1. PROGRAMME OUTCOMES (POs):

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

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<tr>
<th>Graduate attribute</th>
<th>Programme Outcome</th>
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<tbody>
<tr>
<td>PO1 Engineering knowledge</td>
<td>Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems</td>
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<tr>
<td>PO2 Problem analysis</td>
<td>Problem analysis Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.</td>
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<tr>
<td>PO3 Design / development of solutions</td>
<td>Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.</td>
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<tr>
<td>PO4 Conduct investigations of complex problems</td>
<td>Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.</td>
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<tr>
<td>PO5 Modern tool usage</td>
<td>Modern tool usage Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations</td>
</tr>
<tr>
<td>PO6 The Engineer and society</td>
<td>Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering</td>
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B.TECH. CHEMICAL ENGINEERING

CHOICE BASED CREDIT SYSTEM
I TO VIII SEMESTERS (FULL TIME) CURRICULA

CHOICE BASED CREDIT SYSTEM (CBCS)
<table>
<thead>
<tr>
<th>PO7</th>
<th>Environment and sustainability</th>
<th>Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development</th>
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<tbody>
<tr>
<td>PO8</td>
<td>Ethics</td>
<td>Ethics Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice</td>
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<tr>
<td>PO9</td>
<td>Individual and team work</td>
<td>Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.</td>
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<tr>
<td>PO10</td>
<td>Communication</td>
<td>Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.</td>
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<td>PO11</td>
<td>Project management and finance</td>
<td>Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments</td>
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<tr>
<td>PO12</td>
<td>Life-long learning</td>
<td>Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.</td>
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</table>

2. PROGRAM SPECIFIC OUTCOMES (PSOs):
By the completion of Chemical Engineering Programme the student will have following Program-specific outcomes.

1. Graduates will have a strong foundation in engineering, science and current Chemical Engineering practices and will have experience in solving structured and unstructured problems using conventional and innovative solutions.

2. Graduates will be able to effectively describe the Chemical Engineering problem, analyze the data, develop potential solutions, evaluate these solutions, and present the results using their oral, written and electronic media skills.

3. Graduates will have an understanding of ethical and professional responsibilities of an engineer and the impact of engineering solutions on society and the global environment.
### 3. MAPPING OF COURSE OUTCOMES AND PROGRAMME OUTCOMES

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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
ANNA UNIVERSITY, CHENNAI
NON-AUTONOMOUS COLLEGES AFFILIATED COLLEGES
REGULATIONS 2021
CHOICE BASED CREDIT SYSTEM
B.TECH. CHEMICAL ENGINEERING

CURRICULUM FOR SEMESTERS I TO VIII AND SYLLABI FOR SEMESTERS I AND IV

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

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

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

**Two weeks industrial training/internship carries one credit. Industrial training/Internship during IV Semester Summer Vacation will be evaluated in V semester.
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*Open Elective – I shall be chosen from the emerging technologies.

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

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

^ NCC Credit Course level 3 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.
### SEMESTER VII/VIII

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

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

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

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

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

### 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: 166**

### ELECTIVE – MANAGEMENT COURSES

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# MANDATORY COURSES I

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# MANDATORY COURSES II

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<tr>
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## PROFESSIONAL ELECTIVE COURSES: VERTICALS

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

### Registration of Professional Elective Courses from Verticals:

Professional Elective Courses will be registered in Semesters V and VI. These courses are listed in groups called verticals that represent a particular area of specialisation. Students are permitted to choose all Professional Electives from a particular vertical or from different verticals. Further, only one Professional Elective course shall be chosen in a semester horizontally (row-wise). However, two courses are permitted from the same row, provided one course is enrolled in Semester V and another in Semester VI.

The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VIII. The procedure for registration of courses explained above shall be followed for the courses of B.E/B.Tech (Honours) or Minor degree also. For more details on B.E./B.Tech (Honours) or Minor degree refer to Regulations 2021 Clause 4.10.
# PROFESSIONAL ELECTIVE COURSES : VERTICALS

## VERTICAL I: PETROLEUM PROCESS TECHNOLOGY

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## VERTICAL II: ENERGY ENGINEERING

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### VERTICAL III: BIOCHEMICAL 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 of Regulations 2021.

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

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(Choice of courses for Minor degree is to be made from any one vertical of other programmes or from anyone of the following verticals)
### VERTICAL I: FINTECH AND BLOCK CHAIN

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### VERTICAL II: ENTREPRENEURSHIP

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<td>2.</td>
<td>CMG338</td>
<td>Team Building &amp; Leadership Management for Business</td>
<td>PEC</td>
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<td>3.</td>
<td>CMG339</td>
<td>Creativity &amp; Innovation in Entrepreneurship</td>
<td>PEC</td>
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<td>4.</td>
<td>CMG340</td>
<td>Principles of Marketing Management For Business</td>
<td>PEC</td>
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<td>5.</td>
<td>CMG341</td>
<td>Human Resource Management for Entrepreneurs</td>
<td>PEC</td>
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<td>6.</td>
<td>CMG342</td>
<td>Financing New Business Ventures</td>
<td>PEC</td>
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### VERTICAL III: PUBLIC ADMINISTRATION

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<th>SL. NO.</th>
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<tr>
<td>1.</td>
<td>CMG343</td>
<td>Principles of Public Administration</td>
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<td>2.</td>
<td>CMG344</td>
<td>Constitution of India</td>
<td>PEC</td>
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<td>Public Personnel Administration</td>
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<td>4.</td>
<td>CMG346</td>
<td>Administrative Theories</td>
<td>PEC</td>
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<td>CMG347</td>
<td>Indian Administrative System</td>
<td>PEC</td>
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<td>6.</td>
<td>CMG348</td>
<td>Public Policy Administration</td>
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### VERTICAL IV: BUSINESS DATA ANALYTICS

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<td>1.</td>
<td>CMG349</td>
<td>Statistics For Management</td>
<td>PEC</td>
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<td>CMG350</td>
<td>Data Mining For Business Intelligence</td>
<td>PEC</td>
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<td>3.</td>
<td>CMG351</td>
<td>Human Resource Analytics</td>
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<td>4.</td>
<td>CMG352</td>
<td>Marketing And Social Media Web Analytics</td>
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<td>5.</td>
<td>CMG353</td>
<td>Operation And Supply Chain Analytics</td>
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<td>CMG354</td>
<td>Financial Analytics</td>
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### VERTICAL V: ENVIRONMENT AND SUSTAINABILITY

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<td>1.</td>
<td>CES331</td>
<td>Sustainable infrastructure Development</td>
<td>PEC</td>
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<td>CES332</td>
<td>Sustainable Agriculture and Environmental Management</td>
<td>PEC</td>
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<td>3.</td>
<td>CES333</td>
<td>Sustainable Bio Materials</td>
<td>PEC</td>
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<td>4.</td>
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<td>Materials for Energy Sustainability</td>
<td>PEC</td>
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<td>5.</td>
<td>CES335</td>
<td>Green Technology</td>
<td>PEC</td>
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<td>6.</td>
<td>CES336</td>
<td>Environmental Quality Monitoring and Analysis</td>
<td>PEC</td>
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<td>7.</td>
<td>CES337</td>
<td>Integrated Energy Planning for Sustainable Development</td>
<td>PEC</td>
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<td>8.</td>
<td>CES338</td>
<td>Energy Efficiency for Sustainable Development</td>
<td>PEC</td>
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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 don’ts, 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

HS3151   PROFESSIONAL ENGLISH I   L T P C
3 0 0 3

OBJECTIVES:
- To improve the communicative competence of learners
- To learn to use basic grammatic structures in suitable contexts
- To acquire lexical competence and use them appropriately in a sentence and understand their meaning in a text
- To help learners use language effectively in professional contexts
• To develop learners’ ability to read and write complex texts, summaries, articles, blogs, definitions, essays and user manuals.

UNIT I INTRODUCTION TO EFFECTIVE COMMUNICATION

What is effective communication? (Explain using activities) Why is communication critical for excellence during study, research and work? What are the seven C’s of effective communication? What are key language skills? What is effective listening? What does it involve? What is effective speaking? What does it mean to be an excellent reader? What should you be able to do? What is effective writing? How does one develop language and communication skills? What does the course focus on? How are communication and language skills going to be enhanced during this course? What do you as a learner need to do to enhance your English language and communication skills to get the best out of this course?

UNIT 1 INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION

Reading - Reading brochures (technical context), telephone messages / social media messages relevant to technical contexts and emails. Writing - Writing emails / letters introducing oneself.

Grammar - Present Tense (simple and progressive); Question types: Wh/ Yes or No/ and Tags.

Vocabulary - Synonyms; One word substitution; Abbreviations & Acronyms (as used in technical contexts).

UNIT II NARRATION AND SUMMATION

Reading - Reading biographies, travelogues, newspaper reports, Excerpts from literature, and travel & technical blogs. Writing - Guided writing -- Paragraph writing Short Report on an event (field trip etc.)

Grammar --Past tense (simple); Subject-Verb Agreement; and Prepositions.

Vocabulary - Word forms (prefixes& suffixes); Synonyms and Antonyms. Phrasal verbs.

UNIT III DESCRIPTION OF A PROCESS / PRODUCT

Reading – Reading advertisements, gadget reviews; user manuals. Writing - Writing definitions; instructions; and Product /Process description.

Grammar - Imperatives; Adjectives; Degrees of comparison; Present & Past Perfect Tenses.

Vocabulary - Compound Nouns, Homonyms; and Homophones, discourse markers (connectives & sequence words).

UNIT IV CLASSIFICATION AND RECOMMENDATIONS

Reading – Newspaper articles; Journal reports –and Non Verbal Communication ( tables, pie charts etc., ). Writing – Note-making / Note-taking (*Study skills to be taught, not tested); Writing recommendations; Transferring information from non verbal (chart, graph etc, to verbal mode)

Grammar – Articles; Pronouns - Possessive & Relative pronouns.

Vocabulary - Collocations; Fixed / Semi fixed expressions.

UNIT V EXPRESSION

Reading – Reading editorials; and Opinion Blogs; Writing – Essay Writing (Descriptive or narrative).

Grammar – Future Tenses, Punctuation; Negation (Statements & Questions); and Simple, Compound & Complex Sentences.

Vocabulary - Cause & Effect Expressions – Content vs Function words.

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 grammatic structures and use them in right context.
• To read and infer the denotative and connotative meanings of technical texts
• 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)
   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.

MA3151 MATRICES AND CALCULUS

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

UNIT II DIFFERENTIAL CALCULUS

UNIT III FUNCTIONS OF SEVERAL VARIABLES
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  9

UNIT II  ELECTROMAGNETIC WAVES  9
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  9

UNIT IV  BASIC QUANTUM MECHANICS  9
Photons and light waves - Electrons and matter waves –Compton effect - The Schrodinger equation (Time dependent and time independent forms) - meaning of wave function - Normalization –Free particle - particle in a infinite potential well: 1D, 2D and 3D Boxes- Normalization, probabilities and the correspondence principle.

UNIT V  APPLIED QUANTUM MECHANICS  9
The harmonic oscillator(qualitative)- Barrier penetration and quantum tunneling(qualitative)- Tunneling microscope - Resonant diode - Finite potential wells (qualitative)- Bloch’s theorem for particles in a periodic potential –Basics of Kronig-Penney model and origin of energy bands.

COURSE OUTCOMES

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

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

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

UNIT IV  FUELS AND COMBUSTION 9
Fuels: Introduction: Classification of fuels; Coal and coke: Analysis of coal (proximate and ultimate), Carbonization, Manufacture of metallurgical coke (Otto Hoffmann method). Petroleum and Diesel: Manufacture of synthetic petrol (Bergius process), Knocking - octane number, diesel oil - cetane number; Power alcohol and biodiesel.
Combustion of fuels: Introduction: Calorific value - higher and lower calorific values, Theoretical calculation of calorific value; Ignition temperature: spontaneous ignition temperature, Explosive range; Flue gas analysis - ORSAT Method. CO$_2$ emission and carbon foot print.

UNIT V  ENERGY SOURCES AND STORAGE DEVICES 9
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: H$_2$-O$_2$ 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:
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  9

UNIT II  DATA TYPES, EXPRESSIONS, STATEMENTS  9
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  9
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  9
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  9
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/
TEXT-CUM-REFERENCE BOOKS
1. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
2. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.)
3. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
4. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
5. Keeladi – 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
6. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
7. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

GE3152 HERITAGE OF TAMILS

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

GE3171 PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY L T P C

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)
8. Implementing programs using written modules and Python Standard Libraries (pandas, numpy, Matplotlib, scipy)
9. Implementing real-time/technical applications using File handling. (copy from one file to another, word count, longest word)
10. Implementing real-time/technical applications using Exception handling. (divide by zero error, voter’s age validity, student mark range validation)
12. Developing a game activity using Pygame like bouncing ball, car race etc.

TOTAL: 60 PERIODS

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

REFERENCES:

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

CHEMISTRY LABORATORY: (Any seven experiments )

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

CHEMISTRY LABORATORY: (Any seven experiments to be conducted)
1. Preparation of Na₂CO₃ as a primary standard and estimation of acidity of a water sample using the primary standard
2. Determination of types and amount of alkalinity in water sample.
   - 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

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

TEXT BOOK:

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  
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 and comprehend complex academic texts
- To speak fluently and accurately in formal and informal communicative contexts
- To express their opinions effectively in both oral and written medium of communication

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.

HS3251  PROFESSIONAL ENGLISH -II

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

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

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

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

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

TOTAL : 30 PERIODS

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

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

TOTAL: 60 PERIODS

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:

PH3258 PHYSICS OF MATERIALS

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3 0 0 3

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

UNIT I PREPARATION OF MATERIALS

UNIT II ELECTRICAL PROPERTIES OF MATERIALS

UNIT III SEMICONDUCTING PROPERTIES MATERIALS

UNIT IV DIELECTRIC AND MAGNETIC MATERIALS
UNIT V NEW MATERIALS AND APPLICATIONS

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On completion of the course, the students should be able to
CO1: acquire knowledge of phase diagram, and thin film and nanomaterial preparation techniques
CO2: familiarize with conducting materials, basic quantum mechanics, and properties and applications of superconductors.
CO3: gain knowledge on semiconducting materials based on energy level diagrams, its types, temperature effect. Also, fabrication methods for semiconductor devices will be understood.
CO4: realize with theories and applications of dielectric and ferromagnetic materials
CO5: familiarize with ceramics, composites, metallic glasses, shape memory alloys, biomaterials and their important applications.

TEXT BOOKS:

REFERENCES:
UNIT II MAGNETIC CIRCUITS AND ELECTRICAL INSTALLATIONS

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

UNIT III ELECTRICAL MACHINES


UNIT IV ANALOG ELECTRONICS


UNIT V SENSORS AND TRANSDUCERS

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

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

TOTAL: 45 PERIODS

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:
COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for:

i. Drawing engineering curves.

ii. Drawing freehand sketch of simple objects.

iii. Drawing orthographic projection of solids and section of solids.

iv. Drawing development of solids

v. Drawing isometric and perspective projections of simple solids.

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

UNIT I  PLANE CURVES  6+12
Basic Geometrical constructions, Curves used in engineering practices: Conics — Construction of ellipse, parabola and hyperbola by eccentricity method — Construction of cycloid — construction of involutes of square and circle — Drawing of tangents and normal to the above curves.

UNIT II  PROJECTION OF POINTS, LINES AND PLANE SURFACE  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)

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.

TOTAL: (L=30+P=60) 90 PERIODS
• Draw the development of simple solids.

TEXT BOOKS:

REFERENCES:

Publication of Bureau of Indian Standards:

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.

CH3251 INTRODUCTION TO CHEMICAL ENGINEERING

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

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

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

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

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

TOTAL: 45 PERIODS

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

TEXT BOOKS:

REFERENCES:
தலங்கள் – தமிழ் கல்வி - குழுநிலைகள் - மாணிக்கம் கல்வியியல் பதிவிட்டு. அல்லது, மாணிக்கம் குழுநிலைகள் அம்மன் கொலமியை தமிழ் நிலைகள் - பிற்பகுதிகள் பலகை கொண்டு மீண்டும் பலகை கொண்டு குழுநிலைகள் – பிற்பகுதிகள் பலகை கொண்டு மீண்டும் பலகை கொண்டு நிலைகள் - கொண்டு மீண்டும் பலகை கொண்டு மீண்டும் பலகை கொண்டு மீண்டும் பலகை கொண்டு மீண்டும் பலகை கொண்டு மீண்டும் பல.
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**

**TEXT-CUM-REFERENCE BOOKS**

1. தமிழ் நொடு - பண ் பொடும் பண ் பொடும் - பாலூநெடு (தியாரம்: கி.நூற்றாணி பாலூநெடு பாலூநெடு பாலூநெடு பாலூநெடு).
2. கைதிகள் கைதிகள் - போர்ந்து விளு, குண்டுமதி. (மிகுந்த பிரசுரம்).
3. செடிபுரி - கோவில்கள் கோவில்கள் கோவில்கள் கோவில்கள் (தாலமாயிலை கணத் வெளிப்பெடு).
4. மாதபிள்ளை - சயாதபிள்ளை சயாதபிள்ளை. (கோணாலியிலிருந்து பணத்து பணத்து).
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies).
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - ‘Sangam City Civilization on the banks of river Vaigai’ (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

**TOTAL : 15 PERIODS**
### NCC Credit Course Level 1*

<table>
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#### NCC GENERAL

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#### NATIONAL INTEGRATION AND AWARENESS

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<td>Unity in Diversity &amp; Role of NCC in Nation Building</td>
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#### PERSONALITY DEVELOPMENT

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#### LEADERSHIP

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#### SOCIAL SERVICE AND COMMUNITY DEVELOPMENT

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**TOTAL: 30 PERIODS**
# NCC Credit Course Level 1*

**NX3252**

(NAVAL WING) NCC Credit Course Level - I

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## NATIONAL INTEGRATION AND AWARENESS

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**TOTAL : 30 PERIODS**
# NCC Credit Course Level 1*

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**TOTAL : 30 PERIODS**
OBJECTIVES:
The main learning objective of this course is to provide hands on training to the students in:

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

GROUP – A (CIVIL & ELECTRICAL)

PART I CIVIL ENGINEERING PRACTICES 15

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

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

Wood Work Study:
- Studying joints in door panels and wooden furniture
- 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:
- Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding.
- 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 airconditioner.

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

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

BE3272  BASIC ELECTRICAL, ELECTRONICS AND INSTRUMENTATION  L T P C
        ENGINEERING LABORATORY  0 0 4 2

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 Ohm's and Kirchhoff's Laws.
2. Three Phase Power Measurement
3. Load test on DC Shunt Motor.
4. Load test on Self Excited DC Generator
5. Load test on Single phase Transformer
6. Load Test on Induction Motor
7. Characteristics of PN and Zener Diodes
8. Characteristics of BJT, SCR and MOSFET
9. Design and analysis of Half wave and Full Wave rectifiers
10. Measurement of displacement of LVDT

TOTAL: 60 PERIODS

OUTCOMES:
After completing this course, the students will be able to

CO1: Use experimental methods to verify the Ohm's law and Kirchhoff's Law and to measure three phase power

CO2: Analyze experimentally the load characteristics of electrical machines

CO3: Analyze the characteristics of basic electronic devices

CO4: Use LVDT to measure displacement

OBJECTIVES
- To identify varied group discussion skills and apply them to take part in effective discussions in a professional context.
- To be able to communicate effectively through writing.

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 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-describing 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.

LEARNING OUTCOMES
- Speak effectively in group discussions held in a formal/semi formal contexts.
- Write emails and effective job applications.

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

MA3356 DIFFERENTIAL EQUATIONS  

OBJECTIVES :
- To acquaint the students with Differential Equations which are significantly used in engineering problems
- To introduce the basic concepts of PDE for solving standard partial differential equations.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.
- To understand the knowledge of various techniques and methods of solving various types of partial differential equations.
- To understand the finite methods for time dependent partial differential equations.

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

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

UNIT III NUMERICAL METHODS FOR ORDINARY DIFFERENTIAL EQUATIONS 9+3

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

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

TOTAL: 60 PERIODS

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

TEXT BOOKS:

REFERENCES :

CH3301 BASIC MECHANICAL ENGINEERING L T P C 3 0 0 3

COURSE OBJECTIVES:
- To impart knowledge on thermodynamics and thermal engineering power generating units such as engines and theory of machines

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

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

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

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

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

COURSE OUTCOMES:
On Completion of the course, the students would
• Therodynamics and thermal engineering to understand the principles behind the operation of thermal equipments like IC engines and turbines.
• Be able to appreciate the theory behind operation of machinery and be able to design simple mechanisms.

TEXT BOOKS

REFERENCES

Course articulation matrix

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

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

UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS


UNIT II TRANSVERSE LOADING ON BEAMS


UNIT III DEFLECTIONS OF BEAMS

Double integration method – Macaulay’s method – Area – moment theorems for computation of slopes and deflections in beams.

UNIT IV.stresses in beams


UNIT V TORSION AND COLUMNS


TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students would be able to

- Solve the problems related to the structural components under various loading conditions

TEXT BOOKS:


REFERENCE:

## Course articulation matrix

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<td>CO1</td>
<td>Understand the basic concepts of stress, strain and deformation of solids</td>
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<td>CO2</td>
<td>Understand the concept of transverse loading on statistically deterministic beams and its</td>
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<td>CO3</td>
<td>Understand the concept of slope and deflection in beams through Double Integration,</td>
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<td>CO4</td>
<td>Understand the stress distribution concept like bending and shear stresses in beams and leaf springs</td>
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<td>CO5</td>
<td>Understand the stress and deformation in shafts, analysis of columns by Euler’s theory and effect of eccentricity.</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
COURSE OBJECTIVES:

- To enable the students to acquire knowledge on laws of chemistry and its application to solution of mass and energy balance equations for single and network of units and introduce to process simulators.

UNIT I
9
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
9
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
9
Calculation of absolute humidity, molal humidity, relative humidity and percentage humidity - Use of humidity in condensation and drying - Humidity chart, dew point.

UNIT IV
9

UNIT V
9
Determination of Composition by Orsat analysis of products of combustion of solid, liquid and gas fuels - Calculation of excess air from orsat technique, problems on sulphur and sulphur burning compounds - Application of Process simulators in energy and material balance problems.

COURSE OUTCOMES:
On completion of the course, the students would be able to
- Understand the fundamentals of units and stoichiometric equations.
- Write material balance for different chemical process.
- Understand the fundamentals of ideal gas behavior and phase equilibria. Write energy balance for different chemical process.

TEXT BOOKS:

REFERENCE:
Course articulation matrix:

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<tbody>
<tr>
<td>CO1</td>
<td>Understand the concepts of dimensional consistency and effective application of units and dimensions.</td>
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<td>CO2</td>
<td>Analyze a problem statement and balance the material flowing through single and various operations</td>
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<td>CO3</td>
<td>Understand the gas behavior and its properties</td>
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<td>CO4</td>
<td>Understand general energy balance, simplify and apply to open and closed systems</td>
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<td>CO5</td>
<td>Write material and energy balance for unsteady state how material and energy balances are formulated for equation- and modular based flow sheeting codes</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively
COURSE OBJECTIVES:

- To enable the students to acquire a sound knowledge on fluid properties, fluid statics, dynamic characteristics of fluid flow for through pipes and porous medium, flow measurement and fluid machineries

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

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

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

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

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

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

- Understand the fundamental properties of fluids and its characteristics under static conditions.
- Develop empirical correlation using dimensionless analysis.
- Analyze flow of fluid through pipe and over the of solid,
- Understand and select flow meter(s), characteristics of pumps used in Chemical Process Industries

TEXT BOOKS:

REFERENCES:
### Course articulation matrix:

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

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

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

UNIT III  PULP, PAPER, SUGAR AND STARCH INDUSTRIES

UNIT IV  PETROLEUM AND PETRO CHEMICAL INDUSTRIES

UNIT V  FUEL AND INDUSTRIAL GASES

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

TEXT BOOKS:

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

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Program Outcomes</th>
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CH3311 BASIC MECHANICAL ENGINEERING LABORATORY

COURSE OBJECTIVES:
The course is aimed to
- Impart practical knowledge in operating IC engines and conduct experiments.
- To make the students understand the test procedures in testing material for engineering applications

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

EQUIPMENTS REQUIRED FOR A BATCH OF 30 STUDENTS
1. Single cylinder diesel engine coupled with Electrical loading
2. Single cylinder diesel engine coupled with Electrical loading with temperature indicators
3. Single cylinder slow speed diesel engine coupled with Mechanical loading
4. Twin cylinder diesel engine coupled with Electrical loading with Heat balance test setup
5. Single cylinder petrol engine coupled with Electrical loading
6. Two stroke IC Engine model
7. Four stroke IC Engine model
8. Small IC Engine models for study
9. UTM and Hardness test apparatus

L T P C
0 0 3 1.5
COURSE OUTCOMES:
On the completion of the course students are expected to
CO1: Determine Brake power, Indicated power and frictional power of single cylinder diesel engines.
CO2: Determine Brake power, Indicated power and frictional power of twin cylinder diesel engines.
CO3: Determine Brake power, Indicated power and frictional power of single cylinder petrol engines.
CO4: Evaluate the heat distribution from engine and preparing heat balance chart.
CO5: Estimate the engine performance with mechanical loading
CO6: Estimate the PTD and VTD of two and four stroke engines

TOTAL: 45 PERIODS
COURSE OBJECTIVES:

- To learn basic principles involved in estimation and characterization of industrially important materials.

Experiments:

I. Soap Analysis
   a. Estimation of total fatty acid
   b. Estimation of percentage alkali content

II. Oil Analysis
   a. Estimation of free acid
   b. Determination of Saponification value
   c. Determination of iodine value

III. Cement Analysis
   a. Estimation of Silica content
   b. Estimation of mixed oxide content
   c. Estimation of calcium oxide content
   d. Estimation of calcium oxide by rapid method

IV. Coal Analysis
   a. Estimation of Sulphur present in coal
   b. Ultimate analysis of coal
   c. Proximate analysis of coal

V. Analysis of Bleaching Powder
   a. Estimation of available chlorine

VI. Analysis of Glycerol
   Estimation of purity of glycerol

VII. Analysis of fuels
   a. Flash point
   b. Fire point
   c. Cloud point
   d. Pour point
   e. Aniline point

EQUIPMENTS REQUIRED FOR A BATCH OF 30 STUDENTS

COURSE OUTCOMES:

GE3361 PROFESSIONAL DEVELOPMENT

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

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

**MS EXCEL:**

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

**MS POWERPOINT:**

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

**OUTCOMES:**

On successful completion the students will be able to

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

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

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

UNIT III FOURIER TRANSFORMS

UNIT IV LAPLACE TRANSFORMS

UNIT V Z-TRANSFORMS AND DIFFERENCE EQUATIONS

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

TEXT BOOKS
REFERENCES

CH3451 MASS TRANSFER I

COURSE OBJECTIVES:
The course is aimed to enable the students

- Learn and determine mass transfer rates under laminar and turbulent conditions and apply these concepts in the design of humidification columns, dryers and crystallisers.

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

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

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

UNIT IV DRYING 9
Drying – Equilibrium. Classification of dryers, batch drying – Mechanism and time of cross through circulation drying, theoretical estimation of drying rate and time. Continuous dryers – material and energy balance. Advance drying techniques such as freeze drying, microwave drying

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

TOTAL: 45 PERIODS

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

CO1: Understand the fundamentals, types and mechanism of mass transfer operations
CO2: Understand the theories of mass transfer and the concept of inter-phase mass transfer
CO3: Understand the basics of humidification process and its application
CO4: Understand the concept and mechanism of drying operations
CO5: Understand the concept of crystallization process and identification of suitable crystallizer
CO6: Formulate and solve material balances for unit operations such as humidification, drying and crystallization operations.

TEXT BOOKS:


REFERENCES:


### Course articulation matrix:

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Statements</th>
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<td>CO1</td>
<td>Understand the fundamentals, types and mechanism of mass transfer operations</td>
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<td>CO2</td>
<td>Understand the theories of mass transfer and the concept of interphase mass transfer</td>
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<tr>
<td>CO3</td>
<td>Understand the basics of humidification process and its application</td>
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<tr>
<td>CO4</td>
<td>Understand the concept and mechanism of drying operations</td>
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<tr>
<td>CO5</td>
<td>Understand the concept of crystallization process and identification of suitable crystallizer And formulate to solve material balances for unit operations such as humidification, drying and crystallization operations.</td>
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</tbody>
</table>

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

- To impact knowledge in the field of particle size reduction and also construction and working of equipment’s used for mechanical operations.

UNIT I  PARTICLE CHARACTERIZATION AND MEASUREMENT

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

UNIT II  PARTICLE SIZE REDUCTION AND SIZE ENLARGEMENT

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

UNIT III  PARTICLE SEPARATION (GAS-SOLID AND LIQUID-SOLID SYSTEM)

Gravity settling, sedimentation, thickening, elutriation, double cone classifier, rake classifier, bowl classifier. Centrifugal separation - continuous centrifuges, super centrifuges, design of basket centrifuges; industrial dust removing equipment, cyclones and hydro cyclones, electrostatic and magnetic separators, heavy media separations, floatation, jigging.

UNIT IV  FILTRATION AND FILTRATION EQUIPMENTS

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

UNIT V  MIXING AND PARTICLE HANDLING

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

COURSE OUTCOME:

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

- CO1: Understand and determine various properties of particulates
- CO2: Gain Preliminary understanding on Size Reduction and Size Enlargement
- CO3: Understand various separation and purification techniques employed in solid particles
- CO4: Enhance their knowledge on Filtration Process
- CO5: Understand Handling, Storage and Transportation of Solids and Obtain knowledge on various unit operations and their applications

TOTAL: 45 PERIODS

TEXT BOOKS:


REFERENCES:

2. Christie J. Geankoplis, Transport processes and unit operations.
## Course articulation matrix

<table>
<thead>
<tr>
<th>Cours e Outcomes</th>
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<tbody>
<tr>
<td></td>
<td>PO 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15</td>
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<tr>
<td>CO1</td>
<td>Understand and determine various properties of particulates</td>
<td>3 3 3 3 1 1 1 - 3 3 3 2 3 1</td>
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<tr>
<td>CO2</td>
<td>Gain Preliminary understanding on Size Reduction and Size Enlargement</td>
<td>3 2 2 2 2 1 1 - 1 2 2 2 2 3 1</td>
</tr>
<tr>
<td>CO3</td>
<td>Understand various separation and purification techniques employed in solid particles</td>
<td>3 2 2 3 3 1 3 2 1 2 3 2 2 3 3</td>
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<tr>
<td>CO4</td>
<td>Enhance their knowledge on Filtration Process</td>
<td>2 2 2 1 1 1 2 1 1 1 1 1 2 2 1</td>
</tr>
<tr>
<td>CO5</td>
<td>Understand Handling, Storage and Transportation of Solids and Obtain knowledge on various unit operations and their applications</td>
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<tr>
<td>OVERALL CO</td>
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</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
COURSE OBJECTIVES:
The course is aimed to enable the students to
• Learn PVT behaviour of fluids, laws of thermodynamics, thermodynamic property relations
  and their application to fluid flow, power generation and refrigeration processes.

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

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

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

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

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On the completion of the course students are expected to
CO1: Understand the fundamental concepts of thermodynamics and its related functions
CO2: Relate PVT behaviour of fluids and understand the real gas behavior
CO3: Apply second law and analyse the feasibility of system/devices
CO4: Analyse the thermodynamic property relations and their application to fluid flow
CO5: Develop the significance of thermodynamic potentials and their use in the analysis of
processes
CO6: Formulate thermodynamic formulations and the working of compressors and expanders

TEXT BOOKS:

REFERENCES:
2. Narayanan K.V."A Text Book of Chemical Engineering Thermodynamics"Prentice Hall of India
3. Kevin Douglas, Fundamentals of Chemical Engineering Thermodynamics, Timothy
  Anderson,2015
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<td>CO1</td>
<td>Understand the fundamental concepts of thermodynamics and its related functions</td>
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<td>CO2</td>
<td>Relate PVT behaviour of fluids and understand the real gas behavior</td>
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<td>CO3</td>
<td>Apply second law and analyse the feasibility of system/devices</td>
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<tr>
<td>CO4</td>
<td>Analyse the thermodynamic property relations and their application to fluid flow</td>
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<tr>
<td>CO5</td>
<td>Develop the significance of thermodynamic potentials and their use in the analysis of processes and formulate thermodynamic formulations and the working of compressors and expanders</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
COURSE OBJECTIVES:
The course is aimed to
☐ 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.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On the completion of the course students are expected to
CO1: Familiarize 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: Have knowledge about boundary layer flow, laminar and turbulent flows
CO4: Calculate and use overall heat transfer coefficients in designing heat exchangers
CO5: Have knowledge about heat transfer with phase change (Boiling and condensation) and evaporation
CO6: 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

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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>
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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>
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<tr>
<td>CO3</td>
<td>insight about boundary layer flow, laminar and turbulent flows and to calculate and use overall heat transfer coefficients in designing heat exchangers</td>
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<tr>
<td>CO4</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>CO5</td>
<td>The course provides the student with knowledge about heat transfer with phase change (boiling and condensation) and evaporation</td>
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UNIT I ENVIRONMENT AND BIODIVERSITY

UNIT II ENVIRONMENTAL POLLUTION

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

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

UNIT V SUSTAINABILITY PRACTICES

TOTAL: 45 PERIODS

TEXT BOOKS:
5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning.

REFERENCE BOOKS:
COURSE OBJECTIVES:

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

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

*Minimum 10 experiments shall be offered

EQUIPMENT REQUIRED FOR A BATCH OF 30 STUDENTS
1. Viscometer 1 No.
2. Venturi meter 1 No.
3. Orifice meter 1 No.
4. Rotameter 1 No.
5. Weir and Notches 1 No.
6. Open drum with orifice 1 No.
7. Pipes and fittings 1 No.
8. Helical and spiral coils 1 No.
10. Packed column 1 No.
11. Fluidized bed 1 No.

Minimum 10 equipment

TOTAL: 45 PERIODS

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

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

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<tr>
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<td>PO 1</td>
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<tr>
<td>CO1</td>
<td>Identify and characterize flow patterns and regimes</td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>Calibrate flow measurement devices</td>
<td>-</td>
</tr>
<tr>
<td>CO3</td>
<td>Correlate the difference between fixed and fluidized bed columns and its application</td>
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<tr>
<td>CO4</td>
<td>Select pumps for the transportation of fluids based on process conditions/requirements and fluid properties</td>
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<tr>
<td>CO5</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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</tbody>
</table>

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.
COURSE OBJECTIVES:
The course is aimed to
- Develop sound practical knowledge on different types of mechanical operations equipments.

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

EQUIPMENTS REQUIRED FOR A BATCH OF 30 STUDENTS
1. Sieve shaker
2. Leaf filter
3. Plate and Frame Filter Press
4. Sedimentation Jar
5. Jaw Crusher
6. Ball Mill
7. Cyclone Separator
8. Roll Crusher
9. Elutriator
10. Drop Weight Crusher
11. Sieves.

*Minimum 10 experiments shall be offered

COURSE OUTCOMES:
On the completion of the course students are expected to
CO1: Determine the size analysis in solid- solid separation systems
CO2: Capability to select different solid - fluid separation equipments.
CO3: Evaluate the size reduction and various crushing parameters
CO4: Estimate the separation characteristics
CO5: Understand the technical methods related to unit operations in process plant
CO6: Apply and understand fluid particle systems and equipment

TOTAL: 45 PERIODS
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<td>CO1</td>
<td>Determine the size analysis in solid-solids solid separation systems</td>
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<td>Capability to select different solid-fluid separation equipments.</td>
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<td>CO3</td>
<td>Evaluate the size reduction and various crushing parameters</td>
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<td>CO4</td>
<td>Estimate the separation characteristics</td>
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<td>CO5</td>
<td>Understand the technical methods related to unit operations in process plant</td>
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1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.