B.Tech.

IN

MATERIALS SCIENCE AND ENGINEERING

CURRICULUM

AND

SYLLABI OF FIRST YEAR COURSES

(Applicable from 2023 Admission onwards)

Department of Materials Science and Engineering
NATIONAL INSTITUTE OF TECHNOLOGY CALICUT
Kozhikode - 673601, KERALA, INDIA

The Program Educational Objectives (PEOs) of B.Tech. in Materials Science and Engineering

PEO1	To provide the students with a strong understanding of the basics of the materials science and engineering, as well as hands-on experience on the advanced design, preparation (manufacturing), fabrication and characterisation techniques.
PEO2	To create highly skilled and competitive professionals with a passion for problem solving in the rapidly growing area of materials science and engineering for academia and industry.
PEO3	To enable the students to apply engineering models/designs to produce solutions that demonstrate ethical responsibility with due consideration for the sustainable development of the society and environment.
PEO4	To develop interdisciplinary knowledge as well as technical, personal and professional skills required to take-up the demands and challenges faced by the society in the area of materials Science and engineering.

Programme Outcomes (POs) and Programme Specific Outcomes (PSOs) of B.Tech. in Materials Science and Engineering

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**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.
PO4	**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.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**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.
PO7	**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.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**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.
PO11	**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.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1	Apply the knowledge of materials science and engineering to take up the challenges in the multidisciplinary areas.
PSO2	Attain the competence in the development of high performance materials and their characterisation.
PSO3	Accomplishment of technical and personal skills required to take-up the demands and challenges faced by the society.

CURRICULUM

Total credits for completing B.Tech. in Materials Science and Engineering is 150.

COURSE CATEGORIES AND CREDIT REQUIREMENTS:

The structure of B.Tech. programmes shall have the following Course Categories:

Sl. No.	Course Category	Number of Courses	Minimum Credits
1.	Institute Core (IC)	8	22
2.	Program Core (PC) and Program Electives (PE)	25	82
3.	Open Electives (OE)	8	24
4.	Institute Electives (IE) (Entrepreneurship Innovation (EI) + Digital / Automation Technologies (DA) + Humanities, Social Science, Management (HM))	6	18
5.	Activity Credits (AC)	--	4

COURSE REQUIREMENTS

The effort to be put in by the student is indicated in the tables below as follows:
L: Lecture (One unit is of 50 minute duration)
T: Tutorial (One unit is of 50 minute duration)
P: Practical (One unit is of one hour duration)
O: Outside the class effort / self-study (One unit is of one hour duration)

1. INSTITUTE CORE (IC)

a) Mathematics

Sl. No.	Course Code	Course Title	L	T	P	O	Credits
1.	MA 1003E	Mathematics I	3	1*	0	5	3
2.	MA 1013E	Mathematics II	3	1*	0	5	3
3.	MA2001E	Mathematics III	3	1*	0	5	3
4.	MA2011E	Mathematics IV	3	1*	0	5	3
		Total	**12**	**4***	**0**	**20**	**12**

*Optional for Students (can be replaced by self-study)

b) Basic Sciences and Drawing

Sl. No.	Course Code	Course Title	L	T	P	O	Credits
1.	PH1001E	Physics of Materials	3	0	0	6	3
2.	CY1002E	Chemistry of Materials	3	0	0	6	3
		Total	**6**	**0**	**0**	**12**	**6**

c) Professional Communication and Professional Ethics

Sl. No.	Course Code	Course Title	L	T	P	O	Credits
1.	MS1001E	Professional Communication	3	1	0	6	3
2.	MT1006E	Professional Ethics	1	0	0	2	1
		Total	**4**	**1**	**0**	**8**	**4**

2A. PROGRAMME CORE (PC)

Sl. No.	Course Code	Course Title	Pre-requisites	L	T	P	O	Credits
1	MT1001E	Introduction to Materials Science and Engineering	NIL	3	0	0	6	3
2	MT1002E	Engineering Graphics	NIL	2	0	2	6	3
3	EC1003E	Introduction to Electronics	NIL	3	0	0	6	3
4	MT1003E	Eng. Mechanics	NIL	3	0	0	6	3
5	MT1004E	Thermodynamics	NIL	3	0	0	6	3
6	MT1005E	Material Properties	NIL	3	0	2	8	4
7	ME1392E	Mechanical Workshop	NIL	0	0	3	3	2
8	MT2001E	Metallurgical Engineering	NIL	3	0	2	8	4
9	MT2002E	Transport Phenomena	NIL	3	0	0	6	3
10	MT2091E	Materials Testing Lab	NIL	0	0	3	3	2
11	MT2003E	Polymer Science and Technology	NIL	3	0	2	8	4
12	MT2004E	Ceramics and Glasses	NIL	3	0	2	8	4
13	MT2005E	Materials Characterisation	NIL	3	0	2	8	4
14	MT3001E	Composite Materials-	NIL	3	0	2	8	4
15	MT3002E	Corrosion Science and Engineering	NIL	3	0	0	6	3
16	MT3003E	Mechanical Behaviour of Materials	NIL	3	0	0	6	3
17	MT3091E	Functional materials Laboratory	NIL	1	0	3	5	3
18	MT3004E	Computational methods in materials science	NIL	2	0	3	7	4
19	MT3092E	Project Part I	-	-	-	-	-	3

20	MT4091E	Summer Internship	-	-	-	-	-	2
21	MT4092E	Project Part II / Internship $^{\Omega}$	-	-	-	-	-	3
			Total					**67**

2B. LIST OF ELECTIVES

Following courses may be credited under the categories mentioned in the table below, in addition to the Programme Electives.

Sl. No.	Course Code	Course Title	L	T	P	O	Credits	Additional Categories			
								PE	EI	DA	HM
1.	MT3021E	Thermal Engineering	3	0	0	6	3	Y	N	Y	N
2.	MT4023E	Photovoltaic Systems	3	0	0	6	3	Y	N	Y	N
3	MT4093E	Project Part III / Internship/Programme Elective-4 & Programme Elective-5	-	-	-		6				
…	…	…									

3. OPEN ELECTIVES (OE)

Courses offered by Other Departments/Schools/Centres or Approved Online Platforms, with a limit on the maximum number of courses from such platforms specified as per BTech Ordinances and Regulations. In addition, PE courses offered by the Parent department shall be included in this category for students of the Parent department.

4. INSTITUTE ELECTIVES (IE)

In case of the Institute Electives, courses in the appropriate categories offered by other departments/schools/centres also can be credited instead of the courses offered by the School of Materials Science and Engineeirng, subject to the approval from the Course Faculty and Faculty Advisor.

a) Entrepreneurship / Innovation Basket (EI):

Courses proposed by the Departments/Schools/Centres and approved by Institute Innovation Council. Total credits required is 3.

b) **Digital Automation Technologies (DA):**

Courses related to programming / automation tools & techniques / Industry 4.0. Total credits required is 6.

c) Humanities, Social Science, Management (HM):

Courses such as Indian and Foreign languages, Economics, Engineering Management, Financial Management and Design Thinking. Total credits required is 9.

5. ACTIVITY CREDITS (AC)

A minimum of 80 Activity Points are to be acquired for obtaining the 4 Activity Credits required in the curriculum.

Activity points acquired should be a minimum of 20 at the end of S4.
Activity points acquired should be a minimum of 40 at the end of S6.

PROGRAMME STRUCTURE

Semester I

Sl. No.	Course Code	Course Title	L	T	P	O	Credits	Category
1.	MA1003E	Mathematics I	3	1	0	5	3	IC
2.	PH1001E	Physics of Materials	3	0	0	6	3	IC
3.	MS1001E	Professional Communication	3	1	0	6	3	IC
4.	MT1001E	Introduction to Materials Science and Engineering	3	0	0	6	3	PC
5.	EC1003E	Introduction to Electronics	3	0	0	6	3	PC
6.	MT1002E	Engineering Graphics	2	0	2	6	3	PC
		Total					**18**	**--**

Semester II

Sl. No.	Course Code	Course Title	L	T	P	O	Credits	Category
1.	MA1013E	Mathematics II	3	1	0	5	3	IC
2.	CY1002E	Chemistry of Materials	3	0	0	6	3	IC
3.	MT1003E	Eng. Mechanics	3	0	0	6	3	PC
4.	MT1004E	Thermodynamics	3	0	0	6	3	PC
5.	MT1005E	Material Properties	3	0	2	8	4	PC
6.	ME1392E	Mechanical Workshop	0	0	3	3	2	PC
7.	MT1006E	Professional Ethics	1	0	0	2	1	IC
		Total					**19**	**--**

Semester III

Sl. No.	Course Code	Course Title	L	T	P	O	Credits	Category
1.	MA2001E	Mathematics III	3	1	0	5	3	IC
2.	---	DA Elective-1	3	0	0	6	3	DA
3.	----	HM Elective-1				6	3	HM
4.	----	Open Elective - 1				6	3	OE
5.	MT2001E	Metallurgical Engineering	3	0	2	8	4	PC
6.	MT2002E	Transport Phenomena	3	0	0	6	3	PC
7.	MT2091E	Materials Testing Lab	0	0	3	3	2	PC
		Total					**21**	**--**

Semester IV

Sl. No.	Course Code	Course Title	L	T	P	O	Credits	Category
1.	MA2011E	Mathematics IV	3	1	0	5	3	IC
2.	---	Entrepreneurship / Innovation Elective				6	3	EI
3.	MT2003E	Polymer Science and Technology	3	0	2	8	4	PC
4.	MT2004E	Ceramics and Glasses	3	0	2	8	4	PC
5.	MT2005E	Materials Characterisation	3	0	2	8	4	PC
6.	--	Open Elective -2				6	3	OE
Total (Excluding the Minor Courses)					--		**21**	--

Semester V

Sl. No	Course Code	Course Title	L	T	P	O	Credits	Category
1.	--	HM Elective – 2				6	3	IE
2.	MT3001E	Composite Materials	3	0	2	8	4	PC
3.	MT3002E	Corrosion Science and Engineering	3	0	0	6	3	PC
4.	MT3003E	Mechanical Behaviour of Materials	3	0	0	6	3	PC
5	--	Programme Elective-1				6	3	PE
6.	--	Open Elective - 3				6	3	OE
7.	MT3091E	Functional materials Laboratory	1	0	3	5	3	PC
Total (Excluding the Minor Courses)							**22**	--

Semester VI

Sl. No.	Course Code	Course Title	L	T	P	O	Credits	Category
1.	--	DA Elective - 2				6	3	IE
2.	MT3004E	Computational methods in materials science	2	0	3	7	4	PC
3.	--	HM Elective-3				6	3	IE
4.	--	Programme Elective-2				6	3	PE
5.	--	Open Elective - 4				6	3	OE
6.	MT3092E	Project Part I				9	3	PC
Total (Excluding the Minor Courses)							**19**	--

Semester VII

Sl. No.	Course Code	Course Title	L	T	P	O	Credits	Category
1.	--	Programme Elective-3				6	3	PE
2.	--	Open Elective - 5				6	3	OE
3.	--	Open Elective - 6				6	3	OE
4.	--	Open Elective - 7				6	3	OE
5.	--	Open Elective - 8				6	3	OE
6.	MT4091E	Summer Internship				*	2	PC
7.	MT4092E	Project Part II / Internship				9	3	PC
Total (Excluding the Minor Courses)							**20**	--

**Decided by the organisation in which the internship is done*

Semester VIII

Sl. No.	Course Code	Course Title	L	T	P	O	Credits	Category
1.	MT4093E	Project Part III / Internship/Programme Elective-4 & Programme Elective-5	0/6	0	0	18/ 12	6	PE
2.	--	Activity Credits (minimum of 80 points)					4	AC
Total							**10**	--

SEMESTER I

MA1003E MATHEMATICS I

Pre-requisites: NIL

L	T	P	O	C
3	1	0	5	3

Total Lecture Sessions: 39

Course Outcomes:

CO1: Find the limits, check for continuity and differentiability of real valued functions of one variable.
CO2 Find the limits, check for continuity and differentiability of real valued functions of two variables.
CO3: Find the maxima and minima of real valued functions of one or two variables.
CO4: Test the consistency of the system of linear equations and then solve it.
CO5: Diagonalise symmetric matrices and use it to find the nature of quadratic forms.

System of linear equations
Gauss elimination method, row echelon form, row space, row rank, existence and uniqueness, homogeneous case, Linear independence and span of row vectors, Linearly independent solutions, rank-nullity relation for homogeneous linear system. Eigenvalues and eigenvectors of a matrix, Cayley-Hamilton theorem, eigenvectors associated with distinct eigenvalues, diagonalisation of matrices, symmetric, skew-symmetric and orthogonal matrices and their eigenvalues, orthogonal diagonalisation of symmetric matrices, bilinear and quadratic forms, positive definiteness, symmetric coefficient matrix, transformation into principal axes.

Functions of one variable
Limit, continuity, differentiability, local maxima and local minima, mean value theorems, Taylor's theorem, L'hôpital's rule, integration, fundamental theorem of calculus, volume, area, improper integrals, Gamma and Beta functions. Parameterised curves in space, arc length, tangent and normal vectors, curvature and torsion.

Functions of several variables
Limit, continuity, partial derivatives, partial differentiation of composite functions, directional derivatives, gradient, local maxima and local minima of functions of two variables, critical point, saddle point, Taylor's formula for two variables, Hessian, second derivative test, method of Lagrange multipliers.Evaluation of double integral, improper integrals, change of variables, Jacobian, polar coordinates, triple integral, cylindrical and spherical coordinates, mass of a lamina, centre of gravity, moments of inertia

References:

1. H. Anton, I. Bivens and S. Davis, Calculus, 10th edition, New York: John Wiley & Sons, 2015.
2. G. B. Thomas, M.D. Weirand J. Hass, Thomas' Calculus, 12th edition, New Delhi, India: Pearson Education, 2015.
3. E. Kreyszig, Advanced Engineering Mathematics, 10th edition, New York: John Wiley & Sons, 2015.
4. G. Strang, Introduction to Linear Algebra, Wellesley MA: Cambridge Press, 2016.

PH1001E PHYSICS OF MATERIALS

Pre-requisites: NIL

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course Outcomes:

CO1: Explain the fundamentals of quantum mechanics.
CO2: Apply quantum mechanics to electron in crystals and study the formation of bands in solid.
CO3: Apply quantum mechanics and study the electrical properties of solids.
CO4: Explain conductivity in semiconducting materials and influence of dopants on conductivity.

Quantum Mechanics
Wave-particle duality – de Broglie waves – group and phase velocity – Davison-Germer experiment – uncertainty principle – properties and significance of wave function – Schrodinger's wave equation – steady state equation, applications to a free particle and particle in a box.

Band theory of solids
Electrons in periodic potential – origin of band in solid – Bloch theorem – Kronig-Penny model (qualitative) – E-k diagram for free electron and electrons in periodic potential – one dimensional zone scheme – band gap.

Electrical conductivity
Classical electron theory – conductivity – factors affecting resistivity – Quantum mechanical consideration, Fermi energy and Fermi Surface – Fermi distribution function, density of states – Effective mass of electron.

Semiconductors
Intrinsic and extrinsic semiconductors – carrier concentration in n and p type semiconductors – Fermi level – Temperature dependence of electrical conductivity – variation of Fermi level with temperature.

References:

1. A. Beiser, Concepts of Modern Physics (6th Edition), McGraw-Hil, 2003.
2. K. Krane, Modern Physics (2nd Edition), Wiley, 2009.
3. R. E. Hummel, Electronic Properties of Materials (4th Edition), Springer, 2011.
4. M. A. Wahab, Solid State Physics – Structure and Properties of Materials (3rd Edition),Narosa, 2015.

MS1001E PROFESSIONAL COMMUNICATION

Pre-requisites: NIL

L	T	P	O	C
3	1	0	6	3

Total Lecture Sessions : 39

Course Outcomes:

CO1: Distinguish the role and purpose of communication at the workplace and for academic purposes.

CO2: Decide strategies and modes for effective communication in a dynamic workplace.

CO3: Combine multiple approaches for successful and ethical information exchange.

CO4: Estimate best communication practices to assist productivity and congeniality at the workplace.

Listening and Reading Comprehension

Conversation starters: introductions and small talk - Seek and provide information, clarification, polite enquiries, requests, congratulate people, apologise, give and respond to feedback - Describe graphs, tables, and charts - Words often confused: Lexicon and Meaning - Sense Groups - Listening for specific purposes: Listening to lectures, Summarise academic lectures for note-taking - Appropriate Language to Request and Respond - Public Speaking

Vocabulary and Speaking

Developing professional vocabulary - Basic Sentence Structures from Reading Texts - Concord - Functions of Auxiliary Verbs and Modals - Strategies for Effective Reading - Skimming and Scanning, Determine themes and main ideas, Predicting content using photos, images and titles - Critical Reading: Discussing and Summarising text points - Understanding Text Structures: sequencing, comparing and contrasting, relating cause and effect, problems and problem-solving - Discussing Rhetorical and Cultural Aspects in Texts - Text Appreciation: Drawing inferences, Framing Opinions and Judgments on Reading Text

Effective Writing

Note Making and Summarising: Prepare notes from reading texts, Paraphrasing - Use of Multimedia for Assistive Purposes - Paragraph Writing: cohesive devices to connect sentences in a paragraph - transitional devices - Use Text Structures in Paragraphs: sequencing, comparing and contrasting, relating cause and effect, problems and problem-solving - Avoiding Ambiguity and Cleft Sentences - Applications- Writing Instructions, Descriptions and Explanations - Official Letters of Request and Denial - Official E-mails - Abstract Writing - Digital Resources for Effective Communication

Communication at Workplace

Communication Theory - Process of Communication - Modes of Communication - Verbal and Non-Verbal Communication - Tone in Communication - Formal and Informal Communication at Workplace - Passive, Assertive and Aggressive Styles of Communication - Positive Body Language - Group Discussions - Presentation - Workplace Communication - Active Listening - Giving Feedback - Communication Etiquette - Persuasion - Negotiation - Tone and Voice - Telephone etiquette - Establishing Credibility in Conversations - Digital Communication and Netiquette: Conducting Oneself in Virtual Interactions, Constructive use of Social media - Ethical and Culturally Sensitive Communication: Ethical considerations in professional communication, Addressing diversity, Inclusive Communication Practices

References:

1. Bhatnagar, N., & Bhatnagar, M. (2010). Communicative English for engineers and professionals. Dorling Kindersley.
2. Foley, M., & Hall, D. (2018). Longman advanced learners 'grammar: A self-study reference & practice book with answers. Pearson Education.
3. Garner, B. A. (2012). HBR Guide to better business writing: Engage readers, tighten and Brighten, make your case. Harvard Business Review Press.
4. Hewings, M. (2013). Advanced grammar in use: A reference and practice book for Advanced learners of English. Cambridge University Press.

5. Ibbotson, M. (2015). Cambridge English for Engineering. Cambridge University Press.
6. Kumar, S., & Lata, P. (2015). Communication Skills. Oxford University Press.
7. Sudarshana, N., & Savitha, C. (2016). English for Technical Communication. Cambridge English.

MT1001E INTRODUCTION TO MATERIALS SCIENCE AND ENGINEERING

Pre-requisites: NIL

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course Outcomes:

CO1: Analyze the structure-property correlation for engineering materials.
CO2: Analyze the microstructural evolution and defect chemistry in materials.
CO3: Interpret phase diagrams and transformations in metals and alloys.

Introduction to materials science and engineering: Material Tetrahedron, Why Study Materials Science, Review of Atomic Structure and Interatomic Bonding- Classification of Materials: Metals, Polymers, Ceramics, and Composites, Conducting, Non-conducting and Semiconductor Materials- Structure of Materials: Crystalline and Amorphous Structure, Microstructure, Morphology- Crystallography: Crystal Geometry, Unit Cell, Co-ordination Number, Atomic Packing Factor, Lattices, Gaps in Bravais Lattice, Symmetry, Miller Indices for Planes, Miller Indices of Directions, Linear and Planar Density, Inter-Planar Spacing, Close-Packing of Hard Spheres, Stacking of Close-Packed Spheres, Voids in Close-Packed Structures.

Imperfections and solidification mechanisms in solids: Point Defects:- Vacancy, Interstitial, Substitutional Solid Solution, Limits of Solubility, Line Defects:- Edge Dislocation, Screw Dislocation, Surface Defects:- Grain Boundary, Twin Boundary, Stacking Fault, Bulk Defects, Coherent, Semi-Coherent, and Incoherent Interfaces, Critical Nucleus Size and Critical Free Energy-Mechanism of Crystallization, Nucleation, Homogeneous and Heterogeneous Nucleation, Growth, Single Crystal, Polycrystalline Materials, Basic Principles of Solidification of Metals and Alloys. Growth of Crystals- Planar Growth, Dendritic Growth, Solidification Time, Cooling Curves, Non-Crystalline Solids, Glass Transition Temperature.

Phase diagrams: Gibb's Phase Rule, Unary System, Binary Phase Diagrams, Isomorphous Systems, Congruent Phase Diagrams, Free Energy Composition Curves, Construction- Microstructural Changes During Cooling, Tie Line-Lever Rule, Eutectic, Peritectic, Eutectoid, and Peritectoid Reactions- Typical Phase Diagrams, Cu-Ni System, Pb-Sn System, Mg-Pb System, Iron-Iron carbide System, Cu-Zn System, Perform Phase Equilibrium Calculation and Construct Phase Diagram.

References:

1. William D. Callister, Jr., David G. Rethwisch, "Materials Science and Engineering An Introduction", 10th Edition, Wiley, Inc., 2018.
2. James F. Shackelford, "Introduction to Materials Science for Engineers", 8th Edition, Pearson, 2014.
3. V. Raghavan, "Materials Science and Engineering A First Course", Prentice- Hall of India Pvt. Ltd., 2015.
4. William F. Smith., "Principles of Materials Science and Engineering", 3rd Edition, Mc Graw-Hill, 1999.

EC1003E INTRODUCTION TO ELECTRONICS

Pre-requisites: NIL

L	T	P	O	C
3	0	0	6	3

Total Lecture sessions: 39

Course Outcomes:

CO1: Outline the working of basic electronic components.
CO2: Analyze linear circuits using network theorems.
CO3: Evaluate the steady state performance of electric circuits
CO4: Examine simple circuits involving diode, BJT and Op-amp

Applications of electronics in the modern world: Consumer electronics, Industrial, Space and Military, Medical, Agriculture, IoT, automobile. Elements in an Electrical circuit: Resistor, Inductor, Mutual inductance, Capacitor, Voltage and current sources- independent and dependent sources.DC circuits: Kirchoff laws, Mesh and nodal analysis. Network theorems- Star-Delta transformation, Thevenin's theorem, Norton's theorem, Superposition theorem, Maximum power transfer theorem, Reciprocity Theorem, Millman's theorem.

Steady state ac circuit analysis: Sinusoidal steady state response using complex exponential input, voltage and current phasors, impedance, Transformation of a circuit into phasor equivalent circuit, network theorems application to AC, frequency response of ac circuits, active power, reactive power, apparent power, power factor

Diodes and applications: Diode characteristics, voltage and current relationship, diode circuits-rectifiers, peak and envelope detectors, wave shaping circuits, voltage regulators, BJT: Principle of operation, Transistor operating regions, current-voltage characteristics, Transistor in DC, current mirrors, Switch and amplifier circuits with biasing. Operational amplifier: Properties and equivalent circuit model of op-amp, Open loop operation, properties of negative feedback and virtual short, Analysis of op-amp circuits with negative feedback, inverting and non-inverting amplifiers, voltage follower, input and output impedances, summing and difference amplifiers, integrator, differentiator

References:

1. Paul Horowitz, Winfield Hill, The Art of Electronics, 3rd Edition, Cambridge university press, 2015.
2. S. Sedra, K C Smith, Microelectronic Circuits, 7th Edition, Oxford University Press.2017.
3. D. A. Neamen, Electronic Circuit Analysis and Design, 3rd Edition, McGraw-Hill India, 2006.
4. Anant Agarwal, Jeffrey H. Lang, Foundations of Analog and Digital Electronic Circuits, Elsevier, 2005.
5. Jacob Millman, Herbert Taub, Suryaprakash Rao Mothiki, Pulse Digital and Switching Waveforms, McGraw Hill Education; 3rd Edition, 2017.

MT1002E ENGINEERING GRAPHICS

Pre-requisites: NIL

L	T	P	O	C
2	0	2	6	3

Total Sessions: 26L + 26P

Course Outcomes:

CO1: Make use of the Indian Standard Code of Practice in Engineering Drawing
CO2: Represent any engineering object by its orthographic views.
CO3: Convert orthographic views of an engineering object into its isometric view
CO4: Visualize engineering objects and components.

Introduction
Drawing instruments and their uses; lines, lettering and dimensioning; geometrical construction; orthographic projection—first and third angle projections; orthographic projection of points on principal, profile, and auxiliary planes.

Orthographic projection of lines and planes
First angle projection: Orthographic projection of straight line in simple and oblique positions; application of orthographic projection of line; orthographic projection of planes in simple and oblique position on principal and profile planes; orthographic projection of lines and planes on auxiliary planes.

Orthographic projection of solids
First angle projection: Orthographic projection of solids in simple and oblique positions on principal and profile planes; orthographic projections of solids in oblique position using auxiliary plane method; orthographic projection of spheres; Orthographic projection of solids in section.

Development of surfaces of solids; Isometric projection; Introduction to perspective projection.

References:

1. N. D. Bhatt, Engineering Drawing, 54th ed. Anand, India: Charotar Publishing House, 2023.
2. Basant Agrawal and C M Agrawal, Engineering Drawing, 2nd ed. New Delhi, India: McGraw Hill Education (India), 2014.

SEMESTER II

MA1013E MATHEMATICS II

Pre-requisites: NIL

L	T	P	O	C
3	1	0	5	3

Total Lecture Sessions : 39

Course Outcomes

CO1: Find the parametric representation of curves and surfaces in space and evaluate integrals over curves and surfaces
CO2: Understand the convergence of sequences and series and various methods of testing for convergence.
CO3: Solve linear ODEs with constant coefficients.
CO4: Formulate some engineering problems as ODEs and hence solve such problems.
CO5: Use Laplace transform and its properties to solve differential equations and integral equations.

Vector field: divergence, curl, identities involving divergence and curl, scalar potential. Line integral, independence of path, irrotational and solenoidal vector fields, Green's theorem for plane, parameterized surface, surface area and surface integral, flux, Gauss' divergence theorem, Stokes' theorem.

Numerical sequences, Cauchy sequence, convergence of sequences, series, convergence of series, tests for convergence, absolute convergence. Sequence of functions, power series, radius of convergence, Taylor series, periodic functions and Fourier series expansions, half-range expansions.

Existence and uniqueness of solution of first order ordinary differential equations (ODE)s, methods of solutions of first order ODE, linear ODE, linear homogeneous second order ODEs with constant coefficients, fundamental system of solutions, Wronskian, linear independence of solutions, method of undetermined coefficients, solution by variation of parameters, Euler-Cauchy differential equations, applications of ODEs.

Laplace transform, sufficient condition for existence, inverse Laplace transform, Dirac delta function, transforms of derivatives and integrals, shifting theorems, convolution, differentiation and integration of transform, solution of differential equations and integral equations using Laplace transform.

References:

1. E. Kreyszig, Advanced Engineering Mathematics, 10th edition, New Delhi, India: Wiley, 2015.
2. H. Anton, I. Bivens and S. Davis, Calculus, 10th edition, New York: John Wiley & Sons, 2015.
3. V. I. Arnold, Ordinary Differential Equations, New York: Springer, 2006.
4. P. Dyke, An Introduction to Laplace Transforms and Fourier Series, New York: Springer,2014.

CY1002E CHEMISTRY OF MATERIALS

Pre-requisites: NIL

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course Outcomes:

CO1: Apply the concepts of quantum mechanics to simple chemical systems
CO2: Utilize the concepts of structure-property relationship in materials chemistry
CO3: Choose appropriate characterization techniques for the identification of molecules and materials
CO4: Apply the concepts of basic electrochemistry to advanced electrochemical systems

Elementary Quantum Chemistry - Black Body Radiation, Plank's Hypothesis, Wave-Particle Duality, Heisenberg Uncertainty Principle. Bonding in Solids - Radius Ratio, Covalent, Metallic, van der Waals and Hydrogen Bonding in Solids. Orbital Theory - Valence Bond Theory, Hybridization, Structure-Bonding Relations, Molecular Orbital Theory. Structure Types - Spinel, Perovskite, Quasi crystals, Amorphous Materials. Order-Disorder Transformations - Defects and Impurities

Introduction to Spectroscopy - Intensity, Broadening of Spectral Lines, Beer-Lambert Law. Rotational Spectroscopy - Rigid Rotor, Non-rigid Rotor. Vibrational Spectroscopy - Harmonic and Anharmonic Oscillator, Group Frequencies, Spectral Analysis, CO Stretching Frequencies, H-bonding. Electronic Spectroscopy - Born-Oppenheimer Approximation, Nature of Electronic Excitations, Franck-Condon Principle, Woodward–Fieser rules.

Fundamentals of Electrochemistry - Voltammetry, Excitation Signals, Three-electrode System, Half-wave Potential, Concentration Profiles at Electrode Surfaces, Current/Voltage Relationships, Cyclic Voltammetry Switching Potentials, Cathodic and Anodic Peak currents, Fuel Cells.

References:

1. D. A. Mc Quarrie, Quantum Chemistry, University Science Books, Mill Valley CA.,1983.
2. P. W. Atkins and R. S. Friedman, Molecular Quantum Mechanics, 5th Edition, Oxford University Press, India, 2010.
3. A. R. West, Basic Solid State Chemistry, 2nd edition, John Wiley and Sons, New York, 2014.
4. W. D. Callister Jr., Materials Science and Engineering-An Introduction, 8th Edition, Wiley, USA, 2009.
5. C. N. Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy, 4th edition, Tata McGraw Hill, New Delhi, 2010.
6. Donald L. Pavia, Gary M. Lampman, George A. Kriz and James R. Vyvyan, Introduction to Spectroscopy, 4th edition, Brooks/Cole, 2009
7. D. A. Skoog and D. M. West, F. J. Holler and S. R. Crouch, Fundamentals of Analytical Chemistry, 9th Edition, BrooksCole, Florence, 2014.

MT1003E ENGINEERING MECHANICS

Pre-requisites: NIL

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions : 39

Course outcomes

CO1: Perform basic vector operations
CO2: Construct free body diagrams and solve the static problems involving rigid bodies
CO3: Construct shear force bending moment diagrams
CO4: Construct free body diagrams and solve the dynamic problems

Basic vector algebra

Review of basics concepts: Concept of vector and scalar quantities, components of a vector, types of coordinate systems, Cartesian coordinates, polar coordinates, Conversion from one coordinate to another coordinate system.
Basic vector operations- Vector addition, time derivative of a vector, time derivative of a vector in moving coordinates.
Important vector quantities: Position vector, velocity and acceleration. Velocity and acceleration in different frames of references, Force vector, moment of a force about a point, moment of a force about an axis.
Equivalent force systems: translation of a force to a parallel position, resultant of a force system, simplest resultant of special force systems, distributed force systems

Statics

Equations of equilibrium: free-body diagram, free bodies involving interior sections, general equations of equilibrium, problems of equilibrium
Applications of equations of equilibrium: Trusses-solution of simple trusses using method of joints and method of sections; Friction forces: laws of Coulomb friction, simple contact friction problems, belt friction, square screw thread, rolling friction
Section forces in beams: Shear force, axial force and bending moment diagrams

Dynamics

Kinematics: Velocity and acceleration of a particle, Translation and rotation of rigid bodies, Chasle's theorem, Velocity and acceleration of a point, Relation between the velocity and acceleration in different references.
Kinetics: Newton laws of motion, D'Alembert Principle, free body diagrams, Equations of equilibrium, Particle dynamics, plane dynamics of rigid bodies,
Energy Methods, Impulse-momentum methods

References:

1. I. H. Shames, Engineering Mechanics—Statics and Dynamics, 14th Edition, Prentice Hall of India, 2015.
2. F.P. Beer and E.R. Johnston, Vector Mechanics for Engineers – Statics, McGraw Hill Book Company, 2000.
3. J.L. Meriam and L.G. Kraige, Engineering Mechanics – Statics, John Wiley & Sons, 2002.
4. R.C Hibbler, Engineering Mechanics—Statics and Dynamics, 11th Edition, Pearson, India, 2009

MT1004E THERMODYNAMICS

Pre-requisites: NIL

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course Outcomes:

CO1: Describe the basic concepts of thermodynamics
CO2: Ability to apply the various laws of thermodynamics to real systems
CO3: Determine the changes in properties like internal energy, enthalpy, entropy, temperature, pressure and specific volume during various processes
CO4: Ability to identify the limits of thermodynamic systems

Basic concepts
Thermodynamic systems, properties, state and equilibrium, processes and cycles, continuum, classical thermodynamics; forms of energy; energy transfer by heat and work; temperature and zeroth law of thermodynamics; pure substance: phases, phase change processes of pure substances, property diagrams for phase change processes, property tables; ideal-gas: internal energy, enthalpy, compressibility factor, different equations of state.

First law of thermodynamics
First law of thermodynamics applied to closed system executing a process and cycle; energy transfer by mass; first law of thermodynamics applied to steady and unsteady flow processes: steady flow engineering devices; specific heats of ideal gases, thermodynamic processes executed by ideal gases.

Second law of thermodynamics
The second law of thermodynamics: limitations of first law, thermal energy reservoirs, heat engines, Kelvin-Planck statement, energy conversion efficiencies, refrigerators and heat pumps, Clausius statement, equivalence of the two statements, reversible and irreversible processes, irreversibilities, Carnot cycle, Carnot principles, thermodynamic temperature scale, Carnot heat engine, Carnot refrigerator and heat pump; entropy: increase of entropy principle, entropy change of pure substances, isentropic processes, property diagram involving entropy, the T-ds relations, entropy change of liquids and solids, entropy change of ideal gases.

Exergy and property relations
Exergy: reversible work and irreversibility, exergy of fixed mass and flow stream, exergy transfer by heat, work and mass, second law efficiency; thermodynamic property relations: Maxwell relations, Clapeyron equation, general relations for change in properties, Joule-Thomson coefficient, change in properties for real gases.

References:

1. Y. A. Cengel and M. A. Boles, Thermodynamics: An Engineering Approach, 8th ed. Mc Graw- Hill, 2015.
2. R. E. Sonntag and C. Borgnakke, Fundamentals of Thermodynamics, 9th ed., John Wiley & Sons, 2016.
3. M. J. Moran and H. N. Shapiro, Fundamentals of Engineering Thermodynamics, 8th ed. John Wiley & Sons, 2017.
4. J. B. Jones and R. E. Dugon, Engineering Thermodynamics, 1st ed. Prentice Hall, 1996.
5. P. K. Nag, Engineering Thermodynamics, 5th ed. Tata Mc Graw Hill, 2013.

MT1005E MATERIAL PROPERTIES

Pre-requisites: NIL

L	T	P	O	C
3	0	2	8	4

Total Sessions: 39L + 26P

Course Outcomes:

CO1: Comprehend the magnetic, optical, thermal and electrical properties of materials.
CO2: Apply different magnetic, optical properties in to device applications.
CO3: Appraise magnetic, optical, thermal and dielectric properties of materials into various technological applications.

Magnetic Properties of Materials

Introduction, Basic Concepts, Orbital and spin-permanent magnetic moment of atoms, Diamagnetism and Paramagnetism, Ferromagnetism, Antiferromagnetism and Ferrimagnetism, The Influence of Temperature on Magnetic Behaviour, Curie Temperature, Domains and Hysteresis, Magnetostrictive Energy, Magnetic Anisotropy, Soft Magnetic Materials, Hard Magnetic Materials, Magnetic Storage, Superconductivity, Magnetoresistance effect, Magneto-optic Kerr effect, Superconducting Quantum Interference Device (SQUID) and Vibration Sample Magnetometry (VSM), Spintronics, Memory devices, Multiferroic materials

Optical Properties of Materials
Introduction, Electromagnetic Radiation, Light Interactions with Solids, Atomic and Electronic Interactions, Optical Properties of Metals and Nonmetals, Refraction, Reflection, Absorption, Transmission, Color, Opacity and Translucency in Insulators, Applications of optical phenomena: Luminescence, Photoconductivity, Liquid crystals and LCD, LED devices. Lasers: Laser materials, Construction and operation of ruby and semiconductor lasers, Laser Applications in Materials Processing, Laser Ablation, Optical Fibers in Communications.

Thermal properties of materials
Introduction, Heat capacity, Temperature dependence of the heat capacity, Thermal expansion, Thermal conductivity, Mechanism of heat conduction, Thermal Stresses, Thermal resistance, Thermal diffusivity, Emissivity, Thermal stability, Thermal insulation materials.

Electrical Properties
Electrical Conduction, Electrical conductivity, Energy band structures in solids, Electron mobility, Electrical resistivity, Semiconductivity, Temperature dependence of carrier concentration, Factors that affect carrier mobility, The Hall Effect, Dielectric Behavior: Capacitance, Field vectors and Polarization, Types of polarization, Frequency dependence of the Dielectric constant, Dielectric Strength and Dielectric Materials, Ferroelectricity, Piezoelectricity.

References:

1. Charles Kittel, Introduction to Solid State Physics, 8th Ed. John Wiley & Sons 2004
2. Neil W. Ashcroft and N. David Mermin, Solid State Physics, Sauders College, Philadelphia, USA, 1976
3. William D. Callister, Jr., David G. Rethwisch, "Materials Science and Engineering An Introduction", 10th Edition, Wiley, Inc., 2018.
4. Shackelford, James F., et al. CRC materials science and engineering handbook. CRC press, 2016
5. V. Raghavan, "Materials Science and Engineering A First Course", Prentice- Hall of India Pvt. Ltd., 2015.
6. Stephen J. Blundell, Magnetism: A very short introduction, OXFORD. UNIVERSITY PRESS (2012)

ME1392E MECHANICAL WORKSHOP

Pre-requisites: NIL

L	T	P	O	C
0	0	3	3	2

Total Lecture Sessions : 39

Course Outcomes:

CO1: Ability to select suitable material for a given purpose applying knowledge of material properties and processing.
CO2: Ability to use measuring devices like Vernier Calipers, Micrometers, etc.
CO3: Ability to fabricate simple components using basic manufacturing processes like Casting, Forming, Joining and Machining.
CO4: Ability to sequence various operations so as to execute the task within minimum time.

The course is intended to expose the student to various manufacturing processes through hands on training in different sections of Central Workshop. During the course, the student learns the properties and selection of different materials and acquires the skill in using various tools and measuring devices.

1. **Machine Shop:** Study of the basic lathe operations. Turning, step turning, facing, chamfering, thread cutting, grooving, knurling etc.
2. **Fitting:** Study of tools- chipping, filing, cutting, drilling, tapping, about male and female joints, stepped joints. Cutting and edge preparation for lap and butt joints.
3. **Welding:** Study of arc and gas welding, accessories, joint preparation. Welding of lap and butt joints.
4. **Sheet Metal:** Study of tools, selection of different gauge sheets, types of joints. Fabrication of a tray or a funnel.
5. **Smithy:** Study of tools. Forging of square or hexagonal prism/chisel/bolt.
6. **Foundry:** Study of tools, sand preparation. Moulding practice using the given pattern and demonstration on Casting.

References:

1. W. A. J. Chapman, Workshop Technology - Parts 1 & 2, 4th ed. New Delhi, India, CBS Publishers & Distributors Pvt. Ltd., 2007.
2. Welding Handbook. 9th ed. Miami, American Welding Society, 2001.
3. J. Anderson, Shop Theory, New Delhi, India, Tata McGraw Hill, 2002.
4. J. H. Douglass, Wood Working with Machines, Illinois, McKnight & McKnight Pub. Co., 1995.
5. W.A. Tuplin, Modern Engineering Workshop Practice, Odhams Press, 1996.
6. P. L. Jain, Principles of Foundry Technology, 5th ed. New Delhi, India, Tata McGraw Hill, 2009.

MT1006E PROFESSIONAL ETHICS

Pre-requisites: NIL

L	T	P	O	C
1	0	0	2	1

Total Lecture Sessions: 13

Course Outcomes:

CO1: Develop a clear understanding of human values and use it as basis for all the activities.
CO2: Understand and follow the ethical aspects of engineering profession.
CO3: Align with the Code of Ethics prescribed by ASME in all professional activities.
CO4: Assimilate the elements of academic integrity and Honour Codes, and adopt them in all relevant activities.

Human Values
Morals, values and ethics – integrity – work ethic – service learning – civic virtue – sharing – honesty – courage – valuing time – cooperation – commitment – empathy – self-confidence – character.

Ethics in Professional Practice
Ethics in professional context – ethical basis of engineering activities – ethical responsibilities to consumers and customers – safety and risk – ethics in management of intellectual property – environmental matters and sustainability.

Code of Ethics and Academic Integrity
Code of Ethics of ASME – elements of Academic Integrity: honesty, trust, fairness, respect, responsibility – plagiarism as a violation of academic integrity – Honour Codes: specifying the expected ethical standards from the stakeholders of an organization.

References:

1. R.S. Naagarazan, A Textbook on Professional Ethics and Human Values, 3rd edn., 2022, New Age International Pvt. Ltd.
2. A.F. Bainbridge, Ethics for Engineers: A Brief Introduction, 2021, CRC Press
3. E.G. Seebauer and R.L. Barry, Fundamentals of Ethics for Scientists and Engineers
4. ASME Code of Ethics
5. A reference on Academic Integrity, which includes Honour Codes of various reputed institutes