ANNA UNIVERSITY, CHENNAI
NON-AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY
B. E. MECHANICAL AND AUTOMATION ENGINEERING
REGULATIONS 2021
CHOICE BASED CREDIT SYSTEM
I AND II SEMESTERS (FULL TIME) CURRICULA AND SYLLABI

SEMESTER I

SL. 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
PRACTICAL								
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

SL. 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.	PH3259	Applied Materials Science	BSC	3	0	0	3	3
4.	BE3253	Basic Electrical, Electronics Engineering and Measurements	ESC	3	0	0	3	3
5.	GE3251	Engineering Graphics	ESC	2	0	4	6	4
6.		NCC Credit Course Level 1*	-	2	0	0	2	2
PRACTICAL								
7.	GE3271	Engineering Practices Laboratory	ESC	0	0	4	4	2
8.	BE3273	Basic Electrical, Electronics Engineering and Measurements Laboratory	ESC	0	0	4	4	2
			TOTAL	14	2	12	28	22

* 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 dont's, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing.
Discussions would be conducted in small groups of about 20 students with a faculty
mentor each. It would be effective that the faculty mentor assigned is also the faculty advisor for the student for the full duration of the UG programme.

    (iv)   Literary Activity

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

(v)   Proficiency Modules

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

(vi)   Lectures by Eminent People

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

(vii)   Visits to Local Area

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

(viii)   Familiarization to Dept./Branch & Innovations

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

(ix)   Department Specific Activities

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

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

References:
Guide to Induction program from AICTE

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 nonverbal (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
- To listen and comprehend complex academic texts
- To read and infer the denotative and connotative meanings of technical texts
- To write definitions, descriptions, narrations and essays on various topics
- To speak fluently and accurately in formal and informal communicative contexts
- 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.
5. 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
- Use the matrix algebra methods for solving practical problems.
- Apply differential calculus tools in solving various application problems.
- Able to use differential calculus ideas on several variable functions.
- Apply different methods of integration in solving practical problems.
- Apply multiple integral ideas in solving areas, volumes and other practical problems.

TEXT BOOKS:
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. Theory of laser - characteristics - Spontaneous and stimulated emission - Einstein's coefficients - population inversion - Nd-YAG laser, CO_2 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

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

TEXT BOOKS:

1. D.Kleppner and R.Kolenkow. An Introduction to Mechanics. McGraw Hill Education (Indian Edition), 2017.
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. CO_2 emission and carbon foot print.

UNIT V   ENERGY SOURCES AND STORAGE DEVICES   9

Stability of nucleus: mass defect (problems), binding energy; Nuclear energy: light water nuclear power plant, breeder reactor. Solar energy conversion: Principle, working and applications of solar cells; Recent developments in solar cell materials. Wind energy; Geothermal energy; Batteries: Types of batteries, Primary battery - dry cell, Secondary battery - lead acid battery and lithium-ion-battery; Electric vehicles – working principles; Fuel cells: H_2-O_2 fuel cell, microbial fuel cell; Supercapacitors: Storage principle, types and examples.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

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

TEXT BOOKS:

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. ShikhaAgarwal, "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.

GE3151	PROBLEM SOLVING AND PYTHON PROGRAMMING	L	T	P	C
		3	0	0	3

COURSE 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

COURSE 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.

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

COURSE 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

COURSE 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.

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
- Understand the functioning of various physics laboratory equipment.
- Use graphical models to analyze laboratory data.
- Use mathematical models as a medium for quantitative reasoning and describing physical reality.
- Access, process and analyze scientific information.
- Solve problems individually and collaboratively.

CHEMISTRY LABORATORY: (Any seven experiments to be conducted)

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

1. Preparation of Na_2CO_3 as a primary standard and estimation of acidity of a water sample using the primary standard
2. Determination of types and amount of alkalinity in water sample.
   - Split the first experiment into two
3. Determination of total, temporary & permanent hardness of water by EDTA method.

4. Determination of DO content of water sample by Winkler's method.
5. Determination of chloride content of water sample by Argentometric method.
6. Estimation of copper content of the given solution by Iodometry.
7. Estimation of TDS of a water sample by gravimetry.
8. Determination of strength of given hydrochloric acid using pH meter.
9. Determination of strength of acids in a mixture of acids using conductivity meter.
10. Conductometric titration of barium chloride against sodium sulphate (precipitation titration)
11. Estimation of iron content of the given solution using potentiometer.
12. Estimation of sodium /potassium present in water using flame photometer.
13. Preparation of nanoparticles (TiO_2/ZnO/CuO) by Sol-Gel method.
14. Estimation of Nickel in steel
15. Proximate analysis of Coal

TOTAL : 30 PERIODS

COURSE 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
- To compare and contrast products and ideas in technical texts.
- To identify cause and effects in events, industrial processes through technical texts
- To analyze problems in order to arrive at feasible solutions and communicate them orally and in the written format.
- To report events and the processes of technical and industrial nature.
- To present their opinions in a planned and logical manner, and draft effective resumes in context of job search.

TEXT BOOKS
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

COURSE 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 derivates using interpolation polynomials – Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules.

UNIT V   NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS   9+3

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

COURSE 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.

PH3259	APPLIED MATERIALS SCIENCE	L T P C
		3 0 0 3

COURSE OBJECTIVES:
- To make the students to understand the basics of crystallography and its importance in studying materials properties.
- To inculcate the knowledge of phase relationships for the understanding of material properties.
- To understand the electrical properties of materials including free electron theory, applications of quantum mechanics and magnetic materials.
- To instil knowledge on physics of semiconductors, determination of charge carriers and device applications
- To establish a sound grasp of knowledge on different optical properties of materials, optical displays and applications

UNIT I   CRYSTALLOGRAPHY   9
Crystal structures: BCC, FCC and HCP – directions and planes - linear and planar densities – crystal imperfections- edge and screw dislocations – grain and twin boundaries - Burgers vector and elastic strain energy- Slip systems, plastic deformation of materials - Polymorphism – phase changes – nucleation and growth – homogeneous and heterogeneous nucleation.

UNIT II   PHASE DIAGRAMS   9

Phase equilibrium – solubility limit – solid solution (interstitial and substitution) – intermediate phases – intermetallics – electron compound – 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 III   ELECTRICAL AND MAGNETIC PROPERTIES OF MATERIALS   9

Classical free electron theory - Expression for electrical conductivity – Thermal conductivity, expression - Quantum free electron theory :Tunneling – degenerate states – Fermi- Dirac statistics – Density of energy states – Electron in periodic potential – Energy bands in solids – tight binding approximation - Electron effective mass – concept of hole. Magnetic materials: Dia, para and ferromagnetic effects – paramagnetism in the conduction electrons in metals – exchange interaction and ferromagnetism – quantum interference devices – GMR devices.

UNIT IV   SEMICONDUCTORS AND TRANSPORT PHYSICS   9

Intrinsic Semiconductors – Energy band diagram – direct and indirect band gap   semiconductors – Carrier concentration in intrinsic semiconductors – extrinsic   semiconductors - Carrier concentration in N-type & P-type semiconductors – Variation of carrier concentration with temperature – Carrier transport in Semiconductors: Drift, mobility and diffusion – Hall effect and devices – Ohmic contacts – Schottky diode.

UNIT V   OPTICAL PROPERTIES OF MATERIALS   9

Classification of optical materials – Optical processes in semiconductors: optical absorption and emission, charge injection and recombination, optical absorption, loss and gain. Optical processes in quantum wells – Optoelectronic devices: light detectors and solar cells – light emitting diode – laser diode - optical processes in organic semiconductor devices –excitonic state – Electro-optics and nonlinear optics: Modulators and switching devices – plasmonics.

TOTAL: 45 PERIODS

COURSE OUTCOMES :

At the end of the course, the students should be able to

- Know basics of crystallography and its importance for varied materials properties.
- Understand the properties of materials through the study of phase relationships.
- Gain knowledge on the electrical and magnetic properties of materials and their applications
- Understand clearly of semiconductor physics and functioning of semiconductor devices
- Understand the optical properties of materials and working principles of various optical devices.

TEXT BOOKS:

1. V.Raghavan. Materials Science and Engineering: A First Course, Prentice Hall India Learning Private Limited, 2015.
2. Safa Kasap, Principles of Electronic Materials and Devices, Mc-Graw Hill, 2018.
3. Jasprit Singh, Semiconductor Devices: Basic Principles, Wiley (India), 2007.
4. Jasprit Singh, Semiconductor Optoelectronics: Physics and Technology, Mc-Graw Hill India (2019)
5. Safa kasap, Optoelectronics & Photonics: Principles and Practices, Pearson, 2013.

REFERENCES:

1. R.Balasubramaniam, Callister's Materials Science and Engineering. Wiley (Indian Edition), 2014.
2. Wendelin Wright and Donald Askeland, Essentials of Materials Science and Engineering, CL Engineering, 2013.
3. Robert F.Pierret, Semiconductor Device Fundamentals, Pearson, 2006.
4. Simon Sze and Ming-kwei Lee, Semiconductor Devices: Physics and Technology, Wiley, 2015.
5. Pallab Bhattacharya, Semiconductor Optoelectronic Devices, Pearson, 2017.

BE3253   BASIC ELECTRICAL, ELECTRONICS ENGINEERING AND MEASUREMENTS

L T P C
3 0 0 3

COURSE OBJECTIVES:
- To introduce the basics of electric circuits and analysis
- To impart knowledge in the basics of working principles and application of electrical machines
- To introduce analog devices and their characteristics
- To educate on the fundamental concepts of linear integrated circuits
- To introduce the functional elements and working of measuring instruments.

UNIT I   ELECTRICAL CIRCUITS   9
DC Circuits: Circuit Components: Conductor, Resistor, Inductor, Capacitor – Ohm's Law - Kirchhoff's Laws –Independent and Dependent Sources – Simple problems- Nodal Analysis, Mesh analysis with Independent sources only (Steady state)
Introduction to AC Circuits and Parameters: Waveforms, Average value, RMS Value, Instantaneous power, real power, reactive power and apparent power, power factor – Steady state analysis of RLC circuits (Simple problems only)

UNIT II   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 III   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

UNIT IV   LINEAR INTEGRATED CIRCUITS   9
Ideal OP-AMP characteristics, Basic applications of op-amp – Inverting and Non-inverting Amplifiers, summer, differentiator and integrator-S/H circuit, D/A converter (R- 2R ladder), A/D converters- Flash type ADC using OP-AMPS . Functional block, characteristics of 555 timer– Astable multi-vibrator mode.

UNIT V   MEASUREMENTS AND INSTRUMENTATION   9
Functional elements of an instrument, Standards and calibration, Operating Principle , types -Moving Coil and Moving Iron meters, Measurement of three phase power, Energy Meter, Instrument Transformers-CT and PT,DSO- Block diagram- Data acquisition.

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 working principle and applications of electrical machines
  CO3:   Analyze the characteristics of analog electronic devices
  CO4:   Explain the basic concepts of linear integrated circuits
  CO5:   Explain the operating principles of measuring instruments.

TEXT BOOKS
1. D P Kothari and I.J Nagrath, "Basic Electrical and Electronics Engineering", McGraw Hill Education, Second Edition, 2020.
2. Allan S Moris, "Measurement and Instrumentation Principles", Third Edition, Butterworth Heinemann, 2001.
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. Thomas L. Floyd, 'Electronic Devices', 10th Edition, Pearson Education, 2018.
2. A.K. Sawhney, Puneet Sawhney 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, New Delhi, January 2015.
3. Albert Malvino, David Bates, 'Electronic Principles, McGraw Hill Education; 7th edition, 2017

GE3251	ENGINEERING GRAPHICS	L T P C
		2 0 4 4

COURSE OBJECTIVES:

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

1. Drawing engineering curves.
2. Drawing freehand sketch of simple objects.
3. Drawing orthographic projection of solids and section of solids.
4. Drawing development of solids
5. Drawing isometric and perspective projections of simple solids.

CONCEPTS AND CONVENTIONS (Not for Examination)

Importance of graphics in engineering applications — Use of drafting instruments - BIS conventions and specifications — Size, layout and folding of drawing sheets — Lettering and dimensioning.

UNIT I   PLANE CURVES 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

COURSE OUTCOMES:

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

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

TEXT BOOKS:

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*

NX3253	(AIR FORCE 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

GE3271 **ENGINEERING PRACTICES LABORATORY** **L T P C**
0 0 4 2

COURSE OBJECTIVES:
The main learning objective of this course is to provide hands on training to the students in:

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

GROUP – A (CIVIL & ELECTRICAL)

PART I **CIVIL ENGINEERING PRACTICES** **15**
PLUMBING WORK:
  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 inhousehold 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 airconditioner.

SHEET METAL WORK:
  a) Making of a square tray

FOUNDRY WORK:
  a) Demonstrating basic foundry operations.

PART IV   **ELECTRONIC ENGINEERING PRACTICES**   **15**

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

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

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

TOTAL = 60 PERIODS

COURSE OUTCOMES:
 Upon completion of this course, the students will be able to:
  1. 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.
  2. Wire various electrical joints in common household electrical wire work.
  3. Weld various joints in steel plates using arc welding work; Machine various simple processeslike turning, drilling, tapping in parts; Assemble simple mechanical assembly of common household equipments; Make a tray out of metal sheet using sheet metal work.
  4. Solder and test simple electronic circuits; Assemble and test simple electronic components on PCB.

BE3273	**BASIC ELECTRICAL, ELECTRONICS ENGINEERING AND MEASUREMENTS LABORATORY**	L T P C
		0 0 4 2

COURSE OBJECTIVES:
- To train the students in conducting load tests on electrical machines
- To gain practical experience in characterizing electronic devices
- To train the students to use DSO for measurements

LIST OF EXPERIMENTS:

ELECTRICAL
1. Verification of ohms and Kirchhoff's Laws.
2. Load test on DC Shunt Motor.
3. Load test on Self Excited DC Generator
4. Load test on Single phase Transformer
5. Load Test on Induction Motor

ELECTRONICS
6. Experiment on Transistor based application circuits (Inverting and non-inverting amplifier or switching circuits)

    (Or)

    Experiments on Operational Amplifier based Inverting and non-inverting amplifier.

7. Experiments on ADC.
8. Experiments on 555 timer

MEASUREMENTS
9. Study on function of DSO.
10. Measurement of Amplitude, Frequency, Time, Phase Measurement using DSO.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
After completing this course, the students will be able to
1. Use experimental methods to verify the Ohm's and Kirchhoff's Laws.
2. Analyze experimentally the load characteristics of electrical machines
3. Analyze the characteristics of basic electronic devices
4. Use DSO to measure the various parameters

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

B. E. MECHANICAL AND AUTOMATION ENGINEERING

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

I. To enable students to identify, analyse, and solve problems in an advanced contemporary society by using the fundamentals of mathematics and engineering sciences with automation.

II. To enable students to plan, design and manufacture engineering components by effective production methodologies with industrial automation and best management practices.

III. To make students capable, to identify opportunities, work in multidisciplinary teams, establish work ethics, thus fulfilling the requirements of Industry and Research.

IV. To make students capable, to identify opportunities, work in multidisciplinary teams, establish work ethics, thus fulfilling the requirements of Industry and Research.

V. To inculcate in our students, healthy interpersonal skills, entrepreneurship skills, communication skills, adhering to good values.

PROGRAM OUTCOMES (POs)

PO **GRADUATE ATTRIBUTE**

1 **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2 **Problem analysis**: Identify, formulate, review research literature and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3 **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4 **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5 **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

6 **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7 **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8 **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9   **Individual and team work**: Function effectively as an individual, and as a member or leader in diver steams, and in multi-disciplinary settings.

10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12 **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independentandlife-longlearninginthebroadestcontextoftechnologicalchange.

I.   PROGRAM SPECIFIC OUTCOMES (PSOs)

1.   To synthesize technical data and concepts of Machine Design and Thermal Engineering to function effectively in the areas of research and development using software tools

2.   To design and fabricate Special Purpose Machine tools using the concepts of Unconventional Machining to enhance the efficiency of modern Manufacturing systems

3.   To design, analyse and develop automated systems in combination of mechanical, hydraulic, pneumatic, electrical & electronic devices & computers

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REGULATIONS 2021
CHOICE BASED CREDIT SYSTEM
B. E. MECHANICAL AND AUTOMATION ENGINEERING
CURRICULUM FOR SEMESTERS I TO VIII AND SYLLABI FOR SEMESTERS III AND IV

SEMESTER I

SL. 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.	GE3152	அறிவியல் தமிழ் /Scientific Thoughts in Tamil	HSMC	1	0	0	1	1
PRACTICAL								
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**

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	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.	PH3259	Applied Materials Science	BSC	3	0	0	3	3
4.	BE3253	Basic Electrical, Electronics Engineering and Measurements	ESC	3	0	0	3	3
5.	GE3251	Engineering Graphics	ESC	2	0	4	6	4
6.	GE3252	தமிழர் மரபு /Heritage of Tamils	HSMC	1	0	0	1	1
7.		NCC Credit Course Level 1*	-	2	0	0	2	0
PRACTICAL								
8.	GE3271	Engineering Practices Laboratory	ESC	0	0	4	4	2
9.	BE3273	Basic Electrical, Electronics Engineering and Measurements Laboratory	ESC	0	0	4	4	2
10.	GE3272	Communication Laboratory / Foreign Language $	EEC	0	0	4	4	2
				14	**1**	**16**	**31**	**23**

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**

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	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.	ME3351	Engineering Mechanics	PCC	3	0	0	3	3
3.	PR3351	Thermodynamics and Thermal Engineering	PCC	3	0	0	3	3
4.	CE3391	Fluid Mechanics and Machinery	ESC	3	1	0	4	4
5.	ME3493	Manufacturing Technology	PCC	3	0	0	3	3
6.	MR3392	Electrical Drives and Actuators	PCC	3	0	0	3	3
PRACTICALS								
7.	MR3361	Electrical Drives and Actuators Laboratory	ESC	0	0	4	4	2
8.	ME3382	Manufacturing Technology Laboratory	PCC	0	0	4	4	2
9.	GE3361	Professional Development $	EEC	0	0	2	2	1
			TOTAL	18	2	10	30	25

$ Skill Based Course

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	ME3392	Engineering Materials and Metallurgy	PCC	3	0	0	3	3
2.	MR3391	Digital Electronics and Microprocessor	PCC	3	0	0	3	3
3.	MF3391	Mechanics of Materials	ESC	3	0	0	3	3
4.	ME3491	Theory of Machines	PCC	3	0	0	3	3
5.	MR3491	Sensors and Instrumentation	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.	CE3481	Strength of Materials and Fluid Machinery Laboratory	PCC	0	0	4	4	2
9.	MR3461	Sensors and Instrumentation Laboratory	PCC	0	0	4	4	2
			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

SEMESTER V

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	CPR333	Machine Design	PCC	3	0	0	3	3
2.	MR3591	Fluid Power Systems and Industrial Automation	PCC	3	0	0	3	3
3.		Professional Elective I	PEC	-	-	-	-	3
4.		Professional Elective II	PEC	-	-	-	-	3
5.		Professional Elective III	PEC	-	-	-	-	3
6.		Professional Elective IV	PEC	-	-	-	-	3
7.		Mandatory Course-I**&**	MC	3	0	0	3	0
PRACTICALS								
8.	MR3561	Industrial Automation Laboratory	PCC	0	0	4	4	2
			TOTAL	-	-	-	-	20

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

SEMESTER VI

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	ME3791	Mechatronics and IOT	PCC	3	0	0	3	3
2.	ME3592	Metrology and Measurements	PCC	3	0	0	3	3
3.		Open Elective – I*	OEC	3	0	0	3	3
4.		Professional Elective V	PEC	-	-	-	-	3
5.		Professional Elective VI	PEC	-	-	-	-	3
6.		Professional Elective VII	PEC	-	-	-	-	3
7.		Professional Elective VIII	PEC	-	-	-	-	3
8.		Mandatory Course-II**&**	MC	3	0	0	3	0
9.		NCC Credit Course Level 3**#**		3	0	0	3	0
PRACTICALS								
10.	ME3581	Metrology and Dynamics Laboratory	PCC	0	0	4	4	2
11.	AN3611	Design and Fabrication Project	PCC	0	0	2	2	1
			TOTAL	-	-	-	-	24

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

& **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.	MR3691	Robotics	PCC	3	0	0	3	3
2.	GE3791	Human Values and Ethics	HSMC	2	0	0	2	2
3.		Elective – Management #	HSMC	3	0	0	3	3
4.		Open Elective – II**	OEC	3	0	0	3	3
5.		Open Elective – III***	OEC	3	0	0	3	3
6.		Open Elective – IV***	OEC	3	0	0	3	3
PRACTICALS								
7.	AN3711	Mechatronics and Robotics Laboratory	PCC	0	0	4	4	2
			TOTAL	**17**	**0**	**4**	**21**	**19**

*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

SEMESTER VIII/VII*

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	AN3811	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

PROGRESS THROUGH KNOWLEDGE

TOTAL CREDITS: 164

ELECTIVE – MANAGEMENT COURSES

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PERWEEK			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

S. 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

S. 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 1	VERTICAL 2	VERTICAL 3	VERTICAL 4	VERTICAL 5	VERTICAL 6	VERTICAL 7
AUTOMATION	APPLIED ROBOTICS	COMPUTATIONAL ENGINEERING	DIGITAL AND GREEN MANUFACTURING	PRODUCT AND PROCESS DEVELOPMENT	DIVERSIFIED COURSES GROUP 1	DIVERSIFIED COURSES GROUP 2
Object Oriented Programming in C++	Robots and Systems in Smart Manufacturing	Computational Solid Mechanics	Digital Manufacturing and IoT	Value Engineering	Embedded system and Programming	Automobile Engineering
Power Electronics	Drone Technologies	Computational Fluid Dynamics and Heat transfer	Lean Manufacturing	Additive Manufacturing	Finite Element Analysis	Micro Electro Mechanical Systems
Computer Architecture and Organisation	Mircrorobotics	Theory on Computation and Visualization	Modern Robotics	CAD/CAM	Refrigeration and Air Conditioning	Non Traditional Machining Process
Virtual Instrumentation	Agricultural Robotics and Automation	Computational Bio-Mechanics	Green Manufacturing Design and Practices	Design For X	Design for Manufacturing	Design Concepts in Engineering
Industrial Network Protocols	Collaborative Robotics	Advanced Statistics and Data Analytics	Environment Sustainability and Impact Assessment	Ergonomics in Design	Process Planning and Cost Estimation	Composite Materials and Mechanics
Motion Control System	Robot Operating Systems	CAD and CAE	Energy Saving Machinery and Components	New Product Development	Design of Jigs and Fixtures	Renewable Energy Technologies
Total Integrated Automation	Medical Robotics	Machine Learning for Intelligent Systems	Green Supply Chain Management	Product Life Cycle Management	Gas Dynamics and Jet Propulsion	Metal and Powder Forming Techniques
Digital Twin and Industry 5.0	Humanoid Robotics	Computer Aided Inspection	Computer Integrated Manufacturing	Operational Research	Industry 4.0	Fundamentals of Nanoscience

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 / diversified group. Students are permitted to choose all the 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 the Regulations 2021, Clause 4.10.

PROFESSIONAL ELECTIVE COURSES : VERTICALS

VERTICAL 1: AUTOMATION

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMR345	Object Oriented Programming in C++	PEC	3	0	0	3	3
2.	EE3591	Power Electronics	PEC	3	0	0	3	3
3.	CCS376	Computer Architecture and Organisation	PEC	3	0	0	3	3
4.	CBM372	Virtual Instrumentation	PEC	3	0	0	3	3
5.	CMR346	Industrial Network Protocols	PEC	3	0	0	3	3
6.	CMR347	Motion Control System	PEC	3	0	0	3	3
7.	CMR348	Total Integrated Automation	PEC	3	0	0	3	3
8.	CMR349	Digital Twin and Industry 5.0	PEC	3	0	0	3	3

VERTICAL 2: APPLIED ROBOTICS

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CRA331	Robots and Systems in Smart Manufacturing	PEC	3	0	0	3	3
2.	CRA332	Drone Technologies	PEC	3	0	0	3	3
3.	CRA333	Mircrorobotics	PEC	3	0	0	3	3
4.	CRA334	Agricultural Robotics and Automation	PEC	3	0	0	3	3
5.	CRA335	Collaborative Robotics	PEC	3	0	0	3	3
6.	CRA336	Robot Operating Systems	PEC	3	0	0	3	3
7.	CRA337	Medical Robotics	PEC	3	0	0	3	3
8.	CRA338	Humanoid Robotics	PEC	3	0	0	3	3

VERTICAL 3: COMPUTATIONAL ENGINEERING

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CME367	Computational Solid Mechanics	PEC	3	0	0	3	3
2.	CME368	Computational Fluid Dynamics and Heat transfer	PEC	3	0	0	3	3
3.	CME369	Theory on Computation and Visualization	PEC	3	0	0	3	3
4.	CME370	Computational Bio-Mechanics	PEC	3	0	0	3	3
5.	CME371	Advanced Statistics and Data Analytics	PEC	3	0	0	3	3
6.	CME372	CAD and CAE	PEC	2	0	2	4	3
7.	CME373	Machine Learning for Intelligent Systems	PEC	3	0	0	3	3
8.	AN3001	Computer Aided Inspection	PEC	3	0	0	3	3

VERTICAL 4: DIGITAL AND GREEN MANUFACTURING

SL. NO.	COURSE CODE	COURSETITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIOD	CREDITS
				L	T	P		
1.	CME346	Digital Manufacturing and IoT	PEC	2	0	2	4	3
2.	CME347	Lean Manufacturing	PEC	3	0	0	3	3
3.	CME348	Modern Robotics	PEC	2	0	2	4	3
4.	CME349	Green Manufacturing Design and Practices	PEC	3	0	0	3	3
5.	CME350	Environment Sustainability and Impact Assessment	PEC	3	0	0	3	3
6.	CME351	Energy Saving Machinery and Components	PEC	3	0	0	3	3
7.	CME352	Green Supply Chain Management	PEC	3	0	0	3	3
8.	ME3792	Computer Integrated Manufacturing	PEC	3	0	0	3	3

VERTICAL 5: PRODUCT AND PROCESS DEVELOPMENT

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIOD	CREDITS
				L	T	P		
1.	CME338	Value Engineering	PEC	3	0	0	3	3
2.	CME339	Additive Manufacturing	PEC	2	0	2	4	3
3.	CME340	CAD/CAM	PEC	3	0	0	3	3
4.	CME341	Design For X	PEC	3	0	0	3	3
5.	CME342	Ergonomics in Design	PEC	3	0	0	3	3
6.	CME343	New Product Development	PEC	3	0	0	3	3
7.	CME344	Product Life Cycle Management	PEC	3	0	0	3	3
8.	CME399	Operational Research	PEC	2	0	2	4	3

VERTICAL 6: DIVERSIFIED COURSES GROUP 1

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MR3492	Embedded Systems and Programming	PEC	2	0	2	4	3
2.	CPR332	Finite Element Analysis	PEC	3	0	0	3	3
3.	CME385	Refrigeration and Air Conditioning	PEC	3	0	0	3	3
4.	CME391	Design for Manufacturing	PEC	3	0	0	3	3
5.	CME396	Process Planning and Cost Estimation	PEC	3	0	0	3	3
6.	CMF331	Design of Jigs and Fixtures	PEC	3	0	0	3	3
7.	CME400	Gas Dynamics and Jet Propulsion	PEC	3	0	0	3	3
8.	CMF340	Industry 4.0	PEC	3	0	0	3	3

VERTICAL 7: DIVERSIFIED COURSES GROUP 2

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CME380	Automobile Engineering	PEC	3	0	0	3	3
2.	CMR385	Micro Electro Mechanical Systems	PEC	3	0	0	3	3
3.	CME387	Non-traditional Machining Processes	PEC	3	0	0	3	3
4.	CME381	Design Concepts in Engineering	PEC	3	0	0	3	3
5.	CME382	Composite Materials and Mechanics	PEC	3	0	0	3	3
6.	CME365	Renewable Energy Technologies	PEC	3	0	0	3	3
7.	ML3591	Metal and Powder Forming Techniques	PEC	3	0	0	3	3
8.	MLC331	Fundamentals of Nanoscience	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	CATEGORY	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 Reality 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.	OAS352	Space Engineering	OEC	3	0	0	3	3
10.	OIM351	Industrial Management	OEC	3	0	0	3	3
11.	OIE354	Quality Engineering	OEC	3	0	0	3	3
12.	OSF351	Fire Safety Engineering	OEC	3	0	0	3	3
13.	OML351	Introduction to non-destructive testing	OEC	3	0	0	3	3
14.	OAE352	Fundamentals of Aeronautical engineering	OEC	3	0	0	3	3
15.	OGI351	Remote Sensing Concepts	OEC	3	0	0	3	3
16.	OAI351	Urban Agriculture	OEC	3	0	0	3	3
17.	OEN351	Drinking Water Supply and Treatment	OEC	3	0	0	3	3
18.	OEE352	Electric Vehicle technology	OEC	3	0	0	3	3
19.	OEI353	Introduction to PLC Programming	OEC	3	0	0	3	3
20.	OCH351	Nano Technology	OEC	3	0	0	3	3
21.	OCH352	Functional Materials	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.	OPE351	Introduction to Petroleum Refining and Petrochemicals	OEC	3	0	0	3	3
30.	OPE352	Energy Conservation and Management	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.	OAS353	Space Vehicles	OEC	3	0	0	3	3
14.	OIM352	Management Science	OEC	3	0	0	3	3

15.	OIM353	Production Planning and Control	OEC	3	0	0	3	3
16.	OIE353	Operations Management	OEC	3	0	0	3	3
17.	OSF352	Industrial Hygiene	OEC	3	0	0	3	3
18.	OSF353	Chemical Process Safety	OEC	3	0	0	3	3
19.	OML352	Electrical, Electronic and Magnetic materials	OEC	3	0	0	3	3
20.	OML353	Nanomaterials and applications	OEC	3	0	0	3	3
21.	OMV351	Marine Propulsion	OEC	3	0	0	3	3
22.	OMV352	Marine Merchant Vehicles	OEC	3	0	0	3	3
23.	OMV353	Elements of Marine Engineering	OEC	3	0	0	3	3
24.	OAE353	Drone Technologies	OEC	3	0	0	3	3
25.	OGI352	Geographical Information System	OEC	3	0	0	3	3
26.	OAI352	Agriculture Entrepreneurship Development	OEC	3	0	0	3	3
27.	OEN352	Biodiversity Conservation	OEC	3	0	0	3	3
28.	OEE353	Introduction to control systems	OEC	3	0	0	3	3
29.	OEI354	Introduction to Industrial Automation Systems	OEC	3	0	0	3	3
30.	OCH353	Energy Technology	OEC	3	0	0	3	3
31.	OCH354	Surface Science	OEC	3	0	0	3	3
32.	OBT353	Environment and Agriculture	OEC	3	0	0	3	3
33.	OFD354	Fundamentals of Food Engineering	OEC	3	0	0	3	3
34.	OFD355	Food safety and Quality Regulations	OEC	3	0	0	3	3
35.	OPY353	Nutraceuticals	OEC	3	0	0	3	3
36.	OTT354	Basics of Dyeing and Printing	OEC	3	0	0	3	3
37.	OTT355	Fibre Science	OEC	3	0	0	3	3
38.	OTT356	Garment Manufacturing Technology	OEC	3	0	0	3	3
39.	OPE353	Industrial safety	OEC	3	0	0	3	3
40.	OPE354	Unit Operations in Petro Chemical Industries	OEC	3	0	0	3	3
41.	OPT352	Plastic Materials for Engineers	OEC	3	0	0	3	3
42.	OPT353	Properties and Testing of Plastics	OEC	3	0	0	3	3
43.	OEC353	VLSI Design	OEC	3	0	0	3	3
44.	OEC354	Industrial IoT and	OEC	2	0	2	4	3

		Industry 4.0						
45.	OBM353	Wearable devices	OEC	3	0	0	3	3
46.	OBM354	Medical Informatics	OEC	3	0	0	3	3

SUMMARY

		Credits per Semester								Total Credits
S.No	Subject Area	I	II	III	IV	V	VI	VII/VIII	VIII/VII	
1	HSMC	4	4					5		13
2	BSC	12	7	4	2					25
3	ESC	5	11	6	3					25
4	PCC			14	16	8	9	5		52
5	PEC					12	12			24
6	OEC						3	9		12
7	EEC	1	1	1					10	13
8	Non-Credit /(Mandatory)					√	√			
	Total	22	23	25	21	20	24	19	10	164

Table header spanning: **B.E. MECHANICAL AND AUTOMATION**

.
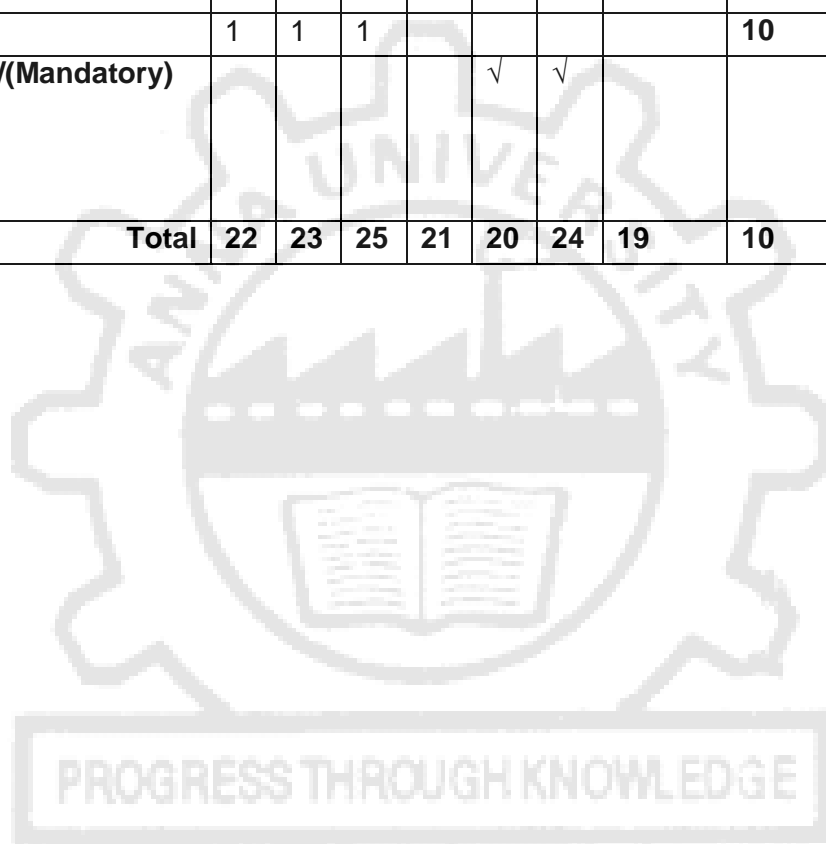
ENROLLMENT FOR B.E. / B. TECH. (HONOURS) / MINOR DEGREE (OPTIONAL)

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E. / B. Tech. (Honours) or 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 addition to all the verticals of other programmes)

Vertical I	Vertical II	Vertical III	Vertical IV	Vertical V
Fintech and Block Chain	**Entrepreneurship**	**Public Administration**	**Business Data Analytics**	**Environment and Sustainability**
Financial Management	Foundations of Entrepreneruship	Principles of Public Administration	Statistics for Management	Sustainable infrastructure Development
Fundamentals of Investment	Team Building and Leadership Management for Business	Constitution of India	Datamining for Business Intelligence	Sustainable Agriculture and Environmental Management
Banking, Financial Services and Insurance	Creativity and 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. NO.	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 and Leadership Management for Business	PEC	3	0	0	3	3
3.	CMG339	Creativity and 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 Entrepreneurship	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	CATE GORY	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	CATE GORY	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

COURSE 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:
1. Understand how to solve the given standard partial differential equations.
2. Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.
3. Appreciate the physical significance of Fourier series techniques in solving one- and two-dimensional heat flow problems and one-dimensional wave equations.
4. 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.
5. 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", 44[th]Edition, Khanna Publishers, New Delhi, 2018.
2. Kreyszig E, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, New Delhi, India, 2018.

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, 2021.
3. James. G., "Advanced Modern Engineering Mathematics", 4thEdition, 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.

ME3351	**ENGINEERING MECHANICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

1	To Learn the use scalar and vector analytical techniques for analysing forces in statically determinate structures
2	To introduce the equilibrium of rigid bodies, vector methods and free body diagram
3	To study and understand the distributed forces, surface, loading on beam and intensity.
4	To learn the principles of friction, forces and to determine the apply the concepts of frictional forces at the contact surfaces of various engineering systems.
5	To develop basic dynamics concepts – force, momentum, work and energy;

UNIT I   STATICS OF PARTICLES   9
Fundamental Concepts and Principles, Systems of Units, Method of Problem Solutions, Statics of Particles - Forces in a Plane, Resultant of Forces, Resolution of a Force into Components, Rectangular Components of a Force, Unit Vectors. Equilibrium of a Particle- Newton's First Law of Motion, Space and Free-Body Diagrams, Forces in Space, Equilibrium of a Particle in Space.

UNIT II   EQUILIBRIUM OF RIGID BODIES   9
Principle of Transmissibility, Equivalent Forces, Vector Product of Two Vectors, Moment of a Force about a Point, Varignon's Theorem, Rectangular Components of the Moment of a Force, Scalar Product of Two Vectors, Mixed Triple Product of Three Vectors, Moment of a Force about an Axis, Couple - Moment of a Couple, Equivalent Couples, Addition of Couples, Resolution of a Given Force into a Force -Couple system, Further Reduction of a System of Forces, Equilibrium in Two and Three Dimensions - Reactions at Supports and Connections.

UNIT III   DISTRIBUTED FORCES   9
Centroids of lines and areas – symmetrical and unsymmetrical shapes, Determination of Centroids by Integration, Theorems of Pappus-Guldinus, Distributed Loads on Beams, Centre of Gravity of a Three-Dimensional Body, Centroid of a Volume, Composite Bodies, Determination of Centroids of Volumes by Integration. Moments of Inertia of Areas and Mass - Determination of the Moment of Inertia of an Area by Integration, Polar Moment of Inertia, Radius of Gyration of an Area, Parallel-Axis Theorem, Moments of Inertia of Composite Areas, Moments of Inertia of a Mass - Moments of Inertia of Thin Plates, Determination of the Moment of Inertia of a Three-Dimensional Body by Integration.

UNIT IV   FRICTION   9
The Laws of Dry Friction, Coefficients of Friction, Angles of Friction, Wedge friction, Wheel Friction, Rolling Resistance, Ladder friction.

UNIT V   DYNAMICS OF PARTICLES   9
Kinematics - Rectilinear Motion and Curvilinear Motion of Particles. Kinetics- Newton's Second Law of Motion -Equations of Motions, Dynamic Equilibrium, Energy and Momentum Methods - Work of a Force, Kinetic Energy of a Particle, Principle of Work and Energy, Principle of Impulse and Momentum, Impact of bodies.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course the students would be able to
1. Illustrate the vector and scalar representation of forces and moments
2. Analyse the rigid body in equilibrium
3. Evaluate the properties of distributed forces
4. Determine the friction and the effects by the laws of friction
5. Calculate dynamic forces exerted in rigid body

TEXT BOOKS:

1. Beer Ferdinand P, Russel Johnston Jr., David F Mazurek, Philip J Cornwell, Sanjeev Sanghi, Vector Mechanics for Engineers: Statics and Dynamics, McGraw Higher Education., 12thEdition, 2019.
2. Vela Murali, "Engineering Mechanics-Statics and Dynamics", Oxford University Press, 2018.

REFERENCES:

1. Boresi P and Schmidt J, Engineering Mechanics: Statics and Dynamics, 1/e, Cengage learning, 2008.
2. Hibbeller, R.C., Engineering Mechanics: Statics, and Engineering Mechanics: Dynamics, 13th edition, Prentice Hall, 2013.
3. Irving H. Shames, Krishna Mohana Rao G, Engineering Mechanics – Statics and Dynamics, 4thEdition, Pearson Education Asia Pvt. Ltd., 2005.
4. Meriam J L and Kraige L G, Engineering Mechanics: Statics and Engineering Mechanics: Dynamics, 7th edition, Wiley student edition, 2013.
5. Timoshenko S, Young D H, Rao J V and SukumarPati, Engineering Mechanics, 5thEdition, McGraw Hill Higher Education, 2013.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	1	2							2	3	1	1
2	3	2	2	1	2							2	3	1	1
3	3	2	3	1	2							2	3	1	2
4	3	2	3	1	2							2	3	1	2
5	3	2	3	1	2							2	3	1	2
Low (1); Medium (2); High (3)															

PROGRESS THROUGH KNOWLEDGE

PR3351   **THERMODYNAMICS AND THERMAL ENGINEERING**   **L T P C**
                                                               3 0 0 3

COURSE OBJECTIVES:
1. To impart knowledge of basic principles of thermodynamics via real world engineering examples.
2. To analyse and evaluate air standard cycles.
3. To analyse and evaluate Steam power cycles.
4. Summarize the governing concepts of Refrigeration and Air conditioning.
5. To introduce various modes of heat transfer, related to real time scenarios of thermodynamics applied in engineering practice.

UNIT I   BASICS OF THERMODYNAMICS   9
Systems, Zeroth law, first law. Heat and work transfer in flow and non-flow processes. Second law-Kelvin-Planck and Clausius statement, Concept of Entropy -Clausius inequality, Entropy change in non-flow processes.

UNIT II   AIR STANDARD CYCLE   7
Otto, Diesel, Dual and Brayton cycles - Air standard efficiency and Mean effective pressure.

UNIT III   VAPOUR POWER CYCLES   11

Properties of steam – Rankine cycle – Steam Nozzles Principles of Psychrometry and refrigeration systems- Vapour compression - Vapour absorption - Coefficient of performance, Properties of refrigerants – Basic Principle and types Air conditioning systems.

UNIT IV   COMPRESSORS AND JET PROPULSION   9

Compressors types - performance of Reciprocating compressors – Simple jet propulsion system – Thrust rocket motor – Specific impulse.

UNIT V   HEAT TRANSFER   9

Conduction in simple plane, radial and composite walls – Basics of Convective heat transfer - Fundamentals of Radioactive heat transfer – Flow through heat exchangers (LMTD and NTU).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Will demonstrate understanding of the nature of the thermodynamic processes for pure
      substances and interpret the Laws of Thermodynamics

CO2: Will analyses and evaluate air standard cycles

CO3: Will understand the vapour power cycles.

CO4: Will learn the air compressors for pneumatic applications and aircraft vehicle

CO5: Will get exposed to the basics and modes of heat transfer.

COs/Pos&PS Os	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	1	1	2	2	-	1	-	-	-	-	1	1	1	1
CO2	3	1	1	2	2	-	1	-	-	-	-	1	1	1	1
CO3	3	1	1	2	2	-	1	-	-	-	-	1	1	1	1
CO4	3	1	1	2	2	-	1	-	-	-	-	1	1	1	1
CO5	3	1	1	2	2	-	1	-	-	-	-	1	1	1	1
CO/PO & PSO Average	3	1	1	2	2	-	1	-	-	-	-	1	1	1	1
1 – Slight, 2 – Moderate, 3 – Substantial															

Mapping of COs with POs and PSOs

TEXT BOOKS:

1. Nag.P.K. "Engineering Thermodynamics", Tata McGraw-Hill, New Delhi, Sixth edition, 2017.
2. Rathakrishnan. E., "Fundamentals of Engineering Thermodynamics", McGraw Hill Education; Sixth edition, 2017.

REFERENCES:

1. Holman.J.P. "Heat Transfer", 10th Ed. McGraw-Hill, 2017.
2. Mahesh M. Rathore, "Thermal Engineering Vol I and II " Tata McGraw-Hill Education, 2018
3. Venwylen and Sontag, "Classical Thermodynamics", Wiley Eastern, 1987
4. Arora C.P, "Refrigeration and Air Conditioning", Tata McGraw-Hill, New Delhi, 2013.
5. Merala C, Pother, Craig W, Somerton, "Thermodynamics for Engineers", Schaum Outline Series, Tata McGraw-Hill, New Delhi, 2013.

CE3391   **FLUID MECHANICS AND MACHINERY**   **L T P C**
                                                                     3 1 0 4

COURSE OBJECTIVES:

1. To introduce the students about properties of the fluids, behaviour of fluids under static conditions.
2. To impart basic knowledge of the dynamics of fluids and boundary layer concept.
3. To expose to the applications of the conservation laws to a) flow measurements b) flow through pipes (both laminar and turbulent) and c) forces on pipe bends.
4. To exposure to the significance of boundary layer theory and its thicknesses.
5. To expose the students to basic principles of working of hydraulic machineries and to design Pelton wheel, Francis and Kaplan turbine, centrifugal and reciprocating pumps.

UNIT I   FLUID PROPERTIES AND FLOW CHARACTERISTICS   10+3
Properties of fluids – Fluid statics - Pressure Measurements - Buoyancy and floatation - Flow characteristics - Eulerian and Lagrangian approach - Concept of control volume and system - Reynold's transportation theorem - Continuity equation, energy equation and momentum equation - Applications.

UNIT II   FLOW THROUGH PIPES AND BOUNDARY LAYER   9+3
Reynold's Experiment - Laminar flow through circular conduits - Darcy Weisbach equation - friction factor - Moody diagram - Major and minor losses - Hydraulic and energy gradient lines - Pipes in series and parallel - Boundary layer concepts - Types of boundary layer thickness.

UNIT III   DIMENSIONAL ANALYSIS AND MODEL STUDIES   8+3
Fundamental dimensions - Dimensional homogeneity - Rayleigh's method and Buckingham Pi theorem - Dimensionless parameters - Similitude and model studies - Distorted and undistorted models.

UNIT IV   TURBINES   9+3
Impact of jets - Velocity triangles - Theory of rotodynamic machines - Classification of turbines - Working principles - Pelton wheel - Modern Francis turbine - Kaplan turbine - Work done - Efficiencies - Draft tube - Specific speed - Performance curves for turbines - Governing of turbines.

UNIT V   PUMPS   9+3
Classification of pumps - Centrifugal pumps - Working principle - Heads and efficiencies– Velocity triangles - Work done by the impeller - Performance curves - Reciprocating pump working principle - Indicator diagram and it's variations - Work saved by fitting air vessels - Rotary pumps.

                                                TOTAL: 60 PERIODS

OUTCOMES: On completion of the course, the student is expected to be able to
1. Understand the properties and behaviour in static conditions. Also to understand the conservation laws applicable to fluids and its application through fluid kinematics and dynamics
2. Estimate losses in pipelines for both laminar and turbulent conditions and analysis of pipes connected in series and parallel. Also to understand the concept of boundary layer and its thickness on the flat solid surface.
3. Formulate the relationship among the parameters involved in the given fluid phenomenon and to predict the performances of prototype by model studies
4. Explain the working principles of various turbines and design the various types of turbines.
5. Explain the working principles of centrifugal, reciprocating and rotary pumps and design the centrifugal and reciprocating pumps

TEXT BOOKS:
1. Modi P.N. and Seth, S.M. Hydraulics and Fluid Mechanics, Standard Book House, New Delhi, 22nd edition (2019)
2. Jain A. K. Fluid Mechanics including Hydraulic Machines, Khanna Publishers, New Delhi, 2014.
3. Kumar K. L., Engineering Fluid Mechanics, Eurasia Publishing House(p) Ltd. New Delhi, 2016.

REFERENCES:
1. Fox W.R. and McDonald A.T., Introduction to Fluid Mechanics John-Wiley and Sons, Singapore, 2011.
2. Pani B S, Fluid Mechanics: A Concise Introduction, Prentice Hall of India Private Ltd, 2016.
3. Cengel Y A and Cimbala J M, Fluid Mechanics, McGraw Hill Education Pvt. Ltd., 2014.
4. S K Som; Gautam Biswas and S Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, Tata

McGraw Hill Education Pvt. Ltd., 2012.
5. Streeter, V. L. and Wylie E. B., Fluid Mechanics, McGraw Hill Publishing Co., 2010.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	2	1	2	2	1	2	1	1	2	3	2	3
2	3	3	3	2	1	2	2	1	2	1	1	2	3	2	3
3	3	3	3	3	1	2	2	1	2	1	1	2	3	3	3
4	3	3	3	3	1	2	2	1	2	1	1	3	3	2	2
5	3	3	3	3	1	2	2	1	2	1	1	3	3	2	2
Low (1) ; Medium (2) ; High (3)															

			L	T	P	C
ME3493	**MANUFACTURING TECHNOLOGY**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

1   To study the concepts and basic mechanics of metal cutting and the factors affecting machinability
2   To learn working of basic and advanced turning machines.
3   To teach the basics of machine tools with reciprocating and rotating motions and abrasive finishing processes.
4   To study the basic concepts of CNC of machine tools and constructional features of CNC.
5   To learn the basics of CNC programming concepts to develop the part programme for Machine centre and turning centre

UNIT – I   MECHANICS OF METAL CUTTING   9
Mechanics of chip formation, forces in machining, Types of chip, cutting tools – single point cutting tool nomenclature, orthogonal and oblique metal cutting, thermal aspects, cutting tool materials, tool wear, tool life, surface finish, cutting fluids and Machinability.

UNIT – II   TURNING MACHINES   9
Centre lathe, constructional features, specification, operations – taper turning methods, thread cutting methods, special attachments, surface roughness in turning, machining time and power estimation. Special lathes - Capstan and turret lathes- tool layout – automatic lathes: semi-automatic – single spindle: Swiss type, automatic screw type – multi spindle

UNIT – III   RECIPROCATING MACHINE TOOLS   9
Reciprocating machine tools: shaper, planer, slotter: Types and operations- Hole making: Drilling, reaming, boring, tapping, type of milling operations-attachments- types of milling cutters– machining time calculation - Gear cutting, gear hobbing and gear shaping – gear finishing methods Abrasive processes: grinding wheel – specifications and selection, types of grinding process – cylindrical grinding, surface grinding, centreless grinding, internal grinding - micro finishing methods

UNIT – IV   CNC MACHINES   9
Computer Numerical Control (CNC) machine tools, constructional details, special features – Drives, Recirculating ball screws, tool changers; CNC Control systems – Open/closed, point-to-point/continuous - Turning and machining centres – Work holding methods in Turning and machining centres, Coolant systems, Safety features.

UNIT – V   PROGRAMMING OF CNC MACHINE TOOLS   9
Coordinates, axis and motion, Absolute vs Incremental, Interpolators, Polar coordinates, Program planning, G and M codes, Manual part programming for CNC machining centers and Turning centers – Fixed cycles, Loops and subroutines, Setting up a CNC machine for machining.

TOTAL 45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Apply the mechanism of metal removal process and to identify the factors involved in improving machinability.
2. Describe the constructional and operational features of centre lathe and other special purpose lathes.
3. Describe the constructional and operational features of reciprocating machine tools.
4. Apply the constructional features and working principles of CNC machine tools.
5. Demonstrate the Program CNC machine tools through planning, writing codes and setting up CNC machine tools to manufacture a given component.

TEXT BOOKS:

1. Kalpakjian. S, "Manufacturing Engineering and Technology", Pearson Education India,7ᵗʰ Edition, 2018.
2. Michael Fitzpatrick, Machining and CNC Technology, McGraw-Hill Education; 4ᵗʰ edition, 2018.

REFERENCES:

1. Roy. A. Lindberg, Processes and materials of manufacture, PHI / Pearson education, 2006.
2. Geofrey Boothroyd, "Fundamentals of Metal Machining and Machine Tools", McGraw Hill, 1984.
3. Rao. P.N "Manufacturing Technology," Metal Cutting and Machine Tools, Tata McGraw- Hill, New Delhi, 2009.
4. A. B. Chattopadhyay, Machining and Machine Tools, Wiley, 2ⁿᵈ edition, 2017.
5. Peter Smid, CNC Programming Handbook, Industrial Press Inc.,; Third edition, 2007

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	1	1	1	3			3		2	3	3	2
2	3	3	3	1	1	1	3			3		2	3	2	2
3	3	3	3	1	1	1	3			3		2	3	2	2
4	3	3	2	1	1	1	3			3		2	3	2	2
5	3	3	3	1	1	1	3			3		2	3	2	3
Low (1) ; Medium (2) ; High (3)															

PROGRESS THROUGH KNOWLEDGE

MR3392   **ELECTRICAL DRIVES AND ACTUATORS**   **L T P C**
                                                                                                                              3 0 0 3

COURSE OBJECTIVES:
1. To familiarize a relay and power semiconductor devices
2. To get a knowledge on drive characteristics
3. To obtain the knowledge on DC motors and drives.
4. To obtain the knowledge on AC motors and drives.
5. To obtain the knowledge on Stepper and Servo motor.

UNIT I   RELAY AND POWER SEMI-CONDUCTOR DEVICES   9
Study of Switching Devices – Relay and Types, Switching characteristics -BJT, SCR, TRIAC, GTO, MOSFET, IGBT and IGCT-: SCR, MOSFET and IGBT - Triggering and commutation circuit - Introduction to Driver and snubber circuits

UNIT II   DRIVE CHARACTERISTICS   9
Electric drive – Equations governing motor load dynamics – steady state stability – multi quadrant Dynamics: acceleration, deceleration, torque, and Direction starting & stopping – Selection of motor.

UNIT III   DC MOTORS AND DRIVES   9
DC Servomotor - Types of PMDC & BLDC motors - principle of operation- emf and torque equations - characteristics and control – Drives- H bridge - Single and Three Phases – 4 quadrant operation – Applications

UNIT IV   AC MOTORS AND DRIVES   9
Introduction – Induction motor drives – Speed control of 3-phase induction motor – Stator voltage control – Stator frequency control – Stator voltage and frequency control – Stator current control – Static rotor resistance control – Slip power recovery control.

UNIT V   STEPPER AND SERVO MOTOR   9
Stepper Motor: Classifications- Construction and Principle of Operation – Modes of Excitation-Drive System-Logic Sequencer - Applications. Servo Mechanism – DC Servo motor-AC Servo motor – Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES
At the end of the course, the student able to:
   CO 1: Recognize the principles and working of relays, drives and motors.
   CO 2: Explain the working and characteristics of various drives and motors.
   CO 3: Apply the solid state switching circuits to operate various types of Motors and
       Drivers
   CO 4: Interpret the performance of Motors and Drives.
   CO 5: Suggest the Motors and Drivers for given applications.

Mapping of COs with POs and PSOs															
COs/Pos&PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	1	1	2	1							1	1		3
CO2	3	1	2	2	1							1	1		3
CO3	3	1	2	2	1							1	1		3
CO4	3	1	1	2	2							1	1		3
CO5	3	1	1	2	2							1	1		3
CO/PO & PSO Average	3	1	1.4	2	1.4							1	1		3
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS:
1. Bimbhra B.S., "Power Electronics", 5th Edition, Kanna Publishers, New Delhi, 2012.
2. Mehta V.K. & Rohit Mehta, "Principles of Electrical Machines", 2nd Edition, S.Chand& Co. Ltd., New Delhi, 2016.

REFERENCES:
1. Gobal K. Dubey, "Fundamentals of Electrical Drives", 2nd Edition, Narosal Publishing House, New Delhi, 2001.
2. Theraja B.L. &Theraja A.K., "A Text Book of Electrical Technology", 2nd Edition, S.Chand& Co. Ltd., New Delhi, 2012.
3. Singh M.D. &Kanchandhani K.B., "Power Electronics", McGraw Hill, New Delhi, 2007

MR3361   **ELECTRICAL DRIVES AND ACTUATORS LABORATORY**   **L T P C**
                                                                          0 0 4 2

COURSE OBJECTIVES:

1. To impart knowledge on Performance of the fundamental control practices associated with AC and DC machines (starting, reversing, braking, plugging, etc.) using power electronics To impart industry oriented learning
2. To evaluate the use of computer-based analysis tools to review the major classes of machines and their physical basis for operation

LIST OF EXPERIMENTS:

1. Load test on DC Motor
2. Load test on 3 Phase Induction Motor
3. Load test on 3 Phase Synchronous Motor.
4. Rheostat based Speed control of motors (AC and DC)
5. Switching circuits of MOSFET, IGBT, SCR and TRAIC.
6. Gate pulsation generation using PWM signals.
7. Speed control of DC motor using Power Electronic Drive.
8. Position and direction control DC servomotor using Power Electronic Drive.
9. Position, direction and speed control of BLDC and PMDC motors using Power Electronic Drive.
10. Position, Direction and speed control of stepper Motor.
11. Four quadrant operation of three-phase Induction Motor using Power Electronic Drive.
12. VFD control of single phase and three-phase induction motor using Power Electronic Drive.
13. AC servomotor position, direction and speed control using Power Electronic Drive.
    (Any 10 experiments)

TOTAL: 60 PERIODS

COURSE OUTCOMES:
At the end of the course, the student able to:
CO1: Practice the basic working of AC, DC motor, stepper motor, servo motor and synchronous motor using power electronic drive
CO2: Demonstrate the control of AC, DC motor, stepper motor, servo motor and synchronous motor using power electronic drive
CO 3:Analyze the performance of AC, DC motor, stepper motor, servo motor and synchronous motor using power electronic drive

COs/POs&PSOs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	1	1							1	2	2	3
CO2	3	2	1	1	1							1	2	2	3
CO3	3	2	1	1	1							1	2	2	3
CO/PO & PSO Average	3	2	1	1	1							1	2	2	3
1 – Slight, 2 – Moderate, 3 – Substantial															

(Table title: Mapping of COs with POs and PSOs)

List of Equipment's:

1. DC Motor with load – 1. N.o.
2. 3 Phase Induction Motor with load – 1. N.o.
3. 3 Phase Synchronous Motor with load – 1. N.o.
4. Rheostat based Speed control of motors (AC and DC) with load – 1. N.o.
5. MOSFET, IGBT, SCR and TRAIC – 1. N.o.
6. DC motor with speed control Drive. – 1. N.o.
7. DC servomotor with Power Electronic Drive (Position, Direction and speed). – 1. N.o.
8. BLDC and PMDC motors with Power Electronic Drive (Position, Direction and speed). – 1. N.o.
9. Stepper Motor with Power Electronic Drive (Position, Direction and speed). – 1. N.o.
10. Three-phase Induction Motor with Power Electronic Drive. – 1. N.o.
11. VFD with single phase and three-phase induction motor. – 1. N.o.
12. AC servomotor with Power Electronic Drive (Position, Direction and speed). – 1. N.o.

ME3382	**MANUFACTURING TECHNOLOGY LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

COURSE OBJECTIVES:

1 To Selecting appropriate tools, equipment's and machines to complete a given job.

2 To Performing various welding process using GMAW and fabricating gears using gear making machines.

3 To Performing various machining process such as rolling, drawing, turning, shaping, drilling, milling and analyzing the defects in the cast and machined components.

LIST OF EXPERIMENTS

1. Fabricating simple structural shapes using Gas Metal Arc Welding machine.

2. Preparing green sand moulds with cast patterns.

3. Taper Turning and Eccentric Turning on circular parts using lathe machine.

4. Knurling, external and internal thread cutting on circular parts using lathe machine.

5. Shaping – Square and Hexagonal Heads on circular parts using shaper machine.

6. Drilling and Reaming using vertical drilling machine.

7. Milling contours on plates using vertical milling machine.

8. Cutting spur and helical gear using milling machine.

9. Generating gears using gear hobbing machine.

10. Generating gears using gear shaping machine.

11. Grinding components using cylindrical and centerless grinding machine.

12. Grinding components using surface grinding machine.

13. Cutting force calculation using dynamometer in milling machine

14. Cutting force calculation using dynamometer in lathe machine

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

S.No.	NAME OF THE EQUIPMENT	Qty.
1.	Centre Lathes	7 Nos.
2.	Shaper	1 No.
3.	Horizontal Milling Machine	1 No.
4.	Vertical Milling Machine	1 No.
5.	Surface Grinding Machine	1 No.
6.	Cylindrical Grinding Machine	1 No.
7.	Radial Drilling Machine	1 No.
8.	Lathe Tool Dynamometer	1 No.
9.	Milling Tool Dynamometer	1 No.
10.	Gear Hobbing Machine	1 No.
11.	Gear Shaping Machine	1 No.
12.	Arc welding transformer with cables and holders	2 Nos.
13.	Oxygen and Acetylene gas cylinders, blow pipe and other welding outfit	1 No.
14.	Moulding table, Moulding equipments	2 Nos.

TOTAL:60 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Demonstrate the safety precautions exercised in the mechanical workshop and join two metals using GMAW.
2. The students able to make the work piece as per given shape and size using machining process such as rolling, drawing, turning, shaping, drilling and milling.
3. The students become make the gears using gear making machines and analyze the defects in the cast and machined components

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3						1		2			1	1	2	2
2	3						1		2			1	1	2	2
3	3						1		2			1	1	2	2
Low (1) ; Medium (2) ; High (3)															

ME3392	ENGINEERING MATERIALS AND METALLURGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1   To learn the constructing the phase diagram and using of iron-iron carbide phase diagram for microstructure formation.
2   To learn selecting and applying various heat treatment processes and its microstructure formation.
3   To illustrate the different types of ferrous and non-ferrous alloys and their uses in engineering field.
4   To illustrate the different polymer, ceramics and composites and their uses in engineering field.
5   To learn the various testing procedures and failure mechanism in engineering field.

UNIT I   CONSTITUTION OF ALLOYS AND PHASE DIAGRAMS   9

Constitution of alloys – Solid solutions, substitutional and interstitial – phase diagrams, Isomorphous, eutectic, eutectoid, peritectic, and peritectoid reactions, Iron – Iron carbide equilibrium diagram. Classification of steel and cast-Iron microstructure, properties and application.

UNIT II   HEAT TREATMENT   9

Definition – Full annealing, stress relief, recrystallisation and spheroidising –normalizing, hardening and tempering of steel. Isothermal transformation diagrams – cooling curves superimposed on I.T. diagram – continuous cooling Transformation (CCT) diagram – Austempering, Martempering – Hardenability, Jominy end quench test -case hardening, carburizing, Nitriding, cyaniding, carbonitriding – Flame and Induction hardening – Vacuum and Plasma hardening – Thermo-mechanical treatments- elementary ideas on sintering.

UNIT III   FERROUS AND NON-FERROUS METALS   9

Effect of alloying additions on steel (Mn, Si, Cr, Mo, Ni, V,Ti& W) – stainless and tool steels – HSLA - Maraging steels – Grey, white, malleable, spheroidal – alloy cast irons, Copper and its alloys – Brass, Bronze and Cupronickel – Aluminium and its alloys; Al-Cu – precipitation strengthening treatment – Titanium alloys, Mg-alloys, Ni-based super alloys – shape memory alloys- Properties and Applications-overview of materials standards

UNIT IV   NON-METALLIC MATERIALS   9

Polymers – types of polymers, commodity and engineering polymers – Properties and applications of PE, PP, PS, PVC, PMMA, PET, PC, PA, ABS, PAI, PPO, PPS, PEEK, PTFE, Thermoset polymers – Urea and Phenol formaldehydes –Nylon, Engineering Ceramics – Properties and applications of Al2O3, SiC, Si3N4, PSZ and SIALON – intermetallics- Composites- Matrix and reinforcement Materials-applications of Composites - Nano composites.

UNIT V   MECHANICAL PROPERTIES AND DEFORMATION MECHANISMS   9

Mechanisms of plastic deformation, slip and twinning – Types of fracture – fracture mechanics-Griffith's theory- Testing of materials under tension, compression and shear loads – Hardness tests (Brinell, Vickers and Rockwell), Micro and nano-hardness tests, Impact test Izod and charpy, fatigue and creep failure mechanisms.

TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course the students would be able to
1.   Explain alloys and phase diagram, Iron-Iron carbon diagram and steel classification.
2.   Explain isothermal transformation, continuous cooling diagrams and different heat

treatment processes.

3. Clarify the effect of alloying elements on ferrous and non-ferrous metals.
4. Summarize the properties and applications of non-metallic materials.
5. Explain the testing of mechanical properties.

TEXT BOOKS:

1. Kenneth G.Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 9th edition ,2018.
2. Sydney H.Avner, "Introduction to Physical Metallurgy", McGraw Hill Book Company, 1994

REFERENCES:

1. A. Alavudeen, N. Venkateshwaran, and J. T.WinowlinJappes, A Textbook of Engineering Materials and Metallurgy, Laxmi Publications, 2006.
2. Amandeep Singh Wadhwa, andHarvinder Singh Dhaliwal, A Textbook of Engineering Material and Metallurgy, University Sciences Press, 2008.
3. G.S. Upadhyay and Anish Upadhyay, "Materials Science and Engineering", Viva Books Pvt.Ltd, New Delhi, 2020.
4. Raghavan.V, "Materials Science and Engineering", Prentice Hall of India Pvt.Ltd. 6th edition, 2019.
5. Williams D Callister, "Material Science and Engineering" Wiley India Pvt Ltd, 2nd edition Re print 2019.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	3	2								2	2	1	2
2	3	1	3	1		2		1				2	2	1	2
3	3	1	3									2	2	1	2
4	3	1	3				2					2	2	1	2
5	3	1	3	2	2							2	2	1	2
	Low (1) ;			Medium (2) ;			High (3)								

MR3391   **DIGITAL ELECTRONICS AND MICROPROCESSOR**   **L T P C**
                                                             3 0 0 3

COURSE OBJECTIVES:
1. To present the Digital fundamentals, Boolean algebra and its applications in digital systems
2. To familiarize with the design of various combinational digital circuits using logic gates
3. To introduce the analysis and design procedures for synchronous and asynchronous sequential circuits
4. To explain the various semiconductor memories and related technology
5. To introduce the electronic circuits involved in the making of logic gate

UNIT I   **DIGITAL FUNDAMENTALS**   **9**
Number Systems – Decimal, Binary, Octal, Hexadecimal, 1's and 2's complements, Codes – Binary, BCD, Excess 3, Gray, Alphanumeric codes, Boolean theorems, Logic gates, Universal gates, Sum of products and product of sums, Minterms and Maxterms, Karnaugh map Minimization and Quine-McCluskey method of minimization.

UNIT II   **COMBINATIONAL & SYNCHRONOUS SEQUENTIAL CIRCUITS**   **9**
Design of Half and Full Adders, Half and Full Subtractors, Binary Parallel Adder -Multiplexer, Demultiplexer, Decoder, Priority Encoder. Flip flops – SR, JK, T, D, design of clocked sequential circuits – Design of Counters- Shift registers, Universal Shift Register

UNIT III   ASYNCHRONOUS SEQUENTIAL CIRCUITS AND MEMORY DEVICES   9
Stable and Unstable states, output specifications, cycles and races, state reduction, race free assignments, Hazards, Essential Hazards, Pulse mode sequential circuits, Design of Hazard free circuits.   Basic memory structure – ROM -PROM – EPROM – EEPROM –EAPROM, RAM – Static and dynamic RAM - Programmable Logic Devices – Programmable Logic Array (PLA) - Programmable Array Logic (PAL) – Field Programmable Gate Arrays (FPGA).

UNIT IV   8085 PROCESSOR   9
Hardware Architecture, pin diagram – Functional Building Blocks of Processor – Memory organization – I/O ports and data transfer concepts– Timing Diagram – Interrupts.

UNIT V   PROGRAMMING PROCESSOR   9
Instruction - format and addressing modes – Assembly language format – Data transfer, data manipulation& control instructions – Programming: Loop structure with counting & Indexing – Look up table - Subroutine instructions – stack -8255 architecture and operating modes

TOTAL: 45 PERIODS

COURSE OUTCOMES
At the end of the course, the student able to:
CO1: State the fundamental operating concepts behind digital logic circuits and
     microprocessors.
CO 2: Recognize the use of various digital logic circuitsand sub units in microprocessors.
CO 3: Sketch the digital logic circuits and the architectures of microprocessors
CO 4: Design the DLC and Microprocessor for the standard applications.
CO 5: Create the circuits using DLC and Microprocessor for given applications

COs/Pos&PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1	1		1						1	3	3	3
CO2	3	2	1	1		1						1	3	2	3
CO3	3	2	1	1		1						1	3	2	3
CO4	3	2	1	1		1						1	3	2	3
CO5	3	2	1	1		1						1	3	2	3
CO/PO & PSO Average	3	2	1	1		1						1	3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial															

Mapping of COs with POs and PSOs

TEXT BOOKS:
1. M. Morris Mano and Michael D. Ciletti, "Digital Design", 5th Edition, Pearson, 2014.
2. Krishna Kant, "Microprocessor and Microcontrollers", Eastern Company Edition, Prentice
   Hall of India, New Delhi, 2007.

REFERENCES:
1. Charles H.Roth. "Fundamentals of Logic Design", 6th Edition, Thomson Learning, 2013.
2. Thomas L. Floyd, "Digital Fundamentals", 10th Edition, Pearson Education Inc, 2011
3. Muhammad Ali Mazidi & Janice Gilli Mazidi, R.D.Kinely 'The 8051 Micro Controller and Embedded Systems', PHI Pearson Education, 5th Indian reprint, 2003.
4. R.S. Gaonkar, 'Microprocessor Architecture Programming and Application', with 8085, Wiley Eastern Ltd., New Delhi, 2013

ME3391   **MECHANICS OF MATERIALS**   **LT P C**
                                                            3 0 0 3

COURSE OBJECTIVES:
The main learning objective of this course is to prepare students for:
- Applying the principle concepts behind stress, strain and deformation of solids for various engineering applications.
- Analyzing the transverse loading on beams and stresses in beam for various engineering applications.
- Analyzing the torsion principles on shafts and springs for various engineering applications.
- Analyzing the deflection of beams for various engineering applications.
- Analyzing the thin and thick shells and principal stresses in beam for various engineering applications

UNIT I   STRESS AND STRAIN   **9 Hours**

Introduction, Hooke's law, Calculation of stresses in straight, Stepped and tapered sections, Composite sections, Stresses due to temperature change, Shear stress and strain, Lateral strain and Poisson's ratio, Generalized Hooke's law, Bulk modulus, Relationship between elastic constants

UNIT II   ANALYSIS OF STRESS AND STRAIN   **9 Hours**

Plane stress, Stresses on inclined planes, Principal stresses and maximum shear stress, Principal angles, Shear stresses on principal planes, Maximum shear tress, Mohr circle for plane stress conditions. **Cylinders:** Thin cylinder: Hoop's stress, maximum shear stress, circumferential and longitudinal strains, thick cylinders: Lames equations.

UNIT III   SHEAR FORCES AND BENDING MOMENTS   **9 Hours**

Type of beams, Loads and reactions, Relationship between loads, shear forces and bending moments, Shear force and bending moments of cantilever beams, Pin support and roller supported beams subjected to concentrated loads and uniformly distributed constant / varyingloads.

Stress in Beams: Pure bending, Curvature of a beam, Longitudinal strains in beams, Normal stresses in Beams with rectangular, circular, 'I' and 'T' cross sections, Flexure Formula, Bending Stresses, Deflection of beams (Curvature).

UNIT IV   TORSION   **9 Hours**

Circular solid and hallow shafts, Torsional moment of resistance, Power transmission of straight and stepped shafts, Twist in shaft sections, Thin tubular sections, thin-walled sections**Columns:** Buckling and stability, Critical load, Columns with pinned ends, Columns with othersupport conditions, Effective length of columns, Secant formula for columns.

UNIT V   STRAIN ENERGY   **9 Hours**

Castiglioni's theorem I and II, Load deformation diagram, Strain energy due to normalstresses, Shear stresses, Modulus of resilience, Strain energy due to bending and torsion.

Theories of Failure: Maximum Principal stress theory, Maximum shear stress theory.

                                                        TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
- Apply the principal concepts behind stress, strain and deformation of solids for various engineering applications.
- Analyze the transverse loading on beams and stresses in beam for various engineering applications.
- Analyze the torsion principles on shafts and springs for various engineering applications.
- Analyze the deflection of beams for various engineering applications.
- Understanding the concept theories of failure

TEXT BOOKS:
1. Bansal, R.K., Strength of Materials, Laxmi Publications (P) Ltd., 2007
2. Jindal U.C., Strength of Materials, Asian Books Pvt. Ltd., New Delhi, 2007

REFERENCES:
1. Egor. P.Popov " Engineering Mechanics of Solids" Prentice Hall of India, New Delhi, 2001
2. Ferdinand P. Beer, Russell Johnson, J.r. and John J. Dewole Mechanics of Materials, Tata McGraw Hill publishing 'co. Ltd., New Delhi.
3. Hibbeler, R.C., Mechanics of Materials, Pearson Education, Low Price Edition, 2007.
4. Subramanian R., Strength of Materials, oxford University Press, Oxford Higher Education Series, 2007.
5. Hibbeler, R. C. Mechanics of Materials. 6th ed. East Rutherford, NJ: Pearson Prentice Hall, 2004.

ME3491	THEORY OF MACHINES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To study the basic components of mechanisms, analyzing the assembly with respect to the displacement, velocity, and acceleration at any point in a link of a mechanism and design cam mechanisms for specified output motions.
2. To study the basic concepts of toothed gearing and kinematics of gear trains
3. To Analyzing the effects of friction in machine elements
4. To Analyzing the force-motion relationship in components subjected to external forces and analyzing of standard mechanisms.
5. To Analyzing the undesirable effects of unbalances resulting from prescribed motions in mechanism and the effect of dynamics of undesirable vibrations.

UNIT – I   KINEMATICS OF MECHANISMS   9
Mechanisms – Terminology and definitions – kinematics inversions of 4 bar and slide crank chain – kinematics analysis in simple mechanisms – velocity and acceleration polygons– Analytical methods – computer approach – cams – classifications – displacement diagrams - layout of plate cam profiles – derivatives of followers motion – circular arc and tangent cams.

UNIT – II   GEARS AND GEAR TRAINS   9
Spur gear – law of toothed gearing – involute gearing – Interchangeable gears – Gear tooth action interference and undercutting – nonstandard teeth – gear trains – parallel axis gears trains – epicyclic gear trains – automotive transmission gear trains.

UNIT – III   FRICTION IN MACHINE ELEMENTS   9
Surface contacts – Sliding and Rolling friction – Friction drives – Friction in screw threads – Bearings and lubrication – Friction clutches – Belt and rope drives – Friction aspects in brakes– Friction in vehicle propulsion and braking.

UNIT – IV   FORCE ANALYSIS   9
Applied and Constrained Forces – Free body diagrams – static Equilibrium conditions – Two, Three and four members – Static Force analysis in simple machine members – Dynamic Force Analysis – Inertia Forces and Inertia Torque – D'Alembert's principle – superposition principle – dynamic Force Analysis in simple machine members

UNIT – V   BALANCING AND VIBRATION   9
Static and Dynamic balancing – Balancing of revolving and reciprocating masses – Balancing machines –

free vibrations – Equations of motion – natural Frequency – Damped Vibration – bending critical speed of simple shaft – Torsional vibration – Forced vibration – harmonic Forcing – Vibration isolation. (Gyroscopic principles)

TOTAL: 45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Discuss the basics of mechanism.
2. Solve problems on gears and gear trains.
3. Examine friction in machine elements.
4. Calculate static and dynamic forces of mechanisms.
5. Calculate the balancing masses and their locations of reciprocating and rotating masses. Computing the frequency of free vibration, forced vibration and damping coefficient.

TEXT BOOKS:
1. Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms", Oxford University Press, 2017.
2. Ramamurthi. V, "Mechanics of Machines", Narosa Publishing House, 3rd edition 2019.

REFERENCES:
1. AmitabhaGhosh and Asok Kumar Mallik, "Theory of Mechanisms and Machines", Affiliated East-West Pvt. Ltd., 1988.
2. Rao.J.S. and Dukkipati.R.V. "Mechanism and Machine Theory", New Age International Pvt. Ltd., 2nd edition,2014.
3. Rattan, S.S, "Theory of Machines", McGraw-Hill Education Pvt. Ltd., 5th edition 2019.
4. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw-Hill, 2013.
5. Wilson and Sadler, Kinematics and Dynamics of Machinery, Pearson, 2008.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2		2			1				1	3		1
2	3	2	2		2			1				1	3		1
3	3	2	2		2			1			1		3		1
4	3	2	2		2			1				1	3		1
5	3	2	2		2			1				1	3		1
	Low (1) ; Medium (2) ; High (3)														

MR3491 **SENSORS AND INSTRUMENTATION** **L T P C**
3 0 0 3

COURSE OBJECTIVES:
1. To understand the concepts of measurement technology.
2. To learn the various sensors used to measure various physical parameters.
3. To learn the fundamentals of signal conditioning, data acquisition and communication systems used in mechatronics system development
4. To learn about the optical, pressure and temperature sensor
5. To understand the signal conditioning and DAQ systems

UNIT I   INTRODUCTION   9
Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types.

UNIT II   MOTION, PROXIMITY AND RANGING SENSORS   9
Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).

UNIT III   FORCE, MAGNETIC AND HEADING SENSORS   8
Strain Gage, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers.

UNIT IV   OPTICAL, PRESSURE AND TEMPERATURE SENSORS   10
Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors.

UNIT V   SIGNAL CONDITIONING AND DAQ SYSTEMS   9
Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi-channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon successful completion of the course, students should be able to:
CO1: Recognize with various calibration techniques and signal types for sensors.
CO2:Describe the working principle and characteristics of force, magnetic, heading, pressure and temperature, smart and other sensors and transducers.
CO3: Apply the various sensors and transducers in various applications
CO4: Select the appropriate sensor for different applications.
CO5: Acquire the signals from different sensors using Data acquisition systems.

TEXT BOOKS:
1. Ernest O Doebelin, "Measurement Systems – Applications and Design", Tata McGraw-Hill, 2009
2. Sawney A K and Puneet Sawney, "A Course in Mechanical Measurements and Instrumentation and Control", 12th edition, Dhanpat Rai & Co, New Delhi, 2013.

REFERENCES
1. C. Sujatha ... Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley & Sons, Canada, 2001
2. Hans Kurt Tönshoff (Editor), Ichiro, "Sensors in Manufacturing" Volume 1, Wiley-VCH April 2001.
3. John Turner and Martyn Hill, "Instrumentation for Engineers and Scientists", Oxford Science Publications, 1999.
4. Patranabis D, "Sensors and Transducers", 2nd Edition, PHI, New Delhi, 2011.
5. Richard Zurawski, "Industrial Communication Technology Handbook" 2nd edition, CRC Press, 2015

COs/POs & PSOs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1	2	2	1						1	2	1	3
CO2	3	2	1	2	2	1						1	2	1	3
CO3	3	2	1	1	2	1						1	2	1	3
CO4	3	2	1	3	2	1						1	2	1	3
CO5	3	2	1	3	2	1						1	2	1	3
CO/PO & PSO Average	3	2	1	2.2	2	1						1	2	1	3
Mapping of COs with POs and PSOs — 1 – Slight, 2 – Moderate, 3 – Substantial															

GE3451 **ENVIRONMENTAL SCIENCE AND SUSTAINABILITY** **L T P C**
2 0 0 2

COURSE OBJECTIVES:
1. To study the nature and its impacts on human life.
2. To study the environmental pollution, its types, control methods and protection acts
3. To provide the knowledge of about the energy management and energy resources
4. To study the concepts of Sustainability, global warming and Management
5. To study the Sustainability Practices and socio economical changes

UNIT I ENVIRONMENT AND BIODIVERSITY 9
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 9
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 (OHASMS). Environmental protection, Environmental protection acts .

UNIT III RENEWABLE SOURCES OF ENERGY 9
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 9
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 9
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

OUTCOMES:
At the end of the course the students would be able to
1.Understand the nature and its impacts on human life.
2.The students have the knowledge and awareness of Environmental Pollution.
3.Understanding of the energy sources and scientific concepts/principles behind them
4.Understand the concepts of the Sustainability and Management
5.Understand the Sustainability Practices and socio economical changes

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.

REFERENCES:
1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38 .
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT. LTD, New Delhi, 2007.

4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 2005.
5. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013.

CE3481	STRENGTH OF MATERIALS AND FLUID MACHINERY LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE:
1. To study the mechanical properties of metals, wood and spring by testing in laboratory.
2. To verify the principles studied in fluid mechanics and machinery theory by performing experiments in laboratory.

UNIT – I STRENGTH OF MATERIALS   **30**
LIST OF EXPERIMENTS
1. Tension test on mild steel rod
2. Torsion test on mild steel rod
3. Hardness test on metal (Rockwell and Brinell Hardness)
4. Compression test on helical spring
5. Deflection test on carriage spring

UNIT – II FLUID MECHANICS AND MACHINES LABORATORY   **30**
LIST OF EXPERIMENTS
1. (a) Determination of coefficient of discharge of a venturimeter
   (b) Determination of friction factor for flow through pipes
2. (a) Determination of metacentric height
   (b) Determination of forces due to impact of jet on a fixed plate
3. Characteristics of centrifugal pumps
4. Characteristics of reciprocating pump
5. Characteristics of Pelton wheel turbine

TOTAL: 60 PERIODS

OUTCOMES: On completion of the course, the student is expected to be able to

1. Determine the tensile, torsion and hardness properties of metals by testing
2. Determine the stiffness properties of helical and carriage spring
3. Apply the conservation laws to determine the coefficient of discharge of a venturimeter and finding the friction factor of given pipe
4. Apply the fluid static and momentum principles to determine the metacentric height and forces due to impact of jet
5. Determine the performance characteristics of turbine, rotodynamic pump and positive displacement pump.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	3	3	1	1	1	3	1	1	2	2	2	1
2	3	2	1	3	3	1	1	1	3	1	1	2	3	2	1
3	3	3	2	3	2	1	1	1	3	1	1	2	3	2	1
Low (1) ; Medium (2) ; High (3)															

MR3461   **SENSORS AND INSTRUMENTATION LABORATORY**   **L**   **T**   **P**   **C**
   0   **0**   **4**   **2**

COURSE OBJECTIVES
1. To learn about various force, pressure and vibration measuring sensors.
2. To learn about various Temperature, light and magnetic field measuring sensors
3. To learn about various displacement and speed measuring sensors.

LIST OF EXPERIMENTS
SENSORS AND INSTRUMENTATION
1. Determination of Load, Torque and Force using Strain Gauge.
2. Determination of the characteristics of Pressure Sensor and Piezoelectric Force Sensor
3. Determination of Displacement using LVDT.
4. Determine the Characteristics of Various Temperature Sensors.
5. Determine the Characteristics of Various Light Detectors (Optical Sensors).
6. Distance Measurement using Ultrasonic and Laser Sensor.
7. Determine angular velocity of gyroscope,
8. Vibration measurement using Accelerometer.
9. Direction measurement using Magnetometer.
10. Speed, Position and Direction Measurement Using Encoders.
11. Force measurement using 3 axis force sensor.
12. Force Measurement using tactile sensors.
13. Data acquisition, visualization and analysis of signals.

                                                  TOTAL: 60 PERIODS

COURSE OUTCOMES:
Upon the completion of this course, the students will be able to;
CO1: Demonstrate the various contact and non-contact sensors.
CO2: Analyze and Identify appropriate sensors for given applications.
CO3: Create a sensor system for given requirements.

Mapping of COs with POs and PSOs															
COs/POs & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	1	2	1						1	2	1	3
CO2	3	2	1	1	2	1						1	2	1	3
CO3	3	2	1	1	2	1						1	2	1	3
CO/PO & PSO Average	3	2	1	1	2	1						1	2	1	3
1 – Slight, 2 – Moderate, 3 – Substantial															

Equipment List
1. Load, Torque and Force using Strain Gauge – 3 Nos
2. Pressure Sensor and Piezoelectric Force Sensor- 1 No's
3. LVDT setup – 1 No.
4. Temperature Sensors measurement setup with RTD, Thermocouple and Thermistor -1 No.
5. Measurement setup Optical Sensors LDR, Photo transistor, photo diode – 1 each
6. Measurement setup -Ultrasonic and Laser Sensor- 1 No.
7. Gyroscope measurement setup - 1 No.
8. Accelerometer measurement setup - 1 No.
9. Magnetometer measurement setup -1 No.
10. Absolute Encoders and Incremental encoder with DSO/ single board computer- 1 no
11. DAQ with sensor or transducer -1 set
12. 3 axis force sensor – 1 No.
13. Tactile Sensor – 1No.