ANNA UNIVERSITY, CHENNAI
AFFILIATED INSTITUTIONS
REGULATIONS 2021

B.E. PETROCHEMICAL ENGINEERING

CHOICE BASED CREDIT SYSTEM (CBCS)

PROGRAM EDUCATIONAL OBJECTIVES:

After 3 years of graduation, our graduates will be

1. Successful in their careers in the diversified sectors of the Petrochemical Technology.
2. A successful entrepreneur, manager or occupy higher positions.
3. Pursuing higher studies and research programmes in India and abroad.

PROGRAM OUTCOMES:

1. The graduates of the petrochemical technology will be able to apply knowledge of science and engineering to analyze petrochemical technology problems.
2. The graduates of the petrochemical technology will be able to Understand and interpret the problems in petrochemical processes.
3. The graduates of the petrochemical technology will be able to Design and develop appropriate solutions for the petrochemical systems.
4. The graduates of the petrochemical technology will be able to Identify, formulate and solve complex petrochemical technology problems.
5. The graduates of the petrochemical technology will be able to Use the modern engineering skills and software tools to analyze petrochemical technology problems.
6. The graduates of the petrochemical technology will be able to understand the global and societal impact of Petrochemical engineering practice.
7. The graduates of the petrochemical technology will be able to understand the impact of petrochemical technology solutions in environmental context and adopt suitable methods for sustainable development.
8. The graduates of the petrochemical technology will be able to meet the professional and ethical duties.

9. The graduates of the petrochemical technology will function effectively as an individual and in multidisciplinary teams.

10. The graduates of the petrochemical technology will be able to communicate effectively both in verbal and written forms.

11. The graduates of the petrochemical technology will be able to apply principles of management and economics for the effective functioning of Petrochemical and allied Industries.

12. The graduates of the petrochemical technology will engage in lifelong learning.

PROGRAM SPECIFIC OUTCOMES:
Graduates of Petrochemical Technology will:

PSO1: Strong foundation in Chemical, Petroleum & Petrochemical processes and effectively describe various units of modern petroleum refining and petrochemical industries.

PSO2: Effectively describe, analyze, develop appropriate solutions for Chemical, Petroleum & Petrochemical industrial problems using innovative research & development skills with continuous learning efforts.

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# ANNA UNIVERSITY, CHENNAI
NON-AUTONOMOUS COLLEGES AFFILIATED COLLEGES
REGULATIONS 2021
CHOICE BASED CREDIT SYSTEM
B.E. PETROCHEMICAL ENGINEERING
CURRICULUM AND SYLLABI FOR I TO VIII SEMESTERS

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$ Skill Based Course

## SEMESTER II

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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.

$ Skill Based Course
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TOTAL 18  1  10  29  24

$ Skill Based Course

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TOTAL 17  0  8  25  21

# 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.

*Four weeks industrial training/internship carries two credits. Industrial training/internship during IV Semester Summer Vacation will be evaluated in V semester
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* Mandatory Course-I is a Non-credit Course (Student shall select one course from the list given under MC-I)
* Four weeks industrial training/internship carries two credits. 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.
# Four weeks industrial training/internship carries two credits. 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

##Four weeks industrial training/internship carries two credits. Industrial training/Internship during VI Semester Summer Vacation will be evaluated in VII semester

### SEMESTER VIII/VII

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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.

TOTAL CREDITS : 165.5
### ELECTIVE – MANAGEMENT COURSES

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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>
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<td>Hydrocarbon Transportation and Storage</td>
<td>Health, Safety and Environment</td>
<td>Process Intensification</td>
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<td>Renewable and Non-renewable Energy</td>
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<td>Fire and Explosion Control</td>
<td>Transport phenomena</td>
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<td>Hydrogen and Microbial fuel cells</td>
<td>Design of Pressure Vessels and storage Vessels</td>
<td>Process Hazard Analysis Studies</td>
<td>Fluidization Engineering</td>
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<td>Product Design and Development for Petrochemical Engineers</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: Energy Engineering

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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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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.

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| Total | 22 | 26 | 24 | 21 | 19 | 22 | 22 | 10 | 166 |
### VERTICALS FOR MINOR DEGREE (IN ADDITIONS TO ALL THE VERTICALS OF OTHER PROGRAMMES)

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<th>Vertical II Entrepreneurship</th>
<th>Vertical III Public Administration</th>
<th>Vertical IV Business Data Analytics</th>
<th>Vertical V Environment and Sustainability</th>
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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)

**VERTICAL 1: FINTECH AND BLOCK CHAIN**

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### VERTICAL 4: BUSINESS DATA ANALYTICS

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### VERTICAL 5: 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

HS3152

PROFESSIONAL ENGLISH I

OBJECTIVES:
- To improve the communicative competence of learners
- To learn to use basic grammatical 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 Communcation ( 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.

TOTAL: 45 PERIODS

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

MA3151 MATRICES AND CALCULUS

L T P C
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

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
CO1 :Use the matrix algebra methods for solving practical problems.
CO2 :Apply differential calculus tools in solving various application problems.
CO3 :Able to use differential calculus ideas on several variable functions.
CO4 :Apply different methods of integration in solving practical problems.
CO5 :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 ].

REFERENCES :
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 Schrödinger 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.

TOTAL : 45 PERIODS

COURSE OUTCOMES

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

- CO1: Understand the importance of mechanics.
- CO2: Express their knowledge in electromagnetic waves.
- CO3: Demonstrate a strong foundational knowledge in oscillations, optics and lasers.
- CO4: Understand the importance of quantum physics.
- CO5: 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:
5. N.Garcia, A.Damask and S.Schwarz. Physics for Computer Science Students. Springer-Verlag,

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.

CY3151 ENGINEERING CHEMISTRY

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  NANOCHEMISTRY
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

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:
CO1 :To infer the quality of water from quality parameter data and propose suitable treatment methodologies to treat water.
CO2 :To identify and apply basic concepts of nanoscience and nanotechnology in designing the synthesis of nanomaterials for engineering and technology applications.
CO3 :To apply the knowledge of phase rule and composites for material selection requirements.
CO4 :To recommend suitable fuels for engineering processes and applications.
CO5 :To recognize different forms of energy resources and apply them for suitable applications in energy sectors.

TEXT BOOKS:
REFERENCES:

CO-PO & PSO MAPPING

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

GE3151 PROBLEM SOLVING AND PYTHON PROGRAMMING

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

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/

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1 - low, 2 - medium, 3 - high, '-' - no correlation
TEXT-CUM-REFERENCE BOOKS

1. Social Life of Tamils (Dr. K.K. Pillay) A joint publication of TNTB & ESC and RMRL – (in print)

TOTAL: 15 PERIODS
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 Book and Educational Services Corporation, Tamil Nadu)

GE3152 HERITAGE OF TAMILS L T P C

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. கூத்திய மார்பால் - மத்திய பரமால் - மத்திய விளரித்தா - கலந்துகி (கிருத்திகரண்: இருந்து பாடல் - பூச்சித் பூச்சித் காலம் (கிருத்திகரண்: இருந்து பாடல்).
2. கூத்திய மார்பால் - மத்திய பரமால் - மத்திய விளரித்தா - கலந்துகி (கிருத்திகரண்: இருந்து பாடல்).
3. கூத்திய மார்பால் - மத்திய பரமால் - மத்திய விளரித்தா - கலந்துகி (கிருத்திகரண்: இருந்து பாடல்).
4. Social Life of Tamils (Dr. K.K. Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
5. Social Life of the Tamils - The Classical Period (Dr. S. Singaravelu) (Published by: International Institute of Tamil Studies)
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9. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

GE3171 PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY L T P C 0 0 4 2

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, circulate 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)
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/

COs- PO’s & PSO’s MAPPING

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

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
4. 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

COURSE OUTCOMES:
Upon completion of the course, the students should be able to
CO1 : Understand the functioning of various physics laboratory equipment.
CO2 : Use graphical models to analyze laboratory data.
CO3 : Use mathematical models as a medium for quantitative reasoning and describing physical reality.
CO4 : Access, process and analyze scientific information.
CO5 : 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.

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 Na$_2$CO$_3$ 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.
   - Split the first experiment into two
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 (TiO$_2$/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 BOOKS:

CO-PO & PSO MAPPING

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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

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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.

HS3252 PROFESSIONAL ENGLISH -II

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**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

**UNIT II** EXPRESSING CAUSAL RELATIONS IN SPEAKING AND WRITING

**UNIT III** PROBLEM SOLVING

**UNIT IV** REPORTING OF EVENTS AND RESEARCH

**UNIT V** THE ABILITY TO PUT IDEAS OR INFORMATION COGENTLY

**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.

MA3251 STATISTICS AND NUMERICAL METHODS

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 - $2^2$ 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 derivates 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:
PH3253 MATERIALS SCIENCE FOR TECHNOLOGISTS L T P C
3 0 0 3

COURSE OBJECTIVES:
- To make the students effectively to understand the basics of crystallography and crystal imperfections.
- To enable the students to get knowledge on various strengthening methods of materials, and also various mechanical properties and their measurement.
- To impart knowledge on the basics of phase diagrams and their applications.
- To learn about iron-carbon system, and about various ferrous and non-ferrous alloys.
- To introduce the preparation, properties and applications of ceramics, composites and nanomaterials.

UNIT I CRYSTALLOGRAPHY

UNIT II MECHANICAL PROPERTIES

UNIT III PHASE DIAGRAMS
Basic concepts - Gibbs phase rule – Unary phase diagram (iron) - Binary phase diagrams: isomorphous systems (Cu-Ni) – determination of phase composition and phase amounts – tieline and lever rule - binary eutectic diagram with no solid solution and limited solid solution (Pb-Sn) – eutectoid and peritectic reactions - other invariant reactions – microstructural development during the slow cooling: eutectic, hypereutectic and hypoeutectic compositions.
UNIT IV FERROUS AND NONFERROUS ALLOYS


UNIT V CERAMICS, COMPOSITES AND NANO MATERIALS


TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Upon completion of this course, the students should be able to
CO2: Understand the basics of crystallography and its importance in materials properties
CO3: Understand the significance of dislocations, strengthening mechanisms, and tensile, creep, hardness and fracture behavior of materials
CO4: Gain knowledge on binary phase diagrams, and also will be able to determine the phase composition and phase amount.
CO5: Understand about the Fe-C system and various microstructures in it, and also about various ferrous and non-ferrous alloys.
CO6: Get adequate understanding on the preparation, properties and applications of ceramics, composites and nanomaterials.

TEXT BOOKS:


REFERENCES:


BE3252 BASIC ELECTRICAL, ELECTRONICS AND INSTRUMENTATION ENGINEERING

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  9
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  9
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  9

UNIT III  ANALOG ELECTRONICS  9

UNIT V  SENSORS AND TRANSDUCERS  9
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.

TOTAL: 45 PERIODS

COURSE 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:
3. S.K. Bhattacharya, Basic Electrical Engineering, Pearson Education, 2019
4. James A Svoboda, Richard C. Dorf, Dorf’s Introduction to Electric Circuits, Wiley, 2018
REFERENCES:

CO’s, PO’s & PSO’s MAPPING

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CY3251 CHEMISTRY FOR TECHNOLOGISTS L T P C

OBJECTIVES:
The course aims to
- Provide conceptual understanding on spectroscopic and surface analytical techniques.
- Impart knowledge to students on the chemistry of surface and interfaces.
- make students well versed on the chemical analysis of oils, fats, soaps & lubricants.
- Provide deep knowledge to students about various classification and properties of hydrocarbon.
- familiarize students with the identification and characteristics of dyes and their applications.

UNIT I SPECTROSCOPIC TECHNIQUES 9
Spectroscopy: Electromagnetic spectrum - absorption of radiation - electronic, vibrational and rotational transitions. Width and intensities of spectral lines. Flame photometer, Atomic absorption spectroscopy, UV-Vis, IR spectroscopy, Scanning Electron Microscope (SEM) and Transmission Electron Microscope (TEM) - principles, instrumentation (Block diagram) and applications.

UNIT II CHEMISTRY OF INTERFACES 9

UNIT III OILS, FATS, SOAPS & LUBRICANTS 9
Chemical constitution, Chemical analysis of oils and fats – acid, saponification and iodine values, Definitions, determinations and significance. Definition, mechanism of lubrication, preparation of petroliubes, desirable characteristics – viscosity, viscosity index, carbon residue, oxidation stability, flash and fire points, cloud and pour points, aniline point. Semisolid lubricant – greases, preparation of sodium, lithium, calcium and axle greases and uses, consistency test and drop point test. Solid lubricants – graphite and molybdenum disulphide.
UNIT IV HYDROCARBON
Classification of Hydrocarbons. Aliphatic Hydrocarbons: Alkanes – isomerism, conformations,
physical, chemical reactions including free radical mechanism of halogenation, combustion and
pyrolysis. Alkenes– structure of double bond, geometrical isomerism, chemical reactions: addition of
hydrogen, halogen, water, hydrogen halides, ozonolysis, oxidation. Alkynes – structure of triple
bond acidic character of alkynes, addition reaction of hydrogen, halogens, hydrogenhalides and
water. Aromatic hydrocarbons - resonance, aromaticity ; mechanism of electrophilic substitution –
nitration sulphonation, halogenations.

UNIT V COLORANTS
Theory of colour and constitution : chromophore and auxochrome, bathochromic and
hypsochromic shift, classification of dyes based on application and composition. Chemistry of azo
dye – synthesis of Methyl red, Methyl orange, Congo red, phenolphthalein, fluorescein and eosin.

OUTCOMES:
At the end of the course, the students will be able to :
• Understand and apply spectroscopic techniques for the analysis of engineering materials
  for their applications.
• Make use of the applications of adsorption in detergency, wetting, spreading, foaming, degreasing,
  and water repellence and separation processes.
• Analyse and estimate oils, fats, lubricants and soap for their intended applications.
• Distinguish and demonstrate the role of different types of hydrocarbon.
• Realize the chemical structures, properties and relationships of different types of dyes and
  their applications.

TEXT BOOKS:
1. Dara S. S., “A Text Book of Engineering Chemistry”, S. Chand & Co. Ltd., New Delhi,

REFERENCES:
   1995.
   Ltd., New Delhi, 1994.
   University Press, Delhi, 2019.

GE3251 ENGINEERING GRAPHICS

COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for:
1. Drawing engineering curves.
2. Drawing freehand sketch of simple objects.
3. Drawing orthographic projection of solids and section of solids.
4. Drawing development of solids
5. 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  6+12
Basic Geometrical constructions, Curves used in engineering practices: Conics — Construction of ellipse, parabola and hyperbola by eccentricity method — 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  6+12
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  6+12
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.
Practicing three dimensional modeling of simple objects by CAD Software(Not for examination)

UNIT IV  PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES  6 +12
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.
Practicing three dimensional modeling of simple objects by CAD Software(Not for examination)

UNIT V  ISOMETRIC AND PERSPECTIVE PROJECTIONS  6+12
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.
Practicing three dimensional modeling of isometric projection of simple objects by CAD Software(Not for examination)

TOTAL: (L=30+P=60) 90 PERIODS

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 BOOK:

REFERENCES:

Publication of Bureau of Indian Standards:
2. IS 9609 (Parts 0 & 1) — 2001: Technical products documentation — Lettering.

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.

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Low (1); Medium (2); High (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. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
3. 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)
4. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
5. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
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. 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. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
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5. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
6. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
## NCC Credit Course Level 1*

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

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**TOTAL : 30 PERIODS**

## NCC Credit Course Level 1*

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

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**TOTAL : 30 PERIODS**
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 4 Protection of Children and Women Safety
SS 5 Road / Rail Travel Safety
SS 6 New Initiatives
SS 7 Cyber and Mobile Security Awareness

TOTAL : 30 PERIODS

NCC Credit Course Level 1*

NX3253 (AIR FORCE WING) NCC Credit Course Level - I

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COURSE OBJECTIVES:

- 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.
- Wiring various electrical joints in common household electrical wire work.
- 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.
- Soldering and testing simple electronic circuits; Assembling and testing simple electronic components on PCB.

GROUP – A (CIVIL & ELECTRICAL)

PART I CIVIL ENGINEERING PRACTICES 15

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 15

  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 15

WELDING WORK:
  a) Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding.
  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 15

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

TOTAL : 60 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
CO1: 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.
CO2: Wire various electrical joints in common household electrical wire work.
CO3: 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.
CO4: Solder and test simple electronic circuits; Assemble and test simple electronic components on PCB.

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BE3272 BASIC ELECTRICAL, ELECTRONICS AND INSTRUMENTATION 0 0 4 2

COURSE 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

COURSE 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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GE3272 COMMUNICATION LABORATORY (Second Semester)

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
Speaking: discussing the 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
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
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
- 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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**Avg:** 2.4 2.8 3 1.8 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.
OBJECTIVES:
- To introduce the basic concepts of PDE for solving standard partial differential equations.
- 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 series techniques in solving heat flow problems used in various situations.
- To acquaint the student with Fourier transform techniques used in wide variety of situations.
- 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 : PARTIAL DIFFERENTIAL EQUATIONS 9 + 3
Formation of partial differential equations – Solutions of standard types of first order partial differential equations – First order partial differential equations reducible to standard types – Lagrange’s linear equation – Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

UNIT - II : FOURIER SERIES 9 + 3
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 : APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 9 + 3
Classification of PDE – Method of separation of variables – Fourier series solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction (Cartesian coordinates only).

UNIT - IV : FOURIER TRANSFORMS 9 + 3

UNIT - V : Z – TRANSFORMS AND DIFFERENCE EQUATIONS 9 + 3

TOTAL : 60 PERIODS

OUTCOMES:
Upon successful completion of the course, students should be able to:
- Understand how to solve the given standard partial differential equations.
- Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.
- Appreciate the physical significance of Fourier series techniques in solving one and two dimensional heat flow problems and one dimensional wave equations.
- 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.
- Use the effective mathematical tools for the solutions of partial differential equations by using Z transform techniques for discrete time systems.
TEXT BOOKS:

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PE3351 PROCESS CALCULATIONS L T P C
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OBJECTIVE:
- To teach concept of degree of freedom 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.

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.

TOTAL: 45 PERIODS

COURSE OUTCOMES: (Cos)
1. Understand the fundamentals of system of units, apply ideal gas law to solve problems in pure components and mixtures.
2. Apply stoichiometric principles to solve problems and write material balance for different process equipments.
3. Understand and apply basics of humidity to solve problems in humidification and other processes.
4. Understand and apply the basics of energy balance concepts to solve to different chemical processes.
5. Understand the basics of fuels and combustion, to solve problems on combustion of various fuels and also to find excess air.
6. Apply the above knowledge in process flow sheeting calculations.

TEXT BOOKS:

REFERENCES:
### Course Articulation Matrix

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<tr>
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<td>Understand the fundamentals of system of units, apply ideal gas law to solve problems in pure components and mixtures.</td>
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<td><strong>CO2</strong></td>
<td>Apply stoichiometric principles to solve problems and write material balance for different process equipments.</td>
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<td><strong>CO3</strong></td>
<td>Understand and apply basics of humidity to solve problems in humidification and other processes.</td>
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<td><strong>CO4</strong></td>
<td>Understand and apply the basics of energy balance concepts to solve to different chemical processes.</td>
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<td><strong>CO5</strong></td>
<td>Understand the basics of fuels and combustion, to solve problems on combustion of various fuels and also to find excess air.</td>
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<td><strong>CO6</strong></td>
<td>Apply the above knowledge in process flow sheeting calculations.</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 impart to the student knowledge on
- Fluid properties, fluid statics, dynamic characteristics for through pipes and porous medium.
- Flow measurement and fluid machineries.

UNIT I PROPERTIES OF FLUIDS AND CONCEPT OF PRESSURE

UNIT II MOMENTUM BALANCE AND ITS APPLICATIONS
Basic equation of fluid flow – Mass balance in a flowing fluid; continuity- Differential momentum balance; Equations of motion - macroscopic momentum balances - Bernoulli's equation – Correction for fluid friction – Correction for pump work - Velocity potential - Reynolds experiment and significance.

UNIT III DIMENSIONAL ANALYSIS
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.

UNIT IV FLOW OF INCOMPRESSIBLE FLUIDS THROUGH DUCTS

UNIT V TRANSPORTATION AND METERING

OUTCOMES:
CO1: Understand the fundamental properties of fluids, stress-strain relationship in fluids, and its characteristics under static conditions and establish force balance in static systems.
CO2: Apply Bernoulli principle, Navier - Stokes equation and compute pressure variation in static fluid.
CO3: Use of dimensional analysis to derive relationships among process or system variables. Further they would develop dimensionless roupas that help in scale-up studies.
CO4: Understand the different types of flow conditions in fixed bed and fluidized beds.
CO5: 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.
CO6: Understand the impact of technology change and also develop responsibilities to the professional engineering practices.

TEXT BOOKS:

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<td>Understand the fundamental properties of fluids, stress-strain relationship in fluids, and its characteristics under static conditions and establish force balance in static systems.</td>
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<td>CO2</td>
<td>Apply Bernoulli principle, Navier - Stokes equation and compute pressure variation in static fluid.</td>
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<td>CO3</td>
<td>Use of dimensional analysis to derive relationships among process or system variables. Further they would develop dimensionless groups that help in scale-up studies.</td>
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<td>CO4</td>
<td>Understand the different types of flow conditions in fixed bed and fluidized beds.</td>
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<td>CO5</td>
<td>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.</td>
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<td>CO6</td>
<td>Understand the impact of technology change and also develop responsibilities to the professional engineering practices.</td>
<td>PO1 2 PO2 2 PO3 2 PO4 2 PO5 0 PO6 0 PO7 0 PO8 0 PSO1 2 PSO2 3 2</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE:
- To make the students to learn the primary refining operation of crude oil and testing of petroleum products and its treatment techniques.

UNIT I  CRUDE OIL COMPOSITION AND CLASSIFICATION  9
Theories behind the Origin of petroleum – Exploration and production of petroleum – Basics of hydrocarbon chemistry – Composition of crude oil – Impurities present in crude oil – Crude oil classification and its characteristics – Crude oil properties, Crude oil assay – Indigenous and imported crude oils – Crude availability Vs demands – Refining capacity of India.

UNIT II  TESTING OF PETROLEUM PRODUCTS  9

UNIT III  CRUDE PROCESSING  9

UNIT IV  LUBE DISTILLATE TREATMENT TECHNIQUES  9
Lubricating oil classification and its uses – Production of lubricating oils from vacuum distillates with different treatment techniques: Solvent extraction, Deasphalting, Dewaxing, Catalytic dewaxing and Hydrofining process – Industrial Grease – Manufacture of Calcium Grease.

UNIT V  WAX AND BITUMEN PROCESSING TECHNIQUES  9
Paraffinic wax: Classification and its uses, Petroleum jelly manufacture – Bitumen: Types and their properties – Bitumen Testing: Ductility, Penetration Index and Softening point – Asphalt manufacture: Air blowing technology.

TOTAL: 45 PERIODS

OUTCOME:
- CO1. Have knowledge on crude composition, types and their characteristics primary refining operations.
- CO2. Be able to analyse the suitability of test methods to check the quality of crude oil and its products.
- CO3. Have knowledge on the concept of separating crude products using fractionating column.
- CO4. Have knowledge on the significance of units present in the lube complex.
- CO5. Have knowledge on the classification, production and uses of wax and bitumen.
- CO6. Be able to identify the role of additives added in the commercial products of petroleum.

TEXT BOOKS:

REFERENCES:
<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO 1</th>
<th>PO 2</th>
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<th>PO 11</th>
<th>PO 12</th>
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<th>PSO 2</th>
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<tr>
<td>CO1</td>
<td>Acquire knowledge on crude composition, types, characteristics and current trends</td>
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<tr>
<td>CO2</td>
<td>Analyse the suitability of test methods to check the quality of petroleum products</td>
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<tr>
<td>CO3</td>
<td>Understand the concept of separating crude products using fractionating column</td>
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<tr>
<td>CO4</td>
<td>Understand the significance of units present in the lube complex and its operation</td>
<td>3</td>
<td>3</td>
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<tr>
<td>CO5</td>
<td>Understand the classification, production, testing methods and uses of wax and bitumen</td>
<td>3</td>
<td>3</td>
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<tr>
<td>CO6</td>
<td>Identify the role of additives used in the commercial products of petroleum</td>
<td>2</td>
<td>2</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 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, Duhring’s rule. Radiation heat transfer - Black body radiation, Emissivity, Stefan - Boltzman law, Plank’s law, radiation between surfaces.

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 Kirchoff’s law, and will be able to solve radiative problems apply knowledge of heat transfer to solve thermal engineering problems

TEXT BOOKS:
REFERENCES:
Course Articulation Matrix: HEAT TRANSFER

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Program Outcome Statements</th>
<th>PO 1</th>
<th>PO 2</th>
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<th>PO 11</th>
<th>PO 12</th>
<th>PS O1</th>
<th>PS O2</th>
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<tr>
<td>CO1</td>
<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>
<td>3</td>
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<tr>
<td>CO2</td>
<td>understand convective heat transfer and use of heat transfer coefficients for laminar and turbulent flows</td>
<td>2</td>
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<tr>
<td>CO3</td>
<td>Students will be able to calculate and use overall heat transfer coefficients in designing heat exchangers</td>
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<tr>
<td>CO4</td>
<td>The course provides the student with knowledge about heat transfer with phase change (boiling and condensation) and evaporation</td>
<td>2</td>
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<tr>
<td>CO5</td>
<td>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</td>
<td>2</td>
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OVERALL CO  

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVE:
- To impact knowledge in the field of particle size reduction and also deals with the detail 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.

OUTCOME:
At the end of this course, the students will be able to
1. Determine and Estimate various properties of particulates, particle size using advanced analysis techniques
2. Understand the overview of equipment design used for size reduction, and understand the importance of size enlargement.
3. Examine and identify various separation and purification equipment for solid-solid, solid-liquid and solid-gas system.
4. Categorize various filters and problems associated during the implementation and applications of filtration equipments
5. Analyze and understand the working of various types of impellers, mixers, Handling, Storage and Transportation of Solids.
6. Know the future challenges 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

<table>
<thead>
<tr>
<th>Course Outcome(s)</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
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<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
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<tr>
<td>CO1</td>
<td>Determine and Estimate various properties of particulates, particle size</td>
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<td>Understand the overview of equipment design used for size reduction, and</td>
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<td></td>
<td>understand the importance of size enlargement.</td>
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<tr>
<td>CO3</td>
<td>Examine and identify various separation and purification equipment for</td>
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<td>solid-solid, solid-liquid and solid-gas system.</td>
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<td>CO4</td>
<td>Categorize various filters and problems associated during the implementation</td>
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<td></td>
<td>and applications of filtration equipments</td>
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<tr>
<td>CO5</td>
<td>Analyze and understand the working of various types of impellers, mixers,</td>
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<td>Handling, Storage and Transportation of Solids.</td>
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<tr>
<td>CO6</td>
<td>Know the future challenges and Obtain knowledge on various unit operations</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.
PE3481 HEAT TRANSFER LABORATORY LT PC 0042

OBJECTIVE:
- To enable the students to develop a sound working knowledge on different types of heat transfer equipments.

LIST OF EXPERIMENTS
1. Heat Transfer in a Double Pipe Heat Exchanger
2. Heat transfer in Shell and Tube Heat Exchanger
3. Heat Transfer in a Bare and Finned Tube Heat Exchanger
4. Heat transfer in composite wall
5. Heat transfer by Forced / Natural Convection
6. Heat Transfer by Radiation – Determination of Stefan Boltzmann constant
7. Heat Transfer by Radiation – Emissivity measurement
8. Heat transfer in Open Pan Evaporator
9. Heat transfer by Single effect evaporation / Multiple effect evaporation
10. Boiling Heat Transfer
11. Heat Transfer through Packed Bed
12. Heat Transfer in a Horizontal Condenser / Vertical Condenser
13. Heat Transfer in Helical Coils
14. Heat Transfer in Agitated Vessels

Minimum 10 experiments to be offered

TOTAL: 60 PERIODS

OUTCOME:
CO1 : Understand the concepts of heat transfer equipments.
CO2 : Estimate the heat transfer rate and heat transfer co-efficient for heat exchangers.
CO3 : Perform and compare heat transfer operations.
CO4 : Evaluate the parameters in heat transfer equipments.
CO5 : Analyze the heat transfer data from experiments.
CO6 : Solve engineering problems effectively as an individual as well as team work.
## Course Articulation Matrix: HEAT TRANSFER LABORATORY

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand the concepts of heat transfer equipments</td>
<td>PO1 PO2 PO3 PO4 PO5 PO6 PO7 PO8 PO9 PO10 PO11 PO12 PS1 PS2</td>
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<tr>
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<td>3 3 - 1 - - - 2 1 2 1 3 2</td>
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<tr>
<td>CO2</td>
<td>Estimate the heat transfer rate and heat transfer coefficient for heat exchangers</td>
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<td>3 3 - 1 - - - 2 1 2 2 3 2</td>
</tr>
<tr>
<td>CO3</td>
<td>Perform and compare heat transfer operations.</td>
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<td>3 3 - 1 - - - 2 1 2 2 3 2</td>
</tr>
<tr>
<td>CO4</td>
<td>Evaluate the parameters in heat transfer equipments</td>
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<td>3 3 - 1 - - - 2 1 2 2 3 2</td>
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<tr>
<td>CO5</td>
<td>Analyze the heat transfer data from experiments.</td>
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<td>3 3 - 2 - - - 2 1 2 2 3 2</td>
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<tr>
<td>CO6</td>
<td>Solve engineering problems effectively as an individual as well as team work</td>
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<td>3 3 - 2 - - - 2 1 2 3 3 2</td>
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<tr>
<td>Overall CO</td>
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<td>3 3 0 1 0 0 0 0 2 1 2 2 3 2</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVES:
- To learn experimentally to calibrate flow meters, find pressure loss for fluid flows and determine pump characteristics.
- Students develop a sound working knowledge on different types of crushing equipments and separation characteristics of different mechanical operation separators.

LIST OF EXPERIMENTS – Phase – I (minimum 5 Experiments to be conducted)
1. Calibration of constant and variable head meters
2. Open drum orifice and draining time
3. Flow through straight pipe
4. Flow through annular pipe
5. Flow through helical coil and spiral coil
6. Characteristic curves of pumps
7. Pressure drop studies in packed column

LIST OF EXPERIMENTS – Phase- II (minimum 5 Experiments to be conducted)
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. Drop weight crusher
10. Drag on Sphere
11. Effectiveness of screen

TOTAL: 60 PERIODS

OUTCOMES:
- CO1: Correlate the difference between fixed and fluidized bed columns and its application.
- CO2: Select pumps for the transportation of fluids based on process conditions/requirements and fluid properties
- CO3: Compare the results of theoretical analytical models to the actual behavior of real fluid flows and draw sustainable conclusions
- CO4: Determine the size analysis in solid- solid separation systems
- CO5: Evaluate the size reduction and various crushing parameters
- CO6: Work effectively as a team with commitment to the professional ethics among the peer group involved.
### Course Articulation Matrix

<table>
<thead>
<tr>
<th>Course Outcome</th>
<th>Statement</th>
<th>PO1</th>
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<tbody>
<tr>
<td>CO1</td>
<td>Correlate the difference between fixed and fluidized bed columns and its application</td>
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<tr>
<td>CO2</td>
<td>Select pumps for the transportation of fluids based on process conditions/requirements and fluid properties</td>
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<tr>
<td>CO3</td>
<td>Compare the results of theoretical analytical models to the actual behavior of real fluid flows and draw sustainable conclusions</td>
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<tr>
<td>CO4</td>
<td>Determine the size analysis in solid-solid separation systems</td>
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</tr>
<tr>
<td>CO5</td>
<td>Evaluate the size reduction and various crushing parameters</td>
<td>2</td>
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<td>3</td>
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</tr>
<tr>
<td>CO6</td>
<td>Work effectively as a team with commitment to the professional ethics among the peer group involved.</td>
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<td>2</td>
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</tr>
</tbody>
</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:

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

10 Hours

MS EXCEL:

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

10 Hours

MS POWERPOINT:

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

10 Hours

TOTAL: 30 PERIODS
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
- 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.

PE3451 CHEMICAL ENGINEERING THERMODYNAMICS

OBJECTIVE:

- 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 PVT RELATIONS AND FIRST LAW OF THERMODYNAMICS
Scope of thermodynamics, basic concepts and definitions, Equilibrium state and phase rule,
Energy, Work, Temperature and Zeroth Law of Thermodynamics, reversible and irreversible
process, Ideal gas- Equation of State involving ideal and real gas, Law of corresponding states,
Compressibility chart, First Law of Thermodynamics and its consequences.

UNIT II SECOND LAW AND THERMODYNAMIC CORRELATIONS
Application of first Law of Thermodynamics for Flow and non-flow processes. Limitations of the
first Law, statements of second Law of Thermodynamics, Thermodynamic Temperature scale,
Entropy, Third law of thermodynamics. Thermodynamic Potentials, thermodynamic correlation,
Maxwell relations. Clapeyron equation.

UNIT III SOLUTION THERMODYNAMICS
Partial molar properties, ideal and non-ideal solutions, standard states definition and choice,
Gibbs-Duhem equation, activity and property change of mixing, excess properties of mixtures.
Activity coefficient-composition models.

UNIT IV PHASE EQUILIBRIA
Phase equilibrium in ideal solution, excess Gibbs free energy models, Henry's law, fugacity,
Vapor-Liquid Equilibrium at low, moderate and high pressures; bubble and dew point calculation,
thermodynamic consistency test of VLE data, Phase diagrams for homogeneous systems and for
systems with a miscibility gap, effect of temperature and pressure on azeotrope composition,
liquid-liquid equilibrium.

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

TOTAL: 45 PERIODS

OUTCOME:
Upon successful completion of the course, the students would be able to

- Understand PVT relations and first law of thermodynamics
- Apply second law and analyse the feasibility of system/devices
- Understand the systematic development of new class of properties to describe real
mixtures
- Develop the idea of chemical potential to derive the idea of phase equilibria
- Understand the principle of chemical reaction thermodynamics for the prediction of
equilibrium conversion.

TEXT BOOKS:

REFERENCES:
## Course Articulation Matrix

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>CHEMICAL ENGINEERING THERMODYNAMICS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>PO1</td>
</tr>
<tr>
<td>CO1</td>
<td>Understand PVT relations and first law of thermodynamics</td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>Apply second law and analyse the feasibility of system/devices</td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand the systematic development of new class of properties to describe real mixtures</td>
<td>3</td>
</tr>
<tr>
<td>CO4</td>
<td>Develop the idea of chemical potential to derive the idea of phase equilibria</td>
<td>3</td>
</tr>
<tr>
<td>CO5</td>
<td>Understand the principle of chemical reaction thermodynamics for the prediction of equilibrium conversion.</td>
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<td><strong>Overall CO</strong></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 will learn the process involving to convert one form of hydrocarbon into another form of hydrocarbon to meet the customer requirement using cracking, reforming, alkylation, isomerization and polymerization unit processes.

UNIT I VISBREAKING, THERMAL CRACKING AND COKING 9
Thermal Cracking: Process flow schemes, Reaction chemistry and free radical mechanisms, Factors influencing thermal cracking process.
Coking : Principle – Types – Advantages - Process flow schemes - Delayed Coking, Fluid Coking and Flexi-Coking processes - Factors influencing coking process

UNIT II CATALYTIC CRACKING AND HYDRO CRACKING 9
Hydro Cracking: Principle - Advantages - Process flow schemes - Reaction chemistry - Factors influencing hydro cracking process - Commercial Catalyst

UNIT III CATALYTIC REFORMING AND POLYMERIZATION 9

UNIT IV ALKYLATION AND ISOMERIZATION 9

UNIT V FINAL TREATMENT TECHNIQUES 9
Acid gas and Sulphur Removal Techniques: Hydro Desulphurization Processes, Merox process, Metal Oxide process-Iron sponge process, Zinc Oxide process – Chem sweet process, Sulfa Check process, Amine process / Girbotol process and Molecular sieve process. Sulphur recovery using claus process.

TOTAL : 45 PERIODS

OUTCOME:
On completion of the course, the students would be able to
CO1. Understand the need of different secondary process and demonstrate appropriate technologies available to meet the specified needs of the petroleum products.
CO2. Select appropriate technologies to meet the specified needs of lighter petroleum products from heavier feed
CO3. Select appropriate technologies and different flow sheet to get aromatic and olefin compounds from paraffinic feed and getting heavier products from lighter feed.
CO4. Understand different flow sheets, and appropriate technologies to maximize gasoline yield and quality.

CO5. Select appropriate technologies to get cleaner products and demonstrate knowledge on various application of specialty products obtained from crude oil

CO6. Optimization of product blending for quality and quantity improvement.

TEXT BOOKS:

REFERENCES:
## Course Articulation Matrix: PETROLEUM SECONDARY PROCESSING TECHNOLOGY

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcome</th>
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<tr>
<td>CO1</td>
<td>Understand the need of different secondary process and demonstrate appropriate technologies available to meet the specified needs of the petroleum products</td>
<td>PO 1 PO 2 PO 3 PO 4 PO 5 PO 6 PO 7 PO 8 PO 9 PO 10 PO 11 PO 12 PSO 1 PSO 2</td>
</tr>
<tr>
<td>CO2</td>
<td>Select appropriate technologies and different flow sheet to get the specified needs of lighter petroleum products using thermal catalytic and hydro cracking</td>
<td>2 3 2 3 2 2 2 - - - - 2 3</td>
</tr>
<tr>
<td>CO3</td>
<td>Select appropriate technologies and different flow sheet to get aromatic and olefin compound using reforming process</td>
<td>2 3 3 3 2 2 2 - - - - 2 2 3</td>
</tr>
<tr>
<td>CO4</td>
<td>Understand different flow sheets, and appropriate technologies to maximize gasoline yield and quality by Alkylation and Isomerization.</td>
<td>2 2 3 3 2 2 2 - - - - 3 2 2</td>
</tr>
<tr>
<td>CO5</td>
<td>Select appropriate technologies to get cleaner products of petroleum and natural gas</td>
<td>2 3 3 3 2 2 2 - - - - 2 2 3</td>
</tr>
<tr>
<td>CO6</td>
<td>Acquiring knowledge on commercial catalyst used cracking, reforming, alkylation, isomerization &amp; polymerization and its recent advancements</td>
<td>2 2 2 - 2 1 2 - - - - 3 2 2</td>
</tr>
</tbody>
</table>

**Overall CO**

<table>
<thead>
<tr>
<th>PO 1</th>
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<th>PO 8</th>
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</tr>
</tbody>
</table>

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

UNIT III ABSORPTION
Gas Absorption and Stripping – Equilibrium; material balance; limiting gas-liquid ratio; tray tower absorber - calculation of number of theoretical stages, tray efficiency, tower diameter; determination of height of packing using HTU and NTU calculations.

UNIT IV DISTILLATION
Vapour liquid equilibria - Raoult’s law, Principle of distillation - flash distillation, differential distillation, steam distillation, multistage continuous rectification, Number of ideal stages by Mc.Cabe - Thiele method, Total reflux, minimum reflux ratio, optimum reflux ratio.

UNIT V LEACHING & EXTRACTION
Liquid - liquid extraction - solvent characteristics-equilibrium stage wise contact calculations for single stage extraction, multi-stage cross current extraction, multi-stage counter current operation. Solid-liquid equilibria- equilibrium diagram for leaching, single stage leaching, multi stage continuous cross current and counter current leaching, stage calculations, stage efficiency.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On 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 concept and determine the theoretical stages, number of transfer units and height requirements for a gas absorption process
CO4: Identify the suitable distillation techniques, determine the number of trays for stage wise contact and determine the height of the packed tower
CO5: Apply the ternary equilibrium diagram concepts for separation of liquid-liquid extraction process, Describe core principles of leaching, estimate the number of ideal stages in leaching operation

TEXT BOOKS:

REFERENCES:
### Course articulation matrix

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statements</th>
<th>PO</th>
<th>PO</th>
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<th>PS</th>
<th>PS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand the fundamentals, types and mechanism of mass transfer operations</td>
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</tr>
<tr>
<td>CO2</td>
<td>Understand the theories of mass transfer and the concept of inter-phase mass transfer</td>
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<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand concept and determine the theoretical stages, number of transfer units and height requirements for a gas absorption process</td>
<td>3</td>
<td>3</td>
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</tr>
<tr>
<td>CO4</td>
<td>Identify the suitable distillation techniques, determine the number of trays for stage wise contact and determine the height of the packed tower</td>
<td>3</td>
<td>3</td>
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</tr>
<tr>
<td>CO5</td>
<td>Apply the ternary equilibrium diagram concepts for separation of liquid-liquid extraction process, Describe core principles of leaching, estimate the number of ideal stages in leaching operation</td>
<td>3</td>
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<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.

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**CPE339 NATURAL GAS AND LNG PROCESSING**

**OBJECTIVE:**
- To learn the basic concept and properties, composition of natural Gas.
- To impart estimation and production of natural gas.
- To gain knowledge about production of natural gas from condensate oil fields.
- To learn the acid gas treating of natural gas.
- To gain knowledge about dehydration of natural gas and LNG processes.

**UNIT I PROPERTIES AND COMPOSITION OF NATURAL GAS**

**UNIT II ESTIMATION AND PRODUCTION OF NATURAL GAS**
UNIT III  GAS FROM CONDENSATE OIL FIELDS
Processing of condensate well fluids – Cycling of gas condensate reservoirs – Sweep patterns – Katy cycling plant.

UNIT IV  ACID GAS TREATING OF NATURAL GAS
Acid gas removal: Metal oxide process – Slurry process – Amine process – Carbonate washing process – Methanol based process and other process – Sulphur recovery process.

UNIT V  DEHYDRATION OF NATURAL GAS AND LNG PROCESSES

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On successful completion of this course, the students would be able to
CO1: Understand Natural gas processing.
CO2: Understand Gas Compression, Gas Gathering and Transport Installation.
CO3: Apply knowledge operation and trouble shooting of natural gas pipelines.
CO4: Understand dehydration of natural gas
CO5: Evaluate LNG processes and operations
CO6: Create new process technology for NGE and LNG processes.

TEXT BOOKS:

REFERENCES:
## Course Articulation Matrix: NATURAL GAS AND LNG PROCESSES

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PROGRAM OUTCOME</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Remembering knowledge about Natural gas processing.</td>
<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO10  PO11  PO12  PSO1  PSO2</td>
</tr>
<tr>
<td></td>
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<td>3   3   3   2   2   1   1   -   1   1   1   2   2   2</td>
</tr>
<tr>
<td>CO2</td>
<td>Understanding about Natural gas processing, Gas Compression, Gas Gathering and Transport Installation.</td>
<td>3   3   3   2   2   1   1   -   1   1   1   2   2   2</td>
</tr>
<tr>
<td>CO3</td>
<td>Applying knowledge about Operation and trouble shooting of natural gas pipelines.</td>
<td>3   3   3   2   2   1   1   -   1   1   1   2   2   2</td>
</tr>
<tr>
<td>CO4</td>
<td>Analyzing knowledge about dehydration of natural gas</td>
<td>3   3   3   1   1   1   1   -   1   1   1   2   2   2</td>
</tr>
<tr>
<td>CO5</td>
<td>Evaluating LNG processes and operations</td>
<td>3   3   3   3   3   1   1   -   1   1   1   2   2   2</td>
</tr>
<tr>
<td>CO6</td>
<td>Creating new process technology for NGE and LNG processes.</td>
<td>3   3   3   2   2   1   1   -   1   1   1   2   2   2</td>
</tr>
<tr>
<td><strong>OVERALL CO</strong></td>
<td></td>
<td>3   3   3   2   2   1   1   -   1   1   1   2   2   2</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE:
- To enable the students to gain knowledge on different types of chemical reactors, the design of chemical reactors under isothermal and non-isothermal conditions

UNIT I KINETICS OF HOMOGENEOUS REACTIONS 9
Rate equation, elementary, non-elementary reactions, theories of reaction rate - Arrhenius theory, interpretation of kinetic data, integral and differential analysis.

UNIT II IDEAL REACTORS 9
Design equation for constant and variable volume batch reactors, Design of continuous reactors - stirred tank and tubular flow reactor, recycle reactors, combination of reactors - Equal sized CSTRs in series and parallel - Equal sized PFRs in series and parallel, size comparison of reactors.

UNIT III MULTIPLE REACTIONS 9
Design of reactors for multiple reactions – Series, parallel Reactions - factors affecting choice, optimum yield and conversion, selectivity, reactivity.

UNIT IV NON-ISOTHERMAL REACTORS 9
Heats of reaction and equilibrium conversion from thermodynamics, Non-isothermal homogeneous reactor systems, adiabatic reactors, Material and energy balances in batch reactors, Material and energy balances in plug flow and mixed flow reactors.

UNIT V NON IDEAL REACTORS 9
Residence time distribution as a factor of performance; residence time functions and relationship between them in reactors; basic models for non-ideal flow - single parameter model, conversion in non-ideal reactors.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On completion of course, the students would be able to
1. Apply the principles of reaction kinetics, formulate rate equations and analyze the batch reactor data.
2. Analyze the experimental kinetic data to select a suitable reactor for a particular application and to workout conversion and space time for different types of reactors.
3. Evaluate selectivity, reactivity and yield for parallel and mixed reactions.
4. Design isothermal and non-isothermal reactors for homogeneous reactions.
5. Examine how far real reactors deviate from the ideal reactors.
6. Solve the complex reaction engineering problems.

TEXT BOOKS:

REFERENCE:
# Course Articulation Matrix: CHEMICAL REACTION ENGINEERING

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
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<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Apply the principles of reaction kinetics, formulate rate equations and analyze the batch reactor data.</td>
<td>3</td>
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</tr>
<tr>
<td>CO2</td>
<td>Analyze the experimental kinetic data to select a suitable reactor.</td>
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<tr>
<td>CO3</td>
<td>Evaluate selectivity, reactivity and yield for multiple reactions.</td>
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<tr>
<td>CO4</td>
<td>Design isothermal and non-isothermal reactors for homogeneous reactions.</td>
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<td>3</td>
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<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>Examine how far real reactors deviate from the ideal reactors.</td>
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<td>3</td>
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<tr>
<td>CO6</td>
<td>Solve the complex reaction engineering problems.</td>
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</tr>
</tbody>
</table>

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

6


UNIT – II : ENVIRONMENTAL POLLUTION

6


UNIT – III : RENEWABLE SOURCES OF ENERGY.

6

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

6

Development, GDP, Sustainability concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability 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

6


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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*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 9

90
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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’t's, Natural Disasters, Man Made Disasters 9
- DM 3 Fire Service & Fire Fighting 1

ENVIRONMENTAL AWARENESS & CONSERVATION
- EA 1 Environmental Awareness and Conservation 3

GENERAL AWARENESS
- GA 1 General Knowledge 4

ARMED FORCES
- AF 1 Armed Forces, Army, CAPF, Police 6

ADVENTURE
- AD 1 Introduction to Adventure Activities 1

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

TOTAL: 45 PERIODS
NAVAL ORIENTATION  
AF 1  Armed Forces and Navy Capsule  
EEZ 1  EEZ Maritime Security and ICG

ADVENTURE  
AD 1  Introduction to Adventure Activities

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

TOTAL: 45 PERIODS
OBJECTIVE:
- To learn basic principles involved in analysis of petrochemical products.

LIST OF EXPERIMENTS (Any 12 Experiments)
1) Refractive index of petrochemicals
2) Flash and Fire point determination using Cleveland Open cup method
3) Flash and Fire point determination using Pensky Martien Closed cup method
4) Kinematic viscosity determination using Redwood
5) Kinematic viscosity determination using Saybolt
6) Determination of moisture content – KF titrator
7) Total acidity determination
8) Solvent Recovery from petrochemical feed stock
9) Elemental analysis of petrochemicals using GC / NMR
10) Functional group analysis of petrochemicals using UV / FTIR
12) Determination of Density, Apparent Density of Polymer
14) Determination of hardness of Polymers
15) Determination of Glass Transition Temperature (Tg) / Melting Point, (Tm) of Polymers
16) Determination of molecular weight by end group analysis (COOH group) / viscosity method.

OUTCOME:
CO1. Perform the testing of various physical properties of the petroleum products in a safe manner.
CO2. Perform the testing of various chemical properties of the petroleum products in a safe manner.
CO3. Differentiate various petroleum products by performing the specific tests.
CO4. Perform the advanced qualitative and quantitative laboratory tasks, including the operation of advanced analytical instrumentation.
CO5. Ability to communicate and perform in the team
CO6. Ability to understand the significance and theoretical principles behind of each test.

TOTAL: 60 PERIODS
## Course Articulation Matrix: PETROCHEMICAL AND POLYMER ANALYSIS LABORATORY

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Perform the testing of various physical properties of the petrochemical / polymer products in a safe manner</td>
<td>PO 1 PO 2 PO 3 PO 4 PO 5 PO 6 PO 7 PO 8 PO 9 PO 10 PO 11 PO 12 PSO 1 PSO 2</td>
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<td>3 3 1 2 2 - - 3 3 3 - 1 2 2</td>
</tr>
<tr>
<td>CO2</td>
<td>Perform the testing of various chemical properties of the petrochemical / polymer products in a safe manner</td>
<td>PO 1 PO 2 PO 3 PO 4 PO 5 PO 6 PO 7 PO 8 PO 9 PO 10 PO 11 PO 12 PSO 1 PSO 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 3 1 2 2 - - 3 3 3 - 1 2 2</td>
</tr>
<tr>
<td>CO3</td>
<td>Differentiate various petrochemical / polymer products by performing the specific tests</td>
<td>PO 1 PO 2 PO 3 PO 4 PO 5 PO 6 PO 7 PO 8 PO 9 PO 10 PO 11 PO 12 PSO 1 PSO 2</td>
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<td>3 3 3 3 2 - - 3 3 3 - 3 2 3</td>
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<tr>
<td>CO4</td>
<td>Perform the advanced qualitative and quantitative laboratory tasks, including the operation of advanced analytical instrumentation</td>
<td>PO 1 PO 2 PO 3 PO 4 PO 5 PO 6 PO 7 PO 8 PO 9 PO 10 PO 11 PO 12 PSO 1 PSO 2</td>
</tr>
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<td>3 3 - 2 2 - - 3 3 3 - 1 2 2</td>
</tr>
<tr>
<td>CO5</td>
<td>Ability to communicate and perform in the team</td>
<td>PO 1 PO 2 PO 3 PO 4 PO 5 PO 6 PO 7 PO 8 PO 9 PO 10 PO 11 PO 12 PSO 1 PSO 2</td>
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<tr>
<td>CO6</td>
<td>Ability to understand the significance and theoretical principles behind of each test.</td>
<td>PO 1 PO 2 PO 3 PO 4 PO 5 PO 6 PO 7 PO 8 PO 9 PO 10 PO 11 PO 12 PSO 1 PSO 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:
- On completion of the course, the students should be conversant with the theoretical principles and experimental procedures for quantitative estimation of petroleum products.

LIST OF EXPERIMENTS (Any 12 Experiments)
1. Specific gravity determination using API gravity / Specific gravity bottle method
2. Carbon residue determination Canrodson / Rams bottom method
3. Dynamic viscosity measurement / Kinematic viscosity by U-Tube viscometer
4. Moisture content determination using Dean & Stark / Centrifuge method
5. ASTM Distillation to identify petroleum fractions and find out boiling range
6. Aniline point determination
7. Copper strip corrosion testing of petroleum products
8. Cloud and Pour point determination
9. Smoke point determination
10. Reid-Vapor pressure determination of gasoline
11. BS&W separation using Centrifuge method
12. Drop point determination for industrial grease
13. Softening point determination
14. Ductility of bitumen - Determination
15. Penetration index determination
16. Calorific value of petrochemical product

OUTCOME:
- CO1. Perform the testing of various physical properties of the petroleum products in a safe manner.
- CO2. Perform the testing of various chemical properties of the petroleum products in a safe manner.
- CO3. Differentiate various petroleum products by performing the specific tests.
- CO4. Perform the advanced qualitative and quantitative laboratory tasks, including the operation of advanced analytical instrumentation.
- CO5. Ability to communicate and perform in the team
- CO6. Ability to understand the theoretical knowledge

TOTAL: 45 PERIODS
<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcome</th>
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<tbody>
<tr>
<td>CO1</td>
<td>Perform the testing of various physical properties of the petroleum products in a safe manner</td>
<td>3 3 1 2 2 - - 3 3 3 - 1 2 2</td>
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<tr>
<td>CO2</td>
<td>Perform the testing of various chemical properties of the petroleum products in a safe manner</td>
<td>3 3 1 2 2 - - 3 3 3 - 1 2 2</td>
</tr>
<tr>
<td>CO3</td>
<td>Differentiate various petroleum products by performing the specific tests</td>
<td>3 3 3 3 2 - - 3 3 3 - 3 2 3</td>
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<tr>
<td>CO4</td>
<td>Perform the advanced qualitative and quantitative laboratory tasks, including the operation of advanced analytical instrumentation</td>
<td>3 3 - 2 2 - - 3 3 3 - 1 2 2</td>
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<tr>
<td>CO5</td>
<td>Ability to communicate and perform in the team</td>
<td>- - - - 3 - - 3 3 3 - 3 2 2</td>
</tr>
<tr>
<td>CO6</td>
<td>Ability to understand the significance and theoretical principles behind of each test.</td>
<td>- - - - - - - 3 3 3 - - 2 2</td>
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<tr>
<td><strong>Overall CO</strong></td>
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<td>2 2 1 2 2 0 0 3 3 3 0 2 2 2</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.
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: 04

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

UNIT II
Continuous Distillation of Binary Mixtures : Multistage contact operations, Characteristics of multistage tower, McCabe Thiele method, Ponchon Savarit method, Reflux, maximum, minimum and optimum reflux, Use of open steam, Tray efficiency, Determination of height and column diameter, Multistage batch distillation; Principles of azeotropic and extractive distillation, Introduction & Design of multicomponent distillation system.

UNIT III
Gas Absorption and Stripping – Equilibrium; material balance; limiting gas-liquid ratio; tray tower absorber - calculation of number of theoretical stages, tray efficiency, tower diameter; packed tower absorber – rate based approach; determination of height of packing using HTU and NTU calculations.
UNIT IV
Liquid-Liquid Extraction: Ternary liquid equilibria, Triangular graphical representation concept of theoretical or ideal stage. Equipment used for single stage and multistage continuous operation; Analytical and graphical solution of single and multistage operation Super critical fluid extraction.

UNIT V
Adsorption: Description of adsorption processes and their application, Types of adsorption, Nature of adsorbents adsorption equilibria and adsorption hysteresis, Stage wise and continuous contact adsorption operations, Determination of number of stages.

OUTCOMES
CO1: Apply mass transfer principles to various phase equilibrium based separation processes viz. perform graphical calculations for binary distillation
CO2: Analyze and solve problems related to various Mass transfer Operations Understand the basics of distillation process and its application.
CO3: Understand concept and determine the theoretical stages, number of transfer units and height requirements for a gas absorption process.
CO4: Apply the ternary equilibrium diagram concepts to determine the number of stages required for separation of liquid-liquid extraction process.
CO5: Understand the concept of adsorption techniques, various isotherms, membrane separation techniques and ion exchange process
CO6: Design the mass transfer equipments to meet the specified needs of the process industries.

TEXT BOOKS:

REFERENCES:
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<td>CO1</td>
<td>Apply mass transfer principles to various phase equilibrium based separation processes viz. perform graphical calculations for binary distillation</td>
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<tr>
<td>CO2</td>
<td>Analyze and solve problems related to various Mass transfer Operations Understand the basics of distillation process and its application.</td>
<td>3</td>
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<tr>
<td>CO3</td>
<td>Understand concept and determine the theoretical stages, number of transfer units and height requirements for a gas absorption process.</td>
<td>3</td>
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<tr>
<td>CO4</td>
<td>Apply the ternary equilibrium diagram concepts to determine the number of stages required for separation of liquid-liquid extraction process.</td>
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<tr>
<td>CO5</td>
<td>Understand the concept of adsorption techniques, various isotherms, membrane separation techniques and ion exchange process</td>
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<td>CO6</td>
<td>Design the mass transfer equipments to meet the specified needs of the 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.
OBJECTIVE:
- To enable the students to gain knowledge on the selection of catalyst and multiphase reactors for the heterogeneous catalytic reactions.

UNIT I  CATALYST AND ITS CHARACTERIZATION  9
General definition of catalysts, Solid catalysts, Components of catalyst, Industrial catalysts, Preparation of solid catalysts, Precipitation and co-precipitation methods, Sol gel method, Supported catalysts, Impregnation and ion exchange method, Catalyst Characterization techniques-Structural analysis-surface area and pore analysis, Catalysts tests.

UNIT II  KINETICS OF HETEROGENEOUS CATALYTIC REACTIONS  9

UNIT III  DIFFUSION EFFECTS IN CATALYSIS  9
Effect of external transport on catalytic reaction rate, Effect of internal mass transport on catalytic reaction rate, Bulk diffusion, Knudsen diffusion, Surface diffusion, Effectiveness factor for spherical catalysts at isothermal conditions, Significance of intrapellet diffusion.

UNIT IV  CATALYST DEACTIVATION  9

UNIT V  INDUSTRIAL CATALYTIC PROCESSES  9
Steam reforming, Catalytic cracking, Hydro cracking, Three Lumped kinetic model for catalytic cracking of gas oil.

TOTAL: 45 PERIODS

OUTCOMES:
- Understand selection of catalysts, preparation and characterization techniques for multiphase reactors.
- Apply heterogeneous kinetic model for the development of rate equations and rate controlling steps and select a suitable reactor for a particular application.
- Understand the mechanism of internal and external transport processes in reactions with catalysts.
- Analyze the types of catalyst deactivation and develop a kinetic model for various deactivation mechanisms.
- Demonstrate the application of models for industrial catalytic reactions.
- Solve complex kinetic equations by software packages.

TEXT BOOKS:

REFERENCES:
### Course Articulation Matrix: CATALYTIC REACTION ENGINEERING

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<td>Understand selection of catalysts, preparation and characterization techniques for multiphase reactors.</td>
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<td>CO2</td>
<td>Apply heterogeneous kinetic model for the development of rate equations and select a suitable reactor for a particular application.</td>
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<td>CO3</td>
<td>Understand the mechanism of internal and external transport processes in catalytic reactions.</td>
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<td>CO4</td>
<td>Analyze the types of catalyst deactivation and develop a kinetic model for various deactivation mechanisms.</td>
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<tr>
<td>CO5</td>
<td>Demonstrate the application of models for industrial catalytic reactions.</td>
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<td>CO6</td>
<td>Solve complex kinetic equations by software packages.</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
- Develop sound practical knowledge for students on different types of mass transfer equipments

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:

<table>
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<tr>
<th>Course Outcomes</th>
<th>Statements</th>
<th>Program Outcomes</th>
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<tr>
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<td>CO1</td>
<td>Determine the diffusivity practically and compare the results with the empirical correlations.</td>
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<tr>
<td>CO2</td>
<td>Estimate the mass transfer rate and mass transfer co-efficient</td>
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<tr>
<td>CO3</td>
<td>Evaluate the performance/calculate the parameters in different distillation processes</td>
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<tr>
<td>CO4</td>
<td>Evaluate the performance/calculate the parameters in leaching and extraction operations</td>
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<tr>
<td>CO5</td>
<td>Estimate the drying characteristics</td>
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<td>OVERALL CO</td>
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<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.
OBJECTIVE:
- To introduce open and closed loop systems and its responses, control loop components and stability of control systems along with instrumentation.

UNIT I INSTRUMENTATION
Principles of measurements and classification of process instruments, measurement of temperature, pressure, fluid flow, liquid weight and weight flow rate, viscosity, pH, concentration, electrical and thermal conductivity, humidity of gases.

UNIT II OPEN LOOP SYSTEMS
Laplace transformation and its application in process control. 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.

UNIT III CLOSED LOOP SYSTEMS
Closed loop control systems, development of block diagram for feedback control systems, servo and regulatory problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers, transient response of closed-loop control systems and their stability.

UNIT IV FREQUENCY RESPONSE
Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, stability criterion, tuning of controllers Z-N tuning rules, C-C tuning rules.

UNIT V ADVANCED CONTROL SCHEMES
Feedback control of systems with dead time and inverse response. Control systems with multiple loops. Advanced Control Schemes a) Feed forward b) ratio control. Control of distillation towers and heat exchangers,

TOTAL: 45 PERIODS

OUTCOME:
CO1: Understand working principles, types and applications of various process instruments used in chemical and petrochemical industries.
CO2: Develop transient models for processes using material and/or energy balance equations and seek their solution using Laplace Transforms.
CO3: Explain the principles of controllers and control elements and analyze the closed loop control systems to determine the transient response, offset and their stability.
CO4: Understand Frequency response of control systems and tune the PID controllers.
CO5: Analyzing the performance of various of advanced control strategies.
CO6: Identify practical challenges in posing control problems and work in teams on dynamics and controller problems.

TEXT BOOKS:

REFERENCES:
### Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
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<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
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<th>PSO1</th>
<th>PSO2</th>
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<td>Understand working principles, types and applications of various process instruments used in chemical and petrochemical industries.</td>
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<td>CO2</td>
<td>Develop transient models for processes using material and/or energy balance equations and seek their solution using Laplace Transforms.</td>
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<td>CO3</td>
<td>Explain the principles of controllers and control elements and analyze the closed loop control systems to determine the transient response, offset and their stability.</td>
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<td>CO4</td>
<td>Understand Frequency response of control systems and tune the PID controllers.</td>
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<td>CO5</td>
<td>Analyzing the performance of various of advanced control strategies.</td>
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<td>CO6</td>
<td>Identify practical challenges in posing control problems and work in teams on dynamics and controller problems.</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE:
- To get acquainted with process design of distillation columns involving multicomponent and complex mixtures. To learn methodologies practiced in rating and designing heat transfer equipment used in refining and process industry.

UNIT I  MULTICOMPONENT DISTILLATION  9
Dew point and bubble point for multi component mixtures. Design of multi component distillation column, Number of variables, Selection of key components, Selection of column pressure, Feed condition, Plate-to-plate calculations, Empirical short cut methods, Introduction to rigorous solution procedures.

UNIT II  PETROLEUM REFINERY DISTILLATION  9
TBP, EFV, ASTM distillation curves and their relevance, Material balance and flash zone calculations for petroleum refinery distillation columns, Pump around and pump back calculations, Overall energy requirements, Estimation of number of equilibrium stages, Design using Packie charts and Watkins method, Introduction to rigorous solution procedure based on pseudo components.

UNIT III  COLUMN DESIGN  9

UNIT IV  FIRED HEATERS  9
Heat load calculations for furnace heaters used in crude refining, Basic constructional features, Different furnace types, Review of factors to be considered in the design of fired heaters, Introduction to manual calculations methods.

UNIT V  PUMPS AND COMPRESSORS  9
Types of pumps and compressors. Selection criteria. Power rating calculations based on process duty. Use of operating curves of centrifugal pump. NPSHR and NPSHA. Pump Cavitation. Surge problem in compressors.

OUTCOME:
On successful completion of this course, the students will be able to
CO1: Gain the knowledge on the various types of heat exchanger design.
CO2: apply the concepts involved auxiliary equipments like reboilers and condenser, cooling towers
CO3: Understanding the skill in thermal design of heat transfer equipment like shell and tube, Double pipe heat Exchangers and evaporators, and assessing thermal efficiency of the above equipment in practice.
CO5: Evaluating design of distillation, Extraction and absorption columns.
CO6: Design the pumps, fans and compressors

TOTAL: 45 PERIODS

TEXT BOOKS:
Course Articulation Matrix: REFINERY EQUIPMENT DESIGN

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<tr>
<th>Course Outcomes</th>
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<td>Gain the knowledge on the various types of heat exchanger design.</td>
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<tr>
<td>CO2</td>
<td>apply the concepts involved auxiliary equipments like reboilers and condenser, cooling towers</td>
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<tr>
<td>CO3</td>
<td>Understanding the skill in thermal design of heat transfer equipment like shell and tube, double pipe heat Exchangers and evaporators, and assessing thermal efficiency of the above equipment in practice.</td>
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<tr>
<td>CO4</td>
<td>Evaluating design of distillation, Extraction and absorption columns.</td>
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<tr>
<td>CO5</td>
<td>Design the pumps, fans and compressors</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
### NCC Credit Course Level 3*

**NX3651**
**(ARMY WING) NCC Credit Course - III**

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<td>PD 4</td>
<td>Career Counselling, SSB Procedure &amp; Interview Skills</td>
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**TOTAL: 45 PERIODS**

### NCC Credit Course Level 3*

**NX3652**
**(NAVAL WING) NCC Credit Course - III**

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<td>TOTAL : 45 PERIODS</td>
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CHEMICAL REACTION LABORATORY

OBJECTIVES
- Students will develop sound working knowledge on different types of reactors.

LIST OF EXPERIMENTS
1. Kinetic studies in a Batch reactor
2. Kinetic studies in a coiled 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 straight tube PFR
7. RTD studies in a Packed bed reactor
8. RTD studies in a CSTR
9. Study of temperature dependence of rate constant using CSTR.
10. Kinetic studies in Sono chemical reactor

PROCESS CONTROL LABORATORY

OBJECTIVE:
Students will gain the hands on training about the control systems

LIST OF EXPERIMENTS
1. Open loop study on a level system
2. Open loop study on a flow system
3. Open loop study on a thermal system
4. Closed loop study on a level system
5. Closed loop study on a flow system
6. Closed loop study on a thermal system
7. Response of first order system
8. Response of second order system
9. Response of Non-Interacting level System
10. Response of Interacting level System
11. Tuning of a level system
12. Tuning of a flow system
13. Tuning of a thermal system
14. Flow co-efficient of control valves
15. Characteristics of different types of control valves

*Minimum 10 experiments shall be offered.

OUTCOMES:
- Understand rate equation for different types of reactors.
- Design experiments in kinetics to determine conversion and effect of temperature on rate constant.
- Assess the non-ideal behavior of plug flow, mixed flow and packed bed by studying the residence time distribution.
- Understand the prerequisites of control strategies and design different process control systems
- Evaluate the suitable controllers for different chemical & Petrochemical process.
- Analyze and tune the control systems unto stability.

TOTAL: 60 PERIODS
### Course Articulation Matrix: CHEMICAL REACTION AND PROCESS CONTROL LABORATORY

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<th>Statement</th>
<th>Program Outcomes</th>
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<td>Understand rate equation for different types of reactors.</td>
<td>PO1  3 PO2  2 PO3  3 PO4  - PO5  - PO6  - PO7  - PO8  - PO9  - PO10  - PO11  - PO12  - PSO1  - PSO2  - 3 3</td>
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<tr>
<td>CO2</td>
<td>Design experiments in kinetics to determine conversion and effect of temperature on rate constant.</td>
<td>PO1  3 PO2  3 PO3  3 PO4  1 PO5  - PO6  - PO7  - PO8  - PO9  - PO10  - PO11  - PO12  - PSO1  - PSO2  - 3 3</td>
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<tr>
<td>CO3</td>
<td>Assess the non-ideal behavior of plug flow, mixed flow and packed bed by studying the residence time distribution.</td>
<td>PO1  3 PO2  3 PO3  3 PO4  1 PO5  - PO6  - PO7  - PO8  - PO9  - PO10  - PO11  - PO12  - PSO1  - PSO2  - 3 3</td>
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<tr>
<td>CO4</td>
<td>Understand the prerequisites of control strategies and design different process control systems.</td>
<td>PO1  3 PO2  2 PO3  3 PO4  1 PO5  - PO6  - PO7  - PO8  - PO9  - PO10  - PO11  - PO12  - PSO1  - PSO2  - 3 3</td>
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<tr>
<td>CO5</td>
<td>Evaluate the suitable controllers and tune the control systems for different chemical &amp; Petrochemical process.</td>
<td>PO1  3 PO2  3 PO3  2 PO4  2 PO5  - PO6  - PO7  - PO8  - PO9  - PO10  - PO11  - PO12  - PSO1  - PSO2  - 3 2</td>
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<tr>
<td>CO6</td>
<td>Analyze and tune the control systems unto stability</td>
<td>PO1  _ PO2  3 PO3  _ PO4  _ PO5  _ PO6  _ PO7  _ PO8  _ PO9  _ PO10  _ PSO1  _ PSO2  _ 1 2</td>
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**Overall CO**

| PO1  3 PO2  3 PO3  1 PO4  - PO5  - PO6  - PO7  - PO8  - PO9  - PO10  - PO11  - PO12  - PSO1  - PSO2  - 3 3 |

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE:
- To enhance the students to develop enrich practical knowledge on computational process simulator with different refinery operation.
- To provide industrial working environment and practical working knowledge on different chemical and petrochemical process plant operation.
- To give the students an understanding the fundamentals concepts in mathematics, problems solving and computer programming.

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS:
Minimum 10 experiments to be offered
Stand alone desktops/server with respective simulation software’s 30 users.

Softwares:
1. MATLAB Single user license
2. Chemical engineering simulation software
4. Open source MS office

Specific examples in MATLAB/EXCEL/ PROCESS SIMULATION
1. Solving equation of state, regression of parameters using EXCEL/MATLAB
2. Calculation of Reynolds number, friction factor and pressure drop using EXCEL/MATLAB
3. Calculation of heat transfer coefficient in a Heat Exchanger using EXCEL/MATLAB
4. Calculation of minimum Reflux ratio for binary/tertiary system in a fractionators using EXCEL/ MATLAB
5. Calculation of HTU and NTU in a Absorber using EXCEL/MATLAB
6. Calculation of Antoine’s coefficient using EXCEL/MATLAB
7. EstimationofsettlingvelocityofsolidsinliquidsusingStoke’slawusingEXCEL/MATLAB
8. CalculationofminimumnumberofstagesinadistillationcolumnusingEXCEL/MATLAB
9. Solving mass and energy balance problems using EXCEL/MATLAB
10. Dynamic simulation of an Absorption column using PROCESS SIMULATION SOFTWARE TOOL
11. Developing Heat and Mass balance diagram using PROCESS SIMULATION SOFTWARE TOOL

LIST OF SUGGESTED EXERCISES
Practice the following using process simulator. The simulator can be used from Virtual Lab simulators:
1. Change the P & I values and process parameters and observe the change in trend, bar graph and mimics
2. Attend the malfunction occurring in the plant then restoring to its design conditions.
3. Perform the experiments using the simulator by varying the process variables and tabulate the results.
4. Practice correct start up and shut down procedure of plant.

Practice the above exercise on the following modules given below using process simulator.
- Fractionation column for the distillation of binary mixture.
- shell and tube Heat exchanger
- Level and flow control in different sizes of vessel
- Batch Reactor / reaction kinetic studies in batch reactor
- CSTR in series
- Centrifugal pump
- Centrifugal compressor
- Fluidized bed column
- Packed bed column
➢ Cyclone separator  
➢ Evaporator  
➢ Crude Distillation unit  
➢ Manufacture of urea in urea plant  

5. Equations of state using Newton’s method  
6. Regression for parameter estimation using a set of data points  
7. Equilibrium flash distillation (Multicomponent Ideal)  
8. Batch Reactor  
9. CSTR in Series Stage wise contacting equipment  
10. Solving a simple flow sheet by simultaneous approach  
11. Simulation of batch Distillation (binary ideal).  
12. Gravity Flow Tank  
13. Heat Exchanger  
14. Plug Flow Reactor  
15. Absorber  

OUTCOME:  
CO1 : Remembering industrial exposure environment in computational pro-simulation.  
CO2 : Understanding In-depth Processes of chemical and refinery operation.  
CO3: Applying project knowledge and Carry out In-house projects  
CO5: Evaluate the Intricacy & Complexity of process dynamics.  
CO6: Create Employability opportunities in simulation models.  

TOTAL: 60 PERIODS  

REFERENCES:  
## Course Articulation Matrix: COMPUTATIONAL PETROCHEMICAL LABORATORY

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PROGRAM OUTCOME</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Remembering industrial exposure environment in computational pro-simulation.</td>
<td>PO1  2 3 2 2 3 1 - 1 2 3 3 3 2</td>
</tr>
<tr>
<td>CO2</td>
<td>Understanding In-depth Processes of chemical and refinery operation.</td>
<td>PO1  2 3 2 2 3 1 - 1 2 2 3 2 2</td>
</tr>
<tr>
<td>CO3</td>
<td>Applying project knowledge and Carry out In-house projects</td>
<td>PO1  2 3 2 2 3 1 - 1 2 1 3 2 2</td>
</tr>
<tr>
<td>CO4</td>
<td>Analyze Sound Fundamental Concepts of Process Control and safety with DCS Operations.</td>
<td>PO1  2 3 2 2 3 1 - 1 2 1 3 2 3</td>
</tr>
<tr>
<td>CO5</td>
<td>Evaluate the Intricacy &amp; Complexity of process dynamics.</td>
<td>PO1  2 3 2 2 3 1 - 1 3 2 3 2 3</td>
</tr>
<tr>
<td>CO6</td>
<td>Create Employability opportunities in simulation models.</td>
<td>PO1  2 3 2 2 3 1 - 1 1 3 3 2 3</td>
</tr>
<tr>
<td><strong>OVERALL CO</strong></td>
<td></td>
<td>PO1  2 3 2 2 3 1 - 1 2 2 3 2 2</td>
</tr>
</tbody>
</table>

115
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: 04

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

PC3752 PROCESS SAFETY IN PETROCHEMICAL INDUSTRIES

OBJECTIVE:
- To ensure knowledge on the safe handling of petrochemical products

UNIT I PETROLEUM PRODUCTS CLASSIFICATION & HAZARDS

UNIT II UPSTREAM & DOWNSTREAM OPERATION
On and off shore oil operation – Construction of Installation – Pipe line Construction – Maintenance and repair activities – Safety and associated hazards - transportation - Petroleum product storage

UNIT III SAFETY HANDLING OF HYDROCARBON

UNIT IV DISASTER MANAGEMENT PLAN
UNIT V    RULES AND REGULATION

TOTAL: 45 PERIODS

OUTCOMES:
CO1: Understand about the various classes of petrochemical products
CO2: Know about different aspects of pipeline constructional safety aspects of oil transportation
CO3: Obtain knowledge about various safety techniques of safe handling of hydro carbon
CO4: Analyze different aspects of disaster management plans and safety management drill
CO5: Obtain insight into various oil and natural gas legislation in India
CO6: Understand about the various rules and regulations of petroleum industries

REFERENCE BOOKS:
## Course Articulation Matrix: Process Safety in Petrochemical Industries

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand about the various classes of petrochemical products</td>
<td>3</td>
<td>2</td>
<td>-</td>
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<td>-</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>Know about different aspects of pipeline constructional safety aspects of oil transportation</td>
<td>3</td>
<td>2</td>
<td>-</td>
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<td>3</td>
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<td>1</td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>Obtain knowledge about various safety techniques of safe handling of hydrocarbon</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>3</td>
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<td>1</td>
<td>3</td>
</tr>
<tr>
<td>CO4</td>
<td>Analyze different aspects of disaster management plans and safety management drill</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
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<td>-</td>
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<td>1</td>
<td>3</td>
</tr>
<tr>
<td>CO5</td>
<td>Obtain insight into various oil and natural gas legislation in India</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td>CO6</td>
<td>Understand about the various rules and regulations of petroleum industries</td>
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<tr>
<td><strong>Overall CO</strong></td>
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</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVES:
- To impart practical knowledge on the shape and drawing of the process equipments
- To gain knowledge about design of heat exchanging equipment, auxiliary equipments.
- To become a design engineers on process equipments design and drawing consideration of the following:

UNIT I  HEAT EXCHANGER DESIGN  9

UNIT II  DESIGN OF AUXILIARY EQUIPMENTS  9
Design of Reboilers and Condenser, Cooling towers.

UNIT III  EVAPORATOR DESIGN  9

UNIT IV  COLUMN DESIGN  9
Design of distillation columns, Absorption columns, Extraction column, and Adsorption columns.

UNIT V  PUMPS, FANS AND COMPRESSORS  9

TOTAL: 45 PERIODS

OUTCOMES:
On successful completion of this course, the students will be able to
CO1: Remembering knowledge on thermal equipments design and specifications.
CO2: Understanding the skill in thermal design of heat transfer equipment like shell and tube, Double pipe heat Exchangers and evaporators, and assessing thermal efficiency of the above equipment in practice.
CO3: Demonstrate the skills in basic design and drawing of different dryers, cooling towers and adsorption columns.
CO4: Apply the concepts involved in phase separation and design of distillation, Extraction and absorption columns.
CO5: Evaluating auxiliary equipments pumps, fan, compressor and optimizing sizes, materials, and capital and operating costs of equipment commonly used in the chemical processing industries.
CO6: Design the essential elements of a chemical engineering process (equipment sizes, material & energy balances, economics, environmental, safety)

TEXT BOOKS:
REFERENCES:
### Course Articulation Matrix: PROCESS EQUIPMENT DESIGN

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Remembering knowledge on thermal equipments design and specifications.</td>
<td>PO1 2 3 3 3 2 3 1 - 1 2 3 2 2 2 2</td>
</tr>
<tr>
<td>CO2</td>
<td>Understanding the skill in thermal design of heat transfer equipment like shell and tube, Double pipe heat Exchangers and evaporators, and assessing thermal efficiency of the above equipment in practice.</td>
<td>3 3 3 2 3 2 1 - 1 2 2 2 2 2 2</td>
</tr>
<tr>
<td>CO3</td>
<td>Demonstrate the skills in basic design and drawing of different dryers, cooling towers and adsorption columns.</td>
<td>3 3 3 3 2 3 1 - 1 2 1 2 2 2 2</td>
</tr>
<tr>
<td>CO4</td>
<td>Apply the concepts involved in phase separation and design of distillation, Extraction and absorption columns.</td>
<td>3 3 3 2 3 2 1 - 1 2 1 2 2 2 2</td>
</tr>
<tr>
<td>CO5</td>
<td>Evaluating auxiliary equipment’s pumps, fan, compressor and optimizing sizes, materials and capital and operating costs of equipment commonly used in the chemical processing industries.</td>
<td>3 3 3 3 2 3 1 - 1 3 2 2 2 2 2</td>
</tr>
<tr>
<td>CO6</td>
<td>Design the essential elements of a chemical engineering process (equipment sizes, material &amp; energy balances, economics, environmental, safety)</td>
<td>3 3 3 2 3 2 1 - 1 1 3 2 2 2 2</td>
</tr>
</tbody>
</table>
| **OVERALL CO**  |                                                                           | 3 3 3 3 2 3 1 - 1 2 2 2 2 2 2 | 1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
GE3791  HUMAN VALUES AND ETHICS  L T P C  2 0 0 2

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
Reading Text: Excerpts from John Stuart Mills’ On Liberty

UNIT II  SECULAR VALUES
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
Reading Text: Excerpt from The Scientific Temper by Antony Michaelis R

UNIT IV  SOCIAL ETHICS
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
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.

PM3811
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.

TOTAL: 300 PERIODS

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

CPE349
RENEWABLE AND NON-RENEWABLE ENERGY

OBJECTIVES
- To gain Knowledge in capturing and applying forms of energy sources like solar, wind, biomass, geothermal, nuclear energy, hydrogen and fuel cells and challenges associated with implementation.
• To Understand the challenges associated with the development of unconventional hydrocarbons and distribution of unconventional hydrocarbons with emphasis on Indian resources.

UNIT I ENERGY SOURCES & AVAILABILITY
Conventional, Non-conventional, renewable, non renewable sources of energy, prospects & perspectives & advantages. Introduction to different types of non conventional source of energy - solar, wind, biomass, OTEC, geothermal, hydrogen energy, fuel cells, MHD, thermonic convertor, thermo-electric power.

UNIT II SOLAR & WIND ENERGY

UNIT III BIOMASS ENERGY

UNIT IV OTHER ENERGY SOURCES

UNIT V UNCONVENTIONAL NON-RENEWABLE ENERGY
Introduction to Unconventional Hydrocarbon resources- Coal Bed Methane: Geological controls in CBM, Indian Scenario, Gas Hydrates: Structure of gas hydrates and their stability, producibility of gas hydrates and challenges, Indian scenario of gas hydrates, Shale Gas / oil: production techniques applied for shale gas, Indian basins for shale gas/oil potential

TOTAL:45 PERIODS

OUTCOMES
After completion of this course, the student is expected to be able to show the:
• Knowledge in capturing and applying forms of energy sources and its availability
• Understand the concept in various energy sources like solar, wind, biomass, geothermal, nuclear energy, hydrogen and fuel cells
• Analyze the challenges associated with implementation of various renewable energy sources.
• Study the bio-based energy sources and technologies involved in it
• Understanding of the challenges associated with the development of unconventional hydrocarbons and distribution of unconventional hydrocarbons with emphasis on Indian resources.

REFERENCES
1. Unconventional Hydrocarbon Resources, Techniques for Reservoir Engineering Analysis By Reza Barati, Mustafa M. Alhubail · 2020 Publisher:Wiley
### Course Articulation Matrix: RENEWABLE AND NON-RENEWABLE ENERGY

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Knowledge in capturing and applying forms of energy sources and its availability</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
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<td>-</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>Understand the concept in various energy sources like solar, wind, biomass, geothermal, nuclear energy, hydrogen and fuel cells</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
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<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>Analyze the challenges associated with implementation of various renewable energy sources.</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>Study the bio-based energy sources and technologies involved in it</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
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<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>Understanding of the challenges associated with the development of unconventional hydrocarbons and distribution of unconventional hydrocarbons with emphasis on Indian resources.</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
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<td>3</td>
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<tr>
<td>Overall CO</td>
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<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>
OBJECTIVES:
At the end of the course, the student is expected to
- understand and analyse the energy data of industries
- carryout energy accounting and balancing
- conduct energy audit and suggest methodologies for energy savings and
- utilise the available resources in optimal ways

UNIT I INTRODUCTION

UNIT II ELECTRICAL SYSTEMS

UNIT III THERMAL SYSTEMS

UNIT IV ENERGY CONSERVATION IN MAJOR UTILITIES
Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems – Cooling Towers – D.G. sets

UNIT V ECONOMICS
Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of this course, the students can able to analyze the energy data of industries.
CO1: Understand and analyze the energy data of industries
CO2: Carryout energy accounting and balancing
CO3: Understand the principles in thermal systems
CO4: Conduct energy audit and suggest methodologies for energy savings
CO5: Utilize the available resources in optimal ways

TEXT BOOKS:

REFERENCES:
### Course Articulation Matrix: ENERGY CONSERVATION AND MANAGEMENT

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PROGRAM OUTCOME</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>PO1</td>
</tr>
<tr>
<td>CO1</td>
<td>Understand and analyze the energy data of industries</td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>Carryout energy accounting and balancing</td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand the principles in thermal systems</td>
<td>3</td>
</tr>
<tr>
<td>CO4</td>
<td>Conduct energy audit and suggest methodologies for</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>energy savings</td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>Utilize the available resources in optimal ways</td>
<td>3</td>
</tr>
<tr>
<td>OVERALL CO</td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
CPE333  ENERGY AUDITING AND DEMAND SIDE MANAGEMENT  L T P C  3 0 0 3

COURSE OBJECTIVES:
This course enables the students to know
- The growing worldwide concern for conservation of energy has reawakened interest in ecologically sustainability, processes and sources of energy.
- The better ways to conserve the energy from energy audit concepts, Representations and energy conservation schemes.
- Management skills and communication of energy manager.
- Various operational problems and remedies of motor and electrical devices.
- Evaluation of life time of machine based on time value money and demand, economic analysis with respect to demand side management.

UNIT I  ENERGY AUDITING  9

UNIT II  ENERGY EFFICIENT MOTORS  9

UNIT III  POWER FACTOR IMPROVEMENT  9
Power Factor — Methods of Improvement, Location of Capacitors, Pf with Non Linear Loads, Effect of Harmonics on P.F., P.F Motor Controllers.

UNIT IV  LIGHTING AND ENERGY INSTRUMENTS  9
Good Lighting System Design and Practice, Lighting Control ,Lighting Energy Audit - Energy Instruments- Watt Meter, Data Loggers, Thermocouples, Pyrometers, Lux Meters, Tongue Testers ,Application of PLC's

UNIT V  ENERGY ECONOMIC ANALYSIS& DEMAND SIDE MANAGEMENT  9

TOTAL: 45 PERIODS

OUTCOMES
The student will have knowledge on the following concepts
- CO1 Gain the knowledge of Current energy scenario
- CO2 Understand the energy management, auditing.
- CO3 Apply the conservation economic analysis and demand side management
- CO4 Know the Systematic knowledge and skill about assessing the energy efficiency
- CO5 Evaluate the energy auditing and energy management.

TEXTBOOKS:
## Course Articulation Matrix: ENERGY CONSERVATION AND MANAGEMENT

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
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<th>PO7</th>
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<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Gain the knowledge of Current energy scenario</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
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<td>3</td>
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<td>1</td>
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</tr>
<tr>
<td>CO2</td>
<td>Understand the energy management, auditing.</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
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<td>3</td>
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</tr>
<tr>
<td>CO3</td>
<td>Apply the conservation economic analysis and demand side management</td>
<td>1</td>
<td>-</td>
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</tr>
<tr>
<td>CO4</td>
<td>Know the Systematic knowledge and skill about assessing the energy efficiency</td>
<td>1</td>
<td>-</td>
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<td>3</td>
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<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>Evaluate the energy auditing and energy management.</td>
<td>1</td>
<td>-</td>
<td>-</td>
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<td>1</td>
<td>1</td>
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<tr>
<td>Overall CO</td>
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</tr>
</tbody>
</table>

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

- To present a problem oriented in depth knowledge of fuel cell technology.
- To Comprehend the Physics, Chemistry and Engineering of fuel cell and hydrogen technologies and be able to apply this knowledge to solve complex problems;

UNIT I INTRODUCTION TO FUEL CELLS
Introduction – working and types of fuel cell – low, medium and high temperature fuel cell, liquid and methanol types, proton exchange membrane fuel cell solid oxide, microbial fuel cells, hydrogen fuel cells – thermodynamics and electrochemical kinetics of fuel cells.

UNIT II HYDROGEN AND PRODUCTION TECHNIQUES

UNIT III HYDROGEN STORAGE AND APPLICATIONS

UNIT IV THE WORKINGS OF MICROBIAL FUEL CELLS
An introduction to microbial fuel cells-Electrochemical principles – characterization of bioelectrochemical systems-electron transfer mechanisms in biofilms

UNIT V MATERIALS FOR MICROBIAL FUEL CELLS AND REACTOR DESIGN
Anode materials for microbial fuel cells – surface modification – membranes and separators for microbial fuel cells – cathodes for microbial fuel cells – reactor design and scale up.

TOTAL: 45 PERIODS

COURSE OUTCOME

CO1 Gain the knowledge on the various types of fuel cell.
CO2 Apply the concepts involved hydrogen and production techniques
CO3 Understanding the skill in hydrogen storage and applications.
CO4 Understand the principle mechanism and working of microbial fuel cells
CO5 Evaluating the materials used for microbial fuel cells design

REFERENCES:
## Course Articulation Matrix: HYDROGEN AND MICROBIAL FUEL CELLS

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PROGRAM OUTCOME</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Gain the knowledge on the various types of fuel cell.</td>
<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO10  PO11  PO12  PSO1  PSO2</td>
</tr>
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<td></td>
<td></td>
<td>3   1   1   1   -   3   3   -   -   -   2   2   2   2</td>
</tr>
<tr>
<td>CO2</td>
<td>Apply the concepts involved hydrogen and production techniques</td>
<td>3   2   2   1   -   3   3   -   -   -   2   2   2   2</td>
</tr>
<tr>
<td>CO3</td>
<td>Understanding the skill in hydrogen storage and applications</td>
<td>3   2   2   1   -   3   3   -   -   -   2   2   2   2</td>
</tr>
<tr>
<td>CO4</td>
<td>Understand the principle mechanism and working of microbial fuel cells</td>
<td>3   2   2   1   -   3   3   -   -   -   2   2   2   2</td>
</tr>
<tr>
<td>CO5</td>
<td>Evaluating the materials used for microbial fuel cells design</td>
<td>3   2   2   1   -   3   3   -   -   -   2   2   2   2</td>
</tr>
<tr>
<td><strong>OVERALL CO</strong></td>
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<td>3   2   2   1   -   3   3   -   -   -   2   2   2   2</td>
</tr>
</tbody>
</table>

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

UNIT I OVERVIEW OF BIOFUELS

UNIT II BIODIESEL
Biodiesel – Microorganisms and raw materials used for microbial Oil production – Treatment of the feedstocks prior to production of the Biodiesel – Current technologies of biodiesel production – Purification of biodiesel; Industrial production of biodiesel – Biodiesel production from single cell oil.

UNIT III BIOETHANOL

UNIT IV BIOMETHANE AND BIOHYDROGEN

UNIT V OTHER BIOFUELS

TOTAL: 45 PERIODS

COURSE OUTCOME
CO1 Gain the knowledge on the various types of bio-fuel and its overview.
CO2 Apply the concepts involved in production techniques of biodiesel
CO3 Understanding the skill in manufacture the bioethanol
CO4 Understand the principle mechanism and production of biomethane and biohydrogen
CO5 Evaluating the various other fuels like biopropanol – bioglycerol and pyrolysis oil

TEXT BOOKS:

REFERENCES:
## Course Articulation Matrix: biofuels

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Gain the knowledge on the various types of bio-fuel and its overview.</td>
<td>PO1</td>
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<tr>
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<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>Apply the concepts involved in production techniques of biodiesel</td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>Understanding the skill in manufacture the bioethanol</td>
<td>3</td>
</tr>
<tr>
<td>CO4</td>
<td>Understand the principle mechanism and production of biomethane and biohydrogen</td>
<td>3</td>
</tr>
<tr>
<td>CO5</td>
<td>Evaluating the various other fuels like biopropanol – bioglycerol and pyrolysis oil</td>
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<td>Overall CO</td>
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<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.
OBJECTIVES:
- To understand the geographic distribution of unconventional hydrocarbon resources
- To understand characterization of source and reservoir rocks
- To understand methodology to produce these reserves
- To understand environmental consequences of producing these reserves
- Demonstrate awareness related to environmental issues involved in the development of non-conventional hydrocarbon resources.

UNIT I NON-CONVENTIONAL OIL
Continuous Accumulation System
Introduction, geology of Heavy oil, extra heavy oil, Tar Sand and bituminous, oil shales, their origin and occurrence worldwide, resources, reservoir characteristics, new production technologies.

UNIT II SHALE GAS/ OIL RESERVOIR
Introduction to shale gas & basin centered gas, tight reservoirs. Shale gas geology, important occurrences in India, petrophysical properties, Development of shale gas, design of hydro fracturing job, horizontal wells, production profiles.

UNIT III COAL BED METHANE
Formation and properties of coal bed methane. Thermodynamics of coal bed methane. Exploration and Evaluation of CBM. Hydro-fracturing of coal seam. Production installation and surface facilities. Well operations and production equipment.

UNIT IV GAS HYDRATES

UNIT V COAL AND GAS CONVERSION TO OIL
Introduction, classification and principles, pyrolysis, theoretical aspect of processes involved in conversion. Technological development of direct conversion and indirect processes and sustainability of conversions.

TOTAL:45 PERIODS

OUTCOMES:
At the end of the course, the student will be able to
- Recognise and apply the concept of continuous accumulation system.
- Apply the concepts related to exploration and development of Shale Gas Reservoirs.
- Apply the concepts related to exploration and development of Coal Bed Methane.
- Understand and apply the concepts related to formation of gas hydrates.
- Understand and apply different conversion processes for the production of Hydrocarbons.

REFERENCES:
5. Pramod Thakur, Steve Schatzel and KashyAminian, (Editors), 2014, Coal Bed Methane: From Prospects to Pipeline, Elsevier,
### Course Articulation Matrix: UNCONVENTIONAL HYDROCARBON SOURCES

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
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<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>
<th>PO 11</th>
<th>PO 12</th>
<th>PSO 1</th>
<th>PSO 2</th>
</tr>
</thead>
<tbody>
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<td>CO1</td>
<td>Recognize and apply the concept of continuous accumulation system</td>
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<td>CO2</td>
<td>Apply the concepts related to exploration and development of Shale Gas Reservoirs</td>
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<tr>
<td>CO3</td>
<td>Apply the concepts related to exploration and development of Coal Bed Methane</td>
<td>3</td>
<td>3</td>
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<tr>
<td>CO4</td>
<td>Understand and apply the concepts related to formation of gas hydrates</td>
<td>3</td>
<td>3</td>
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<tr>
<td>CO5</td>
<td>Understand and apply different conversion processes for the production of Hydrocarbons</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
CPE345  STORAGE TRANSPORTATION OF CRUDE OIL AND NATURAL GAS  L T P C
3 0 0 3

OBJECTIVE:
- To understand the natural gas regasification technology, crude oil transportation and to learn the concepts of storage.

UNIT I  INTRODUCTION
Crude oil Trade, Selection of Port Location, Ship Building/Shipyards.

UNIT II  NATURAL GAS REGASIFICATION TECHNOLOGY
Commercial Sourcing of Natural Gas, Different Kinds of Regasification Techniques, Regasification Process & Cold Utilization, Synchronization of Degasified gas and Pipelines, Current Status in India

UNIT III  CRUDE OIL TRANSPORTATION
Transportation techniques of crude oil, Pipeline specification, Corrosion Prevention techniques, Pressure drop, Pumps and Booster station, Wax deposition and prevention, Chemical treatment

UNIT IV  DESIGN
Basic Engineering Aspects of Terminal Design, Design of Liquefaction Train, Ship Building/Shipyards, Storage Facilities

UNIT V  CHARTERTICS OF STORAGE

TOTAL: 45 PERIODS

OUTCOME:
CO1: Students would be able to design various terminal design.
CO2: They will be familiarize with the storage systems.
CO3: Compute the Different Kinds of Regasification Techniques.
CO4: Evaluate the Pipeline specification, Corrosion Prevention techniques
CO5: To know about the Properties of Storage Reservoir, Rocks & Fluids
CO6:Regulate the Pressure- Content Hysteresis

TEXT BOOKS:
### Course Articulation Matrix: STORAGE TRANSPORTATION OF CRUDE OIL AND NATURAL GAS

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Students would be able to design various terminal design.</td>
<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO10  PO11  PO12  PSO1  PSO2</td>
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<td>3    3    3    2    2    1    1    -    1    1    1    2    2    2</td>
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<tr>
<td>CO2</td>
<td>They will be familiarize with the storage systems.</td>
<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO10  PO11  PO12  PSO1  PSO2</td>
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<td>3    3    3    2    2    1    1    -    1    1    1    2    2    2</td>
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<tr>
<td>CO3</td>
<td>Compute the Different Kinds of Regasification Techniques.</td>
<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO10  PO11  PO12  PSO1  PSO2</td>
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<td>3    3    3    2    2    1    1    -    1    1    1    2    2    2</td>
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<tr>
<td>CO4</td>
<td>Evaluate the Pipeline specification, Corrosion Prevention techniques</td>
<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO10  PO11  PO12  PSO1  PSO2</td>
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<td>3    3    3    1    1    1    1    -    1    1    1    2    2    2</td>
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<tr>
<td>CO5</td>
<td>To know about the Properties of Storage Reservoir, Rocks &amp; Fluids</td>
<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO10  PO11  PO12  PSO1  PSO2</td>
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<td>3    3    3    3    3    1    1    -    1    1    1    2    2    2</td>
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<tr>
<td>CO6</td>
<td>Regulate the Pressure-Content Hysteresis</td>
<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO10  PO11  PO12  PSO1  PSO2</td>
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<td>3    3    3    1    1    1    1    -    1    1    1    2    2    2</td>
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<td>PO1  PO2  PO3  PO4  PO5  PO6  PO7  PO8  PO9  PO10  PO11  PO12  PSO1  PSO2</td>
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<td>3    3    3    2    2    1    1    -    1    1    1    2    2    2</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE:
- To understand the basic quantitative theories and methodologist in oil sector.

UNIT I
Supply and demand curves, the elasticity of supply and demand, public finance concepts such as consumer surplus, excise and export taxes. Forecasting techniques for the energy industry, including energy prices. Demand and supply for natural gas, cured oil and pipeline transportation, determinants of energy demand, energy markets, energy pricing, stability and performance of energy markets.

UNIT II
The economics of investment, Discounted cash flow analysis, Cost Benefit Analyses, Internal Rate of Return, NPV, Profitability Index, Natural Monopoly theory, National competition Policy, Gas Market Regulation, taxation of the oil and gas industry, government policy and trade permits, Monte Carlo analysis, Net Back Pricing, Transfer Pricing and regulatory aspects.

UNIT III
Application of petroleum engineering principles and economics to the evaluation of oil and gas projects, evaluation principles, time value of money concepts, investment measures, cost estimation, price and production forecasting, risk and uncertainty, project selection and capital budgeting inflation, escalation, operating costs, depreciation, cost recovery.

UNIT IV
Petroleum exploration and production contracts. Sharing of the economic rent, portfolio management. Value creation, Corporate finance & return on capital, economic appraisal methods for oil filed development, reservoir model costs and calculations.

UNIT V
Case studies: Economic study of an oil filed development project, petrochemical plant project, natural gas break even price, natural gas liquefaction cost, LGN transport cost, investment profitability study for a gas pipeline.

TOTAL: 45 PERIODS

OUTCOME:
On the completion of the course students are expected to
CO1: Understand the concept of economics in a process plant, time value of money and cost indices.
CO2: Able to integrate knowledge about financial statements, Depreciation and Accounting.
CO3: Able develop economic balance for petroleum engineering equipment’s and determine the optimum cost for operation.
CO4: Understand the basics of principles of management, types of organization and MIS.
CO5: Understand the theory behind Work measurement technique, Production planning and elements of production control in petrochemical industry.
CO6: Understand the concept of inventory control and the role of control charts in quality control in oil and gas industry.

TEXT BOOKS:
REFERENCES:


# Course Articulation Matrix: PETROLEUM ECONOMICS

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
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<th>PO11</th>
<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand the concept of economics in a process plant, time value of money and cost indices.</td>
<td>3</td>
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</tr>
<tr>
<td>CO2</td>
<td>Able to integrate knowledge about financial statements, Depreciation and Accounting.</td>
<td>3</td>
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<tr>
<td>CO3</td>
<td>Able develop economic balance for petroleum engineering equipment’s and determine the optimum cost for operation.</td>
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<tr>
<td>CO4</td>
<td>Understand the basics of principles of management, types of organization and MIS.</td>
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<tr>
<td>CO5</td>
<td>Understand the theory behind Work measurement technique, Production planning and elements of production control in petrochemical industry</td>
<td>3</td>
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<tr>
<td>CO6</td>
<td>Understand the concept of inventory control and the role of control charts in quality control in oil and gas industry</td>
<td>3</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:
This course offers an insight into the design, operation and maintenance of pipes and piping networks.

UNIT I  PIPING FUNDAMENTALS:

UNIT II  PIPING IN PRACTICE:
Piping Network – Series and Parallel pipes, Pipe Network analysis using spreadsheets. piping for pumps and compressor

UNIT III  GENERIC PIPING DESIGNS:

UNIT IV  PIPING SYSTEMS:
Design considerations for piping systems – water and waste water, steam, compressed air, industrial gases, oil, refrigeration, solid and slurry systems

UNIT V  OPERATION AND MAINTENANCE:
Inspection of Pipelines – Testing techniques and leak detection. Maintenance – Cleaning, coating, freeze prevention, drag reduction, insulation, Common failures and repair techniques, Piping Plan development

TOTAL: 45 PERIODS

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

CO1: Apply the fundamental principles of fluid mechanics to solve fluid flow problems

CO2: Interpret the piping symbols and codes and sketch a piping layout for a given Problem.

CO3: Describe the concepts of generic piping design for optimal design of piping systems

CO4: Explain the process of design of various pipelines systems

CO5: Discuss the techniques involved in inspection and maintenance of pipelines

CO6: Explain various applications of pipes & pipeline systems in process industries

TEXT BOOKS

REFERENCES:
<table>
<thead>
<tr>
<th>Course Outcome</th>
<th>Statement</th>
<th>Piping Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>PO1</td>
</tr>
<tr>
<td>CO1</td>
<td>Apply the fundamental principles of fluid mechanics to solve fluid flow problems</td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>Interpret the piping symbols and codes and sketch a piping layout for a given Problem.</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>Describe the concepts of generic piping design for optimal design of piping systems</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>Explain the process of design of various pipeline systems</td>
<td>2</td>
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<tr>
<td>CO5</td>
<td>Discuss the techniques involved in inspection and maintenance of pipelines</td>
<td>2</td>
</tr>
<tr>
<td>CO6</td>
<td>Explain various applications of pipes &amp; pipeline systems in process industries</td>
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<tr>
<td><strong>Overall CO</strong></td>
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</table>
OBJECTIVES:

- The main objective is to present the industrial related problems, procedures and design.
- Principles for pressure vessels and enhance the understanding of design procedure of pressure vessel and supports.

UNIT I  DESIGN OF PIPE FITTINGS AND JOINTS  9
Stress-strain relationships of elastic materials subjected to tensile, compressive and shear forces; Membrane stresses in shells of revolutions; Theories of failures. Design and schematic of simple bolts and screws. Design and drawing of shafts and couplings.

UNIT II  DESIGN OF PRESSURE VESSELS  9
Unfired pressure vessel: Pressure vessel codes; Design of cylindrical and spherical shells under internal and external pressures; Selection and design of flat plate, tori spherical, ellipsoidal, and conical closures; Shell design of tall vertical vessels; Compensations of openings.

UNIT III  DESIGN OF STORAGE VESSELS  9
Liquid storage tanks: Storage tank codes; Classification; Design of shell, bottom plates, self-supported, and column supported roofs; Wind girder; Nozzles and other accessories.

UNIT IV  FABRICATION AND MATERIALS  9
Fabrication of equipment: Major fabrication steps; Vessel lining; Materials used in fabrication of Chemical Equipments. Vessel Coatings – selection and application. Selection of process equipment’s material. Material selection for process fluids.

UNIT V  DESIGN OF SUPPORTS FOR VESSELS  9

OUTCOME:

CO1: Students would be able to understand the principles Stress-strain relationships of elastic materials Design and drawing of shafts and couplings
CO2: Enhanced the knowledge on Design of cylindrical and spherical shells under internal and external pressures.
CO3: Study on Fundamental and Technological principled involved in design of storage vessels.
CO4: Understanding the principles involved in Material selection for process fluids.
CO5: Understanding the principles involved in piping layout and piping stress Analysis.
CO6: Skills on Fundamental and Technological principles involved design of pressure vessels and storage vessles

TOTAL: 45 PERIODS

TEXT BOOKS:

REFERENCES:
### Course Articulation Matrix: DESIGN OF PRESSURE VESSELS AND STORAGE VESSELS

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PROGRAM OUTCOME</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Students would be able to understand the principles Stress-strain relationships of elastic materials Design and drawing of shafts and couplings</td>
<td>PO1 3 PO2 3 PO3 2 PO4 2 PO5 3 PO6 1 PO7 - PO8 1 PO9 2 PO10 3 PO11 3 PSO1 3 PSO2 3</td>
</tr>
<tr>
<td>CO2</td>
<td>Enhanced the knowledge on Design of cylindrical and spherical shells under internal and external pressures.</td>
<td>PO1 3 PO2 3 PO3 2 PO4 3 PO5 3 PO6 1 PO7 - PO8 1 PO9 2 PO10 2 PO11 3 PSO1 3 PSO2 3</td>
</tr>
<tr>
<td>CO3</td>
<td>Study on Fundamental and Technological principled involved in design of storage vessels.</td>
<td>PO1 3 PO2 3 PO3 2 PO4 2 PO5 3 PO6 1 PO7 - PO8 1 PO9 2 PO10 1 PO11 3 PSO1 3 PSO2 3</td>
</tr>
<tr>
<td>CO4</td>
<td>Understanding the principles involved in Material selection for process fluids.</td>
<td>PO1 3 PO2 3 PO3 2 PO4 3 PO5 3 PO6 1 PO7 - PO8 1 PO9 2 PO10 1 PO11 3 PSO1 3 PSO2 3</td>
</tr>
<tr>
<td>CO5</td>
<td>Understanding the principles involved in piping layout and piping stress Analysis.</td>
<td>PO1 3 PO2 3 PO3 2 PO4 2 PO5 3 PO6 1 PO7 - PO8 1 PO9 3 PO10 2 PO11 3 PSO1 2 PSO2 3</td>
</tr>
<tr>
<td>CO6</td>
<td>Skills on Fundamental and Technological principles involved design of pressure vessels and storage vessels</td>
<td>PO1 3 PO2 3 PO3 2 PO4 3 PO5 3 PO6 1 PO7 - PO8 1 PO9 1 PO10 3 PSO1 3 PSO2 2</td>
</tr>
</tbody>
</table>

**OVERALL CO**

- 1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE:
- To understand the types of corrosion found in the petroleum industries. This course will provide the student with knowledge of the analytical methods needed to diagnose, treat, and monitor corrosion to reduce costs, protect the environment, and increase safety.

UNIT I
9

UNIT II
9

UNIT III
9
Role of oxygen in oil fielded corrosion- down hole and surface equipment - water flood. Removal of oxygen, analysis and criteria for control. Role of carbon dioxide (CO₂) in corrosion-Effect of temperature and pressure - Corrosion of well tubing and other equipments. Role of hydrogen sulphide (H₂S)-Corrosion in downhole, surface, storage and pipelines.

UNIT IV
9

UNIT V
9
Inspection and corrosion monitoring. Oil treatment corrosion - crude oil properties - desalting-sweetening processes. Corrosion in oil storage tank corrosion- oilfield and oil treating facilities-oil/ gas pipelines -offshore platforms- subsea systems.

TOTAL: 45 PERIODS

OUTCOME:
CO1 : Understand the basic concepts of corrosion and its impacts.
CO2 : Understand the various types of corrosion in in petroleum processes.
CO3 : Gain knowledge on removal techniques of various gases in pipelines applications.
CO4 : Understand the corrosion preventing methods.
CO5 : Design the offshore drilling structures based on project requirement.
CO6 : Evaluate the corrosion rate and propose the protection method based on environmental considerations.

TEXT BOOKS:

REFERENCE:
## Course Articulation Matrix:

<table>
<thead>
<tr>
<th>Course Outcome</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
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</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand the basic concepts of corrosion and its impacts.</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>-</td>
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<td>2</td>
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</tr>
<tr>
<td>CO2</td>
<td>Understand the various types of corrosion in petroleum processes.</td>
<td>2</td>
<td>2</td>
<td>2</td>
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<td>1</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>Gain knowledge on removal techniques of various gases in pipelines applications.</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
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<td>-</td>
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<td>-</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>Understand the corrosion preventing methods</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
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<td>-</td>
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<td>1</td>
<td>-</td>
<td>2</td>
<td>2</td>
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</tr>
<tr>
<td>CO5</td>
<td>Design the offshore drilling structures based on project requirement</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
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<td>1</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO6</td>
<td>Evaluate the corrosion rate and propose the protection method based on environmental considerations.</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>-</td>
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<td>1</td>
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<td>2</td>
<td>2</td>
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</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
- To understand about basic concepts behind the product design.
- To know the concept behind the selection and testing of the design.
- To learn about the product architecture.
- To know about the Industrial design.
- To understand the manufacturing design.

UNIT I INTRODUCTION
Strategic importance of Product development - integration of customer, designer, material supplier and process planner, Competitor and customer - behavior analysis. Understanding customer-promoting customer understanding-involve customer in development and managing requirements - Organization process management and improvement.

UNIT II CONCEPT GENERATION, SELECTION AND TESTING

UNIT III PRODUCT ARCHITECTURE
Product development management - establishing the architecture - creation - clustering - geometric layout development - Fundamental and incidental interactions - related system level design issues - secondary systems -architecture of the chunks - creating detailed interface specifications-Portfolio Architecture.

UNIT IV INDUSTRIAL DESIGN
Integrate process design - Managing costs - Robust design - Integrating CAE, CAD, CAM tools – Simulating product performance and manufacturing processes electronically – Need for industrial design-impact – design process - investigation of customer needs - conceptualization - refinement - management of the industrial design process.

UNIT V DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT
Definition - Estimation of Manufacturing cost-reducing the component costs and assembly costs – Minimize system complexity - Prototype basics - Principles of prototyping – Planning for prototypes - Economic Analysis.

COURSE OUTCOMES:
On completion of the course students are expected to
CO1: Know the basic concepts and importance of product design.
CO2: Understand the planning, selection criteria of the design and products.
CO3: Gain knowledge about the product management and architecture.
CO4: Understand the industrial design and tools for designs.
CO5: Understand the economic analysis of the design.

TEXT BOOK

REFERENCES
## Course Articulation Matrix: PRODUCT DESIGN AND DEVELOPMENT FOR PETROCHEMICAL ENGINEERS

<table>
<thead>
<tr>
<th>Course Outcome(s)</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
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<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Know the basic concepts and importance of product design.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
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<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>Understand the planning, selection criteria of the design and products.</td>
<td>3</td>
<td>3</td>
<td>3</td>
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<tr>
<td>CO3</td>
<td>Gain knowledge about the product management and architecture.</td>
<td>3</td>
<td>3</td>
<td>3</td>
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<tr>
<td>CO4</td>
<td>Understand the industrial design and tools for designs.</td>
<td>3</td>
<td>3</td>
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<td>3</td>
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<td>1</td>
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</tr>
<tr>
<td>CO5</td>
<td>Understand the economic analysis of the design.</td>
<td>3</td>
<td>3</td>
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</tr>
</tbody>
</table>

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

- To gain knowledge on BLEVE vapour cloud explosion.
- To learn about principles of fire extinguishers.
- To gain knowledge on industrial fire protection systems.
- To learn about the fire protection and fire safety equipment.
- To gain knowledge on explosive control.

UNIT I  PHYSICS AND CHEMISTRY OF FIRE  9


UNIT II  FIRE PREVENTION AND PROTECTION  9


UNIT III  INDUSTRIAL FIRE PROTECTION SYSTEMS  9


UNIT IV  BUILDING FIRE SAFETY  9

Objectives of fire safe building design, Fire load, fire resistant material and fire testing – structural fire protection – structural integrity – concept of egress design - exit – width calculations - fire certificates – fire safety requirements for high rise buildings.

UNIT V  EXPLOSION PROTECTING SYSTEMS  9

Principles of explosion-detonation and blast waves-explosion parameters – Explosion Protection, Containment, Flame Arrestors, isolation, suppression, venting, explosion relief of large enclosure-explosion venting-inert gases, plant for generation of inert gas rupture disc in process vessels and lines explosion, suppression system based on carbon dioxide (CO₂) and halons-hazards in LPG, ammonia (NH₃).

TOTAL: 45 PERIODS

OUTCOME

On successful completion of this course, the student will able to

CO1 To obtain knowledge on properties of fire and case studies related to fire

CO2 To make familiar about basic concepts of fire and explosion science.

CO3 To know the different source of ignition and their prevention techniques.

CO4 To understand the operation of various types of firefighting equipments.

CO5 To understand the causes and prevention of explosion.
CO6 To equip the students to effectively employ explosion protection techniques and their Significances to suit the industrial requirement.

REFERENCES:
Course Articulation Matrix: FIRE AND EXPLOSION CONTROL

| Course Outcome's | Statement                                                                 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|------------------|---------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1              | To obtain knowledge on properties of fire and case studies related to fire | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -   | -   | 1    | 3 | 2 |
| CO2              | To make familiar about basic concepts of fire and explosion science.       | 3   | 2   | -   | -   | -   | 3   | -   | -   | -   | -   | -   | 1    | 3 | 2 |
| CO3              | To know the different source of ignition and their prevention techniques.  | 2   | 2   | 1   | -   | 3   | -   | -   | -   | -   | -   | -   | 1    | 3 | 2 |
| CO4              | To understand the operation of various types of firefighting equipments.  | 2   | 2   | 2   | -   | -   | -   | -   | 3   | -   | -   | -   | 1    | 3 | 2 |
| CO5              | To understand the causes and prevention of explosion.                     | 1   | 1   | 1   | -   | -   | -   | -   | -   | 3   | -   | 1    | 3 | 2 |
| CO6              | To equip the students to effectively employ explosion protection techniques and their Significances to suit the industrial requirement. | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | 3    | 3 | 2 |
| Overall CO       |                                                                           | 2   | 2   | 1   | -   | 1   | 1   | -   | 1   | 1   | -   | 1    | 3 | 2 |

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVES:
- To understand the basic knowledge on anatomy of human organs and its basic functions.
- To enable the students to learn about various functions and activities of occupational health services.
- To enable students to compare the hazards with the permissible levels.
- To have knowledge about types of hazards arising out of physical, chemical and biological agents.

UNIT I  PHYSICAL HAZARDS
Noise, compensation aspects, noise exposure regulation, properties of sound, occupational damage, risk factors, sound measuring instruments, octave band analyzer, noise networks, noise surveys, noise control program, industrial audiometry, hearing conservation programs- vibration, types, effects, instruments, surveying procedure, permissible exposure limit. Ionizing radiation, types, effects, monitoring instruments, control programs, OSHA standard- nonionizing radiations, effects, types, radar hazards, microwaves and radio-waves, lasers, TLV- cold environments, hypothermia, wind chill index, control measures- hot environments, thermal comfort, heat stress indices, acclimatization, estimation and control.

UNIT II  CHEMICAL HAZARDS

UNIT III  BIOLOGICAL AND ERGONOMICAL HAZARDS
Classification of Biohazardous agents – examples, bacterial agents, rickettsial and chlamydial agents, viral agents, fungal, parasitic agents, infectious diseases - Biohazard control program, employee health program-laboratory safety program-animal care and handling-biological safety cabinets - building design. Work Related Musculoskeletal Disorders –carpal tunnel syndrome CTS- Tendon pain-disorders of the neck- back injuries.

UNIT IV  OCCUPATIONAL HEALTH AND TOXICOLOGY
Concept and spectrum of health - functional units and activities of occupational health services, preemployment and post-employment medical examinations - occupational related diseases, levels of prevention of diseases, notifiable occupational diseases such as silicosis, asbestosis, pneumoconiosis, siderosis, anthracosis, aluminosis and anthrax, lead-nickel, chromium and manganese toxicity, gas poisoning (such as CO, ammonia, coal and dust etc) their effects and prevention – cardio pulmonary resuscitation, audiometric tests, eye tests, vital function tests. Industrial toxicology, local, systemic and chronic effects, temporary and cumulative effects, carcinogens entry into human systems.

UNIT V  OCCUPATIONAL PHYSIOLOGY

TOTAL: 45 PERIODS
OUTCOMES:
The students will be able
CO1: To understand the various physiological functions of our body and the test methods for periodical monitoring of health.
CO2: Determine the physical hazard at workplace and suggest control measures.
CO3: Compute the chemical hazards at workplace with adequate mitigating actions.
CO4: Evaluate the biological and ergonomical hazards at workplace and associated risk factors.
CO5: Practice the occupational health strategies at workplace.
CO6: Regulate the man machine interface in the organization.

REFERENCES:
## Course Articulation Matrix: INDUSTRIAL HYGIENE

<table>
<thead>
<tr>
<th>Course Outcome’s</th>
<th>Statement</th>
<th>Program Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>PO1</td>
</tr>
<tr>
<td>CO1</td>
<td>To understand the various physiological functions of our body and the test methods for periodical monitoring of health.</td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>Determine the physical hazard at workplace and suggest control measures.</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>Compute the chemical hazards at workplace with adequate mitigating actions.</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>Evaluate the biological and ergonomical hazards at workplace and associated risk factors.</td>
<td>3</td>
</tr>
<tr>
<td>CO5</td>
<td>Practice the occupational health strategies at workplace.</td>
<td>2</td>
</tr>
<tr>
<td>CO6</td>
<td>Regulate the man machine interface in the organization.</td>
<td>-</td>
</tr>
<tr>
<td>Overall CO</td>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
OBJECTIVES:
- To provide the students about the various activities/steps to be followed in safe handling the hazardous goods transportation from one location to another location.
- To educate the reasons for the road accident and the roles and responsibilities of a safe Driver and the training needs of the driver.
- To inculcate the culture of safe driving and fuel conservation along with knowing of basic traffic symbols followed throughout the highways.
- To understand the accident reporting and investigation procedures
- To understand the various breaking characteristics of vehicle
- To provide an in depth knowledge about the safe driving safe driving movement of cranes-conveyors

UNIT I TRANSPORTATION OF HAZARDOUS GOODS
Transport emergency card (TREM) – driver training-parking of tankers on the highways-speed of the vehicle – warning symbols – design of the tanker lorries -static electricity-responsibilities of driver – inspection and maintenance of vehicles-check list- loading and decanting procedures – communication.

UNIT II ROAD TRANSPORT
Introduction – factors for improving safety on roads – causes of accidents due to drivers and pedestrians-design, selection, operation and maintenance of motor trucks-preventive maintenance check lists-motor vehicles act – motor vehicle insurance and surveys.

UNIT III DRIVER AND SAFETY
Driver safety programme – selection of drivers – driver training-tacho-graph-driving test-driver’s responsibility-accident reporting and investigation procedures-fleet accident frequency-safe driving incentives-slogans in driver cabin-motor vehicle transport workers act- driver relaxation and rest pauses – speed and fuel conservation – emergency planning and Haz mat codes

UNIT IV ROAD SAFETY

UNIT V SHOP FLOOR AND REPAIR SHOP SAFETY
Transport precautions-safety on manual, mechanical handling equipment operations-safe driving movement of cranes-conveyors etc., servicing and maintenance equipment-grease rack operation-wash rack operation- battery charging-gasoline handling-other safe practices-off the road motorized equipment.

OUTCOMES:
The students will be able to
CO1: Recognize various safety activities undertaken in transporting of hazardous goods
CO2: Understand the various symbols which are specific to the road safety and able to reduce the accidents occurred in the roads.
CO3: Apply for the safe transportation of hazardous goods, creating TREM card and safe loading and unloading procedure.
CO4: To understand the various types of – emergency planning and Haz mat codes
CO5: To understand the loading and unloading of moving cars
CO6: To equip the students to effectively manual, mechanical handling equipment operations
Significances to suit the industrial requirement

REFERENCES
3. K.W.Ogden, “Safer Roads – A guide to Road Safety Engineering”
## Course Articulation Matrix: TRANSPORTATION SAFETY

<table>
<thead>
<tr>
<th>Course Outcome's</th>
<th>Statement</th>
<th>Program Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>PO1</td>
</tr>
<tr>
<td>CO1</td>
<td>Recognize various safety activities undertaken in transporting of hazardous goods</td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>Understand the various symbols which are specific to the road safety and able to reduce the accidents occurred in the roads.</td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>Apply for the safe transportation of hazardous goods, creating TREM card and safe loading and unloading procedure.</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>To understand the various types of – emergency planning and Haz mat codes</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>To understand the loading and unloading of moving cars</td>
<td>1</td>
</tr>
<tr>
<td>CO6</td>
<td>To equip the students to effectively manual, mechanical handling equipment operations Significances to suit the industrial requirement</td>
<td>-</td>
</tr>
<tr>
<td>Overall CO</td>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>

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

- To gain knowledge on PHA, HAZOP studies.
- To learn about BAM testing and thermal analysis.
- To learn about HAZAN, FMEA, FET index.
- To gain knowledge on CPQRA, CAMEO.
- To learn about intermediate, risk on CPQRA.

UNIT I  HAZARD, RISK ISSUES AND HAZARD ASSESSMENT  9
Introduction, hazard, hazard monitoring-risk issue - Hazard assessment, procedure, methodology; safety audit, checklist analysis, what-if analysis, safety review, preliminary hazard analysis (PHA), hazard operability studies (HAZOP).

UNIT II  THERMAL AND MECHANICAL HAZARD ASSESSMENT  9
Applications of Advanced Equipment’s and Instruments, Thermo Calorimetry, Differential Scanning Calorimeter (DSC), Thermo Gravimetric Analyzer (TGA), Accelerated Rate Calorimeter (ARC), Principles of operations, Controlling parameters, Applications, advantages. Explosive Testing, Deflagration Test, Detonation Test, Ignition Test, Minimum ignition energy Test, Sensitiveness Test, Impact Sensitiveness Test (BAM) and Friction Sensitiveness Test (BAM), Shock Sensitiveness Test, Card Gap Test.

UNIT III  RISK QUANTIFICATION AND SOFTWARES  9
Fault Tree Analysis and Event Tree Analysis, Logic symbols, methodology, minimal cut set ranking - fire explosion and Index (FEI)-fire explosion and toxicity index (FETI), various indices - Hazard analysis (HAZAN)- Failure Mode and Effect Analysis (FMEA)

UNIT IV  CHEMICAL PROCESS QUANTITATIVE RISK ANALYSIS  9
CPQRA Definitions-components Techniques of CPQRA-Scope of CPQRA- Applications of CPQRA- Utilization of CPQRA results. Hazard identification based on the properties of chemicals-Chemical inventory analysis- identification of hazardous processes - Estimation of source term, Gas or vapour release, liquid release, two phase release- Heat radiation effects, BLEVE, Pool fires and Jet fire- Gas/vapour dispersion- Explosion, UVCE and Flash fire, Explosion effects and confined explosion- Toxic effects- Plotting the damage distances on plot plant/layout - Software CAMEO, ALOHA & MARPLOT.

UNIT V  APPLICATION OF CPQRA  9
Simple /consequence CPQRA Examples Characterization, application to a new process unit, application to an existing process unit. Intermediate/ Frequency CPQRA characterization-application to existing/new process units. Complex/risk CPQRA Characterization. Application to new or existing process Unit.
Case Studies of Flixborough, Bhopal, Texas, ONGC offshore, HPCL Vizag and Jaipur IOC oil-storage depot incident; Oil, natural gas, chlorine and ammonia storage and transportation hazards.

OUTCOMES:
On successful completion of this course, the students will be able to
- CO1: Understand the basics of hazard and hazard assessment.
- CO2: Know about the various advanced equipment and testing.
- CO3: Acquire software knowledge on risk analysis.
- CO4: Obtain knowledge on application of CPQRA.
- CO5: Analyze the risk associated with chemicals process.
- CO6: Obtain knowledge on chemical process quantitative risk analysis

TOTAL: 45 PERIODS
REFERENCE BOOKS:
## Course Articulation Matrix: PROCESS HAZARD ANALYSIS STUDIES

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand the basics of hazard and hazard assessment</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
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</tr>
<tr>
<td>CO2</td>
<td>Know about the various advanced equipment and testing.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
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<td>1</td>
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<td>1</td>
<td>2</td>
<td>2</td>
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</tr>
<tr>
<td>CO3</td>
<td>Acquire software knowledge on risk analysis.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
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</tr>
<tr>
<td>CO4</td>
<td>Obtain knowledge on application of CPQRA.</td>
<td>3</td>
<td>3</td>
<td>3</td>
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<td>1</td>
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<td>1</td>
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</tr>
<tr>
<td>CO5</td>
<td>Analyze the risk associated with chemicals process.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
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<tr>
<td>CO6</td>
<td>Obtain knowledge on chemical process quantitative risk analysis</td>
<td>3</td>
<td>3</td>
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</tr>
</tbody>
</table>

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

UNIT III  WORKPLACE SAFETY AND SAFETY SYSTEMS

UNIT IV  HAZARDS AND RISK MANAGEMENT

UNIT V  ENVIRONMENTAL HEALTH AND SAFETY MANAGEMENT

OUTCOMES:
After completion of this course, the student is expected to be able to:
CO1: Describe, with example, the common work-related diseases and accidents in occupational setting
CO2: Name essential members of the Occupational Health team
CO3: 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
CO4: Analyze the occupational safety and health is organization.
CO5: Obtain knowledge on accident investigation environmental health and safety management
CO6: Know about the concept of environmental health and safety management

REFERENCES:
1. Fundamentals of Industrial Safety and Health by Dr.K.U.Mistry, Siddharth Prakashan, 2012
2. Environmental and Health and Safety Management by Nicholas P. Cheremisinoff and Madelyn L. Graffia, William Andrew Inc. NY, 1995
### Course Articulation Matrix: HEALTH SAFETY AND ENVIRONMENTAL MANAGEMENT

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Describe, with example, the common work-related diseases and accidents in occupational setting</td>
<td>PO1 3 PO2 3 PO3 2 PO4 2 PO5 1 PO6 1 PO7 - PO8 1 PO9 1 PO10 1 PO11 1 PO12 2 PSO1 2 PSO2 2</td>
</tr>
<tr>
<td>CO2</td>
<td>Name essential members of the Occupational Health team</td>
<td>PO1 3 PO2 3 PO3 2 PO4 2 PO5 1 PO6 1 PO7 - PO8 1 PO9 1 PO10 1 PO11 1 PO12 2 PSO1 2 PSO2 2</td>
</tr>
<tr>
<td>CO3</td>
<td>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</td>
<td>PO1 3 PO2 3 PO3 2 PO4 2 PO5 1 PO6 1 PO7 - PO8 1 PO9 1 PO10 1 PO11 1 PO12 2 PSO1 2 PSO2 2</td>
</tr>
<tr>
<td>CO4</td>
<td>Analyze the occupational safety and health is organization.</td>
<td>PO1 3 PO2 3 PO3 1 PO4 1 PO5 1 PO6 1 PO7 - PO8 1 PO9 1 PO10 1 PO11 1 PO12 2 PSO1 2 PSO2 2</td>
</tr>
<tr>
<td>CO5</td>
<td>Obtain knowledge on accident investigation environmental health and safety management</td>
<td>PO1 3 PO2 3 PO3 1 PO4 1 PO5 1 PO6 1 PO7 - PO8 1 PO9 1 PO10 1 PO11 1 PO12 2 PSO1 2 PSO2 2</td>
</tr>
<tr>
<td>CO6</td>
<td>Know about the concept of environmental health and safety management</td>
<td>PO1 3 PO2 3 PO3 1 PO4 1 PO5 1 PO6 1 PO7 - PO8 1 PO9 1 PO10 1 PO11 1 PO12 2 PSO1 2 PSO2 2</td>
</tr>
<tr>
<td>Overall CO</td>
<td></td>
<td>PO1 3 PO2 3 PO3 2 PO4 2 PO5 1 PO6 1 PO7 - PO8 1 PO9 1 PO10 1 PO11 1 PO12 2 PSO1 2 PSO2 2</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVES
The course is aimed to
- To understand the need of safety in industries.
- To understand the safety regulations.
- To identify the hazards in the process plants.
- To Know about safety audit
- To understand the risk analysis techniques.

UNIT I NEED FOR SAFETY IN INDUSTRIES
Importance & objectives of safety- Safety Programmes – components and realization; Potential hazards – extreme operating conditions, toxic chemicals; safe handling

UNIT II PLANT SAFETY AND SAFETY REGULATION
Implementation of safety procedures – periodic inspection and replacement; Accidents - identification and prevention; Criteria for setting & layout of chemical plant, Factories Act and Safety Regulations.

UNIT III PLANT HAZARDS & RISK ANALYSIS
Fire hazards- Chemical hazards, Toxic hazards, Explosion hazards, Electrical hazards, Mechanical hazards, Radiation hazards, Noise hazards-Overall risk analysis--emergency planning-on site & off site emergency planning, risk management ISO 14000, EMS models case studies. Quantitative risk assessment - rapid and comprehensive risk analysis; Risk due to Radiation, explosion due to over pressure, jet fire-fire ball.

UNIT IV SAFETY AUDIT
Objective of safety audit- Hazard identification safety audits, checklist, what if analysis, vulnerability models event tree analysis fault tree analysis, Hazan past accident analysis Fixborough-Mexico-Madras-Vizag Bopal analysis

UNIT V RISK ANALYSIS TECHNIQUES
Hazard & Operability (HAZOP) studies-Hazard Analysis (HAZAN)-Fault Tree Analysis Consequence Analysis.

COURSE OUTCOMES:
On completion of the course students are expected to
CO1: Understand the importance of safety and its objectives.
CO2: Understand the implementation of safety and identification and prevention of Accidents.
CO3: Know about the types of hazards, emergency plan and ISO standards for safety studies.
CO4: Do the safety audit in plants.
CO5: Do the risk analysis in industries using the various techniques.

TEXT BOOKS
REFERENCES
### Course Articulation Matrix: PLANT SAFETY AND RISK MANAGEMENT

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
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<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
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</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand the importance of safety and its objectives</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
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<tr>
<td>CO2</td>
<td>Understand the implementation of safety and identification and prevention of Accidents</td>
<td>3</td>
<td>3</td>
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</tr>
<tr>
<td>CO3</td>
<td>Know about the types of hazards, emergency plan and ISO standards for safety studies</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
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<td>2</td>
<td>2</td>
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</tr>
<tr>
<td>CO4</td>
<td>Do the safety audit in plants.</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<td>2</td>
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<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>Do the risk analysis in industries using the various techniques</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
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</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
- Describe mass, momentum and energy transport at molecular, microscopic and macroscopic level to determine velocity, temperature and concentration profiles.

UNIT I  MOMENTUM TRANSPORT  9
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  9
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  9
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  9

UNIT V  TRANSPORT IN TURBULENT FLOWS AND ANALOGIES  9
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.

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.

TOTAL: 45 PERIODS
TEXT BOOKS:

REFERENCES:
Course Articulation Matrix: **TRANSPORT PHENOMENA**

<table>
<thead>
<tr>
<th>Cours e Outcom es</th>
<th>Statement</th>
<th>Program Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>PO1</td>
</tr>
<tr>
<td>CO1</td>
<td>Understand the mechanisms of momentum, heat and mass transfer each at molecular, micro and macro levels.</td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>Develop mathematical models to determine transfer fluxes and velocity, temperature and concentration distribution for flow channels, heat sources and systems involving diffusion and reactions.</td>
<td>3</td>
</tr>
<tr>
<td>CO3</td>
<td>Determine the interrelationship between the molecular, microscopic and macroscopic descriptions of transport processes and compare the various coordinate systems to formulate equations of change.</td>
<td>3</td>
</tr>
<tr>
<td>CO4</td>
<td>Apply the equation of change for different coordinate systems and solve of momentum, mass and heat transport problems.</td>
<td>3</td>
</tr>
<tr>
<td>CO5</td>
<td>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.</td>
<td>3</td>
</tr>
<tr>
<td>Overall CO</td>
<td></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.
UNIT I  INTRODUCTION AND FIRST PRINCIPLES  9

UNIT II  LUMPED SYSTEMS   9
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  9
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  9
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 ($R^2$)

UNIT V  SIMULATION OF BASIC MODELS  9
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.

TOTAL: 45 PERIODS

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
<table>
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<th>Statements</th>
<th>Program Outcomes</th>
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<td></td>
<td></td>
<td>PO 1</td>
</tr>
<tr>
<td>CO1</td>
<td>Understand the fundamentals of modeling and their applications to transport/energy equations, chemical and phase equilibria kinetics</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>Associate the model with constitutive relations such as phenomenological laws, rate equations, equations of state, property estimation methods</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>Create the mathematical models for different unit operations equipments</td>
<td>2</td>
</tr>
<tr>
<td>CO4</td>
<td>Analyze the principles of steady state/unsteady state lumped systems and steady state/ unsteady state distributed systems</td>
<td>2</td>
</tr>
<tr>
<td>CO5</td>
<td>Apply relevant solution methods for the mathematical models with relevant initial and/or boundary conditions</td>
<td>2</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 enable the students to compute molecular weight averages from the molecular weight distribution, Condensation polymerization and transition in polymers.

UNIT I INTRODUCTION


UNIT II ADDITION AND CONDENSATION POLYMERIZATION


UNIT III MOLECULAR WEIGHTS OF POLYMERS

Molecular weight of polymer: Number average and Weight average molecular weights – Degree of polymerization – molecular weight distribution – Polydispersity – Molecular weight determination.– Gel Permeation Chromatography, Osmometry and Light Scattering

UNIT IV GLASS TRANSITIONS TEMPERATURE

Glass transition Temperature: significance and experimental study – Melting Point of polymer - significance and experimental study – Relationship between Tg and Tm – Crystallinity in polymers – effect of crystallization– factors affecting crystallization - Polymer Density / Apparent Density, Viscosity measurements.

UNIT V PLASTICS PROCESS – MOLDING TECHNIQUES

Injection molding: Principle, Types and advantages - Blow molding: Principle, Types and advantages - Thermoforming: Principle, Types and advantages - Compression molding: Principle, Types and advantages - Extrusion : Principle, Types and advantages – Calendering : Principle, Types and advantages

COURSE OUTCOME:

CO1: Understand the fundamentals of Monomer, Polymer and its types.
CO2: Understand the addition and condensation polymerization mechanism.
CO3: Acquire knowledge on molecular weight and its significance
CO4: Acquire knowledge on glass transition temperature and melting point
CO5: Understand the concept of different molding techniques for different applications
CO6: Understand the manufacture of water soluble polymers and bio degradable polymers

TEXT BOOKS:


REFERENCES:

## Course Articulation Matrix: POLYMER TECHNOLOGY

<table>
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<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcome</th>
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<td>PO 1 PO 2 PO 3 PO 4 PO 5 PO 6 PO 7 PO 8 PO 9 PO 10 PO 11 PO 12 PSO 1 PSO 2</td>
</tr>
<tr>
<td>CO1</td>
<td>Understand the fundamentals of Monomer, Polymer and its types</td>
<td>3   1   1   1   -   -   -   -   -   -   -   -   -   2   2</td>
</tr>
<tr>
<td>CO2</td>
<td>Understand the addition and condensation polymerization mechanism</td>
<td>3   2   2   2   1   -   -   -   -   -   -   -   -   -   3   2   2</td>
</tr>
<tr>
<td>CO3</td>
<td>Acquire knowledge on molecular weight and its significance</td>
<td>3   3   2   1   3   3   1   -   -   -   -   -   -   -   1   2   2</td>
</tr>
<tr>
<td>CO4</td>
<td>Acquire knowledge on glass transition temperature and melting point</td>
<td>3   2   2   1   3   2   1   -   -   -   -   -   -   -   1   2   2</td>
</tr>
<tr>
<td>CO5</td>
<td>Understand the concept of different moulding techniques for different applications</td>
<td>2   3   2   2   3   3   2   -   -   -   -   -   -   -   3   2   2</td>
</tr>
<tr>
<td>CO6</td>
<td>Understand the manufacture of water soluble polymers and bio degradable polymers</td>
<td>3   2   2   2   1   -   2   -   -   2   -   2   2   2</td>
</tr>
<tr>
<td></td>
<td><strong>Overall CO</strong></td>
<td>3   2   2   2   2   1   1   -   -   -   -   -   -   2   2   2</td>
</tr>
</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
OBJECTIVE:
- To enable the students to learn the design aspects of fluidized beds.

UNIT I BASICS OF FLUIDIZATION
Packed bed – Velocity – Pressure drop relations – Correlations of Ergun, Kozney karman – On set of fluidization – Properties of fluidized beds – Development of fluidization from fixed bed.

UNIT II FLUIDIZED BED TYPES

UNIT III DESIGN ASPECTS

UNIT IV HEAT AND MASS TRANSFER IN FLUIDIZED BEDS
Heat and mass transfer in fluidized bed systems – Industrial applications and case studies of fluidized bed systems.

UNIT V OTHER TYPES OF FLUIDIZATION
Single stage and multistage fluidization – Collection of fines – Use of cyclones.

TOTAL: 45 PERIODS

OUTCOME:
CO1: Understand the basics and governing equations of fluidization
CO2: Understand the fluidization conditions/behaviours as well as types of fluidization
CO3: Analyse and apply design concepts for designing the fluidization systems.
CO4: Understand heat and mass transfer concepts & case studies in fluidization.
CO5: Understand the various accessories used & stages of fluidization.
CO6: Knowledge on industrial applications of fluidization systems.

TEXT BOOKS:

REFERENCES:
<table>
<thead>
<tr>
<th>Course Outcome</th>
<th>Statement</th>
<th>CO1</th>
<th>CO2</th>
<th>CO3</th>
<th>CO4</th>
<th>CO5</th>
<th>CO6</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Understand the basics and governing equations of fluidization</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>3</td>
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<td>-</td>
</tr>
<tr>
<td>CO2</td>
<td>Understand the fluidization conditions/behaviours as well as types of fluidization</td>
<td>2</td>
<td>1</td>
<td>-</td>
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<td>2</td>
<td>-</td>
</tr>
<tr>
<td>CO3</td>
<td>Analyse and apply design concepts for designing the fluidization systems.</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>CO4</td>
<td>Understand heat and mass transfer concepts &amp; case studies in fluidization.</td>
<td>2</td>
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178
OBJECTIVE:

- To focus on the wastewater transport system, theory and design technique for the waste water treatment process

UNIT I  INTERNAL TREATMENT PROCESS  9

UNIT II  EXTERNAL TREATMENT PROCESS  9

UNIT III  BOILER WATER AND COOLING WATER  9

UNIT IV  WASTE WATER TREATMENT  9

UNIT V  WATER MANAGEMENT IN INDIA  9

TOTAL: 45 PERIODS

OUTCOME:
On completion of the course, the students will be able to
1. Acquire the basic knowledge on physical and chemical unit operations in water treatment
2. Understand the concepts of external treatment process
3. Explain the importance of boiler and cooling water in industries
4. understand the theory, engineering application, and design technique for the wastewater treatment unit process.
5. Acquire knowledge on conservation of water
6. Understand the need for advanced technologies in water treatment

TEXT BOOKS:

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OBJECTIVES

- This course will able to help the students to be aware of various measurement system used in chemical & petrochemical industries to measure process variables.

UNIT I  PRINCIPLES OF MEASUREMENT:  9

UNIT II  TEMPERATURE MEASUREMENT:  9

UNIT III PRESSURE MEASUREMENT:  9
Principles of Pressure Measurement: Manometers - Bourdon tube - Bellows - Diaphragms - Capacitive pressure sensor - Fibre-optic pressure sensors - Resonant-wire devices - Dead-weight gauge - Special measurement devices for low pressures measurement - Selection of pressure sensors.

UNIT IV FLOW AND VISCOSITY MEASUREMENT:  9

UNIT V LEVEL MEASUREMENT:  9

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

CO1: Discuss the type, performance characteristics and error generation of measurement
CO2: Explain temperature measurement device applied in chemical industries
CO3: Describe various range of pressure measuring system used in process industries
CO4: Illustrate flow and viscosity measurement techniques related to production industries
CO5: Elaborate level measurement tool adopted in industries
CO6: Select suitable measurement instruments required in chemical & petrochemical industries based on learning

TOTAL: 45 PERIODS

TEXT BOOKS

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<td>Discuss the type, performance characteristics and error generation of measurement elements</td>
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<td>Understand &amp; Explain temperature measurement device applied in chemical industries</td>
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<td>Describe various range of pressure measuring system used in process industries.</td>
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**PROGRESS THROUGH KNOWLEDGE**

182
GE3751 PRINCIPLES OF MANAGEMENT

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 9

UNIT II PLANNING 9

UNIT III ORGANISING 9

UNIT IV DIRECTING 9

UNIT V CONTROLLING 9
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.

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GE3752 TOTAL QUALITY MANAGEMENT

UNIT I INTRODUCTION 9
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 9

UNIT III TQM TOOLS & TECHNIQUES I 9

UNIT IV TQM TOOLS & TECHNIQUES II 9
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 9
Introduction - Benefits of ISO Registration-ISO 9000 Series of Standards-Sector-Specific

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 andFMEA.
CO4: Ability to understand Taguchi's Quality Loss Function, Performance Measures and applyQFD, TPM, COQ and BPR.
CO5: Ability to apply QMS and EMS in any organization.

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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.

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

MAPPING OF COS AND POS:

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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

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

TOTAL: 45 PERIODS

TEXT BOOKS:

REFERENCES:

CO’s- PO’s & PSO’s MAPPING

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GE3755 KNOWLEDGE MANAGEMENT

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 acquire 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.

CO’s- PO’s & PSO’s MAPPING

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TEXT BOOK:

REFERENCE:

GE3792 INDUSTRIAL MANAGEMENT L T P C 3 0 0 3

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 9
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 9
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 9
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 9
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.

TEXTBOOKS:
1 M. Govindarajan and S. Natarajan, “Principles of Management”, Prentice Hall of India,
New Delhi, 2009.

REFERENCES:

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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.
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:

TOTAL : 45 PERIODS

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.

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**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) 9
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 9
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 9

UNIT V DISASTER MANAGEMENT: CASE STUDIES 9
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

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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**

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<td>• To adapt a few lifestyle changes that will prevent many health disorders</td>
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<td>• To be cool and handbill every emotion very smoothly in every walk of life</td>
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<td>• To learn to eat cost effective but healthy foods that are rich in essential nutrients</td>
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<td>• To develop immunity naturally that will improve resistance against many health disorders</td>
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**UNIT I HEALTH AND ITS IMPORTANCE**

**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 heath.


**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  
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  
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 - Panchekaran 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  
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:
1. WHAT WE KNOW ABOUT EMOTIONAL INTELLIGENCE How It Affects Learning, Work,
Relationships, and Our Mental Health, by Moshe Zeidner, Gerald Matthews, and Richard D.
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%20c
ook.
3. Read more: https://www.legit.ng/1163909-classes-food-examples-functions.html
5. Benefits of healthy eating https://www.cdc.gov/nutrition/resources-publications/benefits-
of-healthy-eating.html
additives
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
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 versus 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)
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>Home Assign</td>
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<tr>
<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.
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?

TOTAL : 45 PERIODS

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:
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 Limit Value (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

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statement</th>
<th>Program Outcome</th>
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<tbody>
<tr>
<td>CO1</td>
<td>Understand the basic concept of safety.</td>
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<td>CO2</td>
<td>Obtain knowledge of Statutory Regulations and standards.</td>
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<tr>
<td>CO3</td>
<td>Know about the safety Activities of the Working Place.</td>
<td>PO 2 2 2 2 1 2 2 2 3 2 1 2 3 3 3</td>
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<tr>
<td>CO4</td>
<td>Analyze on the impact of Occupational Exposures and their Remedies.</td>
<td>PO 3 3 3 2 2 3 3 3 2 1 3 3 3 3</td>
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<tr>
<td>CO5</td>
<td>Obtain knowledge of Risk Assessment Techniques.</td>
<td>PO 3 2 3 2 2 3 2 3 2 2 3 3 3 3</td>
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<td>Industrial safety</td>
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OPEN ELECTIVE I AND II

OCS351 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING FUNDAMENTALS

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 : 60 PERIODS

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

TOTAL: 30 PERIODS
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: 60 PERIODS

TEXTBOOKS

REFERENCES
1. Perry Lea, “Internet of things for architects”, Packt, 2018

OCS353 DATA SCIENCE FUNDAMENTALS

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
Importing Matplotlib - Simple line plots - Simple scatter plots - visualizing errors - density and contour plots - Histograms - legends - colors - subplots - text and annotation - customization - three dimensional plotting - Geographic Data with Basemap - Visualization with Seaborn

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.

30 PERIODS

PRACTICAL EXERCISES:
30 PERIODS

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.
TEXT BOOKS

REFERENCES

CCS333 AUGMENTED REALITY/VIRTUAL REALITY

L T P C
2 0 2 3

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

<table>
<thead>
<tr>
<th>CO’s</th>
<th>PO’s</th>
<th>PSO’s</th>
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TOTAL: 60 PERIODS
OPEN ELECTIVE 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

TOTAL: 45 PERIODS

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

**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:**

**REFERENCEBOOKS:**

**Websites**
http://civilservicesmentor.com/, http://www.educationobserver.com
http://www.cambridgeenglish.org/in/

**OCE353 LEAN CONCEPTS, TOOLS AND PRACTICES**

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**OBJECTIVE:**
- To impart knowledge about the basics of lean principles, tools and techniques, and implementation in the construction industry.

**UNIT I INTRODUCTION**
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

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.

TOTAL : 45 PERIODS

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:
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
- 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
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
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
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
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

TOTAL : 45 PERIODS

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
- CO3 present strategies for NGOs in attaining sustainable development
- CO4 recognize the importance of providing energy, food security and health equity to all members of the society without damaging the environment
- CO5 understand the environmental legislations

REFERENCE BOOKS

OMG353 DEMOCRACY AND GOOD GOVERNANCE L T P C
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 (9)
UNIT-II Regulatory Institutions – SEBI, TRAI, Competition Commission of India (9)
UNIT-III Lobbying Institutions: Chambers of Commerce and Industries, Trade Unions, Farmers Associations, etc. (9)
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 (9)
UNIT-V Dynamics of Civil Society: New Social Movements, Role of NGO’s, Understanding the political significance of Media and Popular Culture. (9)

REFERENCES:
4. Saima Saeed: Screening the Public Sphere: Media and Democracy in India, 2013

CME365 RENEWABLE ENERGY TECHNOLOGIES L T P C
UNIT – I ENERGY SCENARIO 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.

TOTAL 45 : PERIODS
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:
OBJECTIVES:
The course aims to
- Introduce tools & techniques of design thinking for innovative product
- 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
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
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
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
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
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

TOTAL: 45 PERIODS
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
4. https://blog.forward.in/evaluating-product-innovations-e8178e58b86e
5. https://blog.forward.in/user-guide-for-product-innovation-rubric-857181b253dd
6. https://blog.forward.in/star-up-failure-is-like-true-lie-7812c8efb85

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

UNIT II MATERIAL CHARACTERISTICS AND PROCESS IDENTIFICATION

UNIT III DATA PROCESSING

UNIT IV 3D SCANNING AND MODELLING

UNIT V  INDUSTRIAL APPLICATIONS

TOTAL : 45 PERIODS

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

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  9
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  9
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  9
Concepts of competitive strategy and manufacturing strategies and development of a strategic
improvement programme - Manufacturing strategy in business success strategy formulation 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  9
Principles of sustainable operations - Life cycle assessment manufacturing and service activities -
influence of product design on operations - Process analysis – Capacity management - Quality
management -Inventory management - Just-In-Time systems - Resource efficient design -
Consumerism and sustainable well-being.

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.

TEXT BOOKS:
1. Ibrahim Garbie, “Sustainability in Manufacturing Enterprises Concepts, Analyses and
   Assessments for Industry 4.0”, Springer International Publishing., United States, 2016,
   978-1-84821212-1.

REFERENCES:
   Competitive and Sustainable High-Adding-Value Manufacturing”, Springer,2009, United
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AU3791 ELECTRIC AND HYBRID VEHICLES L T P C 3 0 0 3

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 9

UNIT II ENERGY SOURCES 9

UNIT III MOTORS AND DRIVES 9
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 9
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 9
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.

TOTAL: 45 PERIODS

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:

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OAS352   SPACE ENGINEERING   L T P C

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 - Newton’s 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

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

UNIT II FUNCTIONS OF MANAGEMENT

UNIT III ORGANIZATIONAL BEHAVIOUR
UNIT IV  GROUPDYNAMICS

UNIT V  MODERN CONCEPTS
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

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

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TOTAL: 45 PERIODS

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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  CONTROLCHARTS
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   9
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   9
Process stability, process capability analysis using a Histogram or probability plots and control chart. Gauge capability studies, setting specification limits.

UNIT V   ACCEPTANCESAMPLING   9
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 products 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.

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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**  
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**  
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**  
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**  

**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:**
OML351 INTRODUCTION TO NON-DESTRUCTIVE TESTING

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 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 fibroscopes – 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  
9  
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:

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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

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

ORA351 FOUNDATION OF ROBOTICS L T P C
3 0 0 3

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

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
UNIT – IV  SENSORS IN ROBOTICS

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

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.

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1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS:

REFERENCES:
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  8
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  10
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  9

UNIT IV  BASICS OF AIRCRAFT STRUCTURES  9

UNIT V  BASICS OF PROPULSION  9
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.

TOTAL : 45 PERIODS

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
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

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

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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<td>Critical analysis of Geoinformatics Engineering problems and innovations</td>
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<td>Conceptualization and evaluation of Design solutions</td>
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OAI351 URBAN AGRICULTURE L T P C

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
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
UNIT III SOIL LESS CULTIVATION
Hydroponics, aeroponics, aquaponics: merits and limitations, costs and Challenges, backyard gardens- tactical gardens- street landscaping- forest gardening, greenhouses, urban beekeeping

UNIT IV MODERN CONCEPTS
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
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:

CO-PO MAPPING

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<td>To enhance students ability to formulate solutions to real-world problems pertaining to sustained agricultural productivity using modern technologies.</td>
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<td>To inculcate entrepreneurial skills through strong Industry-Institution linkage.</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 spilt 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:

OEI353  INTRODUCTION TO PLC PROGRAMMING  L T P C 3 0 0 3

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  9
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  9
UNIT III  PLC PROGRAMMING  9
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  9
Communication Protocol – Modbus, HART, Profibus- Communication facilities SCADA: - Hardware and software, Remote terminal units, Master Station and Communication architectures

UNIT V  CASE STUDIES  9
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)  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)
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
3. https://www.etf.ues.rs.ba/~slubura/Procesni%20racunari/Programmable%20Logic%20Contr
ollers%20Programming%20Methods.pdf
MAPPING COURSE OUTCOMES WITH PROGRAMME OUTCOMES

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OFT352 TRADITIONAL INDIAN FOODS

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
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

UNIT III TRADITIONAL FOOD PATTERNS
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:
CO1 To 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 L T P C
3 0 0 3

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 9
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 9
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 12
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 6
Waste disposal-solid and liquid waste; rodent and insect control; use of pesticides; ETP; selecting and installing necessary equipment.

UNIT V FOOD HYGIENE 9
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.

COURSE OUTCOMES:

TOTAL: 45 PERIODS

238
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

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

COURSE OUTCOME
The student will be able to
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OTT351   BASICS OF TEXTILE FINISHING         L T P C
                                                    3 0 0 3

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
9
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 9

UNIT IV
MECHANICAL FINISHES 9

UNIT V
STIFFENING AND SOFTENING 9
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.

TOTAL: 45 PERIODS

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.

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 9
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:

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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

**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  

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
UNIT I  INTRODUCTION
General definition and size effects–important nano structured materials and nano particles - importance of nano materials - Size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties of nanomaterials - surface area - band gap energy and applications. Photochemistry and Electrochemistry of nanomaterials –Ionic properties of nanomaterials- Nano catalysis.

UNIT II  SYNTHESIS OF NANOMATERIALS
Bottom up and Top-down approach for obtaining nano materials - Precipitation methods – sol gel technique – high energy ball milling, CVD and PVD methods, gas phase condensation, magnetron sputtering and laser deposition methods – laser ablation, sputtering.

UNIT III  NANO COMPOSITES
Definition- importance of nanocomposites- nano composite materials-classification of composites- metal/metal oxides, metal-polymer- thermoplastic based, thermoset based and elastomer based-influence of size, shape and role of interface in composites applications.

UNIT IV  NANO STRUCTURES AND CHARACTERIZATION TECHNIQUES
Classifications of nanomaterials - Zero dimensional, one-dimensional and two-dimensional nanostructures- Kinetics in nanostructured materials- multilayer thin films and superlattice-clusters of metals, semiconductors and nanocomposites. Spectroscopic techniques, Diffraction methods, thermal analysis method, BET analysis method.

UNIT V  APPLICATIONS OF NANO MATERIALS
Overview of nanomaterials properties and their applications, nano painting, nano coating, nanomaterials for renewable energy, Molecular Electronics and Nanoelectronics – Nanobots-Biological Applications. Emerging technologies for environmental applications- Practice of nanoparticles for environmental remediation and water treatment.

TOTAL : 45 PERIODS

OUTCOMES:
CO1 - understand the basic properties such as structural, physical, chemical properties of nanomaterials and their applications.
CO2 – able to acquire knowledge about the different types of nano material synthesis
CO3 – describes about the shape, size,structure of composite nano materials and their interference
CO4 – understand the different characterization techniques for nanomaterials
CO5 - develop a deeper knowledge in the application of nanomaterials in different fields.

TEXT BOOKS

REFERENCES

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<td>understand the basic properties such as structural, physical, chemical properties of nanomaterials and their applications</td>
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<td>CO2</td>
<td>acquire knowledge about the different types of nano material synthesis</td>
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<td>CO3</td>
<td>describes about the shape, size, structure of composite nano materials and their interference</td>
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<td>CO4</td>
<td>understand the different characterization techniques for nanomaterials</td>
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<td>develop a deeper knowledge in the application of nanomaterials in different fields</td>
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OCH352 FUNCTIONAL MATERIALS

OBJECTIVE:
- The course emphasis on the molecular safe assembly and materials for polymer electronics

UNIT I INTRODUCTION

UNIT II MOLECULAR SELF ASSEMBLY
UNIT III     BIO-INSPIRED MATERIALS


UNIT IV     SMART OR INTELLIGENT MATERIALS

Criteria for Smartness, Significance of Smart Materials, Representative Examples like Smart Gels and Polymers, Electro/Magneto Rheological Fluids, Smart Electroceramics, Technical Limitations and Challenges, Functional Nanocomposites, Polymer-carbon nanotube composites.

UNIT V     MATERIALS FOR POLYMER ELECTRONICS

Polymers for Electronics, Organic Light Emitting Diodes, Working Principle of OLEDs, Illustrated Examples, Organic Field-Effect Transistors Operating Principle, Design Considerations, Polymer FETs vs Inorganic FETs, Liquid Crystal Displays, Engineering Aspects of Flat Panel Displays, Intelligent Polymers for Data Storage, Polymer-based Data Storage-Principle, Magnetic Vs. Polymer-based Data Storage.

OUTCOME:

- Students will be able to differentiate among various functional properties and select appropriate material for certain functional applications, analyze the nature and potential of functional material.

TEXT BOOK:


REFERENCE:


OPT351     BASICS OF PLASTICS PROCESSING

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

UNIT II EXTRUSION

UNIT III INJECTION MOLDING
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
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

TOTAL : 45 PERIODS

COURSE OUTCOMES
- Ability to find out the correlation between various processing techniques with product properties.
- 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 L T P C 3 0 0 3

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 9
Standard signals- Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids._Classification of signals – Continuous time (CT) and Discrete Time (DT) signals, Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals - Classification of systems- CT systems and DT systems- – Linear & Nonlinear, Time-variant& Time-invariant,Causal & Non-causal, Stable & Unstable.

UNIT II ANALYSIS OF CONTINUOUS TIME SIGNALS 9
Fourier series for periodic signals - Fourier Transform – properties- Laplace Transforms and Properties

UNIT III LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS 9

UNIT IV ANALYSIS OF DISCRETE TIME SIGNALS 9
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

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OEC352 FUNDAMENTALS OF ELECTRONIC DEVICES AND CIRCUITS

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
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
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
Cascode 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.

TEXT BOOKS:

REFERENCES:

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CBM348 FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT L T P C 3 0 0 3

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

UNIT III DESIGN AND TESTING

UNIT IV SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT

UNIT V BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY

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:
4. Mark S Sanders and Ernest J McCormick, "Human Factors in Engineering and
CO's- PO's & PSO's MAPPING

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CBM333 ASSISTIVE TECHNOLOGY 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
Cardiac functions and parameters, principle of External counter pulsation techniques, intra aortic balloon pump, auxiliary ventricle and schematic for temporary bypass of left ventricle, prosthetic heart valves, cardiac pacemaker.

UNIT II HEMODIALYSERS
Physiology of kidney, Artificial kidney, Dialysis action, hemodialyser unit, membrane dialysis, portable dialyser monitoring and functional parameters.

UNIT III HEARING AIDS
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
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
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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OPS352 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

UNIT V NON-LINEAR PROGRAMMING PROBLEMS

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.

TEXT BOOKS:

REFERENCES:
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 - 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.

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OMA354 LINEAR ALGEBRA

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

TOTAL : 45 PERIODS

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

| PO | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | PS | O1 | O2 | O3 |
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OBT352 BASICS OF MICROBIAL TECHNOLOGY

COURSE OBJECTIVE:
- Enable the Non-biological student’s to understand about the basics of life science and their pro and cons for living organisms.

UNIT I BASICS OF MICROBES AND ITS TYPES
Introduction to microbes, existence of microbes, inventions of great scientist and history, types of microorganisms – Bacteria, Virus, Fungi.

UNIT II MICROBIAL TECHNIQUES
Sterilization – types – physical and chemical sterilization, Decontamination, Preservation methods, fermentation, Cultivation and growth of microbes, Diagnostic methods.

UNIT III PATHOGENIC MICROBES
Infectious Disease – Awareness, Causative agent, Prevention and control - Cholera, Dengue, 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

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

OBT353  BASICS OF BIOMOLECULES  L T P C
3 0 0 3

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  9
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  9
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  9

UNIT IV  NUCLEIC ACIDS  9
Introduction to nucleic acid, Difference between nucleotide and nucleoside, composition of DNA & 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


TOTAL: 45 PERIODS

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


OBT354  FUNDAMENTALS OF CELL AND MOLECULAR BIOLOGY

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, Comparison of meiosis 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.

REFERENCES

OCE354 BASICS OF INTEGRATED WATER RESOURCES MANAGEMENT L T P C
3 0 0 3

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).
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  9

UNIT II   INTERPOLATION  9
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  9

UNIT IV   FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS  9
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  9

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.

TEXT BOOKS:

REFERENCES:
Cengage Learning, New Delhi, 2016.

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OMA356  RANDOM PROCESSES  L T P C  3 0 0 3

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 9

UNIT II  RANDOM PROCESSES 9

UNIT III  SPECIAL RANDOM PROCESSES 9

UNIT IV  CORRELATION AND SPECTRAL DENSITIES 9

UNIT V  LINEAR SYSTEMS WITH RANDOM INPUTS 9
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.

TEXT BOOKS

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OMA357 QUEUEING AND RELIABILITY MODELLING

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  9
Classification – Stationary process – Markov process - Poisson process – Discrete parameter

UNIT II  MARKOVIAN QUEUEING MODELS  9
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  9
M/G/1 queue – Pollaczek Khinchin formula - M/D/1 and M/Ek/1 as special cases –  Series
queues – Open Jackson networks.

UNIT IV  SYSTEM RELIABILITY  9
Reliability and hazard functions- Exponential, Normal, Weibull and Gamma failure distribution –

UNIT V  MAINTAINABILITY AND AVAILABILITY  9
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
   Delhi, 2010.

REFERENCES
3. Trivedi, K.S., ”Probability and Statistics with Reliability, Queueing and Computer Science
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

TOTAL 45 : PERIODS

COURSE 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
- Univariate, 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.

TOTAL: 45 PERIODS

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.

TOTAL: 45 PERIODS

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 L T P C
3 0 0 3

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 9

UNIT – II MATERIAL SPECIFICATIONS, ANALYSIS & PROCESS 9
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
New product qualification for Dimensions, Mechanical & Physical Properties, Internal Soundness proving through X-Ray, Radiography, Ultrasonic Testing, MPT, etc. Agreement with customer for testing frequencies. Market Survey on similar products, Risk analysis, validating samples with simulation results, Lesson Learned & Horizontal deployment in 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.)

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)
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

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
## MF3010 MICRO AND PRECISION ENGINEERING

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<td>• Learn about the precision machine tools</td>
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<tr>
<td>• Learn about the macro and micro components.</td>
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<td>• Understand handling and operating of the precision machine tools.</td>
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<td>• Learn to work with miniature models of existing machine tools/robots and other instruments.</td>
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<td>• Learn metrology for micro system</td>
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### UNIT I INTRODUCTION TO MICROSYSTEMS

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:


### UNIT III INTRODUCTION TO PRECISION ENGINEERING

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

Precision machining processes for macro components - Diamond turning, fixed and free abrasive processes, finishing processes.

### UNIT V METROLOGY FOR MICRO SYSTEMS

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:

1. Davim, J. Paulo, ed. Microfabrication and Precision Engineering: Research and
OMF354  COST MANAGEMENT OF ENGINEERING PROJECTS  LT 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 nontechnical 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.

REFERENCES:
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:

AU3002 BATTERIES AND MANAGEMENT SYSTEM L T P
C 3 0 0 3

COURSE OBJECTIVES:
The objective of this course is to make the students understand the working and characteristics of different types of batteries and their management.

UNIT I ADVANCED BATTERIES
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
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
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

UNIT V BMS ARCHITECTURE AND REAL TIME COMPONENTS
Battery Management System- need, operation, classification. BMS ASIC-bq76PL536A-Q1 Battery Monitor IC- CC2662R-Q1 Wireless BMS MCU. Communication Modules- CAN Open-Flex Ray-
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  9

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.

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 these sensors, actuators and electronic control.
5. Design temperature control actuators for vehicles.

TEXT BOOKS:

REFERENCES:

OAS353  SPACE VEHICLES  L T P C
3 0 0 3

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.

OIM352  MANAGEMENT SCIENCE  L T P C  3 0 0 3

COURSE OBJECTIVES:
Of this course are
- To introduce fundamental concepts of management and organization to students.
- To impart knowledge to students on various aspects of marketing, quality control and marketing strategies.
- To make students familiarize with the concepts of human resources management.
- To acquaint students with the concepts of project management and cost analysis.
- To make students familiarize with the concepts of planning process and business strategies.

UNIT I  INTRODUCTION TO MANAGEMENT AND ORGANISATION  9

UNIT II  OPERATIONS AND MARKETING MANAGEMENT  9
Principles and Types of Plant Layout-Methods of Production(Job, batch and Mass Production), Work Study - Basic procedure involved in Method Study and Work Measurement - Business Process Reengineering(BPR)- Statistical Quality Control: control charts for variables and attributes (simple Problems) and Acceptance Sampling, Objectives of Inventory control, EOQ, ABC Analysis, Purchase Procedure, Stores

UNIT III HUMAN RESOURCES MANAGEMENT

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.

UNIT IV PROJECT MANAGEMENT

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).

UNIT V STRATEGIC MANAGEMENT AND CONTEMPORARY STRATEGIC ISSUES


TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, Students will be able to
CO1: Plan an organizational structure for a given context in the organization to carry out production operations through Work-study.
CO2: Survey the markets, customers and competition better and price the given product appropriately.
CO3: Ensure quality for a given product or service.
CO4: Plan, schedule and control projects through PERT and CPM.
CO5: Evaluate strategy for a business or service organization.

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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.

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).

TOTAL : 45 PERIODS
TEXT BOOKS:

REFERENCES
7. Samson Eilon, "Elements of Production Planning and Control", Universal Book Corpn.1984

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OIE353 OPERATIONS MANAGEMENT

COURSE OBJECTIVES:
- 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
Principles, Types, Planning tools and techniques.

UNIT III DESIGN OF PRODUCT, PROCESS AND WORK SYSTEMS 9

UNIT IV MATERIALS MANAGEMENT 9

UNIT V SCHEDULING AND PROJECT MANAGEMENT 9
Project Management – Scheduling Techniques, PERT, CPM; Scheduling - work centers – nature, importance; Priority rules and techniques, shopfloor control; Flow shop scheduling – Johnson’sAlgorithm – 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:
1. Demonstrate an understanding of how occupational hygiene standards are set and used in
work health and safety.
2. Compare and contrast the roles of environmental and biological monitoring in work health and
safety.
3. Outline strategies for identifying, assessing and controlling risks associated with airborne
gases, vapours and particulates.
4. Discuss how personal protective equipment can be used to reduce risks associated with
workplace exposures.
5. Provide high-level advice on managing and controlling noise and noise-related hazards.

UNIT I INTRODUCTION AND SCOPE
Occupational Health and Environmental Safety Management - Principles practices. Comm on
Occupational diseases: Occupational Health Management Services at the work place. Pre-
employment, periodic medical examination of workers, medical surveillance for control of
occupational diseases and health records.

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
Element of training cycle, Assessment of needs. Techniques of training, design and development
of training programs. Training methods and strategies types of training. Evaluation and review of
training programs. Occupational Health Hazards, Promoting Safety, Safety and Health training,
Stress and Safety, Exposure Limit.

UNIT IV OCCUPATIONAL SAFETY, HEALTH AND ENVIRONMENT MANAGEMENT
Bureau of Indian standards on safety and health 14489 - 1998 and 15001 – 2000, OSHA, Process
Safety Management (PSM) as per OSHA, PSM principles, OHSAS – 18001, EPA Standards,
Performance measurements to determine effectiveness of PSM. Importance of Industrial safety,
role of safety department.

UNIT V INDUSTRIAL HAZARDS
i. Radiation: Types and effects of radiation on human body, Measurement and detection of
radiation intensity. Effects of radiation on human body, Measurement – disposal of radioactive
waste, Control of radiation.
ii. Noise and Vibration: Sources, and its control, Effects of noise on the 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 : 45 PERIODS:
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,

CO’s- PO’s & PSO’s MAPPING

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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, Magnetosstriction, 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, bimetallic 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:

REFERENCE BOOKS:
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 engineering.

UNIT I   NANOMATERIALS
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
Size and interface/interphase effects, interfacial thermodynamics, phase diagrams, diffusivity, grain growth, and thermal stability of nanomaterials.

UNIT III   PROCESSING
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
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
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.

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OMR353  SENSORS  L T P C  3 0 0 3

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

UNIT – IV  OPTICAL, PRESSURE, TEMPERATURE AND OTHER SENSORS

UNIT – V  SIGNAL CONDITIONING

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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1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS

REFERENCES

ORA352 
CONCEPTS IN MOBILE ROBOTS

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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 L T P C 3 0 0 3

COURSE OBJECTIVES:
1. To impart knowledge on basics of propulsion system and ship dynamic movements
2. To educate them on basic layout and propulsion equipment’s
3. To impart basic knowledge on performance of the ship
4. To impart basic knowledge on Ship propeller and its types
5. 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
- 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
- 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
- Propeller dimension, Propeller and its types – fixed propeller, control pitch propeller, kort nozzle, ducted propeller, voith schneider, Parts of propeller, 3 blade - 5 blade - 6 blade propellers and its advantages, propeller boss hub, crown nut, propeller skew, pitch of propeller - Thrust creation by propeller. Propeller Material – Propeller balancing - static and dynamic.
UNIT V  BASICS OF RUDDER
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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OMV351  MARINE MERCHANT VESSELS  LT P C  3 0 0 3

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
Archimedes Principle- Laws of floatation- Meta centre - stability of floating and submerged bodies-
Density, relative density - Displacement -Pressure -centre of pressure.

UNIT II  TYPES OF SHIP
General cargo ship - Refrigerated cargo ships - Container ships - Roll-on Roll-off ships - Oil
tankers- Bulk carriers - Liquefied Natural Gas carriers - Liquefied Petroleum Gascarriers - Chemical
tankers - Passenger ships

UNIT III  SHIPBUILDING MATERIALS
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

TOTAL: 45 PERIODS

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

OMV352 ELEMENTS OF MARINE ENGINEERING

OBJECTIVES:
At the end of the course, students are expected to
1. Understand the role of Marine machinery systems
2. Be familiar with Marine propulsion machinery system
3. Acquaint with Marine Auxiliary machinery system
4. Have acquired basics of Marine Auxiliary boiler system
5. 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
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
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
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
Importance of Propellor 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

TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course, students should able to,
1. Distinguish the role of various marine machinery systems
2. Relate the components of marine propulsion machinery system
3. Explain the importance of marine auxiliary machinery system
4. Acquire knowledge of marine boiler system
5. Understand the importance of ship propellors 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

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COURSE OBJECTIVES:
1. To understand the basics of drone concepts
2. To learn and understand the fundaments 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
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
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
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
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
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: Createthe programs for various drones

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TEXT BOOKS

REFERENCES

OGI352 GEOGRAPHICAL 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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OAI352 AGRICULTURE ENTREPRENEURSHIP DEVELOPMENT

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  9
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  9

UNIT IV  ENTREPRENEURIAL OPPORTUNITIES: ECONOMIC GROWTH PERSPECTIVE  9
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.

UNIT V  ENTREPRENEURIAL PROMOTION MEASURES AND GOVERNMENT SUPPORT  9
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.

TOTAL: 45 PERIODS

COURSE OUTCOMES
1. Judge about agricultural finance, banking and cooperation
2. Evaluate basic concepts, principles and functions of financial management
3. Improve the skills on basic banking and insurance schemes available to customers
4. Analyze various financial data for efficient farm management
5. Identify the financial institutions

TEXT BOOKS

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<td>PSO2 To enhance students ability to formulate solutions to real-world problems pertaining to sustained agricultural productivity using modern technologies.</td>
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<td>PSO3 To inculcate entrepreneurial skills through strong Industry-Institution linkage.</td>
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OEN352 BIODIVERSITY CONSERVATION

OBJECTIVE:
The identification of different aspects of biological diversity and conservation techniques.

UNIT I INTRODUCTION
Concept of Species, Variation; Introduction to Major Plant Groups; Evolutionary relationships between Plant Groups; Nomenclature and History of plant taxonomy; Systems of Classification and their Application; Study of Plant Groups; Study of Identification Characters; Study of important families of Angiosperms; Plant Diversity Application.

UNIT II INTRODUCTION TO ANIMAL DIVERSITY AND TAXONOMY
Principles and Rules of Taxonomy; ICZN Rules, Animal Study Techniques; Concepts of Taxon, Categories, Holotype, Paratype, Topotype etc; Classification of Animal kingdom, Invertebrates, Vertebrates, Evolutionary relationships between Animal Groups.

UNIT III MICROBIAL DIVERSITY
Microbes and Earth History, Magnitude, Occurrence and Distribution. Concept of Species, Criteria for Classification, Outline Classification of Microorganisms (Bacteria, Viruses and Protozoa);
Criteria for Classification and Identification of Fungi; Chemical and Biochemical Methods of Microbial Diversity Analysis

UNIT IV MEGA DIVERSITY
Biodiversity Hot-spots, Floristic and Faunal Regions in India and World; IUCN Red List; Factors affecting Diversity, Impact of Exotic Species and Human Disturbance on Diversity, Dispersal, Diversity-Stability Relationship; Socio-economic Issues of Biodiversity; Sustainable Utilization of Bioresources; National Movements and International Convention/Treaties on Biodiversity.

UNIT V CONSERVATIONS OF BIODIVERSITY
In-Situ Conservation- National parks, Wildlife sanctuaries, Biosphere reserves; Ex-situ conservation- Gene bank, Cryopreservation, Tissue culture bank; Long term captive breeding, Botanical gardens, Animal Translocation, Zoological Gardens; Concept of Keystone Species, Endangered Species, Threatened Species, Rare Species, Extinct Species

TOTAL: 45 PERIODS

TEXT BOOKS:

REFERENCES:

OUTCOMES
Upon successful completion of this course, students will:
CO1: An insight into the structure and function of diversity for ecosystem stability.
CO2: Understand the concept of animal diversity and taxonomy
CO3: Understand socio-economic issues pertaining to biodiversity
CO4: An understanding of biodiversity in community resource management.
CO5: Student can apply fundamental knowledge of biodiversity conservation to solve problems associated with infrastructure development.

CO’s- PO’s & PSO’s MAPPING

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<tr>
<th>CO’s</th>
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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 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


UNIT V STATE VARIABLE ANALYSIS

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.
COURSE OBJECTIVES:

- To educate on design of signal conditioning circuits for various applications.
- To introduce signal transmission techniques and their design.
- Study of components used in data acquisition systems interface techniques.
- To educate on the components used in distributed control systems.
- 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)
Market survey of Industrial Data Networks.

**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

**CO’s- PO’s & PSO’s MAPPING**

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<thead>
<tr>
<th>CO’s</th>
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• 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.

TOTAL: 45 PERIODS

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:
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
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

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

COURSE OUTCOME - NUTRACEUTICALS

| 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. |

CO – PO MAPPING

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OTT354      BASICS OF DYEING AND PRINTING L T P C 3 0 0 3

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

UNIT III  DYEING

UNIT IV  PRINTING
Definition of printing – Difference between printing and dyeing- Classification thickeners – Requirements to be good thickener, printing paste Preparation - different styles of printing.

UNIT V  MACHINERIES

TOTAL: 45 PERIODS

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

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>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Program Outcome</th>
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<td>Statement</td>
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<td>CO1</td>
<td>Classification of fibres and production of natural fibres</td>
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<td>CO2</td>
<td>Regenerated and synthetic</td>
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</table>
FT3201  FIBRE SCIENCE

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.

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 labelling 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 care labelling

TEXT BOOKS:
2. Gerry Cooklin, “Introduction to Clothing Manufacture” Blackwell Science Ltd., 1995. 64

REFERENCES:

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UNIT I  INTRODUCTION
Units of energy, conversion factors, general classification of energy, world energy resources and energy consumption, Indian energy resources and energy consumption, energy crisis, energy alternatives, Renewable and non-renewable energy sources and their availability. Prospects of Renewable energy sources

UNIT II  CONVENTIONAL ENERGY
Conventional energy resources, Thermal, hydel and nuclear reactors, thermal, hydel and nuclear power plants, efficiency, merits and demerits of the above power plants, combustion processes, fluidized bed combustion.

UNIT III  NON-CONVENTIONAL ENERGY
Solar energy, solar thermal systems, flat plate collectors, focusing collectors, solar water heating, solar cooling, solar distillation, solar refrigeration, solar dryers, solar pond, solar thermal power generation, solar energy application in India, energy plantations. Wind energy, types of windmills, types of wind rotors, Darrieus rotor and Gravian rotor, wind electric power generation, wind power in India, economics of wind farm, ocean wave energy conversion, ocean thermal energy conversion, tidal energy conversion, geothermal energy.

UNIT IV  BIOMASS ENERGY
Biomass energy resources, thermo-chemical and biochemical methods of biomass conversion, combustion, gasification, pyrolysis, biogas production, ethanol, fuel cells, alkaline fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, solid polymer electrolyte fuel cell, magneto hydrodynamic power generation, energy storage routes like thermal energy storage, chemical, mechanical storage and electrical storage.

UNIT V  ENERGY CONSERVATION
Energy conservation in chemical process plants, energy audit, energy saving in heat exchangers, distillation columns, dryers, ovens and furnaces and boilers, steam economy in chemical plants, energy conservation.

TOTAL : 45 PERIODS

OUTCOMES:
On completion of the course, the students will be able to
CO1: Students will be able to describe the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels.
CO2: Students will excel as professionals in the various fields of energy engineering
CO3: Compare different renewable energy technologies and choose the most appropriate based on local conditions.
CO4: Explain the technological basis for harnessing renewable energy sources.
CO5: Identify and critically evaluate current developments and emerging trends within the field of renewable energy technologies and to develop in-depth technical understanding of energy problems at an advanced level.

TEXT BOOKS

REFERENCES
Course articulation matrix

<table>
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<th>Course Outcomes</th>
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<td>CO1</td>
<td>Students will be able to describe the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels.</td>
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<td>CO2</td>
<td>Students will excel as professionals in the various fields of energy engineering.</td>
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<td>CO3</td>
<td>Compare different renewable energy technologies and choose the most appropriate based on local conditions.</td>
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<td>CO4</td>
<td>Explain the technological basis for harnessing renewable energy sources.</td>
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<td>CO5</td>
<td>Identify and critically evaluate current developments and emerging trends within the field of renewable energy technologies and to develop in-depth technical understanding of energy problems at an advanced level.</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

**OBJECTIVE:**
- To enable the students to analyze properties of a surfaces and correlate them to structure, chemistry, and physics and surface modification technique.

**UNIT I** SURFACE STRUCTURE AND EXPERIMENTAL PROBES
Relevance of surface science to Chemical and Electrochemical Engineering, Heterogeneous Catalysis and Nanoscience; Surface structure and reconstructions, absorbate structure, Band and Vibrational structure, Importance of UHV techniques, Electronic probes and molecular beams, Scanning probes and diffraction, Qualitative introduction to electronic and vibrational spectroscopy.
UNIT II  ADSORPTION, DYNAMICS, THERMODYNAMICS AND KINETICS AT SURFACES 9
Interactions at the surface, Physisorption, Chemisorption, Diffusion, dynamics and reactions of atoms/molecules on surfaces, Generic reaction mechanism on surfaces, Adsorption isotherms, Kinetics of adsorption, Use of temperature desorption methods

UNIT III  LIQUID INTERFACES 9
Structure and Thermodynamics of liquid-solid interface, Self-assembled monolayers, Electrified interfaces, Charge transfer at the liquid-solid interfaces, Photoelectrochemical processes, Gratzel cells

UNIT IV  HETEROGENEOUS CATALYSIS 9
Characterization of heterogeneous catalytic processes, Microscopic kinetics to catalysis, Overview of important heterogeneous catalytic processes: Haber-Bosch, Fishcher-Tropsch and Automotive catalysis, Role of promoters and poisons, Bimetallic surfaces, surface functionalization and clusters in catalysis, Role of Sabatier principle in catalyst design, Rate oscillations and spatiotemporal pattern formation

UNIT V  EPITAXIAL GROWTH AND NANO SURFACE-STRUCTURES 9

TOTAL: 45 PERIODS

OUTCOME:
• Upon completion of this course, the students can understand, predict and design surface properties based on surface structure. Students would understand the physics and chemistry behind surface phenomena.

TEXT BOOK:

REFERENCE:

OPT352  PLASTIC MATERIALS FOR ENGINEERS  L T P C  3 0 0 3

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  9
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  9
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  9
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

TOTAL : 45 PERIODS

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 on polyester, 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  L T P C
3 0 0 3

COURSE OBJECTIVES

- To understand the relevance of standards and specifications as well as the specimen preparation for polymer testing.

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• 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  9

UNIT II  MECHANICAL PROPERTIES  9
Mechanical properties: Tensile, compression, flexural, shear, tear strength, hardness, impact strength, resilience, abrasion resistance, creep and stress relaxation, compression set, dynamic fatigue, ageing properties. Basic concepts of stress and strain, short term tests: Viscoelastic behavior (simple models: Kelvin model for creep and stress relaxation, Maxwell-Voigt model, strain recovery and dynamic response), Effect of structure and composition on mechanical properties, Behavior of reinforced polymers.

UNIT III  THERMAL RHEOLOGICAL PROPERTIES  9
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  9
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  9

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, thermostets and elastomers.

REFERENCES
OEC353  VLSI DESIGN  L T P C  3 0 0 3

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  9
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  9

UNIT III  SEQUENTIAL LOGIC CIRCUITS AND CLOCKING STRATEGIES  9

UNIT IV  INTERCONNECT, MEMORY ARCHITECTURE  9
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  9
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

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CBM370 WEARABLE DEVICES L T P C 3 0 0 3

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.
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 9
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 9
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.

Course Outcomes:
Upon completion of the course, students will be able to:
1. Explain the structure and functional capabilities of Hospital Information System.
2. Describe the need of computers in medical imaging and automated clinical laboratory.
3. Articulate the functioning of information storage and retrieval in computerized patient record system.
4. Apply the suitable decision support system for automated clinical diagnosis.
5. Discuss the application of virtual reality and telehealth technology in medical industry.

TEXT BOOKS:

REFERENCES:
UNIT I BIOLOGICAL TREATMENT PROCESS

UNIT II WASTE BIOMASS AND ITS VALUE ADDITION
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
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
- To learn the various methods biological treatment
- To know the details of waste biomass and its value addition
- To develop the bioconversion processes to convert wastes to energy
- To synthesize the chemicals and enzyme from wastes
- To produce the biocompost from wastes
- To apply the theoretical knowledge for the development of value added products

TEXT BOOKS

REFERENCE BOOKS
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:
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 & IN PATIENT 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

VERTICAL 1: FINTECH AND BLOCK CHAIN

CMG331 FINANCIAL MANAGEMENT LT P C 3 0 0 3

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 MANGEMENT
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,

CMG332 FUNDAMENTALS OF INVESTMENT LT P C 3 0 0 3

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 TOEQUITY 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

REFERENCES

TOTAL: 45 PERIODS

REFERENCES:

CMG333 BANKING, FINANCIAL SERVICES AND INSURANCE LT P C 3 0 0 3

OBJECTIVES
• Understand the Banking system in India
• Grasp how banks raise their sources and how they deploy it
• Understand the development in banking technology
• Understand the financial services in India
• Understand the insurance Industry in India

UNIT I INTRODUCTION TO INDIAN BANKING SYSTEM
Overview of Banking system – Structure – Functions – Banking system in India - Key Regulations in Indian Banking sector – RBI. Relationship between Banker and Customer - Retail & Wholesale Banking – types of Accounts - Opening and operation of Accounts.

UNIT II MANAGING BANK FUNDS/ PRODUCTS

UNIT III DEVELOPMENT IN BANKING TECHNOLOGY

UNIT IV FINANCIAL SERVICES

UNIT V INSURANCE

TOTAL : 45 PERIODS

REFERENCES:

326

CMG334 INTRODUCTION TO BLOCKCHAIN AND ITS APPLICATIONS

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

TOTAL : 45 PERIODS

REFERENCE
2. Peter Borovykh , Blockchain Application in Finance, Blockchain Driven, 2nd Edition, 2018
UNIT I  CURRENCY EXCHANGE AND PAYMENT

UNIT II  DIGITAL FINANCE AND ALTERNATIVE FINANCE
A Brief History of Financial Innovation, Digitization of Financial Services, Crowd funding, Charity and Equity,. Introduction to the concept of Initial Coin Offering

UNIT III  INSURTECH
InsurTech Introduction , Business model disruption AI/ML in InsurTech ● IoT and InsurTech ,Risk Modeling ,Fraud Detection Processing claims and Underwriting Innovations in Insurance Services

UNIT IV  PEER TO PEER LENDING
P2P and Marketplace Lending, New Models and New Products in market place lending P2P Infrastructure and technologies , Concept of Crowdfunding Crowdfunding Architecture and Technology ,P2P and Crowdfunding unicorns and business models , SME/MSME Lending: Unique opportunities and Challenges, Solutions and Innovations

UNIT V  REGULATORY ISSUES

REFERENCE
5. IIBF, Digital Banking, Taxmann Publication, 2016

CMG336  INTRODUCTION TO FINTECH
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
6. Pranay Gupta, T. Mandy Tham, Fintech: The New DNA of Financial Services Paperback, 2018

TOTAL : 45 PERIODS

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  9
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  9

UNIT III  FUNDAMENTALS OF TECHNOPRENEURSHIP  9
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  9
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  9

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:
2) Donal F Kuratko Entrepreneurship (11th Edition) Theory, Process, Practice by Published 2019 by Cengage Learning,

REFERENCES :
4) David Sheff 2002, China Dawn: The Story of a Technology and Business Revolution,
7) Basics of Technopreneurship: 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 businesses.
- To empower the learners to build robust teams for running and leading a business efficiently and effectively

UNIT I INTRODUCTION TO MANAGING TEAMS
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
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
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

UNIT V LEADERSHIP EFFECTIVENESS

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

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 Creativity - 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
Innovation: Definition - Levels of Innovation - Incremental Vs Radical Innovation - Product Innovation and Process - Technological, Organizational Innovation - Indicators - Characteristics of Innovation in Different Sectors. Theories in Innovation and Creativity - Design Thinking and Innovation - Innovation as Collective Change - Innovation as a system

UNIT IV INNOVATION AND ENTREPRENEURSHIP

UNIT V INNOVATIVE BUSINESS MODELS
Innovative Business Models: Customer Discovery - Customer Segments - Prospect Theory and Developing Value Propositions - Developing Business Models: Elements of 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 DISTRIBUTION MANAGEMENT

UNIT V CONTEMPORARY ISSUES IN MARKETING MANAGEMENT

COURSE OUTCOMES:
After completion of this course, the students will be able to:
CO1 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 9
Sources of recruitment- Internal Vs. External - Domestic Vs. Global Sources - Recruitment Process- Selection techniques - eRecruitment - Interview Types- Employee Engagement.

UNIT IV TRAINING AND EMPLOYEE DEVELOPMENT 9

UNIT V CONTROLLING HUMAN RESOURCES 9

COURSE 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 BUSINESS 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

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
CMG343            PRINCIPLES OF PUBLIC ADMINISTRATION  
UNIT-1  
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  
3. Decision Making: Decision Making - Types, Techniques and Processes  

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

REFERENCES:
4. Agarwal, R.C: Indian Political System; S.Chand & Co., New Delhi.

TOTAL: 45 PERIODS

CMG345
PUBLIC PERSONNEL ADMINISTRATION

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

TOTAL: 45 PERIODS
4. Dwivedi O.P and Jain R.B: India’s Administrative state.
7. Davar R.S. Personnel Management & Industrial Relations

CMG346  
**ADMINISTRATIVE THEORIES**  

**UNIT I**  
Meaning, Scope and significance of Public Administration, Evolution of Public Administration as a discipline and Identity of Public Administration  

**UNIT II**  
Theories of Organization: Scientific Management Theory, Classical Model, Human Relations Theory  

**UNIT III**  
Organization goals and Behaviour, Groups in organization and group dynamics, Organizational Design.  

**UNIT IV**  
Motivation Theories, content, process and contemporary; Theories of Leadership: Traditional and Modern: Process and techniques of decision-making  

**UNIT V**  
Administrative thinkers: Kautilya, Woodrow Willson, C.I. Barnard. Peter Drucker  

TOTAL: 45 PERIODS  

REFERENCES:  
1. Crozior M: The Bureaucratic phenomenon (Chand)  
3. Presthus. R: The Organizational Society (MAC)  
5. Keith Davis: Organization Theory (MAC)

CMG347  
**INDIAN ADMINISTRATIVE SYSTEM**  

**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**  

339
 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
Approaches in Policy Analysis - Institutional Approach – Incremental Approach and System’s Approach – Dror’s Optimal Model

UNIT-III

UNIT-IV
Institutional Framework of Policy making – Role of Bureaucracy – Role of Interest Groups and Role of Political Parties.

UNIT-V
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

TOTAL: 45 PERIODS

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  
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  
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  
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  

UNIT V  CORRELATION AND REGRESSION  

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  
Data mining, Text mining, Web mining, Data ware house.

UNIT II  DATA MINING PROCESS  
Datamining process – KDD, CRISP-DM, SEMMA
Prediction performance measures
UNIT III PREDICTION TECHNIQUES  
Data visualization, Time series – ARIMA, Winter Holts,  

UNIT IV CLASSIFICATION AND CLUSTERING TECHNIQUES  
Classification, Association, Clustering.  

UNIT V MACHINE LEARNING AND AI  
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  

CMG351 HUMAN RESOURCE ANALYTICS  

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.  

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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

TOTAL: 45 PERIODS

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

OBJECTIVE:
- To showcase the opportunities that exist today to leverage the power of the web and social media

UNIT I - MARKETING ANALYTICS  
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.

TOTAL: 45 PERIODS

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

UNIT III INVENTORY MANAGEMENT 9
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.

TOTAL: 45 PERIODS

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.

TOTAL: 45 PERIODS
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

**CO’s- PO’s & PSO’s MAPPING**

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**CES332 SUSTAINABLE AGRICULTURE AND ENVIRONMENTAL MANAGEMENT**  
**L T P C** 3 0 0 3

**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
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
Introduction: Definition of biomaterials, requirements & classification of biomaterials- Types of Biomaterials- Degradable and resorbable biomaterials- engineered natural materials-

UNIT II  BIO POLYMERS
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 polyglycolic 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  NANOBIO MATERIALS

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. Vasif Hassirci, Nesrin Hassirci “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
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
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

UNIT IV PHOTOVOLTAICS
dimensional Graphene, organic or Small molecule-based solar cells materials - copperphthalocyanine and perylenetetracarboxylicbis - benzine – fullerenes - boron subphthalocyaninetin (II) phthalocyanine)

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
UNIT II  POLLUTION TYPES  9
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  9
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  9
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  9
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

TEXT BOOKS
1. Green technology and design for the environment, Samir B. Billatos, Nadia A. Basaly, Taylor &
   Francis, Washington, DC, ©1997

REFERENCE BOOKS
1. Environmental chemistry, Stanley E Manahan, Taylor and Francis, 2017

CES336   ENVIRONMENTAL QUALITY MONITORING AND ANALYSIS   L T P C
                      3 0 0 3

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  9
Introduction- Environmental Standards- Classification of Environmental Standards- Global
Environmental Standards- Environmental Standards in India- Ambient air quality standards- water
quality standard- Environmental Monitoring-Need for environmental monitoring- Concepts of
environmental monitoring- Techniques of Environmental Monitoring.
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) & RISKASSEMENT


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 solid 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

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Program Outcomes</th>
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<tbody>
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CES337 INTEGRATED ENERGY PLANNING FOR SUSTAINABLE DEVELOPMENT

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
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
Conventional Energy Sources - Emissions from fuels – Air, Water and Land pollution – Environmental standards - measurement and controls

UNIT III SUSTAINABLE DEVELOPMENT

UNIT IV RENEWABLE ENERGY TECHNOLOGY

UNIT V ENERGY PLANNING FOR SUSTAINABLE DEVELOPMENT

TOTAL: 45 PERIODS

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

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: