTS  9
Growth of plants in vertical pipes in terraces and inside buildings, micro irrigation concepts suitable for roof top gardening, rain hose system, Green house, polyhouse and shade net system of crop production on roof tops

UNIT V  WASTE MANAGEMENT  9
Concept, scope and maintenance of waste management- recycle of organic waste, garden wastes- solid waste management-scope, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues, waste utilization.

TOTAL: 45 PERIODS

COURSE OUTCOMES
1. Demonstrate the principles behind crop production and various parameters that influences the crop growth on roof tops
2. Explain different methods of crop production on roof tops
3. Explain nutrient and pest management for crop production on roof tops
4. Illustrate crop water requirement and irrigation water management on roof tops
5. Explain the concept of waste management on roof tops

TEXT BOOKS:

REFERENCES:
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<td>PSO1 To make expertise in design and engineering problem solving approach in agriculture with proper knowledge and skill</td>
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### OEE352 ELECTRIC VEHICLE TECHNOLOGY

**L T P C**

3 0 0 3

### COURSE OBJECTIVES

- To provide knowledge about electric machines and special machine
- To understand the basics of power converters
- To know the concepts of controlling DC and AC drive systems
- To understand the architecture and power train components.
- To impart knowledge on vehicle control for standard drive cycles of hybrid electrical vehicles (HEVs)

### UNIT I ROTATING POWER CONVERTERS


### UNIT II STATIC POWER CONVERTERS

- Working and Characteristics of Power Diodes, MOSFET and IGBT. Working of uncontrolled rectifiers, controlled rectifiers (Single phase and Three phase), DC choppers, single and three phase inverters, Multilevel inverters and Matrix Converters.

### UNIT III CONTROL OF DC AND AC MOTOR DRIVES

- Speed control for constant torque, constant HP operation of all electric motors - DC/DC chopper based four quadrant operation of DC motor drives, inverter based V/f Operation (motoring and
braking) of induction motor drives, Transformation theory, vector control operation of Induction motor and PMSM, Brushless DC motor drives, Switched reluctance motor (SRM) drives

UNIT IV HYBRID ELECTRIC VEHICLE ARCHITECTURE AND POWER TRAIN COMPONENTS

UNIT V MECHANICS OF HYBRID ELECTRIC VEHICLES AND CONTROL OF VEHICLES
Fundamentals of vehicle mechanics - tractive force, power and energy requirements for standard drive cycles of HEV’s - motor torque and power rating and battery capacity. HEV supervisory control - Selection of modes - power split mode - parallel mode - engine brake mode - regeneration mode - series parallel mode

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: Able to understand the principles of conventional and special electrical machines.
CO2: Acquired the concepts of power devices and power converters.
CO3: Able to understand the control for DC and AC drive systems.
CO4: Learned the electric vehicle architecture and power train components.
CO5: Acquired the knowledge of mechanics of electric vehicles and control of electric vehicles.

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REFERENCES:
# INTRODUCTION TO PLC PROGRAMMING

**COURSE OBJECTIVES:**

1. Understand basic PLC terminologies digital principles, PLC architecture and operation.
2. Familiarize different programming language of PLC.
3. Develop PLC logic for simple applications using ladder logic.
4. Understand the hardware and software behind PLC and SCADA.
5. Exposures about communication architecture of PLC/SCADA.

## UNIT I  INTRODUCTION TO PLC

Introduction to PLC: Microprocessor, I/O Ports, Isolation, Filters, Drivers, Microcontrollers/DSP, PLC/DDC- PLC Construction: What is a PLC, PLC Memories, PLC I/O, PLC Special I/O, PLC Types.

## UNIT II  PLC INSTRUCTIONS

PLC Basic Instructions: PLC Ladder Language- Function block Programming- Ladder/Function Block functions- PLC Basic Instructions, Basic Examples (Start Stop Rung, Entry/Reset Rung)- Configuration of Sensors, Switches, Solid State Relays-Interlock examples- Timers, Counters, Examples.

## UNIT III  PLC PROGRAMMING

Different types of PLC program, Basic Ladder logic, logic functions, PLC module addressing, registers basics, basic relay instructions, Latching Relays, arithmetic functions, comparison functions, data handling, data move functions, timer-counter instructions, input-output instructions, sequencer instructions

## UNIT IV  COMMUNICATION OF PLC AND SCADA

Communication Protocol – Modbus, HART, Profibus- Communication facilities SCADA: - Hardware and software, Remote terminal units, Master Station and Communication architectures

## UNIT V  CASE STUDIES

Stepper Motor Control- Elevator Control-CNC Machine Control- conveyor control-Interlocking Problems

**TOTAL:45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz / Surprise Test / Solving GATE questions/ etc)**

1. Market survey of the recent PLCs and comparison of their features.
2. Summarize the PLC standards
3. Familiarization of any one programming language (Ladder diagram/ Sequential Function Chart/ Function Block Diagram/ Equivalent open source software)
4. Market survey of Communication Network Used for PLC/SCADA.

**COURSE OUTCOMES:**

**CO1** Know the basic requirement of a PLC input/output devices and architecture. (L1)

**CO2** Ability to apply Basics Instruction Sets used for ladder Logic and Function Block Programming. (L2)

**CO3** Ability to design PLC Programmes by Applying Timer/Counter and Arithmetic and Logic Instructions Studied for Ladder Logic and Function Block. (L3)

**CO4** Able to develop a PLC logic for a specific application on real world problem. (L5)

**CO5** Ability to Understand the Concepts of Communication used for PLC/SCADA. (L1)

**TEXT BOOKS:**

1. Frank Petruzzula, Programmable Logic Controllers, Tata Mc-Graw Hill Edition
2. John W. Webb, Ronald A. Reis, Programmable Logic Controllers Principles and Applications, PHI publication
REFERENCES:
2. J. R. Hackworth and F. D. Hackworth, Programmable Logic Controllers Principles andApplications, Pearson publication

List of Open Source Software/ Learning website:
1. https://nptel.ac.in/courses/108105063

MAPPING COURSE OUTCOMES WITH PROGRAMME OUTCOMES

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OFD352 TRADITIONAL INDIAN FOODS L T P C 3 0 0 3

OBJECTIVE:
• To help students acquire a sound knowledge on diversities of foods, food habits and patterns in India with focus on traditional foods.

UNIT I  HISTORICAL AND CULTURAL PERSPECTIVES 9
Food production and accessibility - subsistence foraging, horticulture, agriculture and pastoralization, origin of agriculture, earliest crops grown. Food as source of physical sustenance, food as religious and cultural symbols; importance of food in understanding human culture - variability, diversity, from basic ingredients to food preparation; impact of customs and traditions on food habits, heterogeneity within cultures (social groups) and specific social contexts - festive occasions, specific religious festivals, mourning etc. Kosher, Halal foods; foods for religious and other fasts.

UNIT II  TRADITIONAL METHODS OF FOOD PROCESSING 9

UNIT III  TRADITIONAL FOOD PATTERNS 9
Typical breakfast, meal and snack foods of different regions of India. Regional foods that have gone Pan Indian / Global. Popular regional foods; Traditional fermented foods, pickles and preserves, beverages, snacks, desserts and sweets, street foods; IPR issues in traditional foods.
UNIT IV COMMERCIAL PRODUCTION OF TRADITIONAL FOODS

Commercial production of traditional breads, snacks, ready-to-eat foods and instant mixes, frozen foods – types marketed, turnover; role of SHGs, SMES industries, national and multinational companies; commercial production and packaging of traditional beverages such as tender coconut water, neera, lassi, buttermilk, dahi. Commercial production of intermediate foods – ginger and garlic pastes, tamarind pastes, masalas (spice mixes), idli and dosa batters.

UNIT V HEALTH ASPECTS OF TRADITIONAL FOODS

Comparison of traditional foods with typical fast foods / junk foods – cost, food safety, nutrient composition, bioactive components; energy and environmental costs of traditional foods; traditional foods used for specific ailments /illnesses.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1To understand the historical and traditional perspective of foods and food habits
CO2 To understand the wide diversity and common features of traditional Indian foods and meal patterns.

TEXT BOOKS:

OFD353 INTRODUCTION TO FOOD PROCESSING

OBJECTIVE:
• The course aims to introduce the students to the area of Food Processing. This is necessary for effective understanding of a detailed study of food processing and technology subjects. This course will enable students to appreciate the importance of food processing with respect to the producer, manufacturer and consumer.

UNIT I PROCESSING OF FOOD AND ITS IMPORTANCE

Source of food - plant, animal and microbial origin; different foods and groups of foods as raw materials for processing – cereals, pulses, grains, vegetables and fruits, milk and animal foods, sea weeds, algae, oil seeds & fats, sugars, tea, coffee, cocoa, spices and condiments, additives; need and significance of processing these foods.

UNIT II METHODS OF FOOD HANDLING AND STORAGE

Nature of harvested crop, plant and animal; storage of raw materials and products using low temperature, refrigerated gas storage of foods, gas packed refrigerated foods, sub-atmospheric storage, Gas atmospheric storage of meat, grains, seeds and flour, roots and tubers; freezing of raw and processed foods.

UNIT III LARGE-SCALE FOOD PROCESSING

Milling of grains and pulses; edible oil extraction; Pasteurisation of milk and yoghurt; canning and bottling of foods; drying – Traditional and modern methods of drying, Dehydration of fruits, vegetables, milk, animal products etc; preservation by use of acid, sugar and salt; Pickling and curing with microorganisms, use of salt, and microbial fermentation; frying, baking, extrusion cooking, snack foods.

UNIT IV FOOD WASTES IN VARIOUS PROCESSES

Waste disposal-solid and liquid waste; rodent and insect control; use of pesticides; ETP; selecting and installing necessary equipment.
UNIT V FOOD HYGIENE
Food related hazards – Biological hazards – physical hazards – microbiological considerations in foods. Food adulteration – definition, common food adulterants, contamination with toxic metals, pesticides and insecticides; Safety in food procurement, storage handling and preparation; Relationship of microbes to sanitation, Public health hazards due to contaminated water and food; Personnel hygiene; Training & Education for safe methods of handling and processing food; sterilization and disinfection of manufacturing plant; use of sanitizers, detergents, heat, chemicals, Cleaning of equipment and premises.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On completion of the course the students are expected to
CO1 Be aware of the different methods applied to processing foods.
CO2 Be able to understand the significance of food processing and the role of food and beverage industries in the supply of foods.

TEXT BOOKS/REFERENCES:

OPY352 IPR FOR PHARMA INDUSTRY L T P C
3 0 0 3

COURSE OBJECTIVES:
- To provide the basic fundamental knowledge of different forms of Intellectual Property Rights in national and international level.
- To provide the significance of the Intellectual Property Rights about the patents, copyrights, industrial design, plant and geographical indications.
- This paper is to study significance of the amended patent act on pharma industry.

UNIT I INTRODUCTION- INTELLECTUAL PROPERTY RIGHTS
Introduction, Types of Intellectual Property Rights - patents, plant varieties protection, geographical indicators, copyright, trademark, trade secrets.

UNIT II PATENTS
Patents-Objective, Introduction, Requirement for patenting- Novelty, Inventive step (Non-obviousness) and industrial application (utility), Non-patentable inventions, rights of patent owner, assignment of patent rights, patent specification (provisional and complete), parts of complete specification, claims, procedure for obtaining patents, compulsory license.

UNIT III PLANT VARIETY-TRADITIONAL KNOWLEDGE – GEOGRAPHICAL INDICATIONS
Plant variety- Justification, criteria for protection of plant variety and protection in India. Traditional knowledge- Concept of traditional knowledge, protection of traditional knowledge under Intellectual Property frame works in national level and Traditional knowledge digital library (TKDL). Geographical Indications – Justification for protection, National and International position.

UNIT IV ENFORCEMENT AND PRACTICAL ASPECTS OF IPR
UNIT V  INTERNATIONAL BACKGROUND OF INTELLECTUAL PROPERTY


TOTAL: 45 PERIODS

TEXT BOOKS:

REFERENCES:
2. Basic Principles of patent law – Basics principles and acquisition of IPR. Ramakrishna T. CIPRA, NLSIU, Bangalore, 2005

Course Outcome
The student will be able to
C1 Understand and differentiate the categories of intellectual property rights.
C2 Describe about patents and procedure for obtaining patents.
C3 Distinguish plant variety, traditional knowledge and geographical indications under IPR.
C4 Provide the information about the different enforcements and practical aspects involved in protection of IPR.
C5 Provide different organizations role and responsibilities in the protection of IPR in the international level.
C6 Understand the interrelationships between different Intellectual Property Rights on International Society

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OTT351  BASICS OF TEXTILE FINISHING

OBJECTIVE:
- To enable the students to understand the basics and different types of finishes required for textile materials and machines used for finishing.
UNIT I  RESIN FINISHING

UNIT II  FLAME PROOF & WATERPROOF
Concept of Flame proof & flame retardancy. Flame retardant finishes for cotton, Concept of waterproof and water repellent Finishes, Durable & Semi durable and Temporary finishes, Concept of Antimicrobial finish.

UNIT III  SOIL RELEASE AND ANTISTATIC FINISHES

UNIT IV  MECHANICAL FINISHES

UNIT V  STIFFENING AND SOFTENING
Concept of stiffening and softening of textile materials. Mechanism in the weight reduction of PET .Concept of Micro encapsulation techniques in finishing process, Nano finish, Plasma Treatment and Bio finishing.

OUTCOMES:
Upon completion of the course, the students will be able to Understand the
CO: 2 Concept of Flame proof & flame retardancy, waterproof and water repellent, Antimicrobial finishes.
CO: 3 Concept of Soil Release, Anti Pilling, UV Protection and Antistatic finishes.
CO: 4 Concept of Mechanical finishing.
CO: 5 Basics of Micro encapsulation techniques, Nano finish, Plasma Treatment.

TOTAL: 45 PERIODS

TEXT BOOKS:

REFERENCES:
1. Microencapsulation in finishing, Review of progress of Colouration, SDC, 2001 62

OTT352  INDUSTRIAL ENGINEERING FOR GARMENT INDUSTRY  L T P C
3 0 0 3

OBJECTIVES:
- To enable the students to learn about basics of industrial engineering and different tools of industrial engineering and its application in apparel industry

UNIT I  INTRODUCTION
Scope of industrial engineering in apparel Industry, role of industrial engineers.
Productivity: Definition - Productivity, Productivity measures. Reduction of work content due to the product and process, Reduction of ineffective time due to the management, due to the worker. Causes for low productivity in apparel industry and measures for improvement.

UNIT II WORK STUDY 9
Definition, Purpose, Basic procedure and techniques of work-study.

Work environment – Lighting, Ventilation, Climatic condition on productivity. Temperature control, humidity control, noise control measures. Safety and ergonomics on work station and work environment

Material Handling – Objectives, Classification and characteristics of material handling equipments, Specialized material handling equipments.

UNIT III METHOD STUDY 9
Definition, Objectives, Procedure, Process charts and symbols. Various charts – Charts indicating process sequence: Outline process chart, flow process chart (man type, material type and equipment type); Charts using time scale – multiple activity chart. Diagrams indicating movement – flow diagram, string diagram, cycle graph, chrono cycle graph, travel chart

MOTION STUDY: Principle of motion economy, Two handed process chart, micro motion analysis – therbligs, SIMO chart.

UNIT IV WORK MEASUREMENT 9
Definition, purpose, procedure, equipments, techniques. Time study - Definition, basics of time study- equipments. Time study forms, Stop watch procedure. Predetermined motion time standards (PMTS). Time Study rating, calculation of standard time, Performance rating – relaxation and other allowances. Calculation of SAM for different garments, GSD.

UNIT V WORK STUDY APPLICATION 9
Application of work study techniques in cutting, stitching and packing in garment industry. Workaids in sewing, Pitch diagram, Line balancing, Capacity planning, scientific method of training.

OUTCOMES:
Upon the completion of the course the student shall be able to understand

CO1: Fundamental concepts of industrial Engineering and productivity
CO2: Method study
CO3: Motion analysis
CO4: Work measurement and SAM
CO5: Ergonomics and its application to garment industry

TOTAL: 45 PERIODS

TEXTBOOKS:

REFERENCES
## Course Articulation Matrix:

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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

### OTT353 BASICS OF TEXTILE MANUFACTURE

**L T P C**

| 3 0 0 3 |

**OBJECTIVES:**
To enable the students to learn about the basics of fibre forming, yarn production, fabric formation, coloration of fabrics and garment manufacturing

**UNIT I NATURAL FIBRES**

Introduction: Definition of staple fibre, filament; Classification of natural and man-made fibres, essential and desirable properties of fibres. Production and cultivation of Natural Fibers: Cultivation of cotton, production of silk (sericulture), wool and jute – physical and chemical structure of these fibres.

**UNIT II REGENERATED AND SYNTHETIC FIBRES**

Production sequence of regenerated and modified cellulosic fibres: viscose rayon, Acetate Rayon, high wet modulus and high tenacity fibres; synthetic fibres – chemical structure, fibre forming polymers, production principles.

**UNIT III BASICS OF SPINNING**

Spinning – principle of yarn formation, sequence of machines for yarn production with short staple fibres and blends, principles of opening and cleaning machines; yarn numbering - calculations

**UNIT IV BASICS OF WEAVING**

Woven fabric – warp, weft, weaving, path of warp; looms – classification, handloom and its parts, powerloom, automatic looms, shuttleless looms, special type of looms; preparatory machines for weaving process and their objectives; basic weaving mechanism - primary, secondary and auxiliary mechanisms,
UNIT V  BASICS OF KNITTING AND NONWOVEN 9


TOTAL: 45 PERIODS

OUTCOMES:
On completion of this course, the students shall have the basic knowledge on
CO1: Classification of fibres and production of natural fibres
CO2: Regenerated and synthetic fibres
CO3: Yarn spinning
CO4: Weaving
CO5: Knitting and nonwoven

TEXTBOOKS

REFERENCES:
Course Articulation Matrix:

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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
COURSE OBJECTIVES

- Understand the fundamentals of plastics processing, such as the relationships between material structural properties and required processing parameters, and so on
- To gain practical knowledge on the polymer selection and its processing
- Understanding the major plastic material processing techniques (Extrusion, Injection molding, Compression and Transfer molding, Blow molding, Thermoforming and casting)
- To understand suitable additives for plastics compounding
- To Propose troubleshooting mechanisms for defects found in plastics products manufactured by various processing techniques

UNIT I  
INTRODUCTION TO PLASTICS PROCESSING
9

UNIT II  
EXTRUSION
9

UNIT III  
INJECTION MOLDING
9
Injection molding – Principles and processing outline, machinery, accessories and functions, specifications, process variables, mould cycle. Types of clamping: hydraulic and toggle mechanisms. Start-up and shut down procedures-Cylinder nozzles- Press capacity projected area -Shot weight Basic theoretical concepts and their relationship to processing - Interaction of moulding process aspect effects in quoted variables. Basic mould types. Reciprocating vs. plunger type injection moulding. Thermoplastic vs. thermosetting injection moulding. Injection moulding vs. other plastic processing techniques. State-of-the art injection moulding techniques - Introduction to trouble shooting

UNIT IV  
COMPRESSION AND TRANSFER MOLDING
9
Compression moulding – Basic principles of compression and transfer moulding-Meaning of terms-Bulk factor and flow properties, moulding materials, process variables and process cycle, Inter relation between flow properties-Curing time-Mould temperature and Pressure requirements. Preforms and preheating- Techniques of preheating. Machines used-Types of compression mould-positive, semi-positive and flash. Common moulding faults and their correction- Finishing of mouldings. Transfer moulding: working principle, equipment, Press capacity-Integral moulds and auxiliary ram moulds, moulding cycle, moulding tolerances, pot transfer, plunger transfer and screw transfer moulding techniques, advantages over compression moulding

UNIT V  
BLOW MOLDING, THERMOFORMING AND CASTING
9

COURSE OUTCOMES

- Ability to find out the correlation between various processing techniques with product properties.

