

ANNA UNIVERSITY, CHENNAI
NON-AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY
REGULATIONS 2021
B.TECH. PETROCHEMICAL TECHNOLOGY
CHOIC BASED CREDIT SYSTEM
I AND II SEMESTERS CURRICULA AND SYLLABI
SEMESTER I

S. No.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	IP3151	Induction Programme	-	-	-	-	-	0
THEORY								
2.	HS3151	Professional English – I	HSMC	3	1	0	4	4
3.	MA3151	Matrices and Calculus	BSC	3	1	0	4	4
4.	PH3151	Engineering Physics	BSC	3	0	0	3	3
5.	CY3151	Engineering Chemistry	BSC	3	0	0	3	3
6.	GE3151	Problem Solving and Python Programming	ESC	3	0	0	3	3
PRACTICALS								
7.	GE3171	Problem Solving and Python Programming Laboratory	ESC	0	0	4	4	2
8.	BS3171	Physics and Chemistry Laboratory	BSC	0	0	4	4	2
TOTAL				15	2	8	25	21

SEMESTER II

S. No.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	HS3251	Professional English – II	HSMC	3	1	0	4	4
2.	MA3251	Statistics and Numerical Methods	BSC	3	1	0	4	4
3.	PH3253	Materials Science for Technologists	BSC	3	0	0	3	3
4.	BE3252	Basic Electrical, Electronics and Instrumentation Engineering	BSC	3	0	0	3	3
5.	CY3251	Chemistry for Technologists	BSC	3	0	0	3	3
6.	GE3251	Engineering Graphics	ESC	2	0	4	6	4
7.		NCC Credit Course Level 1*	-	2	0	0	2	2
PRACTICALS								
7	GE3271	Engineering Practices Laboratory	ESC	0	0	4	4	2
8	BE3272	Basic Electrical, Electronics and Instrumentation Engineering Laboratory	ESC	0	0	4	4	2
TOTAL				17	2	12	31	25

*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.

IP3151

INDUCTION PROGRAMME

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't's, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing.

Discussions would be conducted in small groups of about 20 students with a faculty mentor each. It would be effective that the faculty mentor assigned is also the faculty advisor for the student for the full duration of the UG programme.

(iv) Literary Activity

Literary activity would encompass reading, writing and possibly, debating, enacting a play etc.

(v) Proficiency Modules

This would address some lacunas that students might have, for example, English, computer familiarity etc.

(vi) Lectures by Eminent People

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

(vii) Visits to Local Area

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

(viii) Familiarization to Dept./Branch & Innovations

They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilities.

(ix) Department Specific Activities

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

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

REFERENCES:

Guide to Induction program from AICTE

HS3151

PROFESSIONAL ENGLISH - I

L T P C
3 1 0 4

COURSE OBJECTIVES:

- To improve the communicative competence of learners
- To help learners use language effectively in academic /work contexts
- To build on students' English language skills by engaging them in listening, speaking and grammar learning activities that are relevant to authentic contexts.
- To develop learners' ability to read and write complex texts, summaries, articles, blogs, definitions, essays and user manuals.
- To use language efficiently in expressing their opinions via various media.

INTRODUCTION TO EFFECTIVE COMMUNICATION

1

- What is effective communication? (There are many interesting activities for this.)
- 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 I INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION 11

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** - Self Introduction; Introducing a friend; Conversation - politeness strategies; Telephone conversation; Leave a voicemail; Leave a message with another person; asking for information to fill details in a form. **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 12

Listening - Listening to podcast, anecdotes / stories / event narration; documentaries and interviews with celebrities. **Speaking** - Narrating personal experiences / events; Interviewing a celebrity; Reporting / and summarizing of documentaries / podcasts/ interviews. **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 12

Listening - Listen to a product and process descriptions; a classroom lecture; and advertisements about a products. **Speaking** – Picture description; giving instruction to use the product; Presenting a product; and summarizing a lecture. **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 12

Listening – Listening to TED Talks; Scientific lectures; and educational videos. **Speaking** – Small Talk; Mini presentations and making 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 12

Listening – Listening to debates/ discussions; different viewpoints on an issue; and panel discussions. **Speaking** –group discussions, Debates, and Expressing opinions through Simulations & Role play. **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: 60 PERIODS**COURSE OUTCOMES:**

At the end of the course, learners will be able

- CO1 : To listen and comprehend complex academic texts
- CO2 : To read and infer the denotative and connotative meanings of technical texts
- CO3 : To write definitions, descriptions, narrations and essays on various topics
- CO4 : To speak fluently and accurately in formal and informal communicative contexts
- CO5 : To express their opinions effectively in both oral and written medium of communication

TEXT BOOKS :

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

REFERENCES:

1. Technical Communication – Principles And Practices By Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2016, New Delhi.
2. A Course Book on Technical English By Lakshmi Narayanan, Scitech Publications (India) Pvt. Ltd.
3. English For Technical Communication (With CD) By Aysha Viswamohan, Mcgraw Hill Education, ISBN : 0070264244.
4. Effective Communication Skill, Kulbhusan Kumar, R S Salaria, Khanna Publishing House. Learning to Communicate – Dr. V. Chellammal, Allied Publishing House, New Delhi, 2003.

MA3151**MATRICES AND CALCULUS**

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

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

UNIT I MATRICES**9+3**

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley - Hamilton theorem – Diagonalization of matrices by orthogonal transformation – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms – Applications : Stretching of an elastic membrane.

UNIT II DIFFERENTIAL CALCULUS**9+3**

Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules (sum, product, quotient, chain rules) - Implicit differentiation - Logarithmic differentiation - Applications : Maxima and Minima of functions of one variable.

UNIT III FUNCTIONS OF SEVERAL VARIABLES**9+3**

Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Applications : Maxima and minima of functions of two variables and Lagrange's method of undetermined multipliers.

UNIT IV INTEGRAL CALCULUS**9+3**

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

UNIT V MULTIPLE INTEGRALS**9+3**

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals – Applications : Moments and centres of mass, moment of inertia.

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 :

1. Kreyszig, E., "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. Grewal, B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44th Edition, 2018.
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:

1. Anton. H, Bivens. I and Davis. S, "Calculus", Wiley, 10th Edition, 2016
2. Bali. N., Goyal. M. and Watkins. C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.), New Delhi, 7th Edition, 2009.
3. Jain . R.K. and Iyengar. S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 5th Edition, 2016.
4. Narayanan. S. and Manicavachagom Pillai. T. K., "Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
5. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
6. Srimantha Pal and Bhunia. S.C, "Engineering Mathematics" Oxford University Press, 2015.
7. Thomas. G. B., Hass. J, and Weir. M.D, "Thomas Calculus", 14th Edition, Pearson India, 2018.

PH3151**ENGINEERING PHYSICS****L T P C****3 0 0 3****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**

Multi-particle dynamics: Center of mass (CM) – CM of continuous bodies – motion of the CM – kinetic energy of system of particles. Rotation of rigid bodies: Rotational kinematics – rotational kinetic energy and moment of inertia - theorems of M.I –moment of inertia of continuous bodies – M.I of a diatomic molecule - torque – rotational dynamics of rigid bodies – conservation of angular momentum – rotational energy state of a rigid diatomic molecule - gyroscope - torsional pendulum – double pendulum –Introduction to nonlinear oscillations.

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**

Simple harmonic motion - resonance –analogy between electrical and mechanical oscillating systems - waves on a string - standing waves - traveling waves - Energy transfer of a wave - sound waves - Doppler effect. Reflection and refraction of light waves - total internal reflection - interference –Michelson interferometer –Theory of air wedge and experiment.^[SEP]Theory of laser - characteristics - Spontaneous and stimulated emission - Einstein's coefficients - population inversion - Nd-YAG laser, CO₂ laser, semiconductor laser –Basic applications of lasers in industry.

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.

TOTAL : 45 PERIODS**COURSE OUTCOMES**

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

CO1 : Understand the importance of mechanics.

CO2 : Express their knowledge in electromagnetic waves.

CO3 : Demonstrate a strong foundational knowledge in oscillations, optics and lasers.

CO4 : Understand the importance of quantum physics.

CO5 : Comprehend and apply quantum mechanical principles towards the formation of energy bands.

TEXT BOOKS:

1. D.Kleppner and R.Kolenkow. An Introduction to Mechanics. McGraw Hill Education (Indian Edition), 2017. ^[SEP]
2. E.M.Purcell and D.J.Morin, Electricity and Magnetism, Cambridge Univ.Press, 2013.
3. Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, Concepts of Modern Physics, McGraw-Hill (Indian Edition), 2017.

REFERENCES:

1. R.Wolfson. Essential University Physics. Volume 1 & 2. Pearson Education (Indian Edition), 2009.
2. Paul A. Tipler, Physic – Volume 1 & 2, CBS, (Indian Edition), 2004.
3. K.Thyagarajan and A.Ghatak. Lasers: Fundamentals and Applications, Laxmi Publications, (Indian Edition), 2019.
4. D.Halliday, R.Resnick and J.Walker. Principles of Physics, Wiley (Indian Edition), 2015.
5. N.Garcia, A.Damask and S.Schwarz. Physics for Computer Science Students. Springer-Verlag, 2012.

CY3151**ENGINEERING CHEMISTRY****L T P C****3 0 0 3****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**9**

Water: Sources and impurities, Water quality parameters: Definition and significance of-color, odour, turbidity, pH, hardness, alkalinity, TDS, COD and BOD, flouride and arsenic. Municipal water treatment: primary treatment and disinfection (UV, Ozonation, break-point chlorination). Desalination of brackish water: Reverse Osmosis. Boiler troubles: Scale and sludge, Boiler corrosion, Caustic embrittlement, Priming & foaming. Treatment of boiler feed water: Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) and External treatment – Ion exchange demineralization and zeolite process.

UNIT II NANOCHEMISTRY**9**

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**9**

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. CO₂ 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: H₂-O₂ fuel cell, microbial fuel cell; Supercapacitors: Storage principle, types and examples.

TOTAL: 45 PERIODS**COURSE OUTCOMES**

At the end of the course, the students will be able:

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

TEXT BOOKS:

1. P. C. Jain and Monica Jain, "Engineering Chemistry", 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2018.
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008.
3. S.S. Dara, "A Text book of Engineering Chemistry", S. Chand Publishing, 12th Edition, 2018.

REFERENCES:

1. B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath and James Murday, "Text book of nanoscience and nanotechnology", Universities Press-IIM Series in Metallurgy and Materials Science, 2018.
2. O.G. Palanna, "Engineering Chemistry" McGraw Hill Education (India) Private Limited, 2nd Edition, 2017.
3. Friedrich Emich, "Engineering Chemistry", Scientific International PVT, LTD, New Delhi, 2014.
4. Shikha Agarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, Second Edition, 2019.
5. O.V. Roussak and H.D. Gesser, Applied Chemistry-A Text Book for Engineers and Technologists, Springer Science Business Media, New York, 2nd Edition, 2013.

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

Fundamentals of Computing – Identification of Computational Problems -Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

UNIT II DATA TYPES, EXPRESSIONS, STATEMENTS 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:

1. Allen B. Downey, "Think Python : How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.
2. Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and programming", 1st Edition, BCS Learning & Development Limited, 2017.
- 3.

REFERENCES:

1. Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021.
2. G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1st Edition, Notion Press, 2021.
3. John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data", Third Edition, MIT Press, 2021
4. Eric Matthes, "Python Crash Course, A Hands - on Project Based Introduction to Programming", 2nd Edition, No Starch Press, 2019.
5. <https://www.python.org/>
6. Martin C. Brown, "Python: The Complete Reference", 4th Edition, Mc-Graw Hill, 2018.

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

OBJECTIVES:

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

EXPERIMENTS:

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

1. Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same. (Electricity Billing, Retail shop billing, Sin series, weight of a motorbike, Weight of a steel bar, compute Electrical Current in Three Phase AC Circuit, etc.)
2. Python programming using simple statements and expressions (exchange the values of two variables, circulate the values of n variables, distance between two points).
3. Scientific problems using Conditionals and Iterative loops. (Number series, Number Patterns, pyramid pattern)
4. Implementing real-time/technical applications using Lists, Tuples. (Items present in a library/Components of a car/ Materials required for construction of a building –operations of list & tuples)
5. Implementing real-time/technical applications using Sets, Dictionaries. (Language, components of an automobile, Elements of a civil structure, etc.- operations of Sets & Dictionaries)
6. Implementing programs using Functions. (Factorial, largest number in a list, area of shape)
7. Implementing programs using Strings. (reverse, palindrome, character count, replacing characters)
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)
11. Exploring Pygame tool.
12. Developing a game activity using Pygame like bouncing ball, car race etc.

TOTAL: 60 PERIODS

OUTCOMES:

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

CO1: Develop algorithmic solutions to simple computational problems

CO2: Develop and execute simple Python programs.

CO3: Implement programs in Python using conditionals and loops for solving problems..

CO4: Deploy functions to decompose a Python program.

CO5: Process compound data using Python data structures.

CO6: Utilize Python packages in developing software applications.

TEXT BOOKS:

1. Allen B. Downey, "Think Python : How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.
2. Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and Programming", 1st Edition, BCS Learning & Development Limited, 2017.

REFERENCES:

1. Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021.
2. G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1st Edition, Notion Press, 2021.
3. John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data", Third Edition, MIT Press , 2021
4. Eric Matthes, "Python Crash Course, A Hands - on Project Based Introduction to Programming", 2nd Edition, No Starch Press, 2019.
5. <https://www.python.org/>
6. Martin C. Brown, "Python: The Complete Reference", 4th Edition, Mc-Graw Hill, 2018.

BS3171

PHYSICS AND CHEMISTRY LABORATORY

L T P C
0 0 4 2**PHYSICS LABORATORY: (Any Seven Experiments)****COURSE OBJECTIVES:**

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

LIST OF EXPERIMENTS

1. Torsional pendulum - Determination of rigidity modulus of wire and moment of inertia of regular and irregular objects.
2. Simple harmonic oscillations of cantilever.
3. Non-uniform bending - Determination of Young's modulus
4. Uniform bending – Determination of Young's modulus
5. Laser- Determination of the wave length of the laser using grating
6. Air wedge - Determination of thickness of a thin sheet/wire
7. a) Optical fibre -Determination of Numerical Aperture and acceptance angle
b) Compact disc- Determination of width of the groove using laser.
8. Acoustic grating- Determination of velocity of ultrasonic waves in liquids.

9. Ultrasonic interferometer – determination of the velocity of sound and compressibility of liquids
10. Post office box -Determination of Band gap of a semiconductor.
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 electro analytical 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.
12. Estimation of sodium /potassium present in water using flame photometer.
13. Preparation of nanoparticles (TiO₂/ZnO/CuO) by Sol-Gel method.
14. Estimation of Nickel in steel
15. Proximate analysis of Coal

TOTAL : 30 PERIODS

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:

1. J. Mendham, R. C. Denney, J.D. Barnes, M. Thomas and B. Sivasankar, Vogel's Textbook of Quantitative Chemical Analysis (2009).

HS3251

PROFESSIONAL ENGLISH - II

L T P C
3 1 0 4**COURSE OBJECTIVES**

- To engage learners in meaningful language activities to improve their LSRW skills
- To enhance learners' awareness of general rules of writing for specific audiences
- 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 12

Listening – Evaluative Listening: Advertisements, Product Descriptions, -Audio / video; Listening and filling a Graphic Organiser (Choosing a product or service by comparison). **Speaking** – Marketing a product, Persuasive Speech Techniques. **Reading** - Reading advertisements, user manuals, brochures; **Writing** – Professional emails, Email etiquette - Compare and Contrast Essay; **Grammar** – Mixed Tenses, Prepositional phrases. **Vocabulary** – Contextual meaning of words

UNIT II EXPRESSING CAUSAL RELATIONS IN SPEAKING AND WRITING 12

Listening - Listening to longer technical talks and completing– gap filling exercises. Listening technical information from podcasts – Listening to process/event descriptions to identify cause & effects - **Speaking** – Describing and discussing the reasons of accidents or disasters based on news reports. **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 **Vocabulary** – Word Formation (Noun-Verb-Adj-Adv), Adverbs.

UNIT III PROBLEM SOLVING 12

Listening – Listening to / Watching movie scenes/ documentaries depicting a technical problem and suggesting solutions. **Speaking** – Group Discussion (based on case studies), - techniques and Strategies, **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. **Vocabulary** - Compound Words, Sentence Completion.

UNIT IV REPORTING OF EVENTS AND RESEARCH 12

Listening – Listening Comprehension based on news reports – and documentaries – Precis writing, Summarising, **Speaking** –Interviewing, Presenting an oral report, Mini presentations on select topics; **Reading** –Newspaper articles; **Writing** – Recommendations, Transcoding, Accident Report, Survey Report **Grammar** – Reported Speech, Modals **Vocabulary** – Conjunctions- use of prepositions

UNIT V THE ABILITY TO PUT IDEAS OR INFORMATION COGENTLY 12

Listening – Listening to TED Talks, Presentations, Formal job interviews, (analysis of the interview performance); **Speaking** – Participating in a Role play, (interview/telephone interview), virtual interviews, Making presentations with visual aids; **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 **Vocabulary** – Idioms.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able

CO1 : To compare and contrast products and ideas in technical texts.

CO2 : To identify cause and effects in events, industrial processes through technical texts

CO3 : To analyze problems in order to arrive at feasible solutions and communicate them orally and in the written format.

CO4 : To report events and the processes of technical and industrial nature.

CO5 : To present their opinions in a planned and logical manner, and draft effective resumes in context of job search.

TEXT BOOKS:

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

REFERENCES:

1. Raman. Meenakshi, Sharma. Sangeeta (2019). Professional English. Oxford university press. New Delhi.
2. Improve Your Writing ed. V.N. Arora and Laxmi Chandra, Oxford Univ. Press, 2001, New Delhi.
3. Learning to Communicate – Dr. V. Chellammal. Allied Publishers, New Delhi, 2003
4. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
5. Developing Communication Skills by Krishna Mohan, Meera Bannerji- Macmillan India Ltd. 1990, Delhi.

MA3251**STATISTICS AND NUMERICAL METHODS****L T P C
3 1 0 4****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

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method- Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Eigenvalues of a matrix by Power method and Jacobi's method for symmetric matrices.

UNIT IV INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION 9+3

Lagrange's and Newton's divided difference interpolations – Newton's forward and backward difference interpolation – Approximation of derivatives using interpolation polynomials – Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules.

UNIT V NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS 9+3

Single step methods: Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge-Kutta method for solving first order differential equations - Multi step methods: Milne's and Adams - Bash forth predictor corrector methods for solving first order differential equations.

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:

1. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015.
2. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.

REFERENCES:

1. Burden, R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2014.
3. Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis" Pearson Education, Asia, New Delhi, 7th Edition, 2007.
4. Gupta S.C. and Kapoor V. K., " Fundamentals of Mathematical Statistics", Sultan Chand & Sons, New Delhi, 12th Edition, 2020.
5. Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum's Outlines on Probability and Statistics ", Tata McGraw Hill Edition, 4th Edition, 2012.
6. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", 9th Edition, Pearson Education, Asia, 2010.

COURSE OBJECTIVES:

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

UNIT I CRYSTALLOGRAPHY**9**

Crystallographic directions and planes – metallic crystal structures: BCC, FCC and HCP – linear and planar densities – crystal imperfections- edge and screw dislocations, Burgers vector and elastic strain energy- surface imperfections – grain and twin boundaries – Polymorphism – phase changes – nucleation and growth – homogeneous and heterogeneous nucleation.

UNIT II MECHANICAL PROPERTIES**9**

Tensile test - plastic deformation by slip – slip systems – mechanisms of strengthening in metals: strain hardening, grain size reduction, solid solution strengthening, precipitation hardening – Creep: creep curves, stress and temperature effects, mechanisms of creep, creep-resistant materials – Fracture: ductile and brittle fractures - the Griffith criterion – fracture toughness - Fatigue failure: the S-N curve – factors that affect fatigue life – Hardness: Rockwell and Brinell hardness tests, Knoop and Vickers microhardness tests.

UNIT III PHASE DIAGRAMS**9**

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

UNIT IV FERROUS AND NONFERROUS ALLOYS**9**

The Fe-Fe₃C phase diagram: phases, invariant reactions, development of microstructure in eutectoid, hypoeutectoid and hypereutectoid alloys – influence of other alloying elements in the Fe-C system - phase transformations – isothermal transformation diagram for eutectoid iron-carbon alloy – microstructures: pearlite, bainite, spheroidite and martensite – steels, stainless steels and cast irons – copper alloys – aluminum alloys – titanium alloys.

UNIT V CERAMICS, COMPOSITES AND NANO MATERIALS**9**

Ceramics – types and applications-refractories, abrasives and cements – Composites: classification, role of matrix and reinforcement -Fiber reinforced composites – carbon-carbon composites –Nanomaterials:types, physical, chemical and mechanical properties - carbon nanotubes: properties and applications - synthesis of nanomaterials: sonochemical, molecular epitaxy, physical vapor deposition (PVD) and chemical vapor deposition (CVD). Characterization: Transmission electron microscopy - scanning electron microscopy - Atomic force microscopy - X-ray powder diffraction - Nanoparticle size calculation.

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

- CO1 : Upon completion of this course, the students should be able to
- CO2 : Understand the basics of crystallography and its importance in materials properties
- CO3 : Understand the significance of dislocations, strengthening mechanisms, and tensile, creep, hardness and fracture behavior of materials
- CO4 : Gain knowledge on binary phase diagrams, and also will be able to determine the phase composition and phase amount.

UNIT III ELECTRICAL MACHINES**9**

Construction and Working principle- DC Separately and Self excited Generators, EMF equation, Types and Applications. Working Principle of DC motors, Torque Equation, Types and Applications. Construction, Working principle and Applications of Transformer, Three phase Alternator, Synchronous motor and Three Phase Induction Motor.

UNIT IV ANALOG ELECTRONICS**9**

Resistor, Inductor and Capacitor in Electronic Circuits- Semiconductor Materials: Silicon & Germanium – PN Junction Diodes, Zener Diode – Characteristics Applications – Bipolar Junction Transistor-Biasing, JFET, SCR, MOSFET, IGBT – Types, I-V Characteristics and Applications, Rectifier and Inverters, harmonics

UNIT V SENSORS AND TRANSDUCERS**9**

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

TOTAL : 45 PERIODS**COURSE OUTCOMES :**

After completing this course, the students will be able to

- CO1:** Compute the electric circuit parameters for simple problems
- CO2:** Explain the concepts of domestic wiring and protective devices
- CO3:** Explain the working principle and applications of electrical machines
- CO4:** Analyze the characteristics of analog electronic devices
- CO5:** Explain the types and operating principles of sensors and transducers

TEXT BOOKS:

1. D P Kothari and I.J Nagarath, "Basic Electrical and Electronics Engineering", McGraw Hill Education (India) Private Limited, Second Edition, 2020
2. A.K. Sawhney, Puneet Sawhney 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, 2015.
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:

1. John Bird, "Electrical Circuit theory and technology", Routledge; 2017.
2. Thomas L. Floyd, 'Electronic Devices', 10th Edition, Pearson Education, 2018.
3. Albert Malvino, David Bates, 'Electronic Principles, McGraw Hill Education; 7th edition, 2017
4. Muhammad H.Rashid, "Spice for Circuits and electronics", 4th Edition., Cengage India, 2019.
5. H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw-Hill, New Delhi, 2010

OBJECTIVES :

The course aims to

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

UNIT I SPECTROSCOPIC TECHNIQUES 9

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

UNIT II CHEMISTRY OF INTERFACES 9

Interface region-curved interfaces-thermodynamics of surfaces - Surface film on liquids-Adsorption of gases on Solids-adsorption isotherms – types. Applications of adsorption studies-detergency, wetting, foaming ,defoaming, spreading, water repellency.

UNIT III OILS, FATS, SOAPS & LUBRICANTS 9

Chemical constitution, Chemical analysis of oils and fats – acid, saponification and iodine values, Definitions, determinations and significance. Definition, mechanism of lubrication, preparation of petrolubes, desirable characteristics – viscosity, viscosity index, carbon residue, oxidation stability, flash and fire points, cloud and pour points, aniline point. Semisolid lubricant – greases, preparation of sodium, lithium, calcium and axle greases and uses, consistency test and drop point test.Solid lubricants – graphite and molybdenum disulphide.

UNIT IV HYDROCARBON 9

Classification of Hydrocarbons. Aliphatic Hydrocarbons: Alkanes –I isomerism, conformations, physical, chemical reactions including free radical mechanism of halogenation, combustion and pyrolysis. Alkenes– structure of double bond, geometrical isomerism, chemical reactions: addition of hydrogen, halogen, water, hydrogen halides, ozonolysis, oxidation. Alkynes – structure of triple bond acidic character of alkynes, addition reaction of - hydrogen, halogens, hydrogenhalides and water. Aromatic hydrocarbons - resonance, aromaticity ; mechanism of electrophilic substitution – nitration sulphonation, halogenations.

UNIT V COLORANTS 9

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

TOTAL: 45 PERIODS**OUTCOMES :**

At the end of the course, the students will be able to :

- Understand and apply spectroscopic techniques for the analysis of engineering materials for their applications.
- Make use of the applications of adsorption in detergency, wetting, spreading, foaming, defoaming, and water repellenceand separation processes.
- Analyse and estimate oils, fats, lubricants and soap for their intended applications.
- Distinguish and demonstrate the role of different types of hydrocarbon.
- Realize the chemical structures, properties and relationships of different types of dyes and their applications.

TEXT BOOKS:

1. Dara S. S., "A Text Book of Engineering Chemistry", S. Chand & Co. Ltd., New Delhi, 12th Edition, 2016.
2. Jain. P.C. and Monica Jain, "Engineering Chemistry", DhanpetRai& Sons, New Delhi, 17th Edition, 2018.
A. Ravikrishnan, "Chemistry for Technologists", Sri Krishna, Hi Tech Publishing Company Pvt. Ltd. Chennai, 2015.
3. Arun Pahl and B.S.Paul , " Advanced Organic Chemistry", S.Chand Publishers, Third Edition , New Delhi, 2012.

REFERENCES:

1. B.K. Sharma, "Industrial chemistry", Krishna Prakashan Media (P) Ltd, Meerut, 2014.
2. Shore J., "Colourants and Auxiliaries", Volume 1 & 2, Wood head Publishing Ltd., 2nd Edition, 2002.
3. Shenai V. A., "Chemistry of Dyes and Principles of Dyeing", Sevak Publications, Mumbai, 1995.
4. Trotman E. R., "Dyeing and Chemical Technology of Textile Fibres", B.Y Publishing Pvt. Ltd., New Delhi, 1994.
5. Shikha Agarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, 2019.

GE3251

ENGINEERING GRAPHICSL T P C
2 0 4 4**COURSE OBJECTIVES:**

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

- Drawing engineering curves.
- Drawing freehand sketch of simple objects.
- Drawing orthographic projection of solids and section of solids.
- Drawing development of solids
- 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 AND FREEHAND SKETCHING**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**6+12**

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes and parallel to the other by rotating object method. Visualization concepts and Free Hand sketching: Visualization principles —Representation of Three Dimensional objects — Layout of views- Freehand sketching of multiple views from pictorial views of objects.

Practicing three dimensional modeling of simple objects by CAD Software(Not for examination)

UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES**6+12**

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other — obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids — Prisms, pyramids cylinders and cones.

Practicing three dimensional modeling of simple objects by CAD Software(Not for examination)

UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS**6+12**

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

Practicing three dimensional modeling of isometric projection of simple objects by CAD Software(Not for examination)

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

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

- Use BIS conventions and specifications for engineering drawing.
- Construct the conic curves, involutes and cycloid.
- Solve practical problems involving projection of lines.
- Draw the orthographic, isometric and perspective projections of simple solids.
- Draw the development of simple solids.

TEXT BOOK:

1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 53rd Edition, 2019.
2. Natrajan K.V., "A Text Book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2018.
3. Parthasarathy, N. S. and Vela Murali, "Engineering Drawing", Oxford University Press, 2015

REFERENCES:

1. Basant Agarwal and Agarwal C.M., "Engineering Drawing", McGraw Hill, 2nd Edition, 2019.
2. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Publications, Bangalore, 27th Edition, 2017.
3. Luzzader, Warren.J. and Duff, John M., "Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
4. Parthasarathy N. S. and Vela Murali, "Engineering Graphics", Oxford University, Press, New Delhi, 2015.
5. Shah M.B., and Rana B.C., "Engineering Drawing", Pearson Education India, 2nd Edition, 2009.
6. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 2008.

Publication of Bureau of Indian Standards:

1. IS 10711 — 2001: Technical products Documentation — Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) — 2001: Technical products Documentation — Lettering.
3. IS 10714 (Part 20) — 2001 & SP 46 — 2003: Lines for technical drawings.
4. IS 11669 — 1986 & SP 46 — 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) — 2001: Technical drawings — Projection Methods.

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



NCC Credit Course Level 1*

NX3251	(ARMY WING) NCC Credit Course Level - I	L T P C
		2 0 0 2

NCC GENERAL 6

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

NATIONAL INTEGRATION AND AWARENESS 4

NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1

PERSONALITY DEVELOPMENT 7

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

LEADERSHIP 5

L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2

SOCIAL SERVICE AND COMMUNITY DEVELOPMENT 8

SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL: 30 PERIODS

NCC Credit Course Level 1*

NX3252	(NAVAL WING) NCC Credit Course Level - I	L T	P	C
		2 0	0	2
NCC GENERAL				6
NCC 1	Aims, Objectives & Organization of NCC			1
NCC 2	Incentives			2
NCC 3	Duties of NCC Cadet			1
NCC 4	NCC Camps: Types & Conduct			2
NATIONAL INTEGRATION AND AWARENESS				4
NI 1	National Integration: Importance & Necessity			1
NI 2	Factors Affecting National Integration			1
NI 3	Unity in Diversity & Role of NCC in Nation Building			1
NI 4	Threats to National Security			1
PERSONALITY DEVELOPMENT				7
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving			2
PD 2	Communication Skills			3
PD 3	Group Discussion: Stress & Emotions			2
LEADERSHIP				5
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code			3
L 2	Case Studies: Shivaji, Jhasi Ki Rani			2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT				8
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth			3
SS 4	Protection of Children and Women Safety			1
SS 5	Road / Rail Travel Safety			1
SS 6	New Initiatives			2
SS 7	Cyber and Mobile Security Awareness			1

TOTAL : 30 PERIODS

NCC Credit Course Level 1*

		(AIR FORCE WING)	L	T	P	C
NX3253		NCC Credit Course Level - I	20	0	0	2
NCC GENERAL						6
NCC 1	Aims, Objectives & Organization of NCC					1
NCC 2	Incentives					2
NCC 3	Duties of NCC Cadet					1
NCC 4	NCC Camps: Types & Conduct					2
NATIONAL INTEGRATION AND AWARENESS						4
NI 1	National Integration: Importance & Necessity					1
NI 2	Factors Affecting National Integration					1
NI 3	Unity in Diversity & Role of NCC in Nation Building					1
NI 4	Threats to National Security					1
PERSONALITY DEVELOPMENT						7
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving					2
PD 2	Communication Skills					3
PD 3	Group Discussion: Stress & Emotions					2
LEADERSHIP						5
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code					3
L 2	Case Studies: Shivaji, Jhasi Ki Rani					2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT						8
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth					3
SS 4	Protection of Children and Women Safety					1
SS 5	Road / Rail Travel Safety					1
SS 6	New Initiatives					2
SS 7	Cyber and Mobile Security Awareness					1

TOTAL : 30 PERIODS

COURSE OBJECTIVES:

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

GROUP – A (CIVIL & ELECTRICAL)**PART I CIVIL ENGINEERING PRACTICES****15****PLUMBING WORK:**

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

WOOD WORK:

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

Wood Work Study:

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

PART II ELECTRICAL ENGINEERING PRACTICES**15**

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

GROUP – B (MECHANICAL AND ELECTRONICS)**PART III MECHANICAL ENGINEERING PRACTICES****15****WELDING WORK:**

- a) Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding.
- b) Practicing gas welding.

BASIC MACHINING WORK:

- a) (simple)Turning.
- b) (simple)Drilling.
- c) (simple)Tapping.

ASSEMBLY WORK:

- a) Assembling a centrifugal pump.
- b) Assembling a household mixer.
- c) Assembling an air conditioner.

SHEET METAL WORK:

- a) Making of a square tray

FOUNDRY WORK:

- a) Demonstrating basic foundry operations.

PART IV ELECTRONIC ENGINEERING PRACTICES**15****SOLDERING WORK:**

- a) Soldering simple electronic circuits and checking continuity.

ELECTRONIC ASSEMBLY AND TESTING WORK:

- a) Assembling and testing electronic components on a small PCB.

ELECTRONIC EQUIPMENT STUDY:

- a) Study an elements of smart phone..
- b) Assembly and dismantle of LED TV.
- c) Assembly and dismantle of computer/ laptop

TOTAL : 60 PERIODS**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

- CO1 : Draw pipe line plan; lay and connect various pipe fittings used in common household plumbing work; Saw; plan; make joints in wood materials used in common household wood work.
- CO2 : Wire various electrical joints in common household electrical wire work.
- CO3 : Weld various joints in steel plates using arc welding work; Machine various simple processes like turning, drilling, tapping in parts; Assemble simple mechanical assembly of common household equipments; Make a tray out of metal sheet using sheet metal work.
- CO4 : Solder and test simple electronic circuits; Assemble and test simple electronic components on PCB.

BE3272

**BASIC ELECTRICAL, ELECTRONICS AND INSTRUMENTATION
ENGINEERING LABORATORY****L T P C
0 0 4 2****COURSE OBJECTIVES:**

- To train the students in conducting load tests electrical machines
- To gain practical experience in experimentally obtaining the characteristics of electronic devices and rectifiers
- To train the students to measure three phase power and displacement

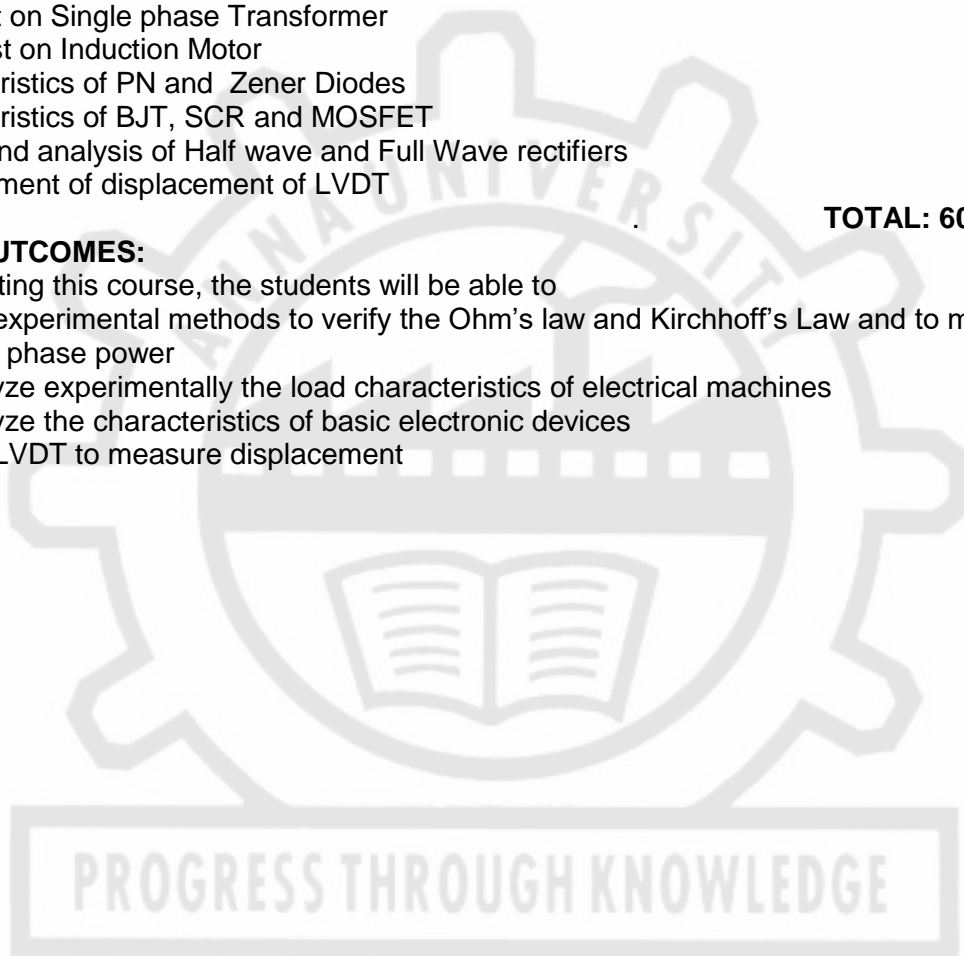
LIST OF EXPERIMENTS

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

TOTAL: 60 PERIODS**COURSE OUTCOMES:**

After completing this course, the students will be able to

- CO1:** Use experimental methods to verify the Ohm's law and Kirchhoff's Law and to measure three phase power
- CO2:** Analyze experimentally the load characteristics of electrical machines
- CO3:** Analyze the characteristics of basic electronic devices
- CO4:** Use LVDT to measure displacement





ANNA UNIVERSITY, CHENNAI
NON-AUTONOMOUS COLLEGES AFFILIATED COLLEGES
REGULATIONS 2021
CHOICE BASED CREDIT SYSTEM

B.TECH. PETROCHEMICAL TECHNOLOGY

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

SEMESTER I

S. No.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	IP3151	Induction Programme	-	-	-	-	-	0
THEORY								
2.	HS3151	Professional English – I	HSMC	3	0	0	3	3
3.	MA3151	Matrices and Calculus	BSC	3	1	0	4	4
4.	PH3151	Engineering Physics	BSC	3	0	0	3	3
5.	CY3151	Engineering Chemistry	BSC	3	0	0	3	3
6.	GE3151	Problem Solving and Python Programming	ESC	3	0	0	3	3
7.	GE3172	அறிவியல் தமிழ் / Scientific Thoughts in Tamil	HSMC	1	0	0	1	1
PRACTICALS								
8.	GE3171	Problem Solving and Python Programming Laboratory	ESC	0	0	4	4	2
9.	BS3171	Physics and Chemistry Laboratory	BSC	0	0	4	4	2
10.	GE3172	English Laboratory §	EEC	0	0	2	2	1
TOTAL				16	1	10	27	22

§ Skill Based Course

SEMESTER II

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	HS3251	Professional English – II	HSMC	2	0	0	2	2
2.	MA3251	Statistics and Numerical Methods	BSC	3	1	0	4	4
3.	PH3253	Materials Science for Technologists	BSC	3	0	0	3	3
4.	BE3252	Basic Electrical, Electronics and Instrumentation Engineering	BSC	3	0	0	3	3
5.	CY3251	Chemistry for Technologists	BSC	3	0	0	3	3
6.	GE3251	Engineering Graphics	ESC	2	0	4	6	4
7.	GE3252	தமிழர் மரபு / Heritage of Tamils	HSMC	1	0	0	1	1
8.		NCC Credit Course Level 1*	-	2	0	0	2	2
PRACTICALS								
7	GE3271	Engineering Practices Laboratory	ESC	0	0	4	4	2
8	BE3272	Basic Electrical, Electronics and Instrumentation Engineering Laboratory	ESC	0	0	4	4	2
9	GE3272	Communication Laboratory / Foreign Language §	EEC	0	0	4	4	2
TOTAL				17	1	16	34	26

#*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

PROGRESS THROUGH KNOWLEDGE

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA3351	Transforms and Partial Differential Equations	BSC	3	1	0	4	4
2.	PE3351	Process Calculations	PCC	3	0	0	3	3
3.	PC3351	Fluid Mechanics for Petrochemical Technologists	PCC	3	0	0	3	3
4.	PC3353	Petroleum Primary Processing Technology	PCC	3	0	0	3	3
5.	CH3491	Heat Transfer	PCC	2	1	0	3	3
6.	PC3352	Mechanical Operations	PCC	3	0	0	3	3
PRACTICALS								
7.	PE3481	Heat Transfer Laboratory	PCC	0	0	4	4	2
8.	PE3361	Fluid Mechanics and Solid Operations laboratory	PCC	0	0	4	4	2
9.	GE33361	Professional Development ^{\$}	EEC	0	0	2	2	1
TOTAL				17	2	10	29	24

^{\$} Skill Based Course

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PE3451	Chemical Engineering Thermodynamics	PCC	3	0	0	3	3
2.	PC3451	Petroleum Secondary Processing Technology	PCC	3	0	0	3	3
3.	CH3451	Mass Transfer I	PCC	3	0	0	3	3
4.	PC3401	Industrial Chemical Technology	PCC	3	0	0	3	3
5.	CPE331	Chemical Reaction Engineering	PCC	3	0	0	3	3
6.	GE3451	Environmental Sciences and Sustainability	BSC	2	0	0	2	2
7.		NCC Credit Course Level 2#		3	0	0	3	3 #
PRACTICALS								
8.	PC3461	Petrochemical and Polymer Analysis Laboratory	PCC	0	0	4	4	2
9.	PC3462	Petroleum Product Testing Laboratory	PCC	0	0	4	4	2
10.	PC3511	Industrial Training/Internship I*	EEC	-	-	-	-	-
TOTAL				17	0	8	25	21

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

*Four weeks industrial training/internship carries two credits. Industrial training/internship during IV Semester Summer Vacation will be evaluated in V semester

SEMESTER V

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	CH3551	Mass Transfer II	PCC	2	1	0	3	3
2.	PC3551	Catalytic Reaction Engineering	PCC	3	0	0	3	3
3.		Professional Elective I	PEC	3	0	0	3	3
4.		Professional Elective II	PEC	3	0	0	3	3
5.		Professional Elective III	PEC	3	0	0	3	3
6.		Mandatory Course-I ^{&}	MC	3	0	0	3	0
PRACTICALS								
7.	PC3511	Industrial Training/Internship I ^{**}	EEC	-	-	-	-	2
8.	CH3561	Mass Transfer Laboratory	PCC	0	0	4	4	2
TOTAL				17	1	4	22	19

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

^{**}Four weeks industrial training/internship carries two credits. Industrial training/internship during IV Semester Summer Vacation will be evaluated in V semester

SEMESTER VI

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PC3652	Process Instrumentation Dynamics and Control	PCC	3	0	0	3	3
2.		Open Elective – I*	OEC	3	0	0	3	3
3.		Professional Elective IV	PEC	3	0	0	3	3
4.		Professional Elective V	PEC	3	0	0	3	3
5.		Professional Elective VI	PEC	3	0	0	3	3
6.		Professional Elective VII	PEC	3	0	0	3	3
7.		Mandatory Course-II ^{&}	MC	3	0	0	3	0
8.		NCC Credit Course Level 3#		3	0	0	3	3 #
PRACTICALS								
9.	PC3611	Chemical Reaction and Process control Laboratory	PCC	0	0	4	4	2
10.	PC3651	Computational Petrochemical Laboratory	PCC	0	0	4	4	2
11.	PC3711	Industrial Training/Internship II ^{**}	EEC	-	-	-	-	-
TOTAL				24	0	8	32	22

*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*

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PC3752	Process Safety in Petrochemical Industries	PCC	3	0	0	3	3
2.	PC3751	Process Equipment Design	PCC	3	0	0	3	3
3.	GE3791	Human values and Ethics	HSMC	2	0	0	2	2
4.		Elective- Management #	HSMC	3	0	0	3	3
5.		Open Elective – II**	OEC	3	0	0	3	3
6.		Open Elective – III***	OEC	3	0	0	3	3
7.		Open Elective – IV***	OEC	3	0	0	3	3
PRACTICALS								
8.	PC3711	Industrial Training/Internship II##	EEC	-	-	-	-	2
TOTAL				20	2	0	20	22

*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*

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	PC3811	Internship#/Project Work	EEC	0	0	20	20	10
TOTAL				0	0	20	20	10

*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

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	GE3751	Principles of Management	HSMC	3	0	0	3	3
2.	GE3752	Total Quality Management	HSMC	3	0	0	3	3
3.	GE3753	Engineering Economics and Financial Accounting	HSMC	3	0	0	3	3
4.	GE3754	Human Resource Management	HSMC	3	0	0	3	3
5.	GE3755	Knowledge Management	HSMC	3	0	0	3	3
6.	GE3792	Industrial Management	HSMC	3	0	0	3	3

MANDATORY COURSES I

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MX3081	Introduction to Women and Gender Studies	MC	3	0	0	3	0
2.	MX3082	Elements of Literature	MC	3	0	0	3	0
3.	MX3083	Film Appreciation	MC	3	0	0	3	0
4.	MX3084	Disaster Management	MC	3	0	0	3	0

MANDATORY COURSES II

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MX3085	Well Being with traditional practices (Yoga, Ayurveda and Siddha)	MC	3	0	0	3	0
2.	MX3086	History of Science and Technology in India	MC	3	0	0	3	0
3.	MX3087	Political and Economic Thought for a Humane Society	MC	3	0	0	3	0
4.	MX3088	State, Nation Building and Politics in India	MC	3	0	0	3	0
5.	MX3089	Industrial Safety	MC	3	0	0	3	0

PROFESSIONAL ELECTIVE COURSES : VERTICALS

Vertical I	Vertical II	Vertical III	Vertical IV
Petrochemical Process Technology	Hydrocarbon Transportation and Storage	Health, Safety and Environment	Process Intensification
Petrochemical Unit processes	Storage Transportation of Crude Oil and Natural Gas	Fire and Explosion Control	Multi component Distillation
Petroleum Exploration and Exploitation Techniques	Petroleum Corrosion Technology	Industrial Hygiene	Process modelling and simulation
Process equipment auxiliaries & Utilities	Piping Engineering	Transportation Safety	Optimization of chemical Processes
Polymer Technology	Unconventional Hydrocarbon sources	Process Hazard Analysis Studies	Modern Separation Techniques
Fertilizer Technology	Design of Pressure Vessels and storage Vessels	Health Safety and Environmental Management	Fluidization Engineering
Petrochemical Derivatives	Natural Gas and LNG Processing	Plant Safety and Risk Management	Process Instrumentation

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: PETROCHEMICAL PROCESS TECHNOLOGY**

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	PC3001	Petrochemical Unit processes	PEC	3	0	0	3	3
2.	PC3002	Petroleum Exploration and Exploitation Techniques	PEC	3	0	0	3	3
3.	PC3003	Process equipment auxiliaries & Utilities	PEC	3	0	0	3	3
4.	CPE332	Polymer Technology	PEC	3	0	0	3	3
5.	PC3004	Fertilizer Technology	PEC	3	0	0	3	3
6.	PC3005	Petrochemical Derivatives	PEC	3	0	0	3	3

VERTICAL II : HYDROCARBON TRANSPORTATION AND STORAGE

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CPE345	Storage Transportation of Crude Oil and Natural Gas	PEC	3	0	0	3	3
2.	CPE341	Petroleum Corrosion Technology	PEC	3	0	0	3	3
3.	CPE343	Piping Engineering	PEC	3	0	0	3	3
4.	CPE347	Unconventional Hydrocarbon sources	PEC	3	0	0	3	3
5.	CPE332	Design of Pressure Vessels and storage Vessels	PEC	3	0	0	3	3
6.	CPE339	Natural Gas and LNG Processing	PEC	3	0	0	3	3

VERTICAL III : HEALTH, SAFETY AND ENVIRONMENT

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CPC331	Fire and Explosion Control	PEC	3	0	0	3	3
2.	CPE338	Industrial Hygiene	PEC	3	0	0	3	3
3.	CPE346	Transportation Safety	PEC	3	0	0	3	3
4.	CPC333	Process Hazard Analysis Studies	PEC	3	0	0	3	3
5.	CPE336	Health Safety and Environmental Management	PEC	3	0	0	3	3
6.	CPE344	Plant Safety and Risk Management	PEC	3	0	0	3	3

VERTICAL IV : PROCESS INTENSIFICATION

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	PC3006	Multi component Distillation	PEC	3	0	0	3	3
2.	CCH331	Process modelling and simulation	PEC	3	0	0	3	3
3.	PC3007	Optimization of chemical Processes	PEC	3	0	0	3	3
4.	PC3008	Modern Separation Techniques	PEC	3	0	0	3	3
5.	CPE335	Fluidization Engineering	PEC	3	0	0	3	3
6.	CPC334	Process Instrumentation	PEC	3	0	0	3	3

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

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OCS351	Artificial Intelligence and Machine Learning Fundamentals	OEC	2	0	2	4	3
2.	OCS352	IoT Concepts and Applications	OEC	2	0	2	4	3
3.	OCS353	Data Science Fundamentals	OEC	2	0	2	4	3
4.	OCS354	Augmented and Virtual Reality	OEC	2	0	2	4	3

OPEN ELECTIVES – III

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OHS351	English for Competitive Examinations	OEC	3	0	0	3	3
2.	OCE353	Lean Concepts, Tools And Practices	OEC	3	0	0	3	3
3.	OMG352	NGOs and Sustainable Development	OEC	3	0	0	3	3
4.	OMG353	Democracy and Good Governance	OEC	3	0	0	3	3
5.	OME353	Renewable Energy Technologies	OEC	3	0	0	3	3
6.	OME354	Applied Design Thinking	OEC	2	0	2	4	3
7.	OMF351	Reverse Engineering	OEC	3	0	0	3	3
8.	OMF353	Sustainable Manufacturing	OEC	3	0	0	3	3
9.	OAU351	Electric and Hybrid Vehicle	OEC	3	0	0	3	3
10.	OAS352	Space Engineering	OEC	3	0	0	3	3
11.	OIM351	Industrial Management	OEC	3	0	0	3	3
12.	OIE354	Quality Engineering	OEC	3	0	0	3	3
13.	OSF351	Fire Safety Engineering	OEC	3	0	0	3	3
14.	OML351	Introduction to non-	OEC	3	0	0	3	3

		destructive testing						
15.	OMR351	Mechatronics	OEC	3	0	0	3	3
16.	ORA351	Foundation of Robotics	OEC	3	0	0	3	3
17.	OAE352	Fundamentals of Aeronautical engineering	OEC	3	0	0	3	3
18.	OGI351	Remote Sensing Concepts	OEC	3	0	0	3	3
19.	OAI351	Urban Agriculture	OEC	3	0	0	3	3
20.	OEE352	Electric Vehicle technology	OEC	3	0	0	3	3
21.	OEI353	Introduction to PLC Programming	OEC	3	0	0	3	3
22.	OBT352	Biomedical Instrumentation	OEC	3	0	0	3	3
23.	OFD352	Traditional Indian Foods	OEC	3	0	0	3	3
24.	OFD353	Introduction to food processing	OEC	3	0	0	3	3
25.	OPY352	IPR for Pharma Industry	OEC	3	0	0	3	3
26.	OTT351	Basics of Textile Finishing	OEC	3	0	0	3	3
27.	OTT352	Industrial Engineering for Garment Industry	OEC	3	0	0	3	3
28.	OTT353	Basics of Textile Manufacture	OEC	3	0	0	3	3
29.	OCH353	Energy Technology	OEC	3	0	0	3	3
30.	OCH354	Surface Science	OEC	3	0	0	3	3
31.	OPT351	Basics of Plastics Processing	OEC	3	0	0	3	3
32.	OEC351	Signals and Systems	OEC	3	0	0	3	3
33.	OEC352	Fundamentals of Electronic Devices and Circuits	OEC	3	0	0	3	3
34.	OBM351	Foundation Skills in integrated product Development	OEC	3	0	0	3	3
35.	OBM352	Assistive Technology	OEC	3	0	0	3	3
36.	OMA352	Operations Research	OEC	3	0	0	3	3
37.	OMA353	Algebra and Number Theory	OEC	3	0	0	3	3
38.	OMA354	Linear Algebra	OEC	3	0	0	3	3

OPEN ELECTIVES – IV

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OHS352	Project Report Writing	OEC	3	0	0	3	3
2.	OCE354	Basics of Integrated Water Resources Management	OEC	3	0	0	3	3
3.	OMA355	Advanced Numerical Methods	OEC	3	0	0	3	3
4.	OMA356	Random Processes	OEC	3	0	0	3	3
5.	OMA357	Queuing and Reliability Modelling	OEC	3	0	0	3	3
6.	OMG354	Production and Operations Management for Entrepreneurs	OEC	3	0	0	3	3
7.	OMG355	Multivariate Data Analysis	OEC	3	0	0	3	3
8.	OME352	Additive Manufacturing	OEC	3	0	0	3	3
9.	OME353	New Product Development	OEC	3	0	0	3	3
10.	OME355	Industrial Design & Rapid Prototyping Techniques	OEC	2	0	2	4	3
11.	OMF352	Micro and Precision Engineering	OEC	3	0	0	3	3
12.	OMF354	Cost Management of Engineering Projects	OEC	3	0	0	3	3
13.	OAU352	Batteries and Management system	OEC	3	0	0	3	3
14.	OAU353	Sensors and Actuators	OEC	3	0	0	3	3
15.	OAS353	Space Vehicles	OEC	3	0	0	3	3
16.	OIM352	Management Science	OEC	3	0	0	3	3
17.	OIM353	Production Planning and Control	OEC	3	0	0	3	3
18.	OIE353	Operations Management	OEC	3	0	0	3	3
19.	OSF352	Industrial Hygiene	OEC	3	0	0	3	3
20.	OML352	Electrical, Electronic and Magnetic materials	OEC	3	0	0	3	3
21.	OML353	Nanomaterials and applications	OEC	3	0	0	3	3
22.	OMR353	Sensors	OEC	3	0	0	3	3
23.	ORA352	Foundation of Automation	OEC	3	0	0	3	3
24.	ORA353	Concepts in Mobile Robotics	OEC	3	0	0	3	3
25.	OMV351	Marine Propulsion	OEC	3	0	0	3	3

26.	OMV352	Marine Merchant Vehicles	OEC	3	0	0	3	3
27.	OMV353	Elements of Marine Engineering	OEC	3	0	0	3	3
28.	OAE353	Drone Technologies	OEC	3	0	0	3	3
29.	OGI352	Geographical Information System	OEC	3	0	0	3	3
30.	OAI352	Agriculture Entrepreneurship Development	OEC	3	0	0	3	3
31.	OEN352	Biodiversity Conservation	OEC	3	0	0	3	3
32.	OEE353	Introduction to control systems	OEC	3	0	0	3	3
33.	OEI354	Introduction to Industrial Automation Systems	OEC	3	0	0	3	3
34.	OBT353	Environment and Agriculture	OEC	3	0	0	3	3
35.	OFD354	Fundamentals of Food Engineering	OEC	3	0	0	3	3
36.	OFD355	Food safety and Quality Regulations	OEC	3	0	0	3	3
37.	OPY353	Nutraceuticals	OEC	3	0	0	3	3
38.	OTT354	Basics of Dyeing and Printing	OEC	3	0	0	3	3
39.	OTT355	Fibre Science	OEC	3	0	0	3	3
40.	OTT356	Garment Manufacturing Technology	OEC	3	0	0	3	3
41.	OCH353	Energy Technology	OEC	3	0	0	3	3
42.	OCH354	Surface Science	OEC	3	0	0	3	3
43.	OPT352	Plastic Materials for Engineers	OEC	3	0	0	3	3
44.	OPT353	Properties and Testing of Plastics	OEC	3	0	0	3	3
45.	OEC353	VLSI Design	OEC	3	0	0	3	3
46.	OEC354	Industrial IoT and Industry 4.0	OEC	2	0	2	4	3
47.	OBM353	Wearable devices	OEC	3	0	0	3	3
48.	OBM354	Medical Informatics	OEC	3	0	0	3	3

SUMMARY

Name of the Programme										
S.No	Subject Area	Credits per Semester								Total Credits
		I	II	III	IV	V	VI	VII/VIII	VIII/VII	
1	HSMC	4	3					5		12
2	BSC	12	13	4	2					31
3	ESC	5	8							13
4	PCC			19	19	8	7	6		59
5	PEC					9	12			21
6	OEC						3	9		12
7	EEC	1	2	1		2		2	10	18
8	Non-Credit (Mandatory)					√	√			
Total		22	26	24	21	19	22	22	10	166



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)

Vertical I Fintech and Block Chain	Vertical II Entrepreneurship	Vertical III Public Administration	Vertical IV Business Data Analytics	Vertical V Environment and Sustainability
Financial Management	Foundations of Entrepreneurship	Principles of Public Administration	Statistics For Management	Sustainable infrastructure Development
Fundamentals of Investment	Team Building & Leadership Management for Business	Constitution of India	Datamining For Business Intelligence	Sustainable Agriculture and Environmental Management
Banking, Financial Services and Insurance	Creativity & Innovation in Entrepreneurship	Public Personnel Administration	Human Resource Analytics	Sustainable Bio Materials
Introduction to Blockchain and its Applications	Principles of Marketing Management For Business	Administrative Theories	Marketing And Social Media Web Analytics	Materials for Energy Sustainability
Fintech Personal Finance and Payments	Human Resource Management for Entrepreneurs	Indian Administrative System	Operation And Supply Chain Analytics	Green Technology
Introduction to Fintech	Financing New Business Ventures	Public Policy Administration	Financial Analytics	Environmental Quality Monitoring and Analysis
-	-	-	-	Integrated Energy Planning for Sustainable Development
-	-	-	-	Energy Efficiency for Sustainable Development

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

VERTICAL 1: FINTECH AND BLOCK CHAIN

SL · N O.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG331	Financial Management	PEC	3	0	0	3	3
2.	CMG332	Fundamentals of Investment	PEC	3	0	0	3	3
3.	CMG333	Banking, Financial Services and Insurance	PEC	3	0	0	3	3
4.	CMG334	Introduction to Blockchain and its Applications	PEC	3	0	0	3	3
5.	CMG335	Fintech Personal Finance and Payments	PEC	3	0	0	3	3
6.	CMG336	Introduction to Fintech	PEC	3	0	0	3	3

VERTICAL 2: ENTREPRENEURSHIP

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG337	Foundations of Entrepreneurship	PEC	3	0	0	3	3
2.	CMG338	Team Building & Leadership Management for Business	PEC	3	0	0	3	3
3.	CMG339	Creativity & Innovation in Entrepreneurship	PEC	3	0	0	3	3
4.	CMG340	Principles of Marketing Management For Business	PEC	3	0	0	3	3
5.	CMG341	Human Resource Management for Entrepreneurs	PEC	3	0	0	3	3
6.	CMG342	Financing New Business Ventures	PEC	3	0	0	3	3

VERTICAL 3: PUBLIC ADMINISTRATION

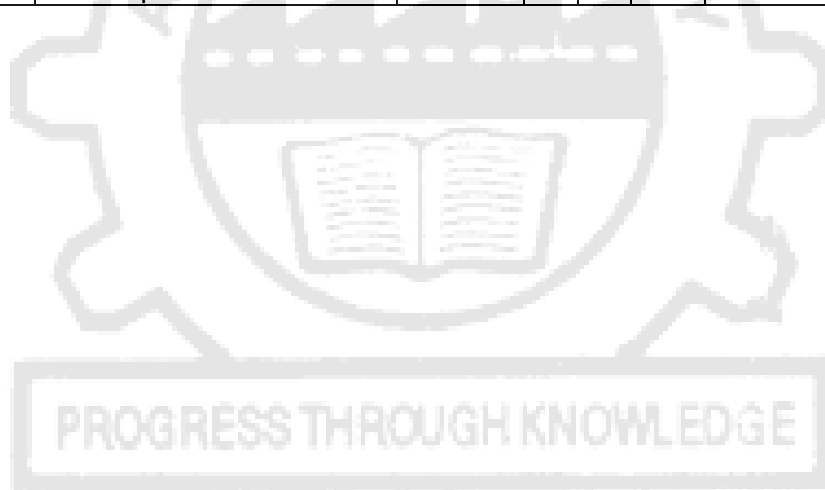
SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG343	Principles of Public Administration	PEC	3	0	0	3	3
2.	CMG344	Constitution of India	PEC	3	0	0	3	3
3.	CMG345	Public Personnel Administration	PEC	3	0	0	3	3
4.	CMG346	Administrative Theories	PEC	3	0	0	3	3
5.	CMG347	Indian Administrative System	PEC	3	0	0	3	3
6.	CMG348	Public Policy Administration	PEC	3	0	0	3	3

VERTICAL 4: BUSINESS DATA ANALYTICS

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG349	Statistics For Management	PEC	3	0	0	3	3
2.	CMG350	Datamining For Business Intelligence	PEC	3	0	0	3	3
3.	CMG351	Human Resource Analytics	PEC	3	0	0	3	3
4.	CMG352	Marketing And Social Media Web Analytics	PEC	3	0	0	3	3
5.	CMG353	Operation And Supply Chain Analytics	PEC	3	0	0	3	3
6.	CMG354	Financial Analytics	PEC	3	0	0	3	3

VERTICAL 5: ENVIRONMENT AND SUSTAINABILITY

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CES331	Sustainable infrastructure Development	PEC	3	0	0	3	3
2.	CES332	Sustainable Agriculture and Environmental Management	PEC	3	0	0	3	3
3.	CES333	Sustainable Bio Materials	PEC	3	0	0	3	3
4.	CES334	Materials for Energy Sustainability	PEC	3	0	0	3	3
5.	CES335	Green Technology	PEC	3	0	0	3	3
6.	CES336	Environmental Quality Monitoring and Analysis	PEC	3	0	0	3	3
7.	CES337	Integrated Energy Planning for Sustainable Development	PEC	3	0	0	3	3
8.	CES338	Energy Efficiency for Sustainable Development	PEC	3	0	0	3	3



MA3351 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS

L	T	P	C
3	1	0	4

OBJECTIVES:

- To introduce the basic concepts of PDE for solving standard partial differential equations.
- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
- To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
- To acquaint the student with Fourier transform techniques used in wide variety of situations.
- To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.

UNIT - I : PARTIAL DIFFERENTIAL EQUATIONS**9 + 3**

Formation of partial differential equations – Solutions of standard types of first order partial differential equations - First order partial differential equations reducible to standard types- Lagrange's linear equation - Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

UNIT - II : FOURIER SERIES**9 + 3**

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

UNIT - III : APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS**9 + 3**

Classification of PDE – Method of separation of variables - Fourier series solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction (Cartesian coordinates only).

UNIT - IV : FOURIER TRANSFORMS**9 + 3**

Statement of Fourier integral theorem– Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

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

Z-transforms - Elementary properties – Convergence of Z-transforms - – Initial and final value theorems - Inverse Z-transform using partial fraction and convolution theorem - Formation of difference equations – Solution of difference equations using Z - transforms.

TOTAL : 60 PERIODS**OUTCOMES :**

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

- Understand how to solve the given standard partial differential equations.
- Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.
- Appreciate the physical significance of Fourier series techniques in solving one and two dimensional heat flow problems and one dimensional wave equations.
- Understand the mathematical principles on transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering.
- Use the effective mathematical tools for the solutions of partial differential equations by using Z transform techniques for discrete time systems.

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, New Delhi, 2018.
2. Kreyszig E, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, New Delhi, India, 2016.

REFERENCES :

1. Andrews. L.C and Shivamoggi. B, "Integral Transforms for Engineers" SPIE Press, 1999.
2. Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 10th Edition, Laxmi Publications Pvt. Ltd, 2015.
3. James. G., "Advanced Modern Engineering Mathematics", 4th Edition, Pearson Education, New Delhi, 2016.
4. Narayanan. S., Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.
5. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2018.
6. Wylie. R.C. and Barrett . L.C., "Advanced Engineering Mathematics "Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.

PE3351**PROCESS CALCULATIONS****L T P C
3 0 0 3****OBJECTIVE:**

- To teach concept of degree of freedom and its application to solution of mass and energy balance equations for single and network of units and introduce to process simulators.

UNIT I**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**

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

UNIT V**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.

TOTAL: 45 PERIODS**COURSE OUTCOMES: (COs)**

1. Understand the fundamentals of system of units, apply ideal gas law to solve problems in pure components and mixtures.

2. Apply stoichiometric principles to solve problems and write material balance for different process equipments.
3. Understand and apply basics of humidity to solve problems in humidification and other processes.
4. Understand and apply the basics of energy balance concepts to solve to different chemical processes.
5. Understand the basics of fuels and combustion, to solve problems on combustion of various fuels and also to find excess air.
6. Apply the above knowledge in process flow sheeting calculations.

TEXT BOOKS:

1. Himmelblau, D.M., "Basic Principles and Calculations in Chemical Engineering", EEE Sixth Edition, Prentice Hall Inc., 2003
2. Felder, R. M. and Rousseau, R. W., "Elementary Principles of Chemical Processes", 3rd Edn., John Wiley & Sons, New York, 2000.
3. Bhatt, B.L., Vora, S.M., "Stoichiometry ", 4th Edition, Tata McGraw-Hill (2004)

REFERENCES:

1. Hougen O A, Watson K M and Ragatz R A, "Chemical process principles" Part I, CBS publishers (1973).
2. Venkatramani. V, Anatharaman. N and Meera Shariffa Begam " Process Calculations" Printice Hall of India, New Delhi,
3. K.V.Narayanan, B.Lakshmipathy,"Stoichiometry and Process Calculation", PHI Learning Ltd.(2013).

PC3351 FLUID MECHANICS FOR PETROCHEMICAL TECHNOLOGISTS L T P C
3 0 0 3

OBJECTIVES:

- To impart to the student knowledge on fluid properties, fluid statics, dynamic characteristics for through pipes and porous medium.
- To impart flow measurement and fluid machineries.

UNIT I PROPERTIES OF FLUIDS AND CONCEPT OF PRESSURE

Introduction – Physical properties of fluids – Types of fluids – Fluid statics and its applications - Hydrostatic equilibrium – Pressure measurement - Rheological properties of fluids.

UNIT II MOMENTUM BALANCE AND ITS APPLICATIONS

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

UNIT III DIMENSIONAL ANALYSIS

The principle of dimensional homogeneity – dimensional analysis, Rayleigh method and the Pi theorem - non-dimensional action of the basic equations - similitude – relationship between dimensional analysis and similitude.

UNIT III FLOW OF INCOMPRESSIBLE FLUIDS THROUGH DUCTS

Flow of incompressible fluids in pipes – Shear stress and skin friction in pipes -laminar flow in pipes and channels –Velocity profile and friction factor for smooth and rough pipes – Loss due to friction in pipes and Fittings – Fluidization – Mechanism – Types – General properties – Applications. Flow past immersed bodies, Drag and Drag coefficient, Flow through beds of solids – Ergun's Equation.

UNIT V TRANSPORTATION AND METERING

Measurement of fluid flow – Orifice meter – Venturimeter – Rotameter – Weirs and notches – Transportation of fluids – Positive displacement pumps – Rotary and Reciprocating pumps – Centrifugal pumps – Performance and characteristics.

TEXT BOOKS:

1. Noel de Nevers, "Fluid Mechanics for Chemical Engineers ", Second Edition, McGraw-Hill, (1991).
2. Munson, B. R., Young, D.F., Okiishi, T.H. "Fundamentals of Fluid Mechanics", 5th Edition, John Wiley, 2006.
3. McCabe W.L, Smith, J C and Harriot. P "Unit operations in Chemical Engineering", McGraw Hill, VII Edition, 2005

REFERENCES:

1. White, F.M., "Fluid Mechanics ", IV Edition, McGraw-Hill Inc., 1999.
2. James O Wilkes and Stacy G Bike, "Fluid Mechanics for Chemical Engineers' Prentice Hall PTR (International series in Chemical Engineering) (1999)

PC3353**PETROLEUM PRIMARY PROCESSING TECHNOLOGY****L T P C
3 0 0 3****OBJECTIVE:**

- To make the students to learn the primary refining operation of crude oil and testing of petroleum products and its treatment techniques.

UNIT I CRUDE OIL COMPOSITION AND CLASSIFICATION**9**

Theories behind the Origin of petroleum – Exploration and production of petroleum – Basics of hydrocarbon chemistry - Composition of crude oil – Impurities present in crude oil - Crude oil classification and its characteristics – Crude oil properties, Crude oil assay – Indigenous and imported crudes – Crude availability Vs demands – Refining capacity of India.

UNIT II TESTING OF PETROLEUM PRODUCTS**9**

IS 1448: Standard – Important commercial petroleum products: LPG, Gasoline, Kerosene, ATF, Diesel, and Lube oil - Specifications, Important testing methods and their Significance.

UNIT III CRUDE PROCESSING**9**

Pretreatment of crude oil – Dehydration and desalting – Types of fractionating column - Types of trays - Flow pattern in the trays – Products separation using Atmospheric distillation - Vacuum distillation of residue products – Reflux types and its significance.

UNIT IV LUBE DISTILLATE TREATMENT TECHNIQUES**9**

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

UNIT V WAX AND BITUMEN PROCESSING TECHNIQUES**9**

Paraffinic wax: Classification and its uses, Petroleum jelly manufacture - Bitumen: Types and their properties – Bitumen Testing: Ductility, Penetration Index and Softening point - Asphalt manufacture: Air blowing technology.

TOTAL: 45 PERIODS**OUTCOME:**

- CO1. Acquire knowledge on crude composition, types and their characteristics primary refining operations.

- CO2. Analyse the suitability of test methods to check the quality of crude oil and its products.
- CO3. Understand the concept of separating crude products using fractionating column
- CO4. Understand the significance of units present in the lube complex.
- CO5. Understand the classification, production and uses of wax and bitumen.
- CO6. Identify the role of additives added in the commercial products of petroleum.

TEXT BOOKS:

1. Ram Prasad, "Petroleum Refining Technology", Khanna Publishers.2008
2. Bhaskara Rao, B.K., "Modern Petroleum Refining Processes", 6th edition, Oxford and IBH Publishing Company Pvt. Ltd. 2018.

REFERENCES:

1. James H. Gary and Glenn E. Handwerk., "Petroleum Refining Technology and Economics", 4th Edition, Marcel Dekker Inc., 2001.
2. Nelson, W.L., "Petroleum Refinery Engineering", McGraw Hill Publishing Company Limited, 1985.
3. Hobson, G.D., "Modern Petroleum Refining Technology ", 5th Edition, John Wiley Publishers, 1984

CH3491**HEAT TRANSFER****L T P C
3 0 0 3****OBJECTIVE:**

The course is aimed to

- Teach the fundamental concepts of heat transfer viz., conduction, convection, radiation, boiling and condensation and its application to the students

UNIT I**9**

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**11**

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**9**

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**8**

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**8**

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

OUTCOMES:

On the completion of the course students are expected to

- CO1: To familiarize the students with the fundamental concepts of Heat Transfer. Provide the student with knowledge about heat transfer by conduction in solids for steady state
- CO2: Students will understand convective heat transfer and use of heat transfer coefficients for laminar and turbulent flows
- CO3: The course gives the student insight about boundary layer flow, laminar and turbulent flows
- CO4: Students will be able to calculate and use overall heat transfer coefficients in designing heat exchangers
- CO5: The course provides the student with knowledge about heat transfer with phase change (Boiling and condensation) and evaporation
- CO6: Students will understand radiative heat transfer including blackbody radiation and Kirchoff's law, and will be able to solve radiative problems apply knowledge of heat transfer to solve thermal engineering problems

TEXT BOOKS:

1. Holman, J. P., 'Heat Transfer', 10th Edn., McGraw Hill, 2010.
2. Ozisik, M. N., Heat Transfer: A Basic Approach, McGraw-Hill, 1984
3. Kern, D.Q., "Process Heat Transfer", McGraw-Hill, 1999.
4. B.K. Dutta, Heat transfer principles and applications, PHI Learning PVT Ltd, 2016

REFERENCES:

1. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 6th Edn., McGraw-Hill, 2001.
2. Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol. I, 4th Edn., Asian Books Pvt. Ltd., India, 1998

PC3352**MECHANICAL OPERATIONS****L T P C
3 0 0 3****OBJECTIVE:**

- To impart knowledge in the field of particle size reduction and also deals with the detail construction and working of equipment's used for mechanical operations.

UNIT I PARTICLE CHARACTERIZATION AND MEASUREMENT**9**

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**9**

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) 9

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 9

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 9

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

TOTAL: 45 PERIODS**OUTCOME:**

At the end of this course, the students will be able to

1. Determine and Estimate various properties of particulates, particle size using advanced analysis techniques
2. Understand the overview of equipment design used for size reduction, and understand the importance of size enlargement.
3. Examine and identify various separation and purification equipment for solid-solid, solid-liquid and solid-gas system.
4. Categorize various filters and problems associated during the implementation and applications of filtration equipments
5. Analyze and understand the working of various types of impellers, mixers, Handling, Storage and Transportation of Solids.
6. Know the future challenges and obtain knowledge on various unit operations and their applications

TEXT BOOKS:

1. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7th Edn., McGraw-Hill, 2005.
2. Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", Tata McGraw Hill, 1997.
3. Foust, A. S., Wenzel, L.A., Clump, C.W., Naus, L., and Anderson, L.B., "Principles of Unit Operations", 2nd Edn., John Wiley & Sons, 1994.
4. Hiroaki Masuda , KoHigashitani and Hideto Yoshida, Powder Technology Handbook, 3rd Edition.

REFERENCES:

1. Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol. II, 4th Edn., Asian Books Pvt. Ltd., India, 1998.
2. Christie J. Geankoplis, Transport processes and unit operations.
3. Sunggyu Lee, Kimberly H. Henthorn, Particle Technology and Applications.
4. Martin Rhodes, Introduction to Particle Technology, Second Edition.

PE3481

HEAT TRANSFER LABORATORY

L T P C
0 0 4 2**OBJECTIVE:**

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

LIST OF EXPERIMENTS

- Heat Transfer in a Double Pipe Heat Exchanger
- Heat transfer in Shell and Tube Heat Exchanger
- Heat Transfer in a Bare and Finned Tube Heat Exchanger
- Heat transfer in composite wall
- Heat transfer by Forced / Natural Convection
- Heat Transfer by Radiation - Determination of Stefan Boltzmann constant
- Heat Transfer by Radiation - Emissivity measurement
- Heat transfer in Open Pan Evaporator
- Heat transfer by Single effect evaporation / Multiple effect evaporation
- Boiling Heat Transfer
- Heat Transfer through Packed Bed
- Heat Transfer in a Horizontal Condenser / Vertical Condenser
- Heat Transfer in Helical Coils
- Heat Transfer in Agitated Vessels

TOTAL: 60 PERIODS**Minimum 10 experiments to be offered****LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS**

- | | |
|---|------------------------|
| 1. Double Pipe Heat Exchanger | 1 No. |
| 2. Shell and Tube heat exchanger | 1 No. |
| 3. Bare and Finned Tube Heat Exchanger | 1 No. |
| 4. Composite wall set up | 1 No. |
| 5. Natural convection set up or Forced convection set up | 1 No. |
| 6. Stefan Boltzmann Apparatus | 1 No. |
| 7. Emissivity measurement set up | 1 No. |
| 8. Open Pan Evaporator | 1 No. |
| 9. Single effect evaporator or Multiple effect evaporator | 1 No. |
| 10. Boiler | 1 Compulsory equipment |
| 11. Packed Bed | 1 No. |
| 12. Vertical Condenser or Horizontal Condenser | 1 No. |
| 13. Helical Coil | 1 No. |
| 14. Agitated Vessel | 1 No. |
| 15. Jacketed vessel | 1 No. |

Any 10 equipment excluding boiler**OUTCOME:**

- Student would be able to calculate heat transfer by conduction, different types of convection using classical models for these phenomena.

PE3361

FLUID MECHANICS AND SOLID OPERATIONS LABORATORY

L T P C

0 0 4 2

OBJECTIVES:

- To learn experimentally to calibrate flow meters, find pressure loss for fluid flows and determine pump characteristics.
- Students develop a sound working knowledge on different types of crushing equipments and separation characteristics of different mechanical operation separators.

LIST OF EXPERIMENTS - Phase – I (minimum 5 Experiments to be conducted)

1. Calibration of constant and variable head meters
2. Open drum orifice and draining time
3. Flow through straight pipe
4. Flow through annular pipe
5. Flow through helical coil and spiral coil
6. Characteristic curves of pumps
7. Pressure drop studies in packed column

EQUIPMENT REQUIRED

1. Venturi meter
2. Orifice meter
3. Rotameter
4. Weir
5. Open drum with orifice
6. Pipes and fittings
7. Helical and spiral coils
8. Centrifugal pump
9. Packed column
10. Fluidized bed

LIST OF EXPERIMENTS - Phase- II (minimum 5 Experiments to be conducted)

1. Sieve analysis
2. Batch filtration studies using a Leaf filter
3. Batch filtration studies using a Plate and Frame Filter press
4. Characteristics of batch Sedimentation
5. Reduction ratio in Jaw Crusher
6. Reduction ratio in Ball mill
7. Separation characteristics of Cyclone separator
8. Reduction ratio of Roll Crusher
9. Drop weight crusher
10. Drag on Sphere
11. Effectiveness of screen

EQUIPMENT REQUIRED

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.

TOTAL: 60 PERIODS**OUTCOMES:**

- Use variable area flow meters and variable head flow meters

- Analyze the flow of fluids through closed conduits, open channels and flow past immersed bodies Select pumps for the transportation of fluids based on process conditions/requirements and fluid properties.
- Determine work index, average particle size through experiments by crushers, ball mill and conducting sieve analysis.
- Design size separation equipments such as cyclone separator, sedimentation, Filters etc.

PE3451

CHEMICAL ENGINEERING THERMODYNAMICS

L T P C
3 0 0 3**OBJECTIVE:**

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

UNIT I PVT RELATIONS AND FIRST LAW OF THERMODYNAMICS 9

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

UNIT II SECOND LAW AND THERMODYNAMIC CORRELATIONS 9

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

UNIT III SOLUTION THERMODYNAMICS 9

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

UNIT IV PHASE EQUILIBRIA 9

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

UNIT V REACTION EQUILIBRIA 9

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

TOTAL: 45 PERIODS**OUTCOME:**

1. Understand the fundamentals of system of units, apply ideal gas law to solve problems in pure components and mixtures.
2. Apply stoichiometric principles to solve problems and write material balance for different process equipments.
3. Understand and apply basics of humidity to solve problems in humidification and other processes.
4. Understand and apply the basics of energy balance concepts to solve to different chemical processes.

- Understand the basics of fuels and combustion, to solve problems on combustion of various fuels and also to find excess air.
- Apply the above knowledge to process flow sheeting in industries.

TEXT BOOKS:

- Sonntag, Borgnakke, Van Wylen, Fundamentals of Thermodynamics, 7th Edition, Wiley India, New Delhi, 2009.
- Narayanan, K.V. A Textbook of Chemical Engineering Thermodynamics Prentice Hall India, 2004
- Smith, van Ness and Abbott, "Chemical Engineering Thermodynamics", 7th Edition, McGraw Hill, New York, 2005

REFERENCES:

- S. I. Sandler, Chemical, Biochemical and Engineering Thermodynamics, Wiley New York, 2006
- Y V C Rao, "Chemical Engineering Thermodynamics", Universities Press, Hyderabad 2005.
- Pradeep Ahuja, "Chemical Engineering Thermodynamics", PHI Learning Ltd (2009).
- Gopinath Halder, "Introduction to Chemical Engineering Thermodynamics", PHI Learning Ltd (2009).

PC3451**PETROLEUM SECONDARY PROCESSING TECHNOLOGY****L T P C
3 0 0 3****OBJECTIVE:**

- Students will learn the process involving to convert one form of hydrocarbon into another form of hydrocarbon to meet the customer requirement using cracking, reforming, alkylation, isomerization and polymerization unit processes.

UNIT I VISBREAKING, THERMAL CRACKING AND COKING**9**

Need and significance of Secondary Processing - Types and functions of Secondary Processing – Visbreaking: Principle - Process flow schemes - Coil type, Soaker drum Processes, operating parameters and advantages – Factors influencing visbreaking process.

Thermal Cracking: Process flow schemes, Reaction chemistry and free radical mechanisms, Factors influencing thermal cracking process.

Coking : Principle – Types – Advantages - Process flow schemes - Delayed Coking, Fluid Coking and Flexi-Coking processes - Factors influencing coking process

UNIT II CATALYTIC CRAKING AND HYDRO CRACKING**9**

Catalytic Cracking: Principle - Advantages - Process flow schemes - Batch process and Continuous process - Fixed bed, Moving bed and Fluidized bed catalytic cracking process, Reaction chemistry and carbonium ion mechanisms, Factors influencing catalytic cracking process. Commercial Catalyst.

Hydro Cracking: Principle - Advantages - Process flow schemes - Reaction chemistry - Factors influencing hydro cracking process - Commercial Catalyst

UNIT III CATALYTIC REFORMING AND POLYMERIZATION**9**

Reforming: Principle - Advantages - Process flow schemes - Batch process and Continuous process - Reaction chemistry – Favourable and unfavourable reactions - Factors influencing reforming process - Commercial Catalyst Other commercial reforming process like Platforming, Houdri Forming, Rhein Forming, Power Forming, Selecto Forming. Ultra Forming and Rex Forming Polymerization: Principle - Advantages - Process flow schemes - Reaction chemistry and mechanisms, Factors influencing polymerization process - Commercial Catalyst.

UNIT IV ALKYLATION AND ISOMERIZATION**9**

Alkylation Process: Principle - Advantages - Process flow schemes - Sulphuric Acid Alkylation, Hydrofluoric Acid Alkylation - Reaction chemistry, Factors influencing alkylation process - catalyst selection.

Isomerization Process: Principle - Advantages - Process flow schemes - Platinum Catalyst and Aluminium Chloride Process - Reaction chemistry, Factors influencing alkylation process - catalyst selection.

UNIT V FINAL TREATMENT TECHNIQUES**9**

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

TOTAL : 45 PERIODS**OUTCOME:**

- CO1.** Understand the need of different secondary process and demonstrate appropriate technologies available to meet the specified needs of the petroleum products.
- CO2.** Select appropriate technologies to meet the specified needs of lighter petroleum products from heavier feed
- CO3.** Select appropriate technologies and different flow sheet to get aromatic and olefin compounds from paraffinic feed and getting heavier products from lighter feed
- CO4.** Understand different flow sheets, and appropriate technologies to maximize gasoline yield and quality.
- CO5.** Select appropriate technologies to get cleaner products and demonstrate knowledge on various application of specialty products obtained from crude oil
- CO6.** Acquiring knowledge on optimization of product blending for quality and quantity improvement.

TEXT BOOKS:

1. Jones, D.S.J. and Pujadó, P.R., Handbook of petroleum processing, Springer, The Netherlands, 2006
2. Nelson, W. L "Petroleum Refinery Engineering", McGraw Hill Publishing Company Limited, 1985.
3. Watkins, R. N "Petroleum Refinery Distillations", 2nd Edition, Gulf Publishing Company, Texas, 1981.

REFERENCES:

1. Parkash, S., Refining processes handbook, Gulf Professional Publishing, 2003
2. Hobson, G. D "Modern Petroleum Refining Technology", 4th Edition, Institute of Petroleum, U. K. 1973.

CH3451

MASS TRANSFER I

L T P C
3 0 0 3**OBJECTIVE:**

The course is aimed to

- 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**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:

1. Treybal, R. E., "Mass Transfer Operations", 3rd Edition, McGraw-Hill, 2017.
2. Geankoplis, C.J., "Transport Processes and Unit Operations", 4th Edition, Prentice Hall Inc., New Jersey, 2003.
3. Narayanan K.V. and Lakshmikutty, B "Mass Transfer – Theory and Applications", 1st Edition, CBS Publishers & Distributors Pvt Ltd, New Delhi, 2014.

REFERENCES:

1. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7th Edition., McGraw-Hill, 2005.
2. Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol. I and II, 5th Edition, Asian Books Pvt. Ltd., India, 2002.
3. Seader J.D. and Henley E.J., "Separation Process Principles", 4th Ed., John Wiley, 2016

PC3401

INDUSTRIAL CHEMICAL TECHNOLOGY

L T P C
3 0 0 3**OBJECTIVES**

The course is aimed to Impart knowledge about unit process and unit operations in various industries. Develop understanding of manufacturing process flow drawing for the manufacturing chemical processes, its applications and major engineering problems encountered in the process

UNIT I CHLORO- ALKALI INDUSTRIES 9

Introduction to chemical processing; symbolic representation of different unit operations and unit processes to build a flow sheet ; Chlor - alkali Industries: Manufacture of Soda ash, Manufacture of caustic soda and chlorine - common salt.

UNIT II ACIDS 9

Sulphur and Sulphuric acid: Mining of sulphur and manufacture of sulphuric acid, Manufacture of hydrochloric acid. Phosphate rock, phosphoric acid.

UNIT III PULP, PAPER, SUGAR AND STARCH INDUSTRIES 9

Pulp – Methods of production – Comparison of pulping processes. Paper – types of paper products, Raw materials, Methods of production. Sugar – Methods of production – by products of the Sugar industry – Starch – Methods of production, Starch derivations.

UNIT IV CEMENT AND INDUSTRIAL GASES 9

Cement – properties of Cement – Methods of production – Fuel Gases – Producer gas, Water gas, Coke oven gas, Natural gas, Liquefied natural gas – Industrial gases – Carbon dioxide, hydrogen, nitrogen and oxygen.

UNIT V FERTILIZER INDUSTRY 9

Fertilizers: Nitrogen Fertilizers; Synthetic ammonia, nitric acid, Urea, Phosphorous Fertilizers: super phosphate and Triple Super phosphate

TOTAL: 45 PERIODS**OUTCOMES:**

On the completion of the course students are expected to

CO1: Understand the various unit operations and processes with their symbols.

CO2: Understand the various chemical reactions involved in the process

CO3: Understand the manufacturing process involved

CO4: Know to draw the process Flow sheet and understand the major engineering problems encountered in the processes

CO5: Learn manufacturing processes of organic and Inorganic Chemicals and its applications.

CO6: Understand the role of chemical Engineering in the production

TEXT BOOKS:

1. M. Gopal Rao, Marshall Sittig Dryden's Outlines of Chemical technology, III Ed., Affiliate East West press, 2018.
2. Austin G.T., "Shreve's Chemical Process Industries", 5th Edition, McGraw-Hill International Book Company, Singapore, 2012.

REFERENCES:

1. Moulin, J.A., M. Makkee, and Diepen, A.V., Chemical Process Technology, Wiley, 2001.
2. Srikumar Koyikkal,"Chemical Process Technology and Simulation",PHI Learning Ltd (2013).
3. Mark W.V. and Bhatia S.C., "Chemical Process Industries", Volume-I and II, 2nd Edition, CBS Publishers and Distributors, New Delhi, 2007.

CPE331

CHEMICAL REACTION ENGINEERING

L T P C
3 0 0 3**OBJECTIVE:**

- To enable the students to gain knowledge on different types of chemical reactors, the design of chemical reactors under isothermal and non-isothermal conditions

UNIT I KINETICS OF HOMOGENEOUS REACTIONS 9

Rate equation, elementary, non-elementary reactions, theories of reaction rate - Arrhenius theory, interpretation of kinetic data, integral and differential analysis.

UNIT II IDEAL REACTORS 9

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

UNIT III MULTIPLE REACTIONS 9

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

UNIT IV NON-ISOTHERMAL REACTORS 9

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

UNIT V NON-IDEAL REACTORS 9

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

TOTAL: 45 PERIODS**OUTCOMES:**

- Apply the principles of reaction kinetics, formulate rate equations and analyze the batch reactor data.
- Analyze the experimental kinetic data to select a suitable reactor for a particular application and to workout conversion and space time for different types of reactors.
- Evaluate selectivity, reactivity and yield for parallel and mixed reactions.
- Design isothermal and non-isothermal reactors for homogeneous reactions.
- Examine how far real reactors deviate from the ideal reactors.
- Solve the complex reaction engineering problems.

TEXT BOOKS:

- Levenspiel O, "Chemical Reaction Engineering", Wiley Eastern Ltd., III Edition, 2000.
- Smith, J.M, "Chemical Engineering Kinetics", McGraw Hill, III Edition, 1981.
- Fogler.H.S., "Elements of Chemical Reaction Engineering", Prentice Hall of India Ltd., III Edition, 2000.

REFERENCE:

- Froment. G.F. & K.B.Bischoff, "Chemical Reactor Analysis and Design", John Wiley and Sons, III Edition, 2010.

GE3451 ENVIRONMENTAL SCIENCES AND SUSTAINABILITY L T P C
2 0 0 2

UNIT - I : ENVIRONMENT AND BIODIVERSITY 6

Definition, scope and importance of environment – need for public awareness. Eco-system and Energy flow– ecological succession. Types of biodiversity: genetic, species and ecosystem diversity– values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ.

UNIT – II : ENVIRONMENTAL POLLUTION 6

Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollutions. Solid, Hazardous and E-Waste management. Case studies on Occupational Health and Safety Management system (OHSAS). Environmental protection, Environmental protection acts .

UNIT – III : RENEWABLE SOURCES OF ENERGY . 6

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

UNIT - IV : SUSTAINABILITY AND MANAGEMENT 6

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

UNIT - V : SUSTAINABILITY PRACTICES 6

Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports. Sustainable energy: Non-conventional Sources, Energy Cycles-carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socio-economical and technological change.

TOTAL: 30 PERIODS

TEXT BOOKS:

1. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers ,2018.
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.
3. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning.
6. Environment Impact Assessment Guidelines, Notification of Government of India, 2006.
7. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998.

REFERENCE BOOKS :

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38 .

- Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
- Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT. LTD, New Delhi, 2007.
- Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 2005.
- Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013.

PC3461

PETROCHEMICAL AND POLYMER ANALYSIS LABORATORY

L T P C
0 0 4 2**OBJECTIVE:**

- To learn basic principles involved in analysis of petrochemical products.

LIST OF EXPERIMENTS (Any 12 Experiments)

- Refractive index of petrochemicals
- Flash and Fire point determination using Cleveland Open cup method
- Flash and Fire point determination using Pensky Martien Closed cup method
- Kinematic viscosity determination using Redwood
- Kinematic viscosity determination using Saybolt
- Determination of moisture content – KF titrator
- Total acidity determination
- Solvent Recovery from petrochemical feed stock
- Elemental analysis of petrochemicals using GC / NMR
- Functional group analysis of petrochemicals using UV / FTIR
- Flue gas Analysis – Orsat Apparatus/Digital flue gas analyzer.
- Determination of Density, Apparent Density of Polymer
- Identification of Polymers : Plastics and Rubber – PE/PP/PS/PVC/PET/ NR/SBR/IR
- Determination of hardness of Polymers
- Determination of Glass Transition Temperature (T_g) / Melting Point, (T_m) of Polymers
- Determination of molecular weight by end group analysis (COOH group) / viscosity method.

TOTAL: 45 PERIODS**OUTCOME:**

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

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

- Refractometer
- Cleveland Open cup Flash and fire point apparatus
- Pensky Martien Flash and fire point apparatus

4. Redwood Viscometer
5. Saybolt Viscometer
6. KF-Titrator
7. Rotary vacuum evaporator.
8. UV- Visible spectrophotometer/FTIR.
9. Gas Chromatography with MS/NMR with MS
10. Sulphur content determination instrument
11. Orsat apparatus/ Digital flue gas analyzer
12. Durometer
13. Melting point apparatus

PC3462

PETROLEUM PRODUCT TESTING LABORATORY

L T P C
0 0 4 2**OBJECTIVE:**

- On completion of the course, the students should be conversant with the theoretical principles and experimental procedures for quantitative estimation of petroleum products.

LIST OF EXPERIMENTS (Any 12 Experiments)

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

TOTAL: 45 PERIODS**OUTCOME:**

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

LIST OF EQUIPMENT

1. Hydrometer
2. Conradson Apparatus / Muffle furnace
3. Brook Field viscometer
4. Dean and Stark apparatus
5. ASTM Distillation apparatus

6. Aniline point apparatus
7. Copper corrosion apparatus
8. Cloud and Pour point apparatus
9. Smoke point apparatus
10. Reid -Vapour pressure apparatus
11. Centrifuge apparatus
12. Drop point apparatus
13. Ring and ball softening point apparatus
14. Ductilometer
15. Penetrometer
16. Bomb calorimeter

