ADVANCED CHEMISTRY

(For Computer Science and allied Engineering)

L	T	Credits
3	0	3

Course Objectives

1. To understand the fundamentals of quantum chemistry, including wave-particle duality, quantum numbers, and molecular orbital theory relevant to computing materials.
2. To comprehend the chemistry and electronic properties of semiconductor materials and the chemical processes involved in semiconductor-device fabrication.
3. To evaluate electrochemical principles governing batteries, supercapacitors, and fuel cells as energy-storage technologies for computing systems.
4. To analyze corrosion mechanisms in electronic devices and design appropriate protective techniques for PCBs, solder joints, and interconnects.
5. To explore the chemistry, synthesis methods, and properties of nanomaterials used in nanoelectronics, quantum computing, and sustainable electronics.

Course Outcomes (COs)

After successful completion of the course, the student will be able to:

CO1	Apply quantum chemistry principles to analyze molecular systems and explain molecular orbital theory for computing materials.	L3–L4 (Apply, Analyze)
CO2	Analyze semiconductor materials, doping chemistry, and fabrication processes used in modern electronic devices.	L3–L4 (Apply, Analyze)
CO3	Evaluate energy-storage technologies including batteries, supercapacitors, and fuel cells for computing and data-centre applications.	L3–L4 (Apply, Analyze)
CO4	Analyze corrosion mechanisms in electronic devices and recommend appropriate protective techniques for PCBs and interconnects.	L3–L4 (Apply, Analyze)
CO5	Design advanced materials solutions using nanotechnology principles and AI-assisted tools for nanoelectronics and quantum computing.	L5–L6 (Evaluate, Create)

M.S. Lakshmi

UNIT I: Quantum Chemistry **09 Hrs**

Fundamentals of quantum chemistry: black-body radiation, photoelectric effect, wave-particle duality, de Broglie wave equation, Heisenberg's uncertainty principle. Fundamentals of quantum mechanics: Schrödinger wave equation, significance of Ψ and Ψ^2; quantum numbers; particle in a one-dimensional box. Molecular orbital theory: bonding in homonuclear and heteronuclear diatomic molecules; energy-level diagrams of O_2 and CO. π-molecular orbitals of butadiene and benzene; calculation of bond order.

UNIT II: Semiconductor Chemistry **10 Hrs**

Atomic structure and chemical bonding relevant to semiconductors; band theory - valence band, conduction band, band-gap energy. Intrinsic and extrinsic semiconductors: silicon, germanium, gallium arsenide. Doping chemistry: n-type (phosphorus, arsenic) and p-type (boron, aluminium) dopants. Chemical vapor deposition (CVD) for thin-film formation; silicon dioxide (SiO2) formation and properties. Chemistry of compound semiconductors: GaAs, InP, SiC.

UNIT III: Electrochemistry and Energy Storage **10 Hrs**

Electrochemical cells: galvanic cells, electrode potential, Nernst equation and problems; potentiometry (redox reactions); conductometry (strong acid vs strong base, weak acid vs strong base). Primary batteries: zinc-air battery, sodium-air battery; secondary batteries — chemistry of charging and discharging of lead-acid, nickel-cadmium, nickel-metal hydride. Lithium-ion batteries: construction, working, and applications of LiCoO2. Supercapacitors: definition, classification and applications; fuel cells — hydrogen fuel cells and direct methanol fuel cells (DMFC). Battery management systems: overcharge protection and thermal management.

UNIT IV: Chemistry of Corrosion and Protective Techniques **10 Hrs**

Corrosion: definition, examples, types — chemical corrosion and electrochemical corrosion; Pilling-Bedworth rule. Galvanic corrosion; concentration-cell corrosion; factors affecting corrosion. Deal-Grove model: thermal oxidation of silicon; passivation layers — silicon dioxide, silicon nitride, and aluminium oxide. Corrosion of printed circuit boards (PCBs): copper oxidation, tin whiskers; corrosion in solder joints and interconnects. Protective techniques: proper design, pure metals, metal alloys, inhibitors; cathodic protection — sacrificial anodic and impressed-current protection; electroplating (nickel) and electroless plating (copper).

M.S. Lokhande

UNIT V: Chemistry of Nanomaterials **09 Hrs**

Introduction to nanochemistry: size-dependent properties, quantum confinement. Carbon nanomaterials: fullerenes, carbon nanotubes (CNTs), graphene; synthesis methods — chemical vapor deposition (CVD), sol-gel process. Quantum dots: synthesis, properties, applications in displays and quantum computing. Metallic nanoparticles: preparation and applications of gold, silver, and copper nanoparticles. Applications: nanoelectronics, interconnects, sensors (optical and biosensors), memory devices. Spintronics materials: magnetic nanoparticles, topological insulators; chemistry of quantum-computing materials — superconducting materials (NbTi, Nb3Sn), ion-trap materials.

Textbooks

1. Jain, P. C., & Jain, M. (2020). Engineering chemistry (17th ed.). Dhanpat Rai Publishing Company.
2. Agarwal, S. (2026). Engineering chemistry (5th ed.). Cambridge University Press.

Reference Books

1. Linden, D., & Reddy, T. B. (Eds.). (2001). Handbook of batteries (3rd ed.). McGraw-Hill.
2. Rao, C. N. R., Müller, A., & Cheetham, A. K. (Eds.). (2007). The chemistry of nanomaterials: Synthesis, properties and applications (Vols. 1–2). Wiley-VCH.
3. Poole, C. P., & Owens, F. J. (2003). Introduction to nanotechnology. John Wiley & Sons.
4. Sharma, B. K., & Gaur, H. (2019). Engineering chemistry. Krishna Prakashan Media.
5. Dara, S. S., &Umare, S. S. (2018). Engineering chemistry (15th ed.). S. Chand Publishing.

Web Resources

- NPTEL. (n.d.). Engineering chemistry courses. https://nptel.ac.in
- IBM Quantum. (n.d.). IBM Qiskit learning. https://learning.quantum.ibm.com
- Google. (n.d.). Google Colab. https://colab.research.google.com
- OpenCV. (n.d.). OpenCV Python documentation. https://docs.opencv.org
- Materials Project. (n.d.). Open nanomaterials database. https://materialsproject.org

ADVANCED CHEMISTRY LAB
(For Computer Science and Allied Engineering)

P	C
3	1.5

LIST OF EXPERIMENTS

(Any **TEN** of the following listed experiments)

(Out of which any **TWO** experiments may be conducted in virtual mode)

List of Lab Experiments

1. Verification of the photoelectric effect and estimation of Planck's constant.
2. Study of the emission spectrum of a hydrogen / mercury-vapour lamp using a spectrometer.
3. Determination of the band-gap energy of a semiconductor sample from its optical absorption edge.
4. Conductometric titration of a strong acid against a strong base.
5. Determination of the EMF of a Daniel cell and verification of the Nernst equation.
6. Determination of the charge–discharge characteristics of a lithium-ion battery / supercapacitor cell.
7. Determination of the specific and equivalent conductance of an electrolyte solution.
8. Determination of the corrosion rate of a copper / mild-steel specimen by the weight-loss method.
9. Study of electroless copper plating for PCB through-hole metallization (demonstration).
10. Preparation and observation of colloidal gold / silver nanoparticles (size-dependent colour-change demonstration).
11. Determination of the viscosity of a polymer / nanomaterial-dispersion solution using an Ostwald viscometer.
12. Determination of the pH and conductivity of an electronic-grade (deionized) water sample used in wafer/PCB cleaning.
13. Potentiometry - determination of redox potentials and emfs
14. Verify Lambert-Beer's law.(Colurimetric estimation of iron)
15. Determination of total hardness of a water sample by the EDTA titrimetric method.
16. Determination of acidity and alkalinity of a water sample by acid titration.
17. Determination of dissolved oxygen (DO) in a water sample by Winkler's method
18. Preparation and study of a urea-formaldehyde / phenol-formaldehyde resin sample.

TEXT BOOKS:

1. "Practical Engineering Chemistry" by K.Mukkanti, etal. B.S.Publications, Hyderabad (2011).
2. "Lab Manual on Engineering Chemistry" by Sudharani, Dhanpat Rai Publications, Co., New Delhi., (2009).

REFERENCE BOOKS:

1. "Engineering Chemistry Lab Manual" by Shuchi Tiwari (2010), SCITECH Publications.
2. "Vogel's Text Book of Quantitative Chemical Analysis", 6th Edition by G. J. Jeffery, J. Bassett, J. Mendham, R.C. Denney, Longman Scientific & Technical Publications, New York.
3. "A Text Book of Engineering Chemistry" by R. N. Goyal and H. Goel, Ane Books (P) Ltd.(2009).
4. "A Text Book on experiments and calculations Engineering" by S.S. Dara, S.Chand& Company Ltd. (2003).
5. "Instrumental methods of Chemical Analysis", GurudeepR, Chatwal Sham, K. Anand, Latest Edition (2015), Himalaya Publications.

M.S. Lakshmi

ENGINEERING CHEMISTRY

(For Mechanical, Civil and Metallurgical Engineering)

L	T	Credits
3	0	3

Course Objectives

1. To understand water chemistry parameters relevant toengineering applications and to design and evaluate water and wastewater treatment processes.
2. To understand electrochemical principles governing corrosion in engineering structures and to evaluate corrosion-prevention and protection methods for infrastructure.
3. To analyze fuels, combustion, and energy-conversion processes.
4. To understand the chemistry, properties, and applications of polymers in civil engineering and to analyze composite materials used in modern construction.
5. To understand principles of green chemistry for sustainable engineering practice and to evaluate environmental impacts of materials and processes.

Course Outcomes (COs)

After successful completion of the course, the student will be able to:

CO1	Recall and explain water chemistry parameters including hardness, alkalinity, BOD, COD and dissolved oxygen; analyze water quality with reference to engineering applications; and apply appropriate treatment methods for boiler feed water and potable water supply.	L1–L3 (Remember, Understand, Apply)
CO2	Analyze electrochemical principles (electrode potential, Nernst equation, Galvanic series) governing corrosion, identify types of corrosion in reinforced concrete and steel, and evaluate cathodic protection and coating strategies for infrastructure.	L4 (Analyze)
CO3	Evaluate fuel properties and combustion processes for engines and boilers, and assess alternative fuels for automotive applications.	L3–L4 (Apply, Analyze)
CO4	Classify polymers by type and polymerization mechanism, and evaluate the properties and engineering applications of polymers, elastomers, fibre-reinforced polymer composites and construction materials.	L4–L5 (Analyze, Evaluate)
CO5	Apply the principles of green chemistry to assess environmental impacts of materials and processes, evaluate sustainable alternatives, and design strategies to minimize pollution and manage solid waste in engineering projects.	L5–L6 (Evaluate, Create)

M.s.Lakde

UNIT I: Water Chemistry and Treatment **10Hrs**

Water chemistry: hardness of water (temporary and permanent), units, estimation of hardness by EDTA method. Boiler troubles: scale and sludge formation, boiler corrosion, caustic embrittlement; internal treatment of boiler feed water. External treatment: a) phosphate conditioning, b) Calgon conditioning, c) treatment with sodium aluminate; ion-exchange (demineralization); reverse osmosis. Domestic water treatment: screening, sedimentation, coagulation-flocculation (alum, ferric chloride, polyelectrolytes), filtration, disinfection (chlorination, breakpoint chlorination, ozonation, UV treatment). Wastewater treatment: primary, secondary (activated sludge, trickling filters) and tertiary treatment; sludge treatment and disposal; water quality indices — alkalinity, pH, dissolved oxygen, BOD, COD.

UNIT II: Electrochemistry and Corrosion **09Hrs**

Electrochemical principles: electrode potential, Nernst equation, Galvanic series. Conductance and conductometric titrations: a) strong acid vs strong base, b) weak acid vs strong base. Types of corrosion: chemical corrosion and Pilling–Bedworth rule; electrochemical corrosion; concentration-cell corrosion; uniform, pitting, crevice, galvanic and stress corrosion. Factors affecting the rate of corrosion. Corrosion-prevention methods: cathodic protection (sacrificial anode and impressed-current systems); protective coatings (galvanizing, electroplating, electroless plating, tinning, metal cladding); corrosion inhibitors.

UNIT III: Energy Chemistry (Fuels and Combustion) **10 Hrs**

Classification of fuels: solid, liquid, gaseous fuels; calorific value - HCV and LCV, Dulong's formula, problems; calorific-value determination using a bomb calorimeter, problems. Solid fuels (coal): classification (anthracite, bituminous, lignite, peat), analysis (proximate, ultimate), carbonization. Liquid fuels (petroleum oil): composition, refining processes (fractional distillation and cracking - thermal and catalytic); synthetic fuels - Fischer-Tropsch synthesis; green fuels - green hydrogen, hythane. Knocking in petrol engines: octane number, anti-knock additives (TEL, MTBE, ethanol); knocking in diesel engines: cetane number, ignition quality, anti-knock additives. Combustion -problems.

UNIT IV: Engineering Polymers and Construction Materials **10Hrs**

Polymer chemistry: polymerization mechanisms (addition, condensation); classification (thermoplastics, thermosets). Engineering polymers: polyethylene, PVC, polypropylene, epoxy resins, polyurethane, and their construction applications.Elastomers: natural rubber, vulcanization, synthetic rubbers (BUNA-S and BUNA-N) and their applications in

engineering (bearings, joints, waterproofing).Composite materials: matrix and reinforcement; types - polymer-matrix, metal-matrix, ceramic-matrix composites. Fibre-reinforced polymers (FRP): glass fibre, carbon fibre, aramid fibre; applications in structural strengthening and rebar replacement

Cement: PortlandCement, setting and hardening mechanismand chemistry of concrete,

UNIT V: Chemistry of Green Engineering **09 Hrs**

Principles of green chemistry and their applications in engineering; Sustainable materials and industrial by-products relevant to manufacturing; air pollution - types, sources, effects; air quality index.

Water pollution: Sources, effects and remedial methods. Chemistry of Greenhouse gases and climate change; Soil chemistry - pH, organic matter, contamination, and remediation.

Solid waste management: Classification, treatment, recycling relevant to manufacturing and machine-shop operations.

Textbooks

1. Jain, P. C., & Jain, M. (2020). Engineering chemistry (17th ed.). Dhanpat Rai Publishing Company.
2. Shikha, A., & Sharma, R. K. (2019). Engineering chemistry. Krishna Prakashan Media.

Reference Books

1. Davis, M. L. (2020). Water and wastewater engineering: Design principles and practice (2nd ed.). McGraw-Hill Education.
2. Dara, S. S., &Umare, S. S. (2018). Engineering chemistry (15th ed.). S. Chand Publishing.
3. Jain, P. C., & Jain, M. (2020). Engineering chemistry (17th ed.). Dhanpat Rai Publishing Company.

Web Resources

- American Concrete Institute. (2021). ACI 222R-01: Protection of metals in concrete against corrosion. https://www.concrete.org
- Bureau of Indian Standards. (2012). IS 456:2000 - Plain and reinforced concrete - Code of practice. https://www.services.bis.gov.in
- U.S. Environmental Protection Agency. (2023). Green chemistry. https://www.epa.gov/greenchemistry
- World Health Organization. (2022). Guidelines for drinking-water quality (4th ed.). https://www.who.int/publications/i/item/9789241549950
- Indian Green Building Council. (2023). LEED India rating systems. https://igbc.in/igbc

ENGINEERING CHEMISTRY LAB
(For Mechanical, Civil and Metallurgical Engineering)

P	C
3	1.5

LIST OF EXPERIMENTS

(Any **TEN** of the following listed experiments)

(Out of which any **TWO** experiments may be conducted in virtual mode)

List of Lab Experiments:

1. Determination of total hardness of a water sample by the EDTA titrimetric method.
2. Determination of alkalinity of a water sample by acid titration.
3. Determination of dissolved oxygen (DO) in a water sample by Winkler's method.
4. Determination of chloride content of a water sample by the argentometric (Mohr's) method.
5. Determination of pH and conductivity of water and soil samples using a pH meter and conductivity meter.
6. Conductometric titration of a strong acid against a strong base.
7. Determination of the corrosion rate of a mild-steel specimen by the weight-loss method.
8. Preparation and study of a urea-formaldehyde / phenol-formaldehyde resin sample.
9. Determination of the chemical Oxygen Demand (COD) of a wastewater sample.]
10. Determination of the flash point and fire point of a lubricating oil using a Pensky-Martens / Abel apparatus.
11. Determination of the viscosity and viscosity index of a lubricating oil using a Redwood viscometer.
12. Determination of the acid value and saponification value of a lubricating oil.
13. Proximate analysis of a coal sample - determination of moisture, volatile matter, ash and fixed carbon.
14. Potentiometry - determination of redox potentials and emfs

M.S. Lakshmi

TEXT BOOKS:

1. "Practical Engineering Chemistry" by K.Mukkanti, etal. B.S.Publications, Hyderabad (2011).
2. "Lab Manual on Engineering Chemistry" by Sudharani, Dhanpat Rai Publications, Co., New Delhi., (2009).

REFERENCE BOOKS:

1. "Engineering Chemistry Lab Manual" by Shuchi Tiwari (2010), SCITECH Publications.
2. "Vogel's Text Book of Quantitative Chemical Analysis", 6th Edition by G. J. Jeffery, J. Bassett, J. Mendham, R.C. Denney, Longman Scientific & Technical Publications, New York.
3. "A Text Book of Engineering Chemistry" by R. N. Goyal and H. Goel, Ane Books (P) Ltd.(2009).
4. "A Text Book on experiments and calculations Engineering" by S.S. Dara, S.Chand& Company Ltd. (2003).
5. "Instrumental methods of Chemical Analysis", GurudeepR, Chatwal Sham, K. Anand, Latest Edition (2015), Himalaya Publications.

M.S. Lakshmi

APPLIED CHEMISTRY

(For Electronics and Communication Engineering& Electrical and Electronics Engineering)

L	T	Credits
3	0	3

Course Objectives

1. To understand quantum chemistry concepts relevant to electronic systems.
2. To study spectroscopy techniques used in material and signal analysis.
3. To analyze semiconductor and electronic material chemistry.
4. To understand electrochemical energy storage and conversion for power and mobility applications.
5. To analyze corrosion mechanisms in electrical infrastructure and develop protection strategies.

Course Outcomes (COs)

After successful completion of the course, the student will be able to:

CO1	Apply quantum chemistry principles to analyze electronic systems and predict molecular-orbital properties.	L3–L4 (Apply, Analyze)
CO2	Analyze spectroscopic techniques for material characterization and interpret spectral data for molecular identification.	L3–L4 (Apply, Analyze)
CO3	Evaluate semiconductor materials and chemical fabrication processes relevant to electronic-device manufacturing.	L3–L4 (Apply, Analyze)
CO4	Analyze electrochemical energy-storage systems (batteries, supercapacitors, fuel cells) and select suitable technologies for power and mobility applications.	L3–L4 (Apply, Analyze)
CO5	Evaluate corrosion mechanisms in electrical infrastructure and design appropriate protection strategies for cables, substations, and grounding systems.	L3–L5 (Apply, Analyze, Evaluate)

UNIT I: Quantum Chemistry **09 Hrs**

Fundamentals of quantum chemistry: black-body radiation, photoelectric effect, wave-particle duality, de Broglie wave equation, Heisenberg's uncertainty principle.Fundamentals of quantum mechanics: Schrödinger wave equation, significance of Ψ and Ψ^2; quantum numbers; particle in a one-dimensional box.Molecular orbital theory: bonding in homo- and hetero-nuclear diatomic molecules; energy-level diagrams of O2 and CO.π-molecular orbitals of butadiene and benzene; calculation of bond order.

M.S. Lakshmi

UNIT II: Spectroscopy **10Hrs**

Introduction: types of energy in molecules, types of spectra, representation and general features of absorption spectra.Microwave spectroscopy: introduction, principle, instrumentation and applications.UV-Visible spectroscopy: chromophore, auxochrome, bathochromic shift, hypsochromic shift, Beer-Lambert law, principle, instrumentation and applications.Infrared (IR) spectroscopy: introduction, principle, instrumentation and applications.

UNIT III: Chemistry of Electronic Materials **09 Hrs**

Atomic structure and chemical bonding relevant to semiconductors; band theory - valence band, conduction band, band-gap energy.Intrinsic and extrinsic semiconductors: silicon, germanium, gallium arsenide.Doping chemistry: n-type (phosphorus, arsenic) and p-type (boron, aluminium) dopants.Chemical vapor deposition (CVD) for thin-film formation; silicon dioxide (SiO_2) formation and properties.Chemistry of compound semiconductors: GaAs, InP, SiC.

UNIT IV: Electrochemical Energy Storage and Conversion **10Hrs**

Fundamentals of electrochemistry**:** electrode potential, Nernst equation and problems, potentiometry (redox reactions). Conductometry: strong acid vs strong base, weak acid vs strong base titrations. Electrochemical cells: Galvanic and electrolytic cells. Primary batteries: construction, working and applications of zinc-air and sodium-air batteries; secondary batteries: lead-acid, Ni-Cd, lithium-ion batteries — construction, charging-discharging reactions and applications. Supercapacitors: definition, classification and applications; electric fuel cells: hydrogen-oxygen and methanol-oxygen fuel cells — construction, working, applications; battery management systems: state of charge, thermal management, safety.

UNIT V: Corrosion Chemistry and Protective Techniques **10Hrs**

Corrosion: definition, examples; chemical and electrochemical corrosion; Pilling-Bedworth rule. Galvanic corrosion, concentration-cell corrosion; uniform, pitting, galvanic, crevice, stress and erosion corrosion; factors affecting corrosion. Protective techniques: proper design, use of pure metal, metal alloys, inhibitors; cathodic protection — sacrificial anodic and impressed-current protection. Galvanizing (hot-dip, electro-galvanizing); electroplating and electroless plating (nickel and copper). Underground-cable and grounding-system corrosion: stray-current corrosion, earth-electrode and grid corrosion; corrosion in substations, battery terminals, and cooling systems of electrical machines.

M.S. Lakshmi

Textbooks

1. Jain, P. C., & Jain, M. (2020). Engineering chemistry (17th ed.). Dhanpat Rai Publishing Company.
2. Agarwal, S. (2026). Engineering chemistry (5th ed.). Cambridge University Press.

Reference Books

1. Streetman, B. G., & Banerjee, S. K. (2015). Solid state electronic devices (7th ed.). Pearson Education.
2. Sze, S. M., & Ng, K. K. (2006). Physics of semiconductor devices (3rd ed.). John Wiley & Sons.
3. Dara, S. S., &Umare, S. S. (2018). Engineering chemistry (15th ed.). S. Chand Publishing.

Web Resources

- IEEE Electron Devices Society. (n.d.). IEEE EDS resources. https://eds.ieee.org
- SEMI. (n.d.). Semiconductor manufacturing standards. https://www.semi.org
- NPTEL. (n.d.). Engineering chemistry courses. https://nptel.ac.in
- IEEE Photonics Society. (n.d.). IEEE Photonics Society resources. https://www.photonicssociety.org
- U.S. Department of Energy. (n.d.). Energy storage database. https://www.energy.gov

M.S. Lakshmi

APPLIED CHEMISTRY LAB

(For Electronics and Communication Engineering& Electrical and Electronics Engineering)

P	C
3	1.5

LIST OF EXPERIMENTS

(Any **TEN** of the following listed experiments)

(Out of which any **TWO** experiments may be conducted in virtual mode)

List of Lab Experiments:

1. Determination of the EMF of a Daniel cell and verification of the Nernst equation.
2. Conductometric titration of a strong acid against a strong base.
3. Determination of pH and conductivity of water and soil samples using a pH meter and conductivity meter.
4. Potentiometry - determination of redox potentials and emfs
5. Determination of the corrosion rate of a mild-steel specimen by the weight-loss method.
6. Determination of the acid value and moisture content of transformer oil.
7. Determination of the viscosity of an insulating oil using a Redwood viscometer.
8. Determination of the flash point and fire point of a transformer/insulating oil.
9. Verification of the photoelectric effect and estimation of Planck's constant.
10. Study of the emission spectrum of a hydrogen / mercury-vapour lamp using a spectrometer.
11. Verify Lambert-