TOTAL HOURS: 45
• Understand the major plastics processing techniques used in moulding (injection, blow, compression, and transfer), extrusion, thermoforming, and casting.
• Acquire knowledge on additives for plastic compounding and methods employed for the same
• Familiarize with the machinery and ancillary equipment associated with various plastic processing techniques.
• Select an appropriate processing technique for the production of a plastic product

REFERENCES

OEC351 SIGNALS AND SYSTEMS

COURSE OBJECTIVES:
• To understand the basic properties of signal & systems
• To know the methods of characterization of LTI systems in time domain
• To analyze continuous time signals and system in the Fourier and Laplace domain
• To analyze discrete time signals and system in the Fourier and Z transform domain

UNIT I CLASSIFICATION OF SIGNALS AND SYSTEMS


UNIT II ANALYSIS OF CONTINUOUS TIME SIGNALS

Fourier series for periodic signals - Fourier Transform – properties- Laplace Transforms and Properties

UNIT III LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS


UNIT IV ANALYSIS OF DISCRETE TIME SIGNALS

Baseband signal Sampling–Fourier Transform of discrete time signals (DTFT)– Properties of DTFT - Z Transform & Properties
UNIT V  LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS  9

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the student will be able to:
CO1:determine if a given system is linear/causal/stable
CO2: determine the frequency components present in a deterministic signal
CO3:characterize continuous LTI systems in the time domain and frequency domain
CO4:characterize discrete LTI systems in the time domain and frequency domain
CO5:compute the output of an LTI system in the time and frequency domains

TEXT BOOKS:

REFERENCES:

OEC352  FUNDAMENTALS OF ELECTRONIC DEVICES AND CIRCUITS  L T P C
3 0 0 3

COURSE OBJECTIVES:
• To give a comprehensive exposure to all types of devices and circuits constructed with discrete components. This helps to develop a strong basis for building linear and digital integrated circuits
• To analyze the frequency response of small signal amplifiers
• To design and analyze single stage and multistage amplifier circuits
• To study about feedback amplifiers and oscillators principles
• To understand the analysis and design of multi vibrators

UNIT I  SEMICONDUCTOR DEVICES  9
PN junction diode, Zener diode, BJT, MOSFET, UJT –structure, operation and V-I characteristics, Rectifiers – Half Wave and Full Wave Rectifier, Zener as regulator

UNIT II  AMPLIFIERS  9
Load line, operating point, biasing methods for BJT and MOSFET, BJT small signal model – Analysis of CE, CB, CC amplifiers- Gain and frequency response –Analysis of CS and Source follower – Gain and frequency response- High frequency analysis.
UNIT III MULTISTAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIER
Cascade amplifier, Differential amplifier – Common mode and Difference mode analysis – Tuned amplifiers – Gain and frequency response – Neutralization methods.

UNIT IV FEEDBACK AMPLIFIERS AND OSCILLATORS

UNIT V POWER AMPLIFIERS AND DC/DC CONVERTERS
Power amplifiers- class A-Class B-Class AB-Class C-Temperature Effect- Class AB Power amplifier using MOSFET –DC/DC convertors – Buck, Boost, Buck-Boost analysis and design.

COURSE OUTCOMES:
At the end of the course the students will be able to
CO1: Explain the structure and working operation of basic electronic devices.
CO2: Design and analyze amplifiers.
CO3: Analyze frequency response of BJT and MOSFET amplifiers
CO4: Design and analyze feedback amplifiers and oscillator principles.
CO5: Design and analyze power amplifiers and supply circuits

TOTAL: 45 PERIODS

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CBM348 FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT

OBJECTIVES:
• To understand the global trends and development methodologies of various types of products and services
• To conceptualize, prototype and develop product management plan for a new product based on the type of the new product and development methodology integrating the hardware, software, controls, electronics and mechanical systems
• To understand requirement engineering and know how to collect, analyze and arrive at requirements for new product development and convert them in to design specification
• To understand system modeling for system, sub-system and their interfaces and arrive at the optimum system specification and characteristics
• To develop documentation, test specifications and coordinate with various teams to validate and sustain up to the EoL (End of Life) support activities for engineering customer

UNIT I  BASICS OF PRODUCT DEVELOPMENT  9

UNIT II  REQUIREMENTS AND SYSTEM DESIGN  9

UNIT III  DESIGN AND TESTING  9

UNIT IV  SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT  9

UNIT V  BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY  9

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of the course, the students will be able to:
• Define, formulate, and analyze a problem
• Solve specific problems independently or as part of a team
• Gain knowledge of the Innovation & Product Development process in the Business Context
• Work independently as well as in teams
• Manage a project from start to finish

TEXT BOOKS:
1. Book specially prepared by NASSCOM as per the MoU.

REFERENCES:
2. Peter F Drucker, “People and Performance”, Butterworth – Heinemann [Elsevier], Oxford,

**CO’s- PO’s & PSO’s MAPPING**

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CBM333 ASSISTIVE TECHNOLOGY L T P C  
3 0 0 3

**OBJECTIVES:**
The student should be made to:
- To know the hardware requirement various assistive devices
- To understand the prosthetic and orthotic devices
- To know the developments in assistive technology

**UNIT I** CARDIAC ASSIST DEVICES 9
Cardiac functions and parameters, principle of External counter pulsation techniques, intra aortic balloon pump, Auxillary ventricle and schematic for temporary bypass of left ventricle, prosthetic heart valves, cardiac pacemaker.

**UNIT II** HEMODIALYSERS 9
Physiology of kidney, Artificial kidney, Dialysis action, hemodialyser unit, membrane dialysis, portable dialyser monitoring and functional parameters.

**UNIT III** HEARING AIDS 9
Anatomy of ear, Common tests – audiograms, air conduction, bone conduction, masking techniques, SISI, Hearing aids – principles, drawbacks in the conventional unit, DSP based hearing aids.

**UNIT IV** PROSTHETIC AND ORTHODIC DEVICES 9
Hand and arm replacement – different types of models, externally powered limb prosthesis, feedback in orthotic system, functional electrical stimulation, sensory assist devices.

**UNIT V** RECENT TRENDS 9
Transcutaneous electrical nerve stimulator, bio-feedback, assistive devices in drug delivery

**TOTAL : 45 PERIODS**

**OUTCOMES:**
On successful completion of this course, the student will be able to
CO1: Interpret the various mechanical techniques that will help in assisting the heart functions.
CO2: Describe the underlying principles of hemodialyzer machine.
CO3: Indicate the methodologies to assess the hearing loss.
CO4: Evaluate the types of assistive devices for mobilization.
CO5: Explain about TENS and biofeedback system.
TEXT BOOKS

REFERENCES
4. Cardiac Assist Devices, Daniel Goldstein (Editor), Mehmet Oz (Editor), Wiley-Blackwell April 2000 ISBN: 978-0-879-93449-1

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OMA352 OPERATIONS RESEARCH

OBJECTIVES:
This course will help the students to
- determine the optimum solution for Linear programming problems.
- study the Transportation and assignment models and various techniques to solve them.
- acquire the knowledge of optimality, formulation and computation of integer programming problems.
- acquire the knowledge of optimality, formulation and computation of dynamic programming problems.
- determine the optimum solution for non-linear programming problems.

UNIT I LINEAR PROGRAMMING

UNIT II TRANSPORTATION AND ASSIGNMENT PROBLEMS

UNIT III INTEGER PROGRAMMING
UNIT IV  DYNAMIC PROGRAMMING PROBLEMS  9

UNIT V  NON - LINEAR PROGRAMMING PROBLEMS  9

TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course, students will be able to
- Could develop a fundamental understanding of linear programming models, able to develop a linear programming model from problem description, apply the simplex method for solving linear programming problems.
- analyze the concept of developing, formulating, modeling and solving transportation and assignment problems.
- solve the integer programming problems using various methods.
- conceptualize the principle of optimality and sub-optimization, formulation and computational procedure of dynamic programming.
- determine the optimum solution for non-linear programming problems.

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OMA353  ALGEBRA AND NUMBER THEORY  L T P C  3 0 0 3

OBJECTIVES:
To introduce the basic notions of groups, rings, fields which will then be used to solve related problems.
To examine the key questions in the Theory of Numbers.

To give an integrated approach to number theory and abstract algebra, and provide a firm basis for further reading and study in the subject.

UNIT I  GROUPS AND RINGS
Groups: Definition - Properties - Homomorphism - Isomorphism - Cyclic groups - Cosets - Lagrange's theorem.
Rings: Definition - Sub rings - Integral domain - Field - Integer modulo n - Ring homomorphism.

UNIT II  FINITE FIELDS AND POLYNOMIALS
Rings - Polynomial rings - Irreducible polynomials over finite fields - Factorization of polynomials over finite fields.

UNIT III  DIVISIBILITY THEORY AND CANONICAL DECOMPOSITIONS
Division algorithm- Base-b representations – Number patterns – Prime and composite numbers – GCD – Euclidean algorithm – Fundamental theorem of arithmetic – LCM.

UNIT IV  DIOPHANTINE EQUATIONS AND CONGRUENCES
Linear Diophantine equations – Congruence’s – Linear Congruence’s - Applications : Divisibility tests - Modular exponentiation - Chinese remainder theorem – 2x2 linear systems.

UNIT V  CLASSICAL THEOREMS AND MULTIPLICATIVE FUNCTIONS
Wilson’s theorem – Fermat’s Little theorem – Euler’s theorem – Euler’s Phi functions – Tau and Sigma functions.

TOTAL: 45 PERIODS

OUTCOMES:
- Explain the fundamental concepts of advanced algebra and their role in modern mathematics and applied contexts.
- Demonstrate accurate and efficient use of advanced algebraic techniques.
- The students should be able to demonstrate their mastery by solving non-trivial problems related to the concepts, and by proving simple theorems about the, statements proven by the text

TEXT BOOKS:

REFERENCES:
COURSE OBJECTIVES:
- To test the consistency and solve system of linear equations.
- To find the basis and dimension of vector space.
- To obtain the matrix of linear transformation and its eigenvalues and eigenvectors.
- To find orthonormal basis of inner product space and find least square approximation.
- To find eigenvalues of a matrix using numerical techniques and perform matrix decomposition.

UNIT I MATRICES AND SYSTEM OF LINEAR EQUATIONS

UNIT II VECTOR SPACES
Vector spaces over Real and Complex fields - Subspace – Linear space - Linear independence and dependence - Basis and dimension.

UNIT III LINEAR TRANSFORMATION
Linear transformation - Rank space and null space - Rank and nullity - Dimension theorem – Matrix representation of linear transformation - Eigenvalues and eigenvectors of linear transformation – Diagonalization.

UNIT IV INNER PRODUCT SPACES
Inner product and norms - Properties - Orthogonal, Orthonormal vectors - Gram Schmidt orthonormalization process - Least square approximation.

UNIT V EIGEN VALUE PROBLEMS AND MATRIX DECOMPOSITION

COURSE OUTCOMES:
After the completion of the course the student will be able to
1. Test the consistency and solve system of linear equations.
2. Find the basis and dimension of vector space.
3. Obtain the matrix of linear transformation and its eigenvalues and eigenvectors.
4. Find orthonormal basis of inner product space and find least square approximation.
5. Find eigenvalues of a matrix using numerical techniques and perform matrix decomposition.

TEXT BOOKS

REFERENCES
OBT352  BASICS OF MICROBIAL TECHNOLOGY  L T P C

3 0 0 3

COURSE OBJECTIVE:
- Enable the Non-biological student’s to understand about the basics of life science and their pros and cons for living organisms.

UNIT I  BASICS OF MICROBES AND ITS TYPES  9
Introduction to microbes, existence of microbes, inventions of great scientist and history, types of microorganisms – Bacteria, Virus, Fungi.

UNIT II  MICROBIAL TECHNIQUES  9
Sterilization – types – physical and chemical sterilization, Decontamination, Preservation methods, fermentation, Cultivation and growth of microbes, Diagnostic methods.

UNIT III  PATHOGENIC MICROBES  9
Infectious Disease – Awareness, Causative agent, Prevention and control - Cholera, Dengu, Malaria, Diarrhea, Tuberculosis, Typhoid, Covid, HIV.

UNIT IV  BENEFICIAL MICROBES  9
Applications of microbes – Clinical microbiology, agricultural microbiology, Food Microbiology, Environmental Microbiology, Animal Microbiology, Marine Microbiology.

UNIT V  PRODUCTS FROM MICROBES  9
Fermented products – Fermented Beverages, Curd, Cheese, Mushroom, Agricultural products – Biopesticide, Biofertilizers, Vermi compost, Pharmaceutical products - Antibiotics, Vaccines

TOTAL: 45 PERIODS

COURSE OUTCOME:
At the end of the course the students will be able to
1. Microbes and their types
2. Cultivation of microbes
3. Pathogens and control measures for safety
4. Microbes in different industry for economy.

TEXT BOOKS
OBJECTIVES:

- The objective is to offer basic concepts of biochemistry to students with diverse background in life sciences including but not limited to the structure and function of various biomolecules and their metabolism.

UNIT I  CARBOHYDRATES
Introduction to carbohydrate, classification, properties of monosaccharide, structural aspects of monosaccharides. Introduction to disaccharide (lactose, maltose, sucrose) and polysaccharide (Heparin, starch, and glycogen) biological function of carbohydrate.

UNIT II  LIPID AND FATTY ACIDS
Introduction to lipid, occurrence, properties, classification of lipid. Importance of phospholipids, sphingolipid and glycerolipid. Biological function of lipid. Fatty acid, Introduction, Nomenclature and classification of fatty acid Essential and non essential fatty acids.

UNIT III  AMINO ACIDS AND PROTEIN.

UNIT IV  NUCLEIC ACIDS
Introduction to nucleic acid, Difference between nucleotide and nucleoside, composition of DNA & amp; RNA Structure of Nitrogen bases in DNA and RNA along with the nomenclature- DNA double helix (Watson and crick) model, types of DNA, RNA.

UNIT V  VITAMINS AND HORMONES

OUTCOMES:

- Students will learn about various kinds of biomolecules and their physiological role.
- Students will gain knowledge about various metabolic disorders and will help them to know the importance of various biomolecules in terms of disease correlation.

TEXT BOOKS

REFERENCES
OBJECTIVES:

- To provide knowledge on the fundamentals of cell biology.
- To understand the signalling mechanisms.
- Understand basic principles of molecular biology at intracellular level to regulate growth, division and development.

UNIT I INTRODUCTION TO CELL
Cell, cell wall and Extracellular Matrix (ECM), composition, cellular dimensions, Evolution, Organisation, differentiation of prokaryotic and Eukaryotic cells, Virus, bacteria, cyanobacteria, mycoplasma and prions.

UNIT II CELL ORGANELLES
Molecular organisation, biogenesis and function Mitochondria, endoplasmic reticulum, golgi apparatus, plastids, chloroplast, leucoplast, centrosome, lysosome, ribosome, peroxisome, Nucleus and nucleolus. Endo membrane system, concept of compartmentalisation.

UNIT III BIO-MEMBRANE TRANSPORT

UNIT IV CELL CYCLE
Cell cycle- Cell division by mitosis and meiosis, Comparision of meosis and mitosis, regulation of cell cycle, cell lysis, Cytokinesis, Cell signaling, Cell communication, Cell adhesion and Cell junction, cell cycle checkpoints.

UNIT V CENTRAL DOGMA

OUTCOMES:

- Understanding of cell at structural and functional level.
- Understand the central dogma of life and its significance.
- Comprehend the basic mechanisms of cell division.

TEXTBOOKS:

REFERENCES:
OPEN ELECTIVE IV

OHS352 PROJECT REPORT WRITING L T P C 3 0 0 3

COURSE OBJECTIVE
The Course will enable Learners to,
- Understand the essentials of project writing.
- Perceive the difference between general writing and technical writing.
- Assimilate the fundamental features of report writing.
- Understand the essential differences that exist between general and technical writing.
- Learn the structure of a technical and project report.

UNIT I

UNIT II

UNIT III
Structure of the Project Report: (Part 1) Framing a Title – Content – Acknowledgement – Funding Details - Abstract – Introduction – Aim of the Study – Background - Writing the research question - Need of the Study/Project Significance, Relevance – Determining the feasibility – Theoretical Framework.

UNIT IV

UNIT V

TOTAL:45 PERIODS

OUTCOMES
By the end of the course, learners will be able to
- Write effective project reports.
- Use statistical tools with confidence.
- Explain the purpose and intension of the proposed project coherently and with clarity.
- Create writing texts to suit achieve the intended purpose.
- Master the art of writing winning proposals and projects.

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- Note: The average value of this course to be used for program articulation matrix.
OMA355 ADVANCED NUMERICAL METHODS

OBJECTIVE:
- To impart knowledge on numerical methods that will come in handy to solve numerically the problems that arise in engineering and technology. This will also serve as a precursor for future research.

UNIT I ALGEBRAIC EQUATIONS AND EIGENVALUE PROBLEM

UNIT II INTERPOLATION
- Central difference: Stirling and Bessel's interpolation formulae; Piecewise spline interpolation: Piecewise linear, piecewise quadratic and cubic spline; Least square approximation for continuous data (upto 3rd degree).

UNIT III NUMERICAL METHODS FOR ORDINARY DIFFERENTIAL EQUATIONS

UNIT IV FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS
- Laplace and Poisson's equations in a rectangular region: Five point finite difference schemes - Leibmann's iterative methods - Dirichlet's and Neumann conditions – Laplace equation in polar coordinates: Finite difference schemes.

UNIT V FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL DIFFERENTIAL EQUATIONS

TOTAL : 45 PERIODS

OUTCOMES:
Upon completion of this course, the students will be able to:
- CO1: demonstrate the understandings of common numerical methods for nonlinear equations, system of linear equations and eigenvalue problems;
- CO2: understand the interpolation theory;
- CO3: understand the concepts of numerical methods for ordinary differential equations;
- CO4: demonstrate the understandings of common numerical methods for elliptic equations;
- CO5: understand the concepts of numerical methods for time dependent partial differential equations.

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OMA356          RANDOM PROCESSES          L T P C
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OBJECTIVES:
- To introduce the basic concepts of probability, one and two dimensional random variables with applications to engineering which can describe real life phenomenon.
- To understand the basic concepts of random processes which are widely used in communication networks.
- To acquaint with specialized random processes which are apt for modelling the real time scenario.
- To understand the concept of correlation and spectral densities.
- To understand the significance of linear systems with random inputs.

UNIT I      RANDOM VARIABLES

UNIT II      RANDOM PROCESSES

UNIT III     SPECIAL RANDOM PROCESSES

UNIT IV      CORRELATION AND SPECTRAL DENSITIES
UNIT V  LINEAR SYSTEMS WITH RANDOM INPUTS

Linear time invariant system – System transfer function – Linear systems with random inputs – Auto correlation and cross correlation functions of input and output.

TOTAL: 45 PERIODS

OUTCOMES
Upon successful completion of the course, students should be able to:

- Understand the basic concepts of one and two dimensional random variables and apply in engineering applications.
- Apply the concept random processes in engineering disciplines.
- Understand and apply the concept of correlation and spectral densities.
- Get an exposure of various distribution functions and help in acquiring skills in handling situations involving more than one variable.
- Analyze the response of random inputs to linear time invariant systems.

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OMA357  QUEUEING AND RELIABILITY MODELLING  L T P C  3 0 0 3

OBJECTIVES:
- To provide necessary basic concepts in probability and random processes for applications such as random signals, linear systems in communication engineering.
- To understand the concept of queueing models and apply in engineering.
- To provide the required mathematical support in real life problems and develop probabilistic models which can be used in several areas of science and engineering.
- To study the system reliability and hazard function for series and parallel systems.
• To implement Markovian Techniques for availability and maintainability which opens up new avenues for research.

UNIT I RANDOM PROCESSES

UNIT II MARKOVIAN QUEUEING MODELS
Markovian queues – Birth and death processes – Single and multiple server queueing models – Little’s formula - Queues with finite waiting rooms.

UNIT III ADVANCED QUEUEING MODELS
M/G/1 queue – Pollaczek Khinchin formula - M/D/1 and M/E_k/1 as special cases – Series queues – Open Jackson networks.

UNIT IV SYSTEM RELIABILITY

UNIT V MAINTAINABILITY AND AVAILABILITY
Maintainability and Availability functions – Frequency of failures – Two Unit parallel system with repair – k out of m systems.

TOTAL: 45 PERIODS

OUTCOMES
Upon successful completion of the course, students should be able to:
• Enable the students to apply the concept of random processes in engineering disciplines.
• Students acquire skills in analyzing various queueing models.
• Students can understand and characterize phenomenon which evolve with respect to time in a probabilistic manner.
• Students can analyze reliability of the systems for various probability distributions.
• Students can be able to formulate problems using the maintainability and availability analyses by using theoretical approach.

TEXT BOOKS

REFERENCES
OBJECTIVES
- To introduce the interdisciplinary approach of water management.
- To develop knowledge base and capacity building on IWRM.

UNIT I OVERVIEW OF IWRM
9

UNIT II WATER USE SECTORS: IMPACTS AND SOLUTION
9
Water users: People, Agriculture, ecosystem and others - Impacts of the water use sectors on water resources - Securing water for people, food production, ecosystems and other uses - IWRM relevance in water resources management.

UNIT III WATER ECONOMICS
9
Economic characteristics of water good and services – Economic instruments – Private sector involvement in water resources management - PPP experiences through case studies.

UNIT IV RECENT TRENDS IN WATER MANAGEMENT
9
River basin management - Ecosystem Regeneration – 5 Rs - WASH - Sustainable livelihood - Water management in the context of climate change.

UNIT V IMPLEMENTATION OF IWRM
9
Barriers to implementing IWRM - Policy and legal framework - Bureaucratic reforms and inclusive development - Institutional Transformation - Capacity building - Case studies on conceptual framework of IWRM.

TOTAL: 45 PERIODS

OUTCOMES
- On completion of the course, the student will be able to apply appropriate management techniques towards managing the water resources.

CO1 Describe the context and principles of IWRM; Compare the conventional and integrated ways of water management.

CO2 Discuss on the different water uses; how it is impacted and ways to tackle these impacts.

CO3 Explain the economic aspects of water and choose the best economic option among the alternatives; illustrate the pros and cons of PPP through case studies.

CO4 Illustrate the recent trends in water management.

CO5 Understand the implementation hitches and the institutional frameworks.

TEXT BOOKS

REFERENCES
2. IWRM Guidelines at River Basin Level (UNESCO, 2008).
OBJECTIVES:

- To know the basic concept and function of Production and Operation Management for entrepreneurship.
- To understand the Production process and planning.
- To understand the Production and Operations Management Control for business owners.

UNIT I  INTRODUCTION TO PRODUCTION AND OPERATIONS MANAGEMENT  9
Functions of Production Management - Relationship between production and other functions – Production management and operations management, Characteristics of modern production and operation management, organisation of production function, recent trends in production /operations management - production as an organisational function, decision making in production Operations research

UNIT II  PRODUCTION & OPERATION SYSTEMS  9
Production Systems- principles – Models - CAD and CAM- Automation in Production - Functions and significance- Capacity and Facility Planning: Importance of capacity planning- Capacity measurement – Capacity Requirement Planning (CRP) process for manufacturing and service industry

UNIT III  PRODUCTION & OPERATIONS PLANNING  9
Facility Planning – Location of facilities – Location flexibility – Facility design process and techniques – Location break even analysis-Production Process Planning: Characteristic of production process systems – Steps for production process- Production Planning Control Functions – Planning phase- Action phase- Control phase - Aggregate production planning

UNIT IV  PRODUCTION & OPERATIONS MANAGEMENT PROCESS  9

UNIT V  CONTROLLING PRODUCTION & OPERATIONS MANAGEMENT  9

OUTCOMES:
Upon completion of this course the learners will be able :
CO 1 To understand the basics and functions of Production and Operation Management for business owners.
CO 2 To learn about the Production & Operation Systems.
CO 3 To acquaint on the Production & Operations Planning Techniques followed by entrepreneurs in Industries.
CO 4 To known about the Production & Operations Management Processes in organisations.
CO 5 To comprehend the techniques of controlling, Production and Operations in industries.

REFERENCES
OMG355 MULTIVARIATE DATA ANALYSIS

OBJECTIVE:
- To know various multivariate data analysis techniques for business research.

UNIT I INTRODUCTION
Uni-variate, Bi-variate and Multi-variate techniques – Classification of multivariate techniques – Guidelines for multivariate analysis and interpretation.

UNIT II PREPARING FOR MULTIVARIATE ANALYSIS
Conceptualization of research model with variables, collection of data — Approaches for dealing with missing data — Testing the assumptions of multivariate analysis.

UNIT III MULTIPLE LINEAR REGRESSION ANALYSIS, FACTOR ANALYSIS
Multiple Linear Regression Analysis – Inferences from the estimated regression function – Validation of the model. - Approaches to factor analysis – interpretation of results.

UNIT IV LATENT VARIABLE TECHNIQUES
Confirmatory Factor Analysis, Structural equation modelling, Mediation models, Moderation models, Longitudinal studies.

UNIT V ADVANCED MULTIVARIATE TECHNIQUES
Multiple Discriminant Analysis, Logistic Regression, Cluster Analysis, Conjoint Analysis, multidimensional scaling.

OUTCOMES:
- Demonstrate a sophisticated understanding of the concepts and methods; know the exact scopes and possible limitations of each method; and show capability of using multivariate techniques to provide constructive guidance in decision making.
- Use advanced techniques to conduct thorough and insightful analysis, and interpret the results correctly with detailed and useful information.
- Show substantial understanding of the real problems; conduct deep analysis using correct methods; and draw reasonable conclusions with sufficient explanation and elaboration.
- Write an insightful and well-organized report for a real-world case study, including thoughtful and convincing details.
- Make better business decisions by using advanced techniques in data analytics.

REFERENCES:
COURSE OBJECTIVES:
- To introduce the development, capabilities, applications, of Additive Manufacturing (AM), and its business opportunities.
- To be acquainted with vat polymerization and material extrusion processes
- To be familiar with powder bed fusion and binder jetting processes.
- To gain knowledge on applications of direct energy deposition, and material jetting processes.
- To impart knowledge on sheet lamination and direct write technologies.

UNIT I INTRODUCTION

UNIT II VAT POLYMERIZATION AND MATERIAL EXTRUSION

UNIT III POWDER BED FUSION AND BINDER JETTING

UNIT IV MATERIAL JETTING AND DIRECTED ENERGY DEPOSITION

UNIT V SHEET LAMINATION AND DIRECT WRITE TECHNOLOGY
Ink-Based Direct Writing (DW): Nozzle Dispensing Processes, Inkjet Printing Processes, Aerosol DW - Applications of DW.

COURSE OUTCOMES:
At the end of this course students shall be able to:
CO1: Recognize the development of AM technology and how AM technology propagated into various businesses and developing opportunities.
CO2: Acquire knowledge on process vat polymerization and material extrusion processes and its applications.
CO3: Elaborate the process and applications of powder bed fusion and binder jetting.
CO4: Evaluate the advantages, limitations, applications of material jetting and directed energy deposition processes.
CO5: Acquire knowledge on sheet lamination and direct write technology.
TEXT BOOKS:

REFERENCES:

CME343 NEW PRODUCT DEVELOPMENT

COURSE OBJECTIVES
1. To introduce the fundamental concepts of the new product development
2. To develop material specifications, analysis and process.
3. To Learn the Feasibility Studies & reporting of new product development.
4. To study the New product qualification and Market Survey on similar products of new product development.
   To learn Reverse Engineering. Cloud points generation, converting cloud data to 3D model.

UNIT – I FUNDAMENTALS OF NPD

UNIT – II MATERIAL SPECIFICATIONS, ANALYSIS & PROCESS
Material specification standards – ISO, DIN, JIS, ASTM, EN, etc. – Awareness on various manufacturing process like Metal castings & Forming, Machining (Conventional, 3 Axis, 4 Axis, 5 Axis, ), Fabrications, Welding process. Qualifications of parts mechanical, physical & Chemical properties and their test report preparation and submission. Fundamentals of DFMEA & PFMEA, Fundamentals of FEA, Bend Analysis, Hot Distortion, Metal and Material Flow, Fill and Solidification analysis.

UNIT – III ESSENTIALS OF NPD

UNIT – IV CRITERIONS OF NPD
UNIT V  REPORTING & FORWARD-THINKING OF NPD

Detailed study on PPAP with 18 elements reporting, APQP and its 5 Sections, APQP vs PPAP, Importance of SOP (Standard Operating Procedure) – Purpose & documents, deployment in shop floor. Prototyping & RPT - Concepts, Application and its advantages, 3D Printing – resin models, Sand cores for foundries; Reverse Engineering. Cloud points generation, converting cloud data to 3D model – Advantages & Limitation of RE, CE (Concurrent Engineering) – Basics, Application and its advantages in NPD (to reduce development lead time, time to Market, Improve productivity and product cost.)

TOTAL : 45 PERIODS

OUTCOMES:
At the end of the course the students would be able to
1. Discuss fundamental concepts and customer specific requirements of the New Product development
2. Discuss the Material specification standards, analysis and fabrication, manufacturing process.
3. Develop Feasibility Studies & reporting of New Product development
4. Analyzing the New product qualification and Market Survey on similar products of new product development
5. Develop Reverse Engineering. Cloud points generation, converting cloud data to 3D model

TEXT BOOKS:
1. Product Development – Sten Jonsson
2. Product Design & Development – Karl T. Ulrich, Maria C. Young, Steven D. Eppinger

REFERENCES:
1. Revolutionizing Product Development – Steven C Wheelwright & Kim B. Clark
2. Change by Design
5. Product Design & Value Engineering – Dr. M.A. Bulsara & Dr. H.R. Thakkar

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Low (1) ; Medium (2) ; High (3)

OME355  INDUSTRIAL DESIGN & RAPID PROTOTYPING TECHNIQUES  L T P C

OBJECTIVES:
The course aims to
- Outline Fundamental concepts in UI & UX
- Introduce the principles of Design and Building an mobile app
- Illustrate the use of CAD in product design
- Outline the choice and use of prototyping tools
- Understanding design of electronic circuits and fabrication of electronic devices

UNIT I  UI/UX
Fundamental concepts in UI & UX - Tools - Fundamentals of design principles - Psychology and Human Factors for User Interface Design - Layout and composition for Web, Mobile and
Devices - Typography - Information architecture - Color theory - Design process flow, wireframes, best practices in the industry - User engagement ethics - Design alternatives

UNIT II APP DEVELOPMENT
SDLC - Introduction to App Development - Types of Apps - web Development - understanding Stack - Frontend - backend - Working with Databases - Introduction to API - Introduction to Cloud services - Cloud environment Setup - Reading and writing data to cloud - Embedding ML models to Apps - Deploying application.

UNIT III INDUSTRIAL DESIGN
Introduction to Industrial Design - Points, lines, and planes - Sketching and concept generation - Sketch to CAD - Introduction to CAD tools - Types of 3D modeling - Basic 3D Modeling Tools - Part creation – Assembly - Product design and rendering basics - Dimensioning & Tolerancing

UNIT IV MECHANICAL RAPID PROTOTYPING
Need for prototyping - Domains in prototyping - Difference between actual manufacturing and prototyping - Rapid prototyping methods - Tools used in different domains - Mechanical Prototyping; 3D Printing and classification - Laser Cutting and engraving - RD Works - Additive manufacturing

UNIT V ELECTRONIC RAPID PROTOTYPING
Basics of electronic circuit design - lumped circuits - Electronic Prototyping - Working with simulation tool - simple PCB design with EDA

COURSE OUTCOMES
At the end of the course, learners will be able to:
- Create quick UI/UX prototypes for customer needs
- Develop web application to test product traction / product feature
- Develop 3D models for prototyping various product ideas
- Built prototypes using Tools and Techniques in a quick iterative methodology

TEXT BOOKS

REFERENCES

MF3010 MICRO AND PRECISION ENGINEERING
COURSE OBJECTIVES:
At the end of this course the student should be able to
- Learn about the precision machine tools
- Learn about the macro and micro components.
- Understand handling and operating of the precision machine tools.
- Learn to work with miniature models of existing machine tools/robots and other instruments.
Learn metrology for micro system

UNIT I  INTRODUCTION TO MICROSYSTEMS  9
Design, and material selection, micro-actuators: hydraulic, pneumatic, electrostatic/ magnetic etc. for medical to general purpose applications. Micro-sensors based on Thermal, mechanical, electrical properties; micro-sensors for measurement of pressure, flow, temperature, inertia, force, acceleration, torque, vibration, and monitoring of manufacturing systems.

UNIT II  FABRICATION PROCESSES FOR MICRO-SYSTEMS:  9
Additive, subtractive, forming process, microsystems-Micro-pumps, micro- turbines, micro engines, micro-robot, and miniature biomedical devices

UNIT III  INTRODUCTION TO PRECISION ENGINEERING  9
Machine tools, holding and handling devices, positioning fixtures for fabrication/ assembly of microsystems. Precision drives: inch worm motors, ultrasonic motors, stick- slip mechanism and other piezo-based devices.

UNIT IV  PRECISION MACHINING PROCESSES  9
Precision machining processes for macro components - Diamond turning, fixed and free abrasive processes, finishing processes.

UNIT V  METROLOGY FOR MICRO SYSTEMS  9
Metrology for micro systems - Surface integrity and its characterization.

TOTAL : 45 PERIODS

COURSE OUTCOMES:
Upon the completion of this course the students will be able to
- Select suitable precision machine tools and operate
- Apply the macro and micro components for fabrication of micro systems.
- Apply suitable machining process
- Able to work with miniature models of existing machine tools/robots and other instruments.
- Apply metrology for micro system

TEXT BOOKS:

REFERENCES:

OMF354  COST MANAGEMENT OF ENGINEERING PROJECTS  L  T  P  C
3  0  0  3

COURSE OBJECTIVES:
- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management
UNIT – I  INTRODUCTION TO COSTING CONCEPTS  9
Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.

UNIT – II  INTRODUCTION TO PROJECT MANAGEMENT  9
Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and non-technical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts

UNIT – III  PROJECT EXECUTION AND COSTING CONCEPTS  9
Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems. Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing

UNIT – IV  COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL  9

UNIT – V  QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT  9
Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
CO1: Understand the costing concepts and their role in decision making.
CO2: Understand the project management concepts and their various aspects in selection.
CO3: Interpret costing concepts with project execution.
CO4: Gain knowledge of costing techniques in service sector and various budgetary control techniques.
CO5: Become familiar with quantitative techniques in cost management.

TEXT BOOKS:

REFERENCES:
COURSE OBJECTIVES:
The objective of this course is to make the students to understand the working and characteristics of different types of batteries and their management.

UNIT I  ADVANCED BATTERIES  9
Li-ion Batteries-different formats, chemistry, safe operating area, efficiency, aging. Characteristics-SOC, DOD, SOH. Balancing-Passive Balancing Vs Active Balancing. Other Batteries- NCM and NCA Batteries. NCR18650B specifications.

UNIT II  BATTERY PACK  9
Battery Pack- design, sizing, calculations, flow chart, real and simulation Model. Peak power – definition, testing methods-relationships with Power, Temperature and ohmic Internal Resistance. Cloud based and Local Smart charging.

UNIT III  BATTERY MODELLING  9
Battery Modelling Methods-Equivalent Circuit Models, Electrochemical Model, Neural Network Model. ECM Comparisons- Rint model, Thevenin model, PNGV model. State space Models-Introduction. Battery Modelling software/simulation frameworks

UNIT IV  BATTERY STATE ESTIMATION  9

UNIT V  BMS ARCHITECTURE AND REAL TIME COMPONENTS  9
Battery Management System- need, operation, classification. BMS ASIC-bq76PL536A-Q1 Battery Monitor IC- CC2662R-Q1 Wireless BMS MCU. Communication Modules- CAN Open-Flex Ray-CANedge1 package. ARBIN Battery Tester. BMS Development with Modeling software and Model-Based Design.

TOTAL : 45 PERIODS

COURSE OUTCOMES:
At the end of this course, students will be able to
1. Acquire knowledge of different Li-ion Batteries performance.
2. Design a Battery Pack and make related calculations.
3. Demonstrate a Battery Model or Simulation.
5. Approach different BMS architectures during real world usage.

TEXT BOOKS

REFERENCE BOOKS
1. Developing Battery Management Systems with Simulink and Model-Based Design-whitepaper
2. Panasonic NCR18650B- DataSheet
3. bq76PL536A-Q1- IC DataSheet
4. CC2662R-Q1- IC DataSheet
COURSE OBJECTIVES:

- The objective of this course is to make the students to list common types of sensor and actuators used in automotive vehicles.

UNIT I INTRODUCTION TO MEASUREMENTS AND SENSORS


UNIT II VARIABLE RESISTANCE AND INDUCTANCE SENSORS

Principle of operation- Construction details- Characteristics and applications of resistive potentiometer- Strain gauges- Resistive thermometers- Thermistors- Piezoresistive sensors Inductive potentiometer- Variable reluctance transducers: EI pick up and LVDT

UNIT III VARIABLE AND OTHER SPECIAL SENSORS

Variable air gap type, variable area type and variable permittivity type- capacitor microphone Piezoelectric, Magnetostrictive, Hall Effect, semiconductor sensor- digital transducers-Humidity Sensor. Rain sensor, climatic condition sensor, solar, light sensor, antiglare sensor.

UNIT IV AUTOMOTIVE ACTUATORS


UNIT V AUTOMATIC TEMPERATURE CONTROL ACTUATORS

Different types of actuators used in automatic temperature control- Fixed and variable displacement temperature control- Semi Automatic- Controller design for Fixed and variable displacement type air conditioning system.

TOTAL =45 PERIODS

COURSE OUTCOMES:

At the end of the course, the student will be able to

1. List common types of sensor and actuators used in vehicles.
2. Design measuring equipment’s for the measurement of pressure force, temperature and flow.
3. Generate new ideas in designing the sensors and actuators for automotive application
4. Understand the operation of the sensors, actuators and electronic control.
5. Design temperature control actuators for vehicles.

TEXT BOOKS:


REFERENCES:

OBJECTIVES:
- To interpret the missile space stations, space vs earth environment.
- To explain the life support systems, mission logistics and planning.
- To deploy the skills effectively in the understanding of space vehicle configuration design.
- To explain Engine system and support of space vehicle
- To interpret nose cone configuration of space vehicle

UNIT I FUNDAMENTAL ASPECTS 9
Energy and Efficiencies of power plants for space vehicles – Typical Performance Values – Mission design – Structural design aspects during launch - role of launch environment on launch vehicle integrity.

UNIT II SELECTION OF ROCKET PROPULSION SYSTEMS 9
Ascent flight mechanics – Launch vehicle selection process – Criteria for Selection for different missions – selection of subsystems – types of staging – Interfaces – selection and criteria for stages and their role in launch vehicle configuration design.

UNIT III ENGINE SYSTEMS, CONTROLS, AND INTEGRATION 9

UNIT IV THRUST VECTOR CONTROL 9
TVC Mechanisms with a Single Nozzle – TVC with Multiple Thrust Chambers or Nozzles – Testing – Integration with Vehicle – SITVC method – other jet control methods - exhaust plume problems in space environment

UNIT V NOSE CONE CONFIGURATION 9
Aerodynamic aspects on the selection of nose shape of a launch vehicle - design factors in the finalization of nose configuration with respect to payload - nose cone thermal protection system - separation of fairings - payload injection mechanism

TOTAL: 45 PERIODS

OUTCOMES:
On successful completion of this course, the student will be able to
- Explain exotic space propulsion concepts, such as nuclear, solar sail, and antimatter.
- Apply knowledge in selecting the appropriate rocket propulsion systems.
- interpret the air-breathing propulsion suitable for initial stages and fly-back boosters.
- Analyze aerodynamics aspect, including boost-phase lift and drag, hypersonic, and re-entry.
- Adapt from aircraft engineers moving into launch vehicle, spacecraft, and hypersonic vehicle design.
5. To make students familiarize with the concepts of planning process and business strategies.

UNITI INTRODUCTION TO MANAGEMENT AND ORGANISATION 9

UNITII OPERATIONS AND MARKETING MANAGEMENT 9

UNITIII HUMAN RESOURCES MANAGEMENT 9
Concepts of HRM, HRD and Personnel Management and Industrial Relations (PMIR), HRM vs PMIR, Basic functions of HR Manager: Manpower planning, Recruitment, Selection, Training and Development, Wage and Salary Administration, Promotion, Transfer, Performance Appraisal, Grievance Handling and Welfare Administration, Job Evaluation and Merit Rating – Capability Maturity Model (CMM) Levels.

UNITIV PROJECT MANAGEMENT 9
Network Analysis, Programme Evaluation and Review Technique (PERT), Critical Path Method (CPM), identifying critical path, Probability of Completing the project within given time, Project Cost Analysis, Project Crashing (simple problems).

UNITV STRATEGIC MANAGEMENT AND CONTEMPORARY STRATEGIC ISSUES 9

OURSEOUTCOMES:
Upon completion of the course, Students will be able to
CO1: Plan an organizational structure for a given context in the organisation to carry out production operation through Work study.
CO2: Survey the markets, customers and competition better and price the given product appropriately.
CO3: Ensure quality of the product or service.
CO4: Plan, schedule and control projects through PERT and CPM.
CO5: Evaluate strategy for a business or service organisation.

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TEXTBOOKS:

REFERENCES:

OIM353 PRODUCTION PLANNING AND CONTROL

COURSE OBJECTIVES:
- To understand the concept of production planning and control act work study,
- To apply the concept of product planning,
- To analyze the production scheduling,
- To apply the Inventory Control concepts.
- To prepare the manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

UNIT I INTRODUCTION
Objectives and benefits of planning and control- Functions of production control- Types of production- Job- batch and continuous- Product development and design- Marketing aspect- Functional aspects- Operational aspect- Durability and dependability aspect aesthetic aspect. Profit consideration- Standardization, Simplification & specialization- Break even analysis- Economics of a new design.

UNIT II WORK STUDY
Method study, basic procedure- Selection- Recording of process - Critical analysis, Development - Implementation - Micro motion and memo motion study – work measurement - Techniques of work measurement - Time study - Production study - Work sampling - Synthesis from standard data - Predetermined motion time standards.

UNIT III PRODUCT PLANNING AND PROCESS PLANNING
Product planning- Extending the original product information- Value analysis- Problems in lack of product planning- Process planning and routing- Pre requisite information needed for process planning- Steps in process planning- Quantity determination in batch production- Machine capacity, balancing- Analysis of process capabilities in a multi product system.

UNIT IV PRODUCTION SCHEDULING

UNIT V INVENTORY CONTROL AND RECENT TRENDS IN PPC
Inventory control- Purpose of holding stock- Effect of demand on inventories- Ordering procedures. Two bin system - Ordering cycle system- Determination of Economic order quantity and economic lot size- ABC analysis - Recorder procedure- Introduction to computer integrated production planning systems- elements of JUST IN TIME SYSTEMS- Fundamentals of MRP II and ERP.

TOTAL: 45 PERIODS
COURSE OUTCOMES:
Upon completion of this course,
CO1: The students can able to prepare production planning and control act work study,
CO2: The students can able to prepare product planning,
CO3: The students can able to prepare production scheduling,
CO4: The students can able to prepare Inventory Control.
CO5: They can plan manufacturing requirements manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

TEXT BOOKS:

REFERENCES

OIE353 OPERATIONS MANAGEMENT

COURSE OBJECTIVE:
- Recognize and appreciate the concept of Production and Operations Management in creating and enhancing a firm’s competitive advantages.
- Describe the concept and contribution of various constituents of Production and Operations Management (both manufacturing and service).
- Relate the interdependence of the operations function with the other key functional areas of a firm.
- Teach analytical skills and problem-solving tools to the analysis of the operations problems.
- Apply scheduling and Lean Concepts for improving System Performance.
UNIT I INTRODUCTION TO OPERATIONS MANAGEMENT
Operations Management – Nature, Importance, historical development, transformation processes, differences between services and goods, a system perspective, functions, challenges, current priorities, recent trends; Operations Strategy – Strategic fit, framework; Supply Chain Management

UNIT II FORECASTING, CAPACITY AND FACILITY DESIGN

UNIT III DESIGN OF PRODUCT, PROCESS AND WORK SYSTEMS

UNIT IV MATERIALS MANAGEMENT

UNIT V SCHEDULING AND PROJECT MANAGEMENT
Project Management – Scheduling Techniques, PERT, CPM; Scheduling - work centers – nature, importance; Priority rules and techniques, shopfloor control; Flow shop scheduling – Johnson’s Algorithm – Gantt charts; personnel scheduling in services.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: The students will appreciate the role of Production and Operations management in enabling and enhancing a firm’s competitive advantages in the dynamic business environment.
CO2: The students will obtain sufficient knowledge and skills to forecast demand for Production and Service Systems.
CO3: The students will able to Formulate and Assess Aggregate Planning strategies and Material Requirement Plan.
CO4: The students will be able to develop analytical skills to calculate capacity requirements and developing capacity alternatives.
CO5: The students will be able to apply scheduling and Lean Concepts for improving System Performance.

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TEXT BOOKS

REFERENCES

OSF352  INDUSTRIAL HYGIENE  L T P C
3 0 0 3

COURSE OBJECTIVES:
- Demonstrate an understanding of how occupational hygiene standards are set and used in work health and safety.
- Compare and contrast the roles of environmental and biological monitoring in work health and safety
- Outline strategies for identifying, assessing and controlling risks associated with airborne gases, vapours and particulates
- Discuss how personal protective equipment can be used to reduce risks associated with workplace exposures
- Provide high-level advice on managing and controlling noise and noise-related hazards

UNIT I  INTRODUCTION AND SCOPE

UNIT II  MONITORING FOR SAFETY, HEALTH & ENVIRONMENT
Occupational Health and Environment Safety Management System, ILO and EPA Standards Industrial Hygiene: Definition of Industrial Hygiene, Industrial Hygiene: Control Methods, Substitution, Changing the process, Local Exhaust Ventilation, Isolation, Wet method, Personal hygiene, housekeeping and maintenance, waste disposal, special control measures.

UNIT III  OCCUPATIONAL HEALTH AND ENVIRONMENTAL SAFETY EDUCATION

UNIT IV  OCCUPATIONAL SAFETY, HEALTH AND ENVIRONMENT MANAGEMENT

UNIT V  INDUSTRIAL HAZARDS
auditory system and health, Measurement of noise, Different air pollutants in industries, Effect of different gases and particulate matter, acid fumes, smoke, fog on human health, Vibration: effects.

TOTAL PERIODS: 45

COURSE OUTCOMES:
Students able to
CO1: Explain and apply human factors engineering concepts in both evaluation of existing systems and design of new systems
CO2: Specify designs that avoid occupation related injuries
CO3: Define and apply the principles of work design, motion economy, and work environment design.
CO4: Identify the basic human sensory, cognitive, and physical capabilities and limitations with respect to human-machine system performance.
CO5: Acknowledge the impact of workplace design and environment on productivity

TEXT BOOKS:

REFERENCES:
2. Frank P Lees - Loss of prevention in Process Industries, Vol. 1 and 2,

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OSF353 CHEMICAL PROCESS SAFETY L T P C
3 0 0 3

COURSE OBJECTIVES
• Teach the principles of safety applicable to the design, and operation of chemical process plants.
• Ensure that potential hazards are identified and mitigation measures are in place to prevent unwanted release of energy.
• Learn about the hazardous chemicals into locations that could expose employees and others to serious harm.
• Focuses on preventing incidents and accidents during large scale manufacturing of chemicals and pharmaceuticals.
• Ensure that the general design of the plant is capable of complying with the dose limits in force and with the radioactive releases.

UNIT I SAFETY IN THE STORAGE AND HANDLING OF CHEMICALS AND GASES 9
Types of storage - general considerations for storage layouts - atmospheric venting, pressure and temperature relief - relief valve sizing calculations - storage and handling of hazardous chemicals and industrial gases, safe disposal methods, reaction with other chemicals, hazards during transportation - pipeline transport - safety in chemical laboratories.

UNIT II CHEMICAL REACTION HAZARDS 9
Hazardous inorganic and organic reactions and processes, Reactivity as a process hazard, Detonations, Deflagrations, and Runaways, Assessment and Testing strategies, Self-heating hazards of solids, Explosive potential of chemicals, Structural groups and instability of chemicals, Thermochemical screening.

UNIT III SAFETY IN THE DESIGN OF CHEMICAL PROCESS PLANTS 9
Design principles - Process design development - types of designs, feasibility survey, preliminary design, Flow diagrams, piping and instrumentation diagram, batch versus continuous operation, factors in equipment scale up and design, equipment specifications - reliability and safety in designing - inherent safety - engineered safety - safety during startup and shutdown - non destructive testing methods - pressure and leak testing - emergency safety devices - scrubbers and flares - new concepts in safety design and operation - Pressure vessel testing standards - Inspection techniques for boilers and reaction vessels.

UNIT IV SAFETY IN THE OPERATION OF CHEMICAL PROCESS PLANTS 9
Properties of chemicals - Material Safety Data Sheets - the various properties and formats used - methods available for property determination. Operational activities and hazards - standards operating procedures - safe operation of pumps, compressors, heaters, column, reactors, pressure vessels, storage vessels, piping systems - effects of pressure, temperature, Flow rate and humidity on operations - corrosion and control measures - condition monitoring - control valves - safety valves - pressure reducing valves, drains, bypass valves, inert gases. Chemical splashes, eye irrigation and automatic showers.

UNIT V SAFETY AND ANALYSIS 9
Safety vs. reliability - quantification of basic events, system safety quantification, Human error analysis, Accident investigation and analysis, OSHAS 18001 and OSHMS.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Students able to
CO1 Differentiate between inherent safety and engineered safety and recognize the importance of safety in the design of chemical process plants.
CO2 Develop thorough knowledge about safety in the operation of chemical plants.
CO3 Apply the principles of safety in the storage and handling of gases.
CO4 Identify the conditions that lead to reaction hazards and adopt measures to prevent them.
CO5 Develop thorough knowledge about

TEXT BOOK

REFERENCES:
OML352 ELECTRICAL, ELECTRONIC AND MAGNETIC MATERIALS L T P C
3 0 0 3

COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for:
- Understanding the importance of various materials used in electrical, electronics and magnetic applications
- Acquiring knowledge on the properties of electrical, electronics and magnetic materials.
- Gaining knowledge on the selection of suitable materials for the given application
- Knowing the fundamental concepts in Semiconducting materials
- Getting equipped with the materials used in optical and optoelectronic applications.

UNIT I DIELECTRIC MATERIALS
Dielectric as Electric Field Medium, leakage currents, dielectric loss, dielectric strength, breakdown voltage, breakdown in solid dielectrics, flashover, liquid dielectrics, electric conductivity in solid, liquid and gaseous dielectrics, Ferromagnetic materials, properties of ferromagnetic materials in static fields, spontaneous, polarization, curie point, anti-ferromagnetic materials, piezoelectric materials, pyroelectric materials.

UNIT II MAGNETIC MATERIALS
Classification of magnetic materials, spontaneous magnetization in ferromagnetic materials, magnetic Anisotropy, Magnetostriiction, diamagnetism, magnetically soft and hard materials, special purpose materials, feebly magnetic materials, Ferrites, cast and cermet permanent magnets, ageing of magnets. Factors effecting permeability and Hysteresis.

UNIT III SEMICONDUCTOR MATERIALS
Properties of semiconductors, Silicon wafers, integration techniques, Large and very large scale Integration techniques. Concept of superconductivity; theories and examples for high temperature superconductivity; discussion on specific superconducting materials; comments on fabrication and engineering applications.

UNIT IV MATERIALS FOR ELECTRICAL APPLICATIONS
Materials used for Resistors, rheostats, heaters, transmission line structures, stranded conductors, bimetals fuses, soft and hard solders, electric contact materials, electric carbon materials, thermocouple materials. Solid, Liquid and Gaseous insulating materials, Effect of moisture on insulation.
UNIT V OPTICAL AND OPTOELECTRONIC MATERIALS


TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of this course, the students will be able to
1. Understand various types of dielectric materials, their properties in various conditions.
2. Evaluate magnetic materials and their behavior.
3. Evaluate semiconductor materials and technologies.
4. Select suitable materials for electrical engineering applications.
5. Identify right material for optical and optoelectronic applications

TEXT BOOKS:

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OML353 NANOMATERIALS AND APPLICATIONS

COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for:
- Understanding the evolution of nanomaterials in the scientific era and make them to understand different types of nanomaterials for the future engineering applications
- Gaining knowledge on dimensionality effects on different properties of nanomaterials
- Getting acquainted with the different processing techniques employed for fabricating nanomaterials
- Having knowledge on the different characterisation techniques employed to characterise the nanomaterials
- Acquiring knowledge on different applications of nanomaterials in different disciplines of
UNIT I  NANOMATERIALS  9
Introduction, Classification: 0D, 1D, 2D, 3D nanomaterials and nano-composites, their mechanical, electrical, optical, magnetic properties; Nanomaterials versus bulk materials.

UNIT II  THERMODYNAMICS & KINETICS OF NANOSTRUCTURED MATERIALS  9
Size and interface/interphase effects, interfacial thermodynamics, phase diagrams, diffusivity, grain growth, and thermal stability of nanomaterials.

UNIT III  PROCESSING  9
Bottom-up and top-down approaches for the synthesis of nanomaterials, mechanical alloying, chemical routes, severe plastic deformation, and electrical wire explosion technique.

UNIT IV  STRUCTURAL CHARACTERISTICS  9
Principles of emerging nanoscale X-ray techniques such as small angle X-ray scattering and X-ray absorption fine structure (XAFS), electron and neutron diffraction techniques and their application to nanomaterials; SPM, Nanoindentation, Grain size, phase formation, texture, stress analysis.

UNIT V  APPLICATIONS  9
Applications of nanoparticles, quantum dots, nanotubes, nanowires, nanocoatings; applications in electronic, electrical and medical industries

TOTAL: 45 PERIODS

COURSE OUTCOMES:
After completion of this course, the students will be able to
1. Evaluate nanomaterials and understand the different types of nanomaterials
2. Recognise the effects of dimensionality of materials on the properties
3. Process different nanomaterials and use them in engineering applications
4. Use appropriate techniques for characterising nanomaterials
5. Identify and use different nanomaterials for applications in different engineering fields.

TEXT BOOKS:

REFERENCES:
OMR353  SENSORS

COURSE OBJECTIVES:
- To learn the various types of sensors, transducers, sensor output signal types, calibration techniques, formulation of system equation and its characteristics.
- To understand basic working principle, construction, Application and characteristics of displacement, speed and ranging sensors.
- To understand and analyze the working principle, construction, application and characteristics of force, magnetic and heading sensors.
- To learn and analyze the working principle, construction, application and characteristics of optical, pressure, temperature and other sensors.
- To familiarize students with different signal conditioning circuits design and data acquisition system.

UNIT – I  SENSOR CLASSIFICATION, CHARACTERISTICS AND SIGNAL TYPES  9

UNIT – II  DISPLACEMENT, PROXIMITY AND RANGING SENSORS  9

UNIT – III  FORCE, MAGNETIC AND HEADING SENSORS  9

UNIT – IV  OPTICAL, PRESSURE, TEMPERATURE AND OTHER SENSORS  9

UNIT – V  SIGNAL CONDITIONING  9

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
CO1: Understand various sensor effects, sensor characteristics, signal types, calibration methods and obtain transfer function and empirical relation of sensors. They can also analyze the sensor response.
CO2: Analyze and select suitable sensor for displacement, proximity and range measurement.
CO3: Analyze and select suitable sensor for force, magnetic field, speed, position and direction measurement.
Co4: Analyze and select suitable sensor for light detection, pressure and temperature measurement and also familiar with other miniaturized smart sensors.

Co5: Select and design suitable signal conditioning circuit with proper compensation and linearizing element based on sensor output signal.

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Average: 3 – Slight, 2 – Moderate, 1 – Substantial

Text Books

References

Course Objectives
1. To introduce mobile robotic technology and its types in detail.
2. To learn the kinematics of wheeled and legged robot.
3. To familiarize the intelligence into the mobile robots using various sensors.
4. To acquaint the localization strategies and mapping technique for mobile robot.
5. To aware the collaborative mobile robotics in task planning, navigation and intelligence.

Unit – I Introduction to Mobile Robotics

Unit – II Kinematics
UNIT – III PERCEPTION

UNIT – IV LOCALIZATION

UNIT – V PLANNING, NAVIGATION AND COLLABORATIVE ROBOTS

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
CO1: Evaluate the appropriate mobile robots for the desired application.
CO2: Create the kinematics for given wheeled and legged robot.
CO3: Analyse the sensors for the intelligence of mobile robotics.
CO4: Create the localization strategies and mapping technique for mobile robot.
CO5: Create the collaborative mobile robotics for planning, navigation and intelligence for desired applications.

TEXTBOOK

REFERENCES:

MV3501 MARINE PROPULSION

COOURSE OBJECTIVES:
- To impart knowledge on basics of propulsion system and ship dynamic movements
- To educate them on basic layout and propulsion equipment’s
- To impart basic knowledge on performance of the ship
- To impart basic knowledge on Ship propeller and its types
- To impart knowledge on ship rudder and its types

UNIT I BASICS SHIP PROPULSION SYSTEM AND EQUIPMENTS
law of floatation - Basics principle of propulsion- Earlier methods of propulsion- ship propulsion machinery- boiler, Marine steam engine, diesel engine, ship power transmission system, ship
dynamic structure, Marine propulsion equipment - shaft tunnel, Intermediate shaft and bearing, stern tube, stern tube sealing etc. degree of freedom, Modern propelling methods- water jet propulsion, screw propulsion.

UNIT II SHIPS MOVEMENTS AND SHIP STABILIZATION 9
Thrust augmented devices, Ship hull, modern ship propulsion design, bow thruster – Advantages, various methods to stabilize the ship- passive and active stabilizer, fin stabilizer, bilge keel - stabilizing and securing ship in port- effect of tides on ship – effect of river water and sea water sailing vessel, Load line and load line of marking- draught markings.

UNIT III SHIPS SPEED AND ITS PERFORMANCE 9
Ship propulsion factors, factors affecting ships speed, various velocities of ship, hull drag, effects of fouling on ships hull, ship wake, relation between powers, Fuel consumption of ship, cavitations - effects of cavitation's, ship turning radius.

UNIT IV BASICS OF PROPELLER 9

UNIT V BASICS OF RUDDER 9
Rudder dimension, Area of rudder and its design, Rudder arrangements, Rudder fittings- Rudder pintle - Rudder types- Balanced rudder, semi balanced rudder, Spade rudder, merits and demerits of various types of rudders, Propeller and rudder interaction, Rudder stopper, movement of rudders, Basic construction of Rudder

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon successful completion of the course, students should be able to:
CO1: Explain the basics of propulsion system and ship dynamic movements
CO2: Familiarize with various components assisting ship stabilization.
CO3: Demonstrate the performance of the ship.
CO4: Classify the Propeller and its types, Materials etc.
CO5: Categories the Rudder and its types, design criteria of rudder.

TEXT BOOKS:
1. GP. Ghose, “Basic Ship propulsion”,2015

REFERENCES BOOKS:

MAPPING OF COS AND POS:

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OBJECTIVES:
At the end of the course, students are expected to acquire
1. Knowledge on basics of Hydrostatics
2. Familiarization on types of merchant ships
3. Knowledge on Shipbuilding Materials
4. Knowledge on marine propeller and rudder
5. Awareness on governing bodies in shipping industry

UNIT I  INTRODUCTION TO HYDROSTATICS  9

UNIT II  TYPES OF SHIP  10
General cargo ship - Refrigerated cargo ships - Container ships - Roll-on Roll-off ships – Oil tankers- Bulk carriers - Liquefied Natural Gas carriers - Liquefied Petroleum Gas carriers - Chemical tankers - Passenger ships

UNIT III  SHIPBUILDING MATERIALS  9
Types of Steels used in Shipbuilding - High tensile steels, Corrosion resistant steels, Steel sandwich panels, Steel castings, Steel forgings - Other shipbuilding materials, Aluminium alloys, Aluminium alloy sandwich panels, Fire protection especially for Aluminium Alloys, Fiber Reinforced Composites

UNIT IV  MARINE PROPELLER AND RUDDER  8
Types of rudder, construction of Rudder-Types of Propeller, Propeller material-Cavitations and its effects on propeller

UNIT V  GOVERNING BODIES FOR SHIPPING INDUSTRY  9
Role of IMO (International Maritime Organization), SOLAS (International Convention for the Safety of Life at Sea), MARPOL (International Convention for the Prevention of Pollution from Ships ) , MLC (Maritime Labour Convention), STCW 2010 (International Convention on Standards of Training, Certification and Watch keeping for Seafarers), Classification societies Administration authorities

OUTCOMES:
Upon completion of this course, students would
1. Acquire Knowledge on floatation of ships
2. Acquire Knowledge on features of various ships
3. Acquire Knowledge of Shipbuilding Materials
4. Acquire Knowledge to identify the different types of marine propeller and rudder
5. Understand the Roles and responsibilities of governing bodies

TEXT BOOKS:
2. Dr.DA Taylor, “Merchant Ship Naval Architecture” I. Mar EST publications, 2006

REFERENCES:
2. MARPOL Consolidated Edition , Bhandakar Publications, 2018
OBJECTIVES:
At the end of the course, students are expected to
- Understand the role of Marine machinery systems
- Be familiar with Marine propulsion machinery system
- Acquaint with Marine Auxiliary machinery system
- Have acquired basics of Marine Auxiliary boiler system
- Be aware of ship propellers and steering system

UNIT I ELEMENTARY KNOWLEDGE ON MARINE MACHINERY SYSTEMS
9
Marine Engineering Terminologies, Parts of Ship, Introduction to Machinery systems on board ships – Propulsion Machinery system, Electricity Generator system, Steering gear system, Air compressors & Air reservoirs, Fuel oil and Lubricating Oil Purifiers, Marine Boiler systems

UNIT II MARINE PROPULSION MACHINERY SYSTEM
9
Two stroke Large Marine slow speed Diesel Engine – General Construction, Basic knowledge of Air starting and reversing mechanism, Cylinder lubrication oil system, Main lubricating oil system and cooling water system

UNIT III MARINE AUXILIARY MACHINERY SYSTEM
9
Four stroke medium speed Diesel engine – General Construction, Inline, V-type arrangement of engine, Difference between slow speed and medium speed engines – advantages, limitations and applications

UNIT IV MARINE BOILER SYSTEM
9
Types of Boiler – Difference between Water tube boiler and Fire tube boiler, Need for boiler on board ships, Uses of steam, Advantages of using steam as working medium, Boiler mountings and accessories – importance of mountings, need for accessories

UNIT V SHIP PROPELLERS AND STEERING MECHANISM
9
Importance of Propeller and Steering gear, Types of propellers - Fixed pitch propellers, Controllable pitch propellers, Water jet propellers, Steering gear systems - 2-Ram and 4 Ram steering gear, Electric steering gear

OUTCOMES:
At the end of the course, students should able to,
- Distinguish the role of various marine machinery systems
- Relate the components of marine propulsion machinery system
- Explain the importance of marine auxiliary machinery system
- Acquire knowledge of marine boiler system
- Understand the importance of ship propellers and steering system

TEXT BOOKS:

REFERENCES:
1. Alan L.Rowen, “Introduction to Practical Marine Engineering, Volume 1&2, The Institute of Marine Engineers (India), Mumbai, 2006
2. A.S.Tambwekar, “Naval Architecture and Ship Construction”, The Institute of Marine Engineers (India), Mumbai, 2015
CRA332  DRONE TECHNOLOGIES  L T P C  
3 0 0 3

COURSE OBJECTIVES:
1. To understand the basics of drone concepts
2. To learn and understand the fundamentals of design, fabrication and programming of drone
3. To impart the knowledge of an flying and operation of drone
4. To know about the various applications of drone
5. To understand the safety risks and guidelines of fly safely

UNIT – I  INTRODUCTION TO DRONE TECHNOLOGY  9
Drone Concept - Vocabulary Terminology- History of drone - Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses- Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and employability

UNIT – II  DRONE DESIGN, FABRICATION AND PROGRAMMING  9
Classifications of the UAV -Overview of the main drone parts- Technical characteristics of the parts -Function of the component parts -Assembling a drone- The energy sources- Level of autonomy- Drones configurations -The methods of programming drone- Download program - Install program on computer- Running Programs- Multi rotor stabilization- Flight modes -Wi-Fi connection.

UNIT – III  DRONE FLYING AND OPERATION  9
Concept of operation for drone -Flight modes- Operate a small drone in a controlled environment- Drone controls Flight operations –management tool –Sensors-Onboard storage capacity -Removable storage devices- Linked mobile devices and applications

UNIT – IV  DRONE COMMERCIAL APPLICATIONS  9
Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing

UNIT – V  FUTURE DRONES AND SAFETY  9
The safety risks- Guidelines to fly safely -Specific aviation regulation and standardization-Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
CO1: Know about a various type of drone technology, drone fabrication and programming.
CO2: Execute the suitable operating procedures for functioning a drone
CO3: Select appropriate sensors and actuators for Drones
CO4: Develop a drone mechanism for specific applications
CO5: Create the programs for various drones

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1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS

REFERENCES

OGI352 GEOGRAPHIC INFORMATION SYSTEM L T P C 3 0 0 3

OBJECTIVES:
To impart the knowledge on basic components, data preparation and implementation of Geographical Information System.

UNIT I FUNDAMENTALS OF GIS
9

UNIT II SPATIAL DATA MODELS
9

UNIT III DATA INPUT AND TOPOLOGY
9

UNIT IV DATA QUALITY AND STANDARDS
9
Data quality - Basic aspects - completeness, logical consistency, positional accuracy, temporal accuracy, thematic accuracy and lineage – Metadata – GIS Standards –Interoperability - OGC - Spatial Data Infrastructure

UNIT V DATA MANAGEMENT AND OUTPUT
9
Import/Export – Data Management functions- Raster to Vector and Vector to Raster Conversion - Data Output - Map Compilation – Chart/Graphs – Multimedia – Enterprise Vs. Desktop GIS- distributed GIS.

TOTAL:45 PERIODS

COURSE OUTCOMES:
On completion of the course, the student is expected to

CO1 Have basic idea about the fundamentals of GIS.
CO2 Understand the types of data models.
CO3 Get knowledge about data input and topology
CO4 Gain knowledge on data quality and standards
CO5 Understand data management functions and data output

TEXTBOOKS:

REFERENCES:

CO – PO – PSO MAPPING: GEOGRAPHIC INFORMATION SYSTEM

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<td>PO8</td>
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<td>Knowledge of Geoinformatics discipline</td>
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<td>Critical analysis of Geoinformatics Engineering problems and innovations</td>
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<td>PSO3</td>
<td>Conceptualization and evaluation of Design solutions</td>
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OAI352 AGRICULTURE ENTREPRENEURSHIP DEVELOPMENT L T P C 3 0 0 3

OBJECTIVES
- To introduce the importance of Agri-business management, its characteristics and principles
- To impart knowledge on the functional areas of Agri-business like Marketing management, Product pricing methods and Market potential assessment.

UNIT I ENTREPRENEURIAL ENVIRONMENT IN INDIAN CONTEXT
Entrepreneur Development(ED): Concept of entrepreneur and entrepreneurship assessing overall business environment in Indian economy- Entrepreneurial and managerial characteristics-Entrepreneurship development programmers (EDP)-Generation incubation and commercialization of ideas and innovations- Motivation and entrepreneurship development- Globalization and the emerging business entrepreneurial environment.
UNIT II AGRIPRNEURSHIP IN GLOBAL ARENA: LEGAL PERSPECTIVE
Importance of agribusiness in Indian economy - International trade-WTO agreements- Provisions related to agreements in agricultural and food commodities - Agreements on Agriculture (AOA)- Domestic supply, market access, export subsidies agreements on sanitary and phyto-sanitary (SPS) measures, Trade related intellectual property rights (TRIPS).

UNIT III ENTREPRENEURSHIP MANAGEMENT: FINANCIAL PERSPECTIVE

UNIT IV ENTREPRENEURIAL OPPORTUNITIES: ECONOMIC GROWTH PERSPECTIVE
Managing an enterprise: Importance of planning, budgeting, monitoring evaluation and follow-up managing competition. Role of ED in economic development of a country- Overview of Indian social, political system and their implications for decision making by individual entrepreneurs- Economic system and its implication for decision making by individual entrepreneurs.

UNITV ENTREPRENEURIAL PROMOTION MEASURES AND GOVERNMENT SUPPORT
Social responsibility of business. Morals and ethics in enterprise management- SWOT analysis-Government schemes and incentives for promotions of entrepreneurship. Government policy on small and medium enterprises (SMEs)/SSIs/MSME sectors- Venture capital (VC), contract framing (CF) and Joint Venture (JV), public-private partnerships (PPP) - overview of agricultural engineering industry, characteristics of Indian farm machinery industry.

COURSE OUTCOMES
- Judge about agricultural finance, banking and cooperation
- Evaluate basic concepts, principles and functions of financial management
- Improve the skills on basic banking and insurance schemes available to customers
- Analyze various financial data for efficient farm management
- Identify the financial institutions

TOTAL: 45 PERIODS

TEXT BOOKS

REFERENCES
## CO-PO MAPPING

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<th>PO/PSO</th>
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| PSO1   | To make expertise in design and engineering problem solving approach in agriculture with proper knowledge and skill | 1   | 2   | 1   | 1   | 1   | 1                                 |
| PSO2   | To enhance students ability to formulate solutions to real-world problems pertaining to sustained agricultural productivity using modern technologies. | 1   | 1   | 2   | 1   | 1   | 1                                 |
| PSO3   | To inculcate entrepreneurial skills through strong Industry-Institution linkage. | 1   | 2   | 1   | 1   | 2   | 1                                 |

## OEE353 INTRODUCTION TO CONTROL SYSTEMS

### OBJECTIVES
- To impart knowledge on various representations of systems.
- To familiarize time response analysis of LTI systems and steady state error.
- To analyze the frequency responses and stability of the systems.
- To analyze the stability of linear systems in frequency domain and time domain.
- To develop linear models mainly state variable model and transfer function model.

### UNIT I MATHEMATICAL MODELS OF PHYSICAL SYSTEMS

- Definition & classification of system – terminology & structure of feedback control theory
- Analogous systems - Physical system representation by Differential equations – Block diagram reduction–Signal flow graphs.

### UNIT II TIME RESPONSE ANALYSIS & ROOTLOCUSTECHNIQUE


### UNIT III FREQUENCY RESPONSE ANALYSIS

- Correlation between Time & Frequency response – Polar plots – Bode Plots – Determination of Transfer Function from Bode plot.
UNIT IV STABILITY CONCEPTS & ANALYSIS
9

UNIT V STATE VARIABLE ANALYSIS
9
Concept of state – State Variable & State Model – State models for linear & continuous time systems—Solution of state & output equation—controllability & observability.

OUTCOMES:
Ability to
CO1: Design the basic mathematical model of physical System.
CO2: Analyze the time response analysis and techniques.
CO3: Analyze the transfer function from different plots.
CO4: Apply the stability concept in various criterion.
CO5: Assess the state models for linear and continuous Systems.

TEXTBOOKS

REFERENCES
2. Control System Dynamics" by Robert Clark, Cambridge University Press, 1996 USA.

<table>
<thead>
<tr>
<th>PO1</th>
<th>PO2</th>
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OEI354 INTRODUCTION TO INDUSTRIAL AUTOMATION SYSTEMS LT P C 3 0 0 3

COURSE OBJECTIVES:
1. To educate on design of signal conditioning circuits for various applications.
2. To Introduce signal transmission techniques and their design.
3. Study of components used in data acquisition systems interface techniques
4. To educate on the components used in distributed control systems
5. To introduce the communication buses used in automation industries.

UNIT I INTRODUCTION
UNIT II AUTOMATION COMPONENTS
Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, process control valves, power electronics devices DIAC, TRIAC, power MOSFET and IGBT. Introduction of DC and AC servo drives for motion control.

UNIT III COMPUTER AIDED MEASUREMENT AND CONTROL SYSTEMS
Role of computers in measurement and control, Elements of computer aided measurement and control, man-machine interface, computer aided process control hardware, process related interfaces, Communication and networking, Industrial communication systems, Data transfer techniques, Computer aided process control software, Computer based data acquisition system, Internet of things (IoT) for plant automation.

UNIT IV PROGRAMMABLE LOGIC CONTROLLERS
Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries.

UNIT V DISTRIBUTED CONTROL SYSTEM
Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 5
1. Market survey of the recent PLCs and comparison of their features.
2. Summarize the PLC standards
3. Familiarization of any one programming language (Ladder diagram/ Sequential Function Chart/ Function Block Diagram/ Equivalent open source software)

COURSE OUTCOMES:
Students able to
CO1 Design a signal conditioning circuits for various application (L3).
CO2 Acquire a detail knowledge on data acquisition system interface and DCS system (L2).
CO3 Understand the basics and Importance of communication buses in applied automation Engineering (L2).
CO4 Ability to design PLC Programmes by Applying Timer/Counter and Arithmetic and Logic Instructions Studied for Ladder Logic and Function Block.(L3)
CO5 Able to develop a PLC logic for a specific application on real world problem. (L5)

TEXT BOOKS:

REFERENCES:
List of Open Source Software/ Learning website:
1. https://archive.nptel.ac.in/courses/108/105/108105062/
2. https://nptel.ac.in/courses/108105063

<table>
<thead>
<tr>
<th>CO’s</th>
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OFD354 FUNDAMENTALS OF FOOD ENGINEERING L T P C 3 0 0 3

OBJECTIVES
The course aims to
- acquaint and equip the students with different techniques of measurement of engineering properties.
- make the students understand the nature of food constituents in the design of processing equipment

UNIT I
Engineering properties of food materials: physical, thermal, aerodynamic, mechanical, optical and electromagnetic properties.

UNIT II
Drying and dehydration: Basic drying theory, heat and mass transfer in drying, drying rate curves, calculation of drying times, dryer efficiencies; classification and selection of dryers; tray, vacuum, osmotic, fluidized bed, pneumatic, rotary, tunnel, trough, bin, belt, microwave, IR, heat pump and freeze dryers; dryers for liquid: Drum or roller dryer, spray dryer and foammat dryers

UNIT III
Size reduction: Benefits, classification, determination and designation of the fineness of ground material, sieve/screen analysis, principle and mechanisms of comminution of food, Rittinger’s, Kick’s and Bond’s equations, work index, energy utilization; Size reduction equipment: Principal types, crushers (jaw crushers, gyratory, smooth roll), hammer mills and impactors, attrition mills, buhr mill, tumbling mills, tumbling mills, ultra fine grinders, fluid jet pulverizer, colloid mill, cutting machines (slicing, dicing, shredding, pulping)

UNIT IV
Mixing: theory of solids mixing, criteria of mixer effectiveness and mixing indices, rate of mixing, theory of liquid mixing, power requirement for liquids mixing; Mixing equipment: Mixers for low or medium-viscosity liquids (paddle agitators, impeller agitators, powder-liquid contacting devices, other mixers), mixers for high viscosity liquids and pastes, mixers for dry powders and particulate solids.

UNIT V
Mechanical Separations: Theory, centrifugation, liquid-liquid centrifugation, liquid-solid centrifugation, clarifiers, desludging and decanting machine, Filtration: Theory of filtration, rate of filtration, pressure drop during filtration, applications, constant-rate filtration and constant-pressure
filtration, derivation of equation; Filtration equipment; plate and frame filter press, rotary filters, centrifugal filters and air filters, filter aids, Membrane separation: General considerations, materials for membrane construction, ultra-filtration, microfiltration, concentration, polarization, processing variables, membrane fouling, applications of ultra-filtration in food processing, reverse osmosis, mode of operation, and applications; Membrane separation methods, demineralization by electrodialysis, gel filtration, ion exchange, per-evaporation and osmotic dehydration.

COURSE OUTCOMES:
At the end of the course the students will be able to
CO1 understand the importance of food polymers
CO2 understand the effect of various methods of processing on the structure and texture of food materials
CO3 understand the interaction of food constituents with respect to thermal, electrical properties to develop new technologies for processing and preservation.

TEXTBOOKS:

OFD355 FOOD SAFETY AND QUALITY REGULATIONS

OBJECTIVES:
• To characterize different type of food hazards, physical, chemical and biological in the industry and food service establishments
• To help become skilled in systems for food safety surveillance
• To be aware of the regulatory and statutory bodies in India and the world
• To ensure processed food meets global standards

UNIT I
Introduction to food safety and security: Hygienic design of food plants and equipments, Food Contaminants (Microbial, Chemical, Physical), Food Adulteration (Common adulterants), Food Additives (functional role, safety issues), Food Packaging & labeling. Sanitation in warehousing, storage, shipping, receiving, containers and packaging materials. Control of rats, rodents, mice, birds, insects and microbes. Cleaning and Disinfection, ISO 22000 – Importance and Implementation

UNIT II
Food quality: Various Quality attributes of food, Instrumental, chemical and microbial Quality control. Sensory evaluation of food and statistical analysis. Water quality and other utilities.

UNIT III
Critical Quality control point in different stages of production including raw materials and processing materials. Food Quality and Quality control including the HACCP system. Food inspection and Food Law, Risk assessment – microbial risk assessment, dose response and exposure response modelling, risk management, implementation of food surveillance system to monitor food safety, risk communication
UNIT IV
Indian and global regulations: FAO in India, Technical Cooperation programmes, Bio-security in Food and Agriculture, World Health Organization (WHO), World Animal Health Organization (OIE), International Plant Protection Convention (IPPC)

UNIT V
Codex Alimentarius Commission - Codex India – Role of Codex Contact point, National Codex contact point (NCCP), National Codex Committee of India – ToR, Functions, Shadow Committees etc.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1 Thorough Knowledge of food hazards, physical, chemical and biological in the industry and food service establishments
CO2 Awareness on regulatory and statutory bodies in India and the world

REFERENCES:
1. Handbook of food toxicology by S. S. Deshpande, 2002
2. The food safety information handbook by Cynthia A. Robert, 2009
4. Microbiological safety of Food by Hobbs BC, 1973

OPY353 NUTRACEUTICALS L T P C 3 0 0 3

OBJECTIVES:
- To understand the basic concepts of Nutraceuticals and functional food, their chemical nature and methods of extraction.
- To understand the role of Nutraceuticals and functional food in health and disease.

UNIT I INTRODUCTION AND SIGNIFICANCE
Introduction to Nutraceuticals and functional foods; importance, history, definition, classification, list of functional foods and their benefits, Phytochemicals, zoochemicals and microbes in food, plants, animals and microbes.

UNIT II PHYTOCHEMICALS AS NUTRACEUTICALS
Phytoestrogens in plants; isoflavones; flavonols, polyphenols, tannins, saponins, lignans, lycopene, chitin, carotenoids. Manufacturing practice of selected nutraceuticals such as lycopene, isoflavonoids, glucosamine, phytosterols. Formulation of functional foods containing nutraceuticals - stability, analytical and labelling issues.

UNIT III ASSESSMENT OF ANTIOXIDANT ACTIVITY
In vitro and in vivo methods for the assessment of antioxidant activity, Comparison of different in vitro methods to evaluate the antioxidant, antioxidant mechanism, Prediction of the antioxidant activity of natural phenolics from electrotopological state indices, Optimising phytochemical release by process technology; Variation of Antioxidant Activity during technological treatments, new food grade peptidases from plant sources.

UNIT IV ROLE IN HEALTH AND DISEASE
The health benefit of - Soy protein, Spirulina, Tea, Olive oil, plant sterols, Broccoli, omega3 fatty acid and eicosanoids. Nutraceuticals and Functional foods in Gastrointestinal disorder, Cancer, CVD, Diabetic Mellitus, HIV and Dental disease; Importance and function of probiotic, prebiotic and synbiotic and their applications, Functional foods and immune competence; role and use in obesity and nervous system disorders.
UNIT V  SAFETY ISSUES
Health Claims, Adverse effects and toxicity of nutraceuticals, regulations and safety issues International and national.

TOTAL: 45 PERIODS

COURSE OUTCOME
CO 1 acquire knowledge about the Nutraceuticals and functional foods, their classification and benefits.
CO 2 acquire knowledge of phytochemicals, zoochemicals and microbes in food, plants, animals and microbes
CO 3 attain the knowledge of the manufacturing practices of selected nutraceutical components and formulation considerations of functional foods.
CO 4 distinguish the various In vitro and In vivo assessment of Antioxidant activity of compounds from plant sources.
CO 5 gain information about the health benefits of various functional foods and nutraceuticals in the prevention and treatment of various lifestyle diseases.
CO 6 Attain the knowledge of the regulatory and safety issues of nutraceuticals at national and international level.

TEXT BOOKS:
3. WEBB, PP, Dietary Supplements and Functional Foods Blackwell Publishing Ltd (United Kingdom), 2006

REFERENCES:
1. Asian Functional Foods (Nutraceutical Science and Technology) by John Shi (Editor), Fereidoon Shahidi (Editor), Chi-Tang Ho (Editor), CRC Publications, Taylor & Francis, 2007

CO – PO MAPPING

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OBJECTIVE:
- To enable the students to learn about the basics of Pretreatment, dyeing, printing and machinery in textile processing.

UNIT I INTRODUCTION 9
Impurities present in different fibres, Inspection of grey goods and lot preparation. Shearing,

UNIT II PRE TREATMENT 9

UNIT III DYEING 9

UNIT IV PRINTING 9
Definition of printing – Difference between printing and dying- Classification thickeners – Requirements to be good thickener, printing paste Preparation - different styles of printing.

UNIT V MACHINERIES 9

OUTCOMES:
Upon completion of the course, the students will be able to Understand the
CO1: Basics of grey fabric
CO2: Basics of pre treatment
CO3: Concept of Dyeing
CO4: Concept of Printing
CO5: Machinery in processing industry

TOTAL: 45 PERIODS

TEXT BOOKS:

REFERENCES:
2. Dr. N N Mahapatra., “Textile dyeing", Wood head publishing India, 2018
4. Bleaching & Mercerizing – BTRA Silver Jubilee Monograph series
Course Articulation Matrix:

<table>
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<tr>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

FT3201  FIBRE SCIENCE  
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COURSE OBJECTIVES
- To enable the students to learn about the types of fibre and its properties.

UNIT I  INTRODUCTION TO TEXTILE FIBRES  
9
Definition of various forms of textile fibres - staple fibre, filament, bicomponent fibres. Classification of Natural and Man-made fibres, essential and desirable properties of Fibres. Production and cultivation of Natural Fibers: Cotton, Silk, Wool -Physical and chemical structure of the above fibres.

UNIT II  REGENERATED FIBRES  
9
Production Sequence of Regenerated Cellulosic fibres: Viscose Rayon, Acetate rayon – High wet modulus fibres: Modal and Lyocel , Tencel

UNIT III  SYNTHETIC FIBRES  
9
Production Sequence of Synthetic Fibers: polymer-Polyester, Nylon, Acrylic and polypropylene. Mineral fibres: fibre glass , carbon . Introduction to spin finishes and texturization

UNIT IV  SPECIALITY FIBRES  
9
Properties and end uses of high tenacity and high modulus fibres, high temperature and flame retardant fibres, Chemical resistant fibres

UNIT V  FUNCTIONAL SPECIALITY FIBRES  
9
Properties and end uses: Fibres for medical application – Biodegradable fibres based on PLA , Super absorbent fibres elastomeric fibres, ultra-fine fibres, electrospun nano fibres, metallic fibres – Gold and Silver coated.

TOTAL : 45 PERIODS
COURSE OUTCOMES
Upon completion of this course, the student would be able to
- Understand the process sequence of various fibres
- Understand the properties of various fibres

TEXT BOOKS:

REFERENCES:

OTT355 GARMENT MANUFACTURING TECHNOLOGY L T P C
3 0 0 3
OBJECTIVE:
- To enable the students to understand the basics of pattern making, cutting and sewing.
- To expose the students to various problems & remedies during garment manufacturing

UNIT I PATTERN MAKING, MARKER PLANNING, CUTTING
Anthropometry, specification sheet, pattern making – principles, basic pattern set drafting, grading, marker planning, spreading & cutting

UNIT II TYPES OF SEAMS, STITCHES AND FUNCTIONS OF NEEDLES
Different types of seams and stitches; single needle lock stitch machine – mechanism and accessories; needle – functions, special needles, needlepoint

UNIT III COMPONENTS AND TRIMS USED IN GARMENT
Sewing thread-construction, material, thread size, packages, accessories – labels, linings, interlinings, wadding, lace, braid, elastic, hook and loop fastening, shoulder pads, eyelets and laces, zip fasteners, buttons

UNIT IV GARMENT INSPECTION AND DIMENSIONAL CHANGES
Raw material, in process and final inspection; needle cutting; sewability of fabrics; strength properties of apparel; dimensional changes in apparel due to laundering, dry-cleaning, steaming and pressing.

UNIT V GARMENT PRESSING, PACKING AND CARE LABELING
Garment pressing – categories and equipment, packing; care 330abelling of apparels

TOTAL: 45 PERIODS
OUTCOMES:
Upon completion of the course, the students will be able to Understand
CO1: Pattern making, marker planning, cutting
CO2: Types of seams, stitches and functions of needles
CO3: Components and trims used in garment
CO4: Garment inspection and dimensional changes
CO5: Garment pressing, packing and careabelling

TEXT BOOKS:
2. Gerry Cooklin, “Introduction to Clothing Manufacture” Blackwell Science Ltd., 1995. 64

REFERENCES:

CO’s PO’s PSO’s

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OPE353 INDUSTRIAL SAFETY L T P C 3 0 0 3

OBJECTIVES:
- To educate about the health hazards and the safety measures to be followed in the industrial environment.
- Describe industrial legislations (Factories Acts, Workmen’s Compensation and other laws) enacted for the protection of employees health at work settings
- Describe methods of prevention and control of Occupational Health diseases, accidents / emergencies and other hazards

UNIT I INTRODUCTION
Need for developing Environment, Health and Safety systems in work places - Accident Case Studies - Status and relationship of Acts - Regulations and Codes of Practice - Role of trade union safety representatives. International initiatives - Ergonomics and work place.
UNIT II OCCUPATIONAL HEALTH AND HYGIENE 9

UNIT III WORKPLACE SAFETY AND SAFETY SYSTEMS 9

UNIT IV HAZARDS AND RISK MANAGEMENT 9

UNIT V ENVIRONMENTAL HEALTH AND SAFETY MANAGEMENT 9

TOTAL: 45 PERIODS

OUTCOMES:
After completion of this course, the student is expected to be able to:
- Describe, with example, the common work-related diseases and accidents in occupational setting
- Name essential members of the Occupational Health team
- What roles can a community health practitioners play in an Occupational setting to ensure the protection, promotion and maintenance of the health of the employee

COURSE OBJECTIVES
- Understand the advantages, disadvantages and general classification of plastic materials
- To know the manufacturing, sources, and applications of engineering thermoplastics
- Understand the basics as well as the advanced applications of various plastic materials in the industry
- To understand the preparation methods of thermosetting materials
- Select suitable specialty plastics for different end applications

UNIT I INTRODUCTION TO PLASTIC MATERIALS 9
Introduction to Plastics – Brief history of plastics, advantages and disadvantages, thermoplastic and thermosetting behavior, amorphous polymers, crystalline polymers and cross-linked structures. General purpose thermoplastics/ Commodity plastics: manufacture, structure, properties and applications of polyethylene (PE), cross-linked PE, chlorinated PE, polypropylene, polyvinyl chloride-compounding, formulation, polypropylene (PP)

UNIT II ENGINEERING THERMOPLASTICS AND APPLICATIONS 9
Engineering thermoplastics – Aliphatic polyamides: structure, properties, manufacture and applications of Nylon 6, Nylon 66. Polyesters: manufacture, structure, properties and uses of PET,
PBT. Manufacture, structure, properties and uses of Polycarbonates, acetal resins, polyimides, PMMA, polyphenylene oxide, thermoplastic polyurethane (PU)

UNIT III THERMOSETTING PLASTICS
Thermosetting Plastics – Manufacture, curing, moulding powder, laminates, properties and uses of phenol formaldehyde resins, urea formaldehyde, melamine formaldehyde, unsaturated polyester resin, epoxy resin, silicone resins, polyurethane resins.

UNIT IV MISCELLANEOUS PLASTICS FOR END APPLICATIONS
Miscellaneous plastics- Manufacture, properties and uses of polystyrene, HIPS, ABS, SAN, poly(tetrafluoroethylene) (PTFE), TFE and copolymers, PVDF, PVA, poly (vinyl acetate), poly (vinyl carbazole), cellulose acetate, PEEK, High energy absorbing polymers, super absorbent polymers-their synthesis, properties and applications

UNIT V PLASTICS MATERIALS FOR BIOMEDICAL APPLICATIONS
Sources, raw materials, methods of manufacturing, properties and applications of bio-based polymers- poly lactic acid (PLA), poly hydroxy alkanoates (PHA), PBAT, bioplastics- bio-PE, bio-PP, bio-PET, polymers for biomedical applications

COURSE OUTCOMES
• To study the importance, advantages and classification of plastic materials
• Summarize the raw materials, sources, production, properties and applications of various engineering thermoplastics
• To understand the application of polyamides, polyesters and other engineering thermoplastics, thermosetting resins
• Know the manufacture, properties and uses of thermosetting resins based onpolyester, epoxy, silicone and PU
• To understand the engineering applications of various polymers in miscellaneous areas and applications of different biopolymers

REFERENCES

OPT353 PROPERTIES AND TESTING OF PLASTICS

COURSE OBJECTIVES
• To understand the relevance of standards and specifications as well as the specimen preparation for polymer testing.
• To study the mechanical properties and testing of polymer materials and their structural property relationships.
• To understand the thermal properties of polymers and their testing methods.
• To gain knowledge on the electrical and optical properties of polymers and their testing methods.
• To study about the environmental effects and prevent polymer degradation.
UNIT I INTRODUCTION TO CHARACTERIZATION AND TESTING OF POLYMERS


UNIT II MECHANICAL PROPERTIES


UNIT III THERMAL RHEOLOGICAL PROPERTIES

Thermal properties: Transition temperatures, specific heat, thermal conductivity, co-efficient of thermal expansion, heat deflection temperature, Vicat softening point, shrinkage, brittleness temperature, thermal stability and flammability. Product testing: Plastic films, sheeting, pipes, laminates, foams, containers, cables and tubes.

UNIT IV ELECTRICAL AND OPTICAL PROPERTIES

Electrical properties: Volume and surface resistivity, dielectric strength, dielectric constant and power factor, arc resistance, tracking resistance, dielectric behavior of polymers (dielectric co-efficient, dielectric polarization), dissipation factor and its importance. Optical properties: transparency, refractive index, haze, gloss, clarity, birefringence.

UNIT V ENVIRONMENTAL AND CHEMICAL RESISTANCE


COURSE OUTCOMES

- Understand the relevance of standards and specifications.
- Summarize the various test methods for evaluating the mechanical properties of the polymers.
- To know the thermal, electrical & optical properties of polymers.
- Identify various techniques used for characterizing polymers.
- Distinguish the processability tests used for thermoplastics, thermosets and elastomers.

REFERENCES

OBJECTIVES:
● Understand the fundamentals of IC technology components and their characteristics.
● Understand combinational logic circuits and design principles.
● Understand sequential logic circuits and clocking strategies.
● Understand Interconnects and Memory Architecture.
● Understand the design of arithmetic building blocks

UNIT I MOS TRANSISTOR PRINCIPLES
MOS logic families (NMOS and CMOS), Ideal and Non Ideal IV Characteristics, CMOS devices. MOS(FET) Transistor DC transfer Characteristics ,small signal analysis of MOSFET.

UNIT II COMBINATIONAL LOGIC CIRCUITS

UNIT III SEQUENTIAL LOGIC CIRCUITS AND CLOCKING STRATEGIES

UNIT IV INTERCONNECT, MEMORY ARCHITECTURE
Interconnect Parameters – Capacitance, Resistance, and Inductance, Logic Implementation using Programmable Devices (ROM, PLA, FPGA), Memory Architecture and Building Blocks.

UNIT V DESIGN OF ARITHMETIC BUILDING BLOCKS
Arithmetic Building Blocks: Data Paths, Adders-Ripple Carry Adder, Carry-Bypass Adder, Carry Select Adder, Carry-Look Ahead Adder, Multipliers, Barrel Shifter, power and speed tradeoffs.

TOTAL: 45 PERIODS

OUTCOMES:
Upon successful completion of the course the student will be able to
CO1: Understand the working principle and characteristics of MOSFET
CO2: Design Combinational Logic Circuits
CO3: Design Sequential Logic Circuits and Clocking systems
CO4: Understand Memory architecture and interconnects
CO5: Design of arithmetic building blocks.

TEXTBOOKS

REFERENCES
CBM370 WEARABLE DEVICES

OBJECTIVES:
The student should be made to:

- To know the hardware requirement of wearable systems
- To understand the communication and security aspects in the wearable devices
- To know the applications of wearable devices in the field of medicine

UNIT I INTRODUCTION TO WEARABLE SYSTEMS AND SENSORS

UNIT II SIGNAL PROCESSING AND ENERGY HARVESTING FOR WEARABLE DEVICES
Wearability issues -physical shape and placement of sensor, Technical challenges - sensor design, signal acquisition, sampling frequency for reduced energy consumption, Rejection of irrelevant information. Power Requirements- Solar cell, Vibration based, Thermal based, Human body as a heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests, Thermopiles.

UNIT III WIRELESS HEALTH SYSTEMS

UNIT IV SMART TEXTILE

UNIT V APPLICATIONS OF WEARABLE SYSTEMS
Medical Diagnostics, Medical Monitoring-Patients with chronic disease, Hospital patients, Elderly patients, neural recording, Gait analysis, Sports Medicine.

TOTAL : 45 PERIODS

OUTCOMES:
On successful completion of this course, the student will be able to

CO1: Describe the concepts of wearable system.
CO2: Explain the energy harvestings in wearable device.
CO3: Use the concepts of BAN in health care.
CO4: Illustrate the concept of smart textile
CO5: Compare the various wearable devices in healthcare system
TEXT BOOKS

REFERENCES

CO's- PO's & PSO's MAPPING

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CBM356 MEDICAL INFORMATICS L T P C
3 0 0 3

Preamble:
1. To study the applications of information technology in health care management.
2. This course provides knowledge on resources, devices, and methods required to optimize the acquisition, storage, retrieval, and use of information in health and biomedicine.

UNIT I INTRODUCTION TO MEDICAL INFORMATICS
Introduction - Structure of Medical Informatics - Internet and Medicine - Security issues, Computer based medical information retrieval, Hospital management and information system, Functional capabilities of a computerized HIS, Health Informatics - Medical Informatics, Bioinformatics

UNIT II COMPUTERS IN CLINICAL LABORATORY AND MEDICAL IMAGING
Automated clinical laboratories - Automated methods in hematology, cytology and histology, Intelligent Laboratory Information System - Computer assisted medical imaging - nuclear medicine, ultrasound imaging, computed X-ray tomography, Radiation therapy and planning, Nuclear Magnetic Resonance.

UNIT III COMPUTERISED PATIENT RECORD
Introduction - conventional patient record, Components and functionality of CPR, Development tools, Intranet, CPR in Radiology - Application server provider, Clinical information system, Computerized prescriptions for patients.

UNIT IV COMPUTER ASSISTED MEDICAL DECISION-MAKING
Neuro computers and Artificial Neural Networks application, Expert system - General model of CMD, Computer--assisted decision support system - production rule system cognitive model, semantic networks, decisions analysis in clinical medicine - computers in the care of critically ill patients, Computer aids for the handicapped.
UNIT V  RECENT TRENDS IN MEDICAL INFORMATICS 9
Virtual reality applications in medicine, Virtual endoscopy, Computer assisted surgery, Surgical simulation, Telemedicine - Tele surgery, Computer assisted patient education and health- Medical education and healthcare information, computer assisted instruction in medicine.

TOTAL: 45 PERIODS

Course Outcomes:
Upon completion of the course, students will be able to:
- Explain the structure and functional capabilities of Hospital Information System.
- Describe the need of computers in medical imaging and automated clinical laboratory.
- Articulate the functioning of information storage and retrieval in computerized patient record system.
- Apply the suitable decision support system for automated clinical diagnosis.
- Discuss the application of virtual reality and telehealth technology in medical industry.

TEXT BOOKS:

REFERENCES:

CO’s- PO’s & PSO’s MAPPING

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OBT355  BIOTECHNOLOGY FOR WASTE MANAGEMENT  L T P C  3 0 0 3

UNIT I  BIOLOGICAL TREATMENT PROCESS 9

UNIT II  WASTE BIOMASS AND ITS VALUE ADDITION 9
Types of waste biomass – Solid waste management - Nature of biomass feedstock – Biobased economy/process – Value addition of waste biomass – Biotransformation of biomass – Biotransformation of marine processing wastes – Direct extraction of biochemicals from biomass – Plant biomass for industrial application

UNIT III  BIOCONVERSION OF WASTES TO ENERGY 9
Perspective of biofuels from wastes - Bioethanol production – Biohydrogen Production – dark and photofermentative process - Biobutanol production – Biogas and Biomethane production - Single stage anaerobic digestion, Two stage anaerobic digestion - Biodiesel production - Enzymatic hydrolysis technologies
UNIT IV CHEMICALS AND ENZYME PRODUCTION FROM WASTES
Production of lactic acid, succinic acid, citric acid – Biopolymer synthesis – Production of Amylases - Lignocellulolytic enzymes - Pectinolytic enzymes - Proteases – Lipases

UNIT V BIOCOMPOSTING OF ORGANIC WASTES
Overview of composting process - Benefits of composting, Role of microorganisms in composting - Factors affecting the composting process - Waste Materials for Composting, Fundamentals of composting process - Composting technologies, Composting systems – Nonreactor Composting, Reactor composting - Compost Quality

COURSE OUTCOMES
After completion of this course, the students should be able
1. To learn the various methods biological treatment
2. To know the details of waste biomass and its value addition
3. To develop the bioconversion processes to convert wastes to energy
4. To synthesize the chemicals and enzyme from wastes
5. To produce the biocompost from wastes
6. To apply the theoretical knowledge for the development of value added products

TEXT BOOKS

REFERENCE BOOKS

OBT356 LIFESTYLE DISEASES

UNIT I INTRODUCTION
Lifestyle diseases – Definition ; Risk factors – Eating, smoking, drinking, stress, physical activity, illicit drug use ; Obesity, diabetes, cardiovascular diseases, respiratory diseases, cancer; Prevention – Diet and exercise.

UNIT II CANCER
Types - Lung cancer, Mouth cancer, Skin cancer, Cervical cancer, Carcinoma oesophagus; Causes Tobacco usage, Diagnosis – Biomarkers, Treatment

UNIT III CARDIOVASCULAR DISEASES
Coronary atherosclerosis – Coronary artery disease; Causes -Fat and lipids, Alcohol abuse -- Diagnosis - Electrocardiograph, echocardiograph, Treatment, Exercise and Cardiac rehabilitation

UNIT IV DIABETES AND OBESITY
Types of Diabetes mellitus; Blood glucose regulation; Complications of diabetes – Paediatric and adolescent obesity – Weight control and BMI
UNIT V  RESPIRATORY DISEASES
Chronic lung disease, Asthma, COPD; Causes - Breathing pattern (Nasal vs mouth), Smoking – Diagnosis - Pulmonary function testing

TOTAL: 45 PERIODS

TEXT BOOKS:

REFERENCES:

OBT357  BIOTECHNOLOGY IN HEALTH CARE  L T P C
3 0 0 3

COURSE OBJECTIVES
The aim of this course is to
1. Create higher standard of knowledge on healthcare system and services
2. Prioritize advanced technologies for the diagnosis and treatment of various diseases

UNIT I  PUBLIC HEALTH

UNIT II  CLINICAL DISEASES
Communicable diseases: Chickenpox / Shingles, COVID-19, Tuberculosis, Hepatitis B, Hepatitis C, HIV / AIDS, Influenza, Swine flu. Non Communicable diseases: Diabetes mellitus, atherosclerosis, fatty liver, Obesity, Cancer

UNIT III  VACCINOLOGY
History of Vaccinology, conventional approaches to vaccine development, live attenuated and killed vaccines, adjuvants, quality control, preservation and monitoring of microorganisms in seed lot systems. Instruments related to monitoring of temperature, sterilization, environment.

UNIT IV  OUTPATIENT & INPATIENT SERVICES
Radiotherapy, Nuclear medicine, surgical units, OT Medical units, G & Obs. units Pediatric, neonatal units, Critical care units, Physical medicine & Rehabilitation, Neurology, Gastroenterology, Endoscopy, Pulmonology, Cardiology.

UNIT V  BASICS OF IMAGING MODALITIES

TOTAL: 45 PERIODS

TEXT BOOKS

REFERENCE BOOKS
LEARNING OBJECTIVES
1. To acquire the knowledge of the decision areas in finance.
2. To learn the various sources of Finance
3. To describe about capital budgeting and cost of capital.
4. To discuss on how to construct a robust capital structure and dividend policy
5. To develop an understanding of tools on Working Capital Management.

UNIT I INTRODUCTION TO FINANCIAL MANAGEMENT
Definition and Scope of Finance Functions - Objectives of Financial Management - Profit Maximization and Wealth Maximization - Time Value of money - Risk and return concepts.

UNIT II SOURCES OF FINANCE
Long term sources of Finance - Equity Shares – Debentures - Preferred Stock – Features – Merits and Demerits. Short term sources - Bank Sources, Trade Credit, Overdrafts, Commercial Papers, Certificate of Deposits, Money market mutual funds etc

UNIT III INVESTMENT DECISIONS
Cost of Capital - Cost of Specific Sources of Capital - Equity -Preferred Stock- Debt - Reserves - Concept and measurement of cost of capital - Weighted Average Cost of Capital.

UNIT IV FINANCING AND DIVIDEND DECISION
Dividend policy - Aspects of dividend policy - practical consideration - forms of dividend policy - - Determinants of Dividend Policy

UNIT V WORKING CAPITAL DECISION

TOTAL : 45 PERIODS

TEXT BOOKS

REFERENCES
2. Prasanna Chandra, Financial Management,
OBJECTIVES:
1. Describe the investment environment in which investment decisions are taken.
2. Explain how to Value bonds and equities
3. Explain the various approaches to value securities
4. Describe how to create efficient portfolios through diversification
5. Discuss the mechanism of investor protection in India.

UNIT I THE INVESTMENT ENVIRONMENT
The investment decision process, Types of Investments – Commodities, Real Estate and Financial Assets, the Indian securities market, the market participants and trading of securities, security market indices, sources of financial information, Concept of return and risk, Impact of Taxes and Inflation on return.

UNIT II FIXED INCOME SECURITIES
Bond features, types of bonds, estimating bond yields, Bond Valuation types of bond risks, default risk and credit rating.

UNIT III APPROACHES TO EQUITY ANALYSIS
Introduction to Fundamental Analysis, Technical Analysis and Efficient Market Hypothesis, dividend capitalisation models, and price-earnings multiple approach to equity valuation.

UNIT IV PORTFOLIO ANALYSIS AND FINANCIAL DERIVATIVES
Portfolio and Diversification, Portfolio Risk and Return; Mutual Funds; Introduction to Financial Derivatives; Financial Derivatives Markets in India

UNIT V INVESTOR PROTECTION
Role of SEBI and stock exchanges in investor protection; Investor grievances and their redressal system, insider trading, investors’ awareness and activism

TOTAL: 45 PERIODS

REFERENCES
UNIT II  MANAGING BANK FUNDS/ PRODUCTS  

UNIT III  DEVELOPMENT IN BANKING TECHNOLOGY  

UNIT IV  FINANCIAL SERVICES  

UNIT V  INSURANCE  

REFERENCES:

TOTAL: 45 PERIODS

CMG334  INTRODUCTION TO BLOCKCHAIN AND ITS APPLICATIONS  LT P C  3 0 0 3
UNIT I  INTRODUCTION TO BLOCKCHAIN  
Blockchain: The growth of blockchain technology - Distributed systems - The history of blockchain and Bitcoin - Features of a blockchain - Types of blockchain, Consensus: Consensus mechanism - Types of consensus mechanisms - Consensus in blockchain. Decentralization: Decentralization using blockchain - Methods of decentralization - Routes to decentralization- Blockchain and full ecosystem decentralization - Smart contracts - Decentralized Organizations- Platforms for decentralization.

UNIT II  INTRODUCTION TO CRYPTOCURRENCY  

UNIT III  ETHEREUM  
Introduction - The Ethereum network - Components of the Ethereum ecosystem - Transactions and messages - Ether cryptocurrency / tokens (ETC and ETH) - The Ethereum Virtual Machine (EVM), Ethereum Development Environment: Test networks - Setting up a private net - Starting up the private network.
UNIT IV WEB3 AND HYPERLEDGE

UNIT V EMERGING TRENDS

REFERENCE
2. Peter Borovykh, Blockchain Application in Finance, Blockchain Driven, 2nd Edition, 2018
OBJECTIVES:
1. To learn about history, importance and evolution of Fintech
2. To acquire the knowledge of Fintech in payment industry
3. To acquire the knowledge of Fintech in insurance industry
4. To learn the Fintech developments around the world
5. To know about the future of Fintech

UNIT I INTRODUCTION
Fintech - Definition, History, concept, meaning, architecture, significance, Goals, key areas in Fintech, Importance of Fintech, role of Fintech in economic development, opportunities and challenges in Fintech, Evolution of Fintech in different sectors of the industry - Infrastructure, Banking Industry, Startups and Emerging Markets, recent developments in FinTech, future prospects and potential issues with Fintech.

UNIT II PAYMENT INDUSTRY
Fintech in Payment Industry-Multichannel digital wallets, applications supporting wallets, onboarding and KYC application, Fintech in Lending Industry- Formal lending, Informal lending, P2P lending, POS lending, Online lending, Payday lending, Microfinance, Crowdfunding.

UNIT III INSURANCE INDUSTRY

UNIT IV FINTECH AROUND THE GLOBE

UNIT V FUTURE OF FINTECH
How emerging technologies will change financial services, the future of financial services, banking on innovation through data, why FinTech banks will rule the world, The FinTech Supermarket, Banks partnering with FinTech start-ups, The rise of BankTech, Fintech impact on Retail Banking, A future without money, Ethics in Fintech.

REFERENCES
4. Parag Y Arjunwadkar, FinTech: The Technology Driving Disruption in the financial service industry CRC Press, 2018
VERTICAL 2: ENTREPRENEURSHIP

CMG337 FOUNDATIONS OF ENTREPRENEURSHIP

Course Objectives
- To develop and strengthen the entrepreneurial quality and motivation of learners.
- To impart the entrepreneurial skills and traits essential to become successful entrepreneurs.
- To apply the principles and theories of entrepreneurship and management in Technology oriented businesses.
- To empower the learners to run a Technology driven business efficiently and effectively

UNIT I INTRODUCTION TO ENTREPRENEURSHIP
Entrepreneurship - Definition, Need, Scope - Entrepreneurial Skill & Traits - Entrepreneur vs. Intrapreneur; Classification of entrepreneurs, Types of entrepreneurs - Factors affecting entrepreneurial development - Achievement Motivation - Contributions of Entrepreneurship to Economic Development.

UNIT II BUSINESS OWNERSHIP & ENVIRONMENT

UNIT III FUNDAMENTALS OF TECHNOPRENEURSHIP
Introduction to Technopreneurship - Definition, Need, Scope - Emerging Concepts - Principles - Characteristics of a technopreneur - Impacts of Technopreneurship on Society - Economy - Job Opportunities in Technopreneurship - Recent trends

UNIT IV APPLICATIONS OF TECHNOPRENEURSHIP
Technology Entrepreneurship - Local, National and Global practices - Intrapreneurship and Technology interactions, Networking of entrepreneurial activities - Launching - Managing Technology based Product / Service entrepreneurship -- Success Stories of Technopreneurs - Case Studies

UNIT V EMERGING TRENDS IN ENTREPRENEURSHIP

TOTAL 45 : PERIODS

OUTCOMES:
Upon completion of this course, the student should be able to:
CO 1 Learn the basics of Entrepreneurship
CO 2 Understand the business ownership patterns and environment
CO 3 Understand the Job opportunities in Industries relating to Technopreneurship
CO 4 Learn about applications of technopreneurship and successful technopreneurs
CO 5 Acquaint with the recent and emerging trends in entrepreneurship

TEXT BOOKS:

REFERENCES:
7. Basics of Technoprenuership: Module 1.1-1.2, Frederico Gonzales, President-PESO Inc; M. Barcelon, UP
8. Journal articles pertaining to Entrepreneurship

CMG338 TEAM BUILDING & LEADERSHIP MANAGEMENT FOR BUSINESS L T P C 3 0 0 3

COURSE OBJECTIVES
- To develop and strengthen the Leadership qualities and motivation of learners.
- To impart the Leadership skills and traits essential to become successful entrepreneurs.
- To apply the principles and theories of Team Building in managing Technology oriented businessess.
- To empower the learners to build robust teams for running and leading a business efficiently and effectively

UNIT I INTRODUCTION TO MANAGING TEAMS 9
Introduction to Team - Team Dynamics - Team Formation – Stages of Team Development - Enhancing teamwork within a group - Team Coaching - Team Decision Making - Virtual Teams - Self Directed Work Teams (SDWTs) - Multicultural Teams.

UNIT II MANAGING AND DEVELOPING EFFECTIVE TEAMS 9
Team-based Organisations- Leadership roles in team-based organisations - Offsite training and team development - Experiential Learning - Coaching and Mentoring in team building - Building High-Performance Teams - Building Credibility and Trust - Skills for Developing Others - Team Building at the Top - Leadership in Teamwork Effectiveness.

UNIT III INTRODUCTION TO LEadership 9
Introduction to Leadership - Leadership Myths – Characteristics of Leader, Follower and Situation - Leadership Attributes - Personality Traits and Leadership- Intelligence Types and Leadership - Power and Leadership - Delegation and Empowerment.

UNIT IV LEADERSHIP IN ORGANISATIONS 9

UNIT V LEADERSHIP EFFECTIVENESS 9
Leadership Behaviour - Assessment of Leadership Behaviors - Destructive Leadership - Motivation and Leadership - Managerial Incompetence and Derailment Conflict Management -
Negotiation and Leadership - Culture and Leadership - Global Leadership – Recent Trends in Leadership.

TOTAL 45 : PERIODS

OUTCOMES:
Upon completion of this course, the student should be able to:
CO 1 Learn the basics of managing teams for business.
CO 2 Understand developing effective teams for business management.
CO 3 Understand the fundamentals of leadership for running a business.
CO 4 Learn about the importance of leadership for business development.
CO 5 Acquaint with emerging trends in leadership effectiveness for entrepreneurs.

REFERENCES:

CMG339 CREATIVITY & INNOVATION IN ENTREPRENEURSHIP  L T P C
3 0 0 3

COURSE OBJECTIVES
- To develop the creativity skills among the learners
- To impart the knowledge of creative intelligence essential for entrepreneurs
- To know the applications of innovation in entrepreneurship.
- To develop innovative business models for business.

UNIT I CREATIVITY
Creativity: Definition- Forms of Creativity-Essence, Elaborative and Expressive Creativities- Quality of Creativity-Existential, Entrepreneurial and Empowerment Creativities – Creative Environment-Creative Technology- Creative Personality and Motivation.

UNIT II CREATIVE INTELLIGENCE
Creative Intelligence: Convergent thinking ability – Traits Congenial to creativity – Creativity Training--Criteria for evaluating Creativy-Credible Evaluation- Improving the quality of our creativity – Creative Tools and Techniques - Blocks to creativity- fears and Disabilities- Strategies for Unblocking- Designing Creativity Enabling Environment.

UNIT III INNOVATION

UNIT IV INNOVATION AND ENTREPRENEURSHIP

UNIT V INNOVATIVE BUSINESS MODELS

OUTCOMES:
Upon completion of this course, the student should be able to:
CO 1 Learn the basics of creativity for developing Entrepreneurship
CO 2 Understand the importance of creative intelligence for business growth
CO 3 Understand the advances through Innovation in Industries
CO 4 Learn about applications of innovation in building successful ventures
CO 5 Acquaint with developing innovative business models to run the business efficiently and effectively

Suggested Readings:
Creativity and Innovation in Entrepreneurship, Kankha, Sultan Chand
Strategic Innovation: Building and Sustaining Innovative Organizations- Course Era, Raj Echambadi.

CMG340 PRINCIPLES OF MARKETING MANAGEMENT FOR BUSINESS  L T P C 3 0 0 3
COURSE OBJECTIVES:
• To provide basic knowledge of concepts, principles, tools and techniques of marketing for entrepreneurs
• To provide an exposure to the students pertaining to the nature and Scope of marketing, which they are expected to possess when they enter the industry as practitioners.
• To give them an understanding of fundamental premise underlying market driven strategies and the basic philosophies and tools of marketing management for business owners.

UNIT I INTRODUCTION TO MARKETING MANAGEMENT 9
Introduction - Market and Marketing – Concepts Functions of Marketing - Importance of Marketing - Marketing Orientations - Marketing Mix-The Traditional 4Ps - The Modern Components of the Mix - The Additional 3Ps - Developing an Effective Marketing Mix.

UNIT II MARKETING ENVIRONMENT 9

UNIT III PRODUCT AND PRICING MANAGEMENT 9

UNIT IV PROMOTION AND DISTRIBUTUION MANAGEMENT 9
Introduction to Promotion – Marketing Channels- Integrated Marketing Communications (IMC) - Introduction to Advertising and Sales Promotion – Basics of Public Relations and Publicity -
UNIT V CONTEMPORARY ISSUES IN MARKETING MANAGEMENT

COURSE OUTCOMES:
After completion of this course, the students will be able to:
CO 1 Have the awareness of marketing management process
CO 2 Understand the marketing environment
CO 3 Acquaint about product and pricing strategies
CO 4 Knowledge of promotion and distribution in marketing management.
CO 5 Comprehend the contemporary marketing scenarios and offer solutions to marketing issues.

REFERENCES:

CMG341 HUMAN RESOURCE MANAGEMENT FOR ENTREPRENEURS
OBJECTIVES:
- To introduce the basic concepts, structure and functions of human resource management for entrepreneurs.
- To create an awareness of the roles, functions and functioning of human resource department.
- To understand the methods and techniques followed by Human Resource Management practitioners.

UNIT I INTRODUCTION TO HRM

UNIT II HUMAN RESOURCE PLANNING
HR Planning - Definition - Factors- Tools - Methods and Techniques - Job analysis- Job rotation- Job Description - Career Planning - Succession Planning - HRIS - Computer Applications in HR - Recent Trends

UNIT III RECRUITMENT AND SELECTION
Sources of recruitment- Internal Vs. External - Domestic Vs. Global Sources - eRecruitment - Selection Process- Selection techniques - eSelection- Interview Types- Employee Engagement.
UNIT IV TRAINING AND EMPLOYEE DEVELOPMENT


UNIT V CONTROLLING HUMAN RESOURCES


OUTCOMES:
Upon completion of this course the learners will be able:
CO 1 To understand the Evolution of HRM and Challenges faced by HR Managers
CO 2 To learn about the HR Planning Methods and practices.
CO 3 To acquaint about the Recruitment and Selection Techniques followed in Industries.
CO 4 To known about the methods of Training and Employee Development.
CO 5 To comprehend the techniques of controlling human resources in organisations.

REFERENCES

CMG342 FINANCING NEW BUSINESS VENTURES

COURSE OBJECTIVES
• To develop the basics of business venture financing.
• To impart the knowledge essential for entrepreneurs for financing new ventures.
• To acquaint the learners with the sources of debt and equity financing.
• To empower the learners towards fund raising for new ventures effectively.

UNIT I ESSENTIALS OF NEW BUSINES VENTURE

UNIT II INTRODUCTION TO VENTURE FINANCING

UNIT III SOURCES OF DEBT FINANCING
UNIT IV SOURCES OF EQUITY FINANCING
Own Capital, Unsecured Loan - Government Subsidies, Margin Money - Equity Funding - Private Equity Fund - Schemes of Commercial banks - Angel Funding – Crowdfunding - Venture Capital.

UNIT V METHODS OF FUND RAISING FOR NEW VENTURES

TOTAL 45 : PERIODS

OUTCOMES:
Upon completion of this course, the students should be able to:
CO 1 Learn the basics of starting a new business venture.
CO 2 Understand the basics of venture financing.
CO 3 Understand the sources of debt financing.
CO 4 Understand the sources of equity financing.
CO 5 Acquaint with the methods of fund raising for new business ventures.

REFERENCES:
1. Principles of Corporate Finance by Brealey and Myers et al., 12TH ed, McGraw Hill Education (India) Private Limited, 2018

VERTICAL 3: PUBLIC ADMINISTRATION

CMG343 PRINCIPLES OF PUBLIC ADMINISTRATION L T P C
3 0 0 3

UNIT-I
1. Meaning, Nature and Scope of Public Administration
2. Importance of Public Administration
3. Evolution of Public Administration

UNIT-II
1. New Public Administration
2. New Public Management
3. Public and Private Administration

UNIT-III
1. Relationships with Political Science, History and Sociology
2. Classical Approach
3. Scientific Management Approach

UNIT-IV
1. Bureaucratic Approach: Max Weber
2. Human Relations Approach : Elton Mayo
3. Ecological Approach : Riggs

UNIT-V
1. Leadership: Leadership - Styles - Approaches
2. Communication: Communication Types - Process - Barriers

TOTAL: 45 PERIODS

REFERENCES:
5. R. Tyagi, Public Administration, Atma Ram & Sons, New Delhi, 1983.

CMG344 CONSTITUTION OF INDIA

UNIT-I
1. Constitutional Development Since 1909 to 1947
3. Constituent Assembly

UNIT-II
1. Fundamental Rights
2. Fundamental Duties
3. Directive Principles of State Policy

UNIT-III
1. President
2. Parliament
3. Supreme Court

UNIT-IV
1. Governor
2. State Legislature
3. High Court

UNIT-V
1. Secularism
2. Social Justice
3. Minority Safeguards

TOTAL: 45 PERIODS

REFERENCES:
3. Johari J.C.: Indian Politics, Vishal Publications Ltd, New Delhi
4. Agarwal R.C: Indian Political System; S.Chand & Co., New Delhi
UNIT-I
1. Meaning, Scope and Importance of Personnel Administration
2. Types of Personnel Systems: Bureaucratic, Democratic and Representative systems

UNIT-II
1. Generalist Vs Specialist
2. Civil Servants’ Relationship with Political Executive
3. Integrity in Administration.

UNIT-III
1. Recruitment: Direct Recruitment and Recruitment from Within
2. Training: Kinds of Training
3. Promotion

UNIT-IV
1. All India Services
2. Service Conditions
3. State Public Service Commission

UNIT-V
1. Employer Employee Relations
2. Wage and Salary Administration
3. Allowances and Benefits

REFERENCES:
1. Stahl Glean O: Public Personnel Administration
4. Dwivedi O.P and Jain R.B: India’s Administrative state.
7. Davar R.S. Personnel Management & Industrial Relations

TOTAL: 45 PERIODS
UNIT V  
Administrative thinkers: Kautilya, Woodrow Willson, C.I. Barnard . Peter Drucker  

REFERENCES:  
1. Crozier M : The Bureaucratic phenomenon (Chand)  
3. Presthus. R : The Organizational Society (MAC)  
5. Keith Davis : Organization Theory (MAC)  

TOTAL: 45 PERIODS

CMG347 INDIAN ADMINISTRATIVE SYSTEM  
L T P C  
3 0 0 3  

UNIT I  
Evolution and Constitutional Context of Indian Administration, Constitutional Authorities: Finance Commission, Union Public Services Commission, Election Commission, Comptroller and Auditor General of India, Attorney General of India  

UNIT II  
Role & Functions of the District Collector, Relationship between the District Collector and Superintendent of Police, Role of Block Development Officer in development programmes, Local Government  

UNIT III  
Main Features of 73rd Constitutional Amendment Act 1992, Salient Features of 74th Constitutional Amendment Act 1992  

UNIT IV  
Coalition politics in India, Integrity and Vigilance in Indian Administration  

UNIT V  
Corruption – Ombudsman, Lok Pal & Lok Ayuktha  

REFERENCES:  
1. S.R. Maheswari : Indian Administration  
2. Khera. S.S : Administration in India  
3. Ramesh K. Arora : Indian Public Administration  
4. T.N. Chaturvedi : State administration in India  
5. Basu, D.D : Introduction to the Constitution of India  

TOTAL: 45 PERIODS

CMG348 PUBLIC POLICY ADMINISTRATION  
L T P C  
3 0 0 3  

UNIT-I  

UNIT-II  

UNIT-III  
UNIT-IV (9)
Institutional Framework of Policy making – Role of Bureaucracy – Role of Interest Groups and Role of Political Parties.

UNIT-V (9)
Introduction to the following Public Policies – New Economic Policy – Population Policy – Agriculture policy - Information Technology Policy.

REFERENCES:
4. Pradeep Saxena : Public Policy Administration and Development

VERTICAL 4: BUSINESS DATA ANALYTICS

CMG349 STATISTICS FOR MANAGEMENT L T P C
3 0 0 3

OBJECTIVE:
➢ To learn the applications of statistics in business decision making.

UNIT I INTRODUCTION 9
Basic definitions and rules for probability, Baye’s theorem and random variables, Probability distributions: Binomial, Poisson, Uniform and Normal distributions.

UNIT II SAMPLING DISTRIBUTION AND ESTIMATION 9
Introduction to sampling distributions, Central limit theorem and applications, sampling techniques, Point and Interval estimates of population parameters.

UNIT III TESTING OF HYPOTHESIS - PARAMETRIC TESTS 9
Hypothesis testing: one sample and two sample tests for means of large samples (z-test), one sample and two sample tests for means of small samples (t-test), ANOVA one way.

UNIT IV NON-PARAMETRIC TESTS 9

UNIT V CORRELATION AND REGRESSION 9

TOTAL: 45 PERIODS

OUTCOMES:
➢ To facilitate objective solutions in business decision making.
➢ To understand and solve business problems
➢ To apply statistical techniques to data sets, and correctly interpret the results.
➢ To develop skill-set that is in demand in both the research and business environments
➢ To enable the students to apply the statistical techniques in a work setting.

REFERENCES:
CMG350                  DATAMINING FOR BUSINESS INTELLIGENCE                  L T P C
                                                                 3 0 0 3

OBJECTIVES :

 To know how to derive meaning form huge volume of data and information.
 To understand how knowledge discovering process is used in business decision making.

UNIT I          INTRODUCTION                                           9
Data mining, Text mining, Web mining, Data ware house.

UNIT II         DATA MINING PROCESS                                    9
Datamining process – KDD, CRISP-DM, SEMMA
Prediction performance measures

UNIT III        PREDICTION TECHNIQUES                                  9
Data visualization, Time series – ARIMA, Winter Holts,

UNIT IV         CLASSIFICATION AND CLUSTERING TECHNIQUES               9
Classification, Association, Clustering.

UNIT V          MACHINE LEARNING AND AI                               9
Genetic algorithms, Neural network, Fuzzy logic, Ant Colony optimization, Particle Swarm optimization

TOTAL: 45 PERIODS

OUTCOMES:

1. Learn to apply various data mining techniques into various areas of different domains.
2. Be able to interact competently on the topic of data mining for business intelligence.
3. Apply various prediction techniques.
4. Learn about supervised and unsupervised learning technique.
5. Develop and implement machine learning algorithms

REFERENCES :

1. Jaiwei Ham and Micheline Kamber, Data Mining concepts and techniques, Kauffmann Publishers 2006
2. Efraim Turban, Ramesh Sharda, Jay E. Aronson and David King, Business Intelligence, Prentice Hall, 2008.
7. G. K. Gupta, Introduction to Data mining with Case Studies, Prentice hall of India, 2011
9. Elizabeth Vitt, Michael Luckevich Stacia Misner, Business Intelligence, Microsoft, 2011
OBJECTIVE:

- To develop the ability of the learners to define and implement HR metrics that are aligned with the overall business strategy.
- To know the different types of HR metrics and understand their respective impact and application.
- To understand the impact and use of HR metrics and their connection with HR analytics.
- To understand common workforce issues and resolving them using people analytics.

UNIT I - INTRODUCTION TO HR ANALYTICS
People Analytics - stages of maturity - Human Capital in the Value Chain : impact on business – HR metrics and KPIs.

UNIT II - HR ANALYTICS I: RECRUITMENT
Recruitment Metrics : Fill-up ratio - Time to hire - Cost per hire - Early turnover - Employee referral hires - Agency hires - Lateral hires - Fulfillment ratio- Quality of hire.

UNIT III - HR ANALYTICS - TRAINING AND DEVELOPMENT
Training & Development Metrics : Percentage of employees trained- Internally and externally trained -Training hours and cost per employee - ROI.

UNIT IV - HR ANALYTICS EMPLOYEE ENGAGEMENT AND CAREER PROGRESSION
Employee Engagement Metrics : Talent Retention index - Voluntary and involuntary turnover-grades, performance, and service tenure - Internal hired index Career Progression Metrics: Promotion index - Rotation index - Career path index.

UNIT V - HR ANALYTICS IV: WORKFORCE DIVERSITY AND DEVELOPMENT
Workforce Diversity and Development Metrics : Employees per manager – Workforce age profiling - Workforce service profiling - Churnover index - Workforce diversity index - Gender mix

OUTCOME:

- The learners will be conversant about HR metrics and ready to apply at work settings.
- The learners will be able to resolve HR issues using people analytics.

REFERENCES:
CMG352  MARKETING AND SOCIAL MEDIA WEB ANALYTICS  L T P C  3 0 0 3

OBJECTIVE:
- To showcase the opportunities that exist today to leverage the power of the web and social media

UNIT I  MARKETING ANALYTICS  9
Marketing Budget and Marketing Performance Measure, Marketing - Geographical Mapping, Data Exploration, Market Basket Analysis

UNIT II  COMMUNITY BUILDING AND MANAGEMENT  9
History and Evolution of Social Media - Understanding Science of Social Media – Goals for using Social Media - Social Media Audience and Influencers - Digital PR - Promoting Social Media Pages - Linking Social Media Accounts - The Viral Impact of Social Media.

UNIT III  SOCIAL MEDIA POLICIES AND MEASUREMENTS  9
Social Media Policies - Etiquette, Privacy - ethical problems posed by emerging social media technologies - The Basics of Tracking Social Media.

UNIT IV  WEB ANALYTICS  9
Data Collection, Overview of Qualitative Analysis, Business Analysis, KPI and Planning, Critical Components of a Successful Web Analytics Strategy, Proposals & Reports, Web Data Analysis.

UNIT V  SEARCH ANALYTICS  9
Search engine optimization (SEO), user engagement, user-generated content, web traffic analysis, online security, online ethics, data visualization.

OUTCOME:
- The Learners will understand social media, web and social media analytics and their potential impact.

REFERENCES:
2. Christian Fuchs, Social Media a critical introduction, SAGE Publications Ltd, 2014
5. Ric T. Peterson, Web Analytics Demystified, Celilo Group Media and CafePress 2004

CMG353  OPERATION AND SUPPLY CHAIN ANALYTICS  L T P C  3 0 0 3

OBJECTIVE:
- To treat the subject in depth by emphasizing on the advanced quantitative models and methods in operations and supply chain management and its practical aspects and the latest developments in the field.

UNIT I  INTRODUCTION  9
Descriptive, predictive and prescriptive analytics, Data Driven Supply Chains – Basics, transforming supply chains.

UNIT II  WAREHOUSING DECISIONS  9
P-Median Methods - Guided LP Approach, Greedy Drop Heuristics, Dynamic Location Models, Space Determination and Layout Methods.
UNIT III INVENTORY MANAGEMENT
Dynamic Lot sizing Methods, Multi-Echelon Inventory models, Aggregate Inventory system and LIMIT, Risk Analysis in Supply Chain, Risk pooling strategies.

UNIT IV TRANSPORTATION NETWORK MODELS

UNIT V MCDM MODELS
Analytic Hierarchy Process(AHP), Data Envelopment Analysis (DEA), Fuzzy Logic an Techniques, the analytical network process (ANP), TOPSIS.

OUTCOME:
- To enable quantitative solutions in business decision making under conditions of certainty, risk and uncertainty.

REFERENCES:

CMG354 FINANCIAL ANALYTICS

OBJECTIVE:
- This course introduces a core set of modern analytical tools that specifically target finance applications.

UNIT I CORPORATE FINANCE ANALYSIS
Basic corporate financial predictive modelling- Project analysis- cash flow analysis- cost of capital, Financial Break even modelling, Capital Budget model-Payback, NPV, IRR.

UNIT II FINANCIAL MARKET ANALYSIS
Estimation and prediction of risk and return ( bond investment and stock investment) –Time series-examining nature of data, Value at risk, ARMA, ARCH and GARCH.

UNIT III PORTFOLIO ANALYSIS
Portfolio Analysis – capital asset pricing model, Sharpe ratio, Option pricing models- binomial model for options, Black Scholes model and Option implied volatility.

UNIT IV TECHNICAL ANALYSIS
UNIT V  CREDIT RISK ANALYSIS
Credit Risk analysis: Data processing, Decision trees, logistic regression and evaluating credit risk model.

OUTCOME
• The learners should be able to perform financial analysis for decision making using excel, Python and R.

REFERENCES:

VERTICAL 5: ENVIRONMENT AND SUSTAINABILITY

CES331  SUSTAINABLE INFRASTRUCTURE DEVELOPMENT  L T P C
3 0 0 3

OBJECTIVE:
• To impart knowledge about sustainable Infrastructure development goals, practices and to understand the concepts of sustainable planning, design, construction, maintenance and decommissioning of infrastructure projects.

UNIT I  SUSTAINABLE DEVELOPMENT GOALS

UNIT II  SUSTAINABLE INFRASTRUCTURE PLANNING

UNIT III  SUSTAINABLE CONSTRUCTION PRACTICES AND TECHNIQUES
UNIT IV  SUSTAINABLE CONSTRUCTION MATERIALS


UNIT V  SUSTAINABLE MAINTENANCE OF INFRASTRUCTURE PROJECTS


TOTAL: 45 PERIODS

OUTCOME:
On completion of the course, the student is expected to be able to
CO1 Understand the environment sustainability goals at global and Indian scenario.
CO2 Understand risks in development of projects and suggest mitigation measures.
CO3 Apply lean techniques, LBMS and new construction techniques to achieve sustainability in infrastructure construction projects.
CO4 Explain Life Cycle Analysis and life cycle cost of construction materials.
CO5 Explain the new technologies for maintenance of infrastructure projects.

REFERENCES:
7. Munier N, "Introduction to Sustainability", Springer2005
OBJECTIVES:
• To educate the students about the issues of sustainability in agroecosystems, introduce the concepts and principles of agroecology as applied to the design and management of sustainable agricultural systems for a changing world.

UNIT I AGROECOLOGY, AGROECOSYSTEM AND SUSTAINABLE AGRICULTURE CONCEPTS 9
Ecosystem definition - Biotic Vs. abiotic factors in an ecosystem - Ecosystem processes - Ecological services and agriculture - Problems associated with industrial agriculture/food systems - Defining sustainability - Characteristics of sustainable agriculture - Difference between regenerative and sustainable agriculture systems

UNIT II SOIL HEALTH, NUTRIENT AND PEST MANAGEMENT 9
Soil health definition - Factors to consider (physical, chemical and biological) - Composition of healthy soils - Soil erosion and possible control measures - Techniques to build healthy soil - Management practices for improving soil nutrient - Ecologically sustainable strategies for pest and disease control

UNIT III WATER MANAGEMENT 9
Soil water storage and availability - Plant yield response to water - Reducing evaporation in agriculture - Earthworks and tanks for rainwater harvesting - Options for improving the productivity of water - Localized irrigation - Irrigation scheduling - Fertigation - Advanced irrigation systems and agricultural practices for sustainable water use

UNIT IV ENERGY AND WASTE MANAGEMENT 9
Types and sources of agricultural wastes - Composition of agricultural wastes - Sustainable technologies for the management of agricultural wastes - Useful and high value materials produced using different processes from agricultural wastes - Renewable energy for sustainable agriculture

UNIT V EVALUATING SUSTAINABILITY IN AGROECOSYSTEMS 9
Indicators of sustainability in agriculture - On-farm evaluation of agroecosystem sustainability - Alternative agriculture approaches/ farming techniques for sustainable food production - Goals and components of a community food system - Case studies

TOTAL: 45 PERIODS

OUTCOME
• On completion of the course, the student is expected to be able to
CO1 Have an in-depth knowledge about the concepts, principles and advantages of sustainable agriculture
CO2 Discuss the sustainable ways in managing soil health, nutrients, pests and diseases
CO3 Suggest the ways to optimize the use of water in agriculture to promote an ecological use of resources
CO4 Develop energy and waste management plans for promoting sustainable agriculture in non-sustainable farming areas.

CO5 Assess an ecosystem for its level of sustainability and prescribe ways of converting to a sustainable system through the redesign of a conventional agroecosystem.

REFERENCES:
1. Approaches to Sustainable Agriculture – Exploring the Pathways Towards the Future of Farming, Oberc, B.P. & Arroyo Schnell, A., IUCN, Belgium, 2020

CO – PO Mapping - SUSTAINABLE AGRICULTURE PRACTICES

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CES333 SUSTAINABLE BIOMATERIALS L T P C 3 0 0 3

OBJECTIVES
• To Impart knowledge of biomaterials and their properties
• To learn about Fundamentals aspects of Biopolymers and their applications
• To learn about bioceramics and biopolymers
• To introduce the students about metals as biomaterials and their usage as implants
• To make the students understand the significance of bionanomaterials and its applications.

UNIT I INTRODUCTION TO BIOMATERIALS 9

UNIT II BIO POLYMERS 9
Molecular structure of polymers -Molecular weight - Types of polymerization techniques–Types of polymerization reactions- Physical states of polymers- Common polymeric biomaterials - Polyethylene -Poly(methylmethacrylate) (PMMA)-Polyactic acid (PLA) and polylactic acid (PGA) - Polycaprolactone (PCL) - Other biodegradable polymers –Polyurethane- reactions polymers for medical purposes - Collagens- Elastin- Cellulose and derivatives-Synthetic polymeric membranes and their biological applications
UNIT III BIO CERAMICS AND BIOCOMPOSITES

General properties- Bio ceramics -Silicate glass - Alumina (Al2O3) -Zirconia (ZrO2)-Carbon-Calcium phosphates (CaP)- Resorbable Ceramics- surface reactive ceramics- Biomedical Composites-Polymer Matrix Composite(PMC)-Ceramic Matrix Composite(CMC)-Metal Matrix Composite (MMC)-glass ceramics - Orthopedic implants-Tissue engineering scaffolds

UNIT IV METALS AS BIOMATERIALS

Biomedical metals-types and properties-stainless steel-Cobalt chromium alloys-Titanium alloys-Tantalum-Nickel titanium alloy (Nitinol)- magnesium-based biodegradable alloys-surface properties of metal implants for osteointegration-medical application-corrosion of metallic implants – biological tolerance of implant metals

UNIT V NANOBIOIMATERIALS


TOTAL: 45 PERIODS

OUTCOMES

• Students will gain familiarity with Biomaterials and they will understand their importance.
• Students will get an overview of different biopolymers and their properties
• Students gain knowledge on some of the important Bioceramics and Biocomposite materials
• Students gain knowledge on metals as biomaterials
• Student gains knowledge on the importance of nanobiomaterials in biomedical applications.

REFERENCES

6. VasifHasirci, NesrinHasirci “Fundamentals of Biomaterials” Springer, 2018

CES334 MATERIALS FOR ENERGY SUSTAINABILITY L T P C

3 0 0 3

OBJECTIVES

• To familiarize the students about the challenges and demands of energy sustainability
• To provide fundamental knowledge about electrochemical devices and the materials used.
• To introduce the students to various types of fuel cell
• To enable students to appreciate novel materials and their usage in photovoltaic application
• To introduce students to the basic principles of various types Supercapacitors and the materials used.
UNIT I  SUSTAINABLE ENERGY SOURCES  9
Introduction to energy demand and challenges ahead – sustainable source of energy (wind, solar etc.) – electrochemical energy systems for energy harvesting and storage – materials for sustainable electrochemical systems building – India centric solutions based on locally available materials – Economics of wind and solar power generators vs. conventional coal plants – Nuclear energy

UNIT II  ELECTROCHEMICAL DEVICES  9
Electrochemical Energy – Difference between primary and secondary batteries – Secondary battery (Li-ion battery, Sodium-ion battery, Li-S battery, Li-O₂ battery, Nickel Cadmium, Nickel Metal Hydride) – Primary battery (Alkaline battery, Zinc-Carbon battery) – Materials for battery (Anode materials – Lithiated graphite, Sodiated hard carbon, Silicon doped graphene, Lithium Titanate) (Cathode Materials – S, LiCoO₂, LiFePO₄, LiMn₂O₄) – Electrolytes for Lithium-ion battery (ethylene carbonate and propylene carbonate based)

UNIT III  FUEL CELLS  9

UNIT IV  PHOTOVOLTAICS  9

UNIT V  SUPERCAPACITORS  9
Supercapacitor –types of supercapacitors (electrostatic double-layer capacitors, pseudo capacitors and hybrid capacitors) - design of supercapacitor-three and two electrode cell-parameters of supercapacitor- Faradaic and non - Faradaic capacitance – electrode materials (transition metal oxides (MO), mixed metal oxides, conducting polymers (CP), Mxenes, nanocarbons, non-noble metal, chalcogenides, hydroxides and 1D-3D metal-organic frame work (MOF), activated carbon fibres (ACF)- Hydroxides-Based Materials - Polyaniline (PANI), a ternary hybrid composite-conductive polypyrrole hydrogels – Different types of nanocomposites for the SC electrodes (carbon–carbon composites, carbon-MOs composites, carbon-CPs composites and MOs-CPs composites) - Two-Dimensional (2D) Electrode Materials - 2D transition metal carbides, carbonitrides, and nitrides.

TOTAL: 45 PERIODS

OUTCOMES
• Students will acquire knowledge about energy sustainability.
• Students understand the principles of different electrochemical devices.
• Students learn about the working of fuel cells and their application.
• Students will learn about various Photovoltaic applications and the materials used.
• The students gain knowledge on different types of supercapacitors and the performance of various materials.
REFERENCES
5. Materials for Supercapacitor applications; B.Viswanathan. M.Aulice Scibioh

CES335 GREEN TECHNOLOGY L T P C 3 0 0 3

COURSE OBJECTIVE:
- To acquire knowledge on green systems and the environment, energy technology and efficiency, and sustainability.
- To provide green engineering solutions to energy demand, reduced energy footprint.

UNIT I PRINCIPLES OF GREEN CHEMISTRY
Historical Perspectives and Basic Concepts. The twelve Principles of Green Chemistry and green engineering. Green chemistry metrics- atom economy, E factor, reaction mass efficiency, and other green chemistry metrics, application of green metrics analysis to synthetic plans.

UNIT II POLLUTION TYPES
Pollution – types, causes, effects, and abatement. Waste – sources of waste, different types of waste, chemical, physical and biochemical methods of waste minimization and recycling.

UNIT III GREEN REAGENTS AND GREEN SYNTHESIS
Environmentally benign processes- alternate solvents- supercritical solvents, ionic liquids, water as a reaction medium, energy-efficient design of processes- photo, electro and sono chemical methods, microwave-assisted reactions

UNIT IV DESIGNING GREEN PROCESSES
Safe design, process intensification, in process monitoring. Safe product and process design – Design for degradation, Real-time Analysis for pollution prevention, inherently safer chemistry for accident prevention

UNIT V GREEN NANOTECHNOLOGY
Nanomaterials for water treatment, nanotechnology for renewable energy, nanotechnology for environmental remediation and waste management, nanotechnology products as potential substitutes for harmful chemicals, environmental concerns with nanotechnology

TOTAL: 45 PERIODS

COURSE OUTCOMES
CO1: To understand the principles of green engineering and technology
CO2: To learn about pollution using hazardous chemicals and solvents
CO3: To modify processes and products to make them green and safe.
CO4: To design processes and products using green technology
CO5 – To understand advanced technology in green synthesis
OBJECTIVES:

- To understand and study the complexity of the environment in relation to pollutants generated due to industrial activity.
- To analyze the quality of the environmental parameters and monitor the same for the purpose of environmental risk assessment.

UNIT I ENVIRONMENTAL MONITORING AND STANDARDS


UNIT II MONITORING OF ENVIRONMENTAL PARAMETERS


UNIT III ANALYTICAL METHODS FOR ENVIRONMENTAL MONITORING

Classification of Instrumental Method- Analysis of Organic Pollutants by Spectrophotometric methods - Determination of nitrogen, phosphorus and, chemical oxygen demand (COD) in sewage; Biochemical oxygen demand (BOD)- Sampling techniques for air pollution measurements; analysis of particulates and air pollutants like oxides of nitrogen, oxides of sulfur, carbon monoxide, hydrocarbon; Introduction to advanced instruments for environmental analysis

UNIT IV ENVIRONMENTAL MONITORING PROGRAMME (EMP) & RISKASSESSMENT


UNIT V AUTOMATED DATA ACQUISITION AND PROCESSING

Data Acquisition for Process Monitoring and Control - The Data Acquisition System - Online Data Acquisition, Monitoring, and Control - Implementation of a Data Management System - Review of Observational Networks - Sensors and transducers- classification of transducers- data acquisition system- types of data acquisition systems- data management and quality control; regulatory overview.

TOTAL: 45 PERIODS

COURSE OUTCOMES

After completion of this course, the students will know

| CO1 | Basic concepts of environmental standards and monitoring. |
| CO2 | the ambient air quality and water quality standards; |
| CO3 | the various instrumental methods and their principles for environmental monitoring |
| CO4 | The significance of environmental standards in monitoring quality and sustainability |
of the environment.

CO5 the various ways of raising environmental awareness among the people.

CO6 Know the standard research methods that are used worldwide for monitoring the environment.

TEXTBOOKS
2. Handbook of environmental analysis: chemical pollutants in the air, water, soil, and soil wastes / Pradyot Patnaik, © 1997 by CRC Press, Inc

REFERENCES
1. Environmental monitoring / edited by G. Bruce Wiersma, © 2004 by CRC Press LLC.

Course Articulation Matrix

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<tr>
<th>Course Outcomes</th>
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CES337 INTEGRATED ENERGY PLANNING FOR SUSTAINABLE DEVELOPMENT L T P C 3 0 0 3

COURSE OBJECTIVES:
1. To create awareness on the energy scenario of India with respect to world
2. To understand the fundamentals of energy sources, energy efficiency and resulting environmental implications of energy utilisation
3. Familiarisation on the concept of sustainable development and its benefits
4. Recognize the potential of renewable energy sources and its conversion technologies for attaining sustainable development
5. Acquainting with energy policies and energy planning for sustainable development

UNIT I ENERGY SCENARIO 9
Comparison of energy scenario – India and World (energy sources, generation mix, consumption pattern, T&D losses, energy demand, per capita energy consumption) – energy pricing – Energy security

UNIT II ENERGY AND ENVIRONMENT 9
Conventional Energy Sources - Emissions from fuels – Air, Water and Land pollution – Environmental standards - measurement and controls

UNIT III SUSTAINABLE DEVELOPMENT 9
UNIT IV  RENEWABLE ENERGY TECHNOLOGY  

UNIT V  ENERGY PLANNING FOR SUSTAINABLE DEVELOPMENT  

COURSE OUTCOMES:  
Upon completion of this course, the students will be able to
1. Understand the world and Indian energy scenario
2. Analyse energy projects, its impact on environment and suggest control strategies
3. Recognise the need of Sustainable development and its impact on human resource development
4. Apply renewable energy technologies for sustainable development
5. Fathom Energy policies and planning for sustainable development.

REFERENCES:  
7. https://www.niti.gov.in/verticals/energy

CES338 ENERGY EFFICIENCY FOR SUSTAINABLE DEVELOPMENT  
L T P C
3 0 0 3

COURSE OBJECTIVES:  
1. To understand the types of energy sources, energy efficiency and environmental implications of energy utilisation
2. To create awareness on energy audit and its impacts
3. To acquaint the techniques adopted for performance evaluation of thermal utilities
4. To familiarise on the procedures adopted for performance evaluation of electrical utilities
5. To learn the concept of sustainable development and the implication of energy usage

UNIT I  ENERGY AND ENVIRONMENT  
Primary energy sources - Coal, Oil, Gas – India Vs World with respect to energy production and consumption, Climate Change, Global Warming, Ozone Depletion, UNFCCC, COP

UNIT II  ENERGY AUDITING  
Need and types of energy audit. Energy management (audit) approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments
UNIT III ENERGY EFFICIENCY IN THERMAL UTILITIES
Energy conservation avenues in steam generation and utilisation, furnaces, Thermic Fluid Heaters. Insulation and Refractories - Commercial waste heat recovery devices: recuperator, regenerator, heat pipe, heat exchangers (Plate, Shell & Tube), heat pumps, and thermocompression

UNIT IV ENERGY CONSERVATION IN ELECTRICAL UTILITIES
Demand side management - Power factor improvement – Energy efficient transformers - Energy conservation avenues in Motors, HVAC, fans, blowers, pumps, air compressors, illumination systems and cooling towers

UNIT V SUSTAINABLE DEVELOPMENT

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to
1. Understand the prevailing energy scenario
2. Familiarise on energy audits and its relevance
3. Apply the concept of energy audit on thermal utilities
4. Employ relevant techniques for energy improvement in electrical utilities
5. Understand Sustainable development and its impact on human resource development

REFERENCES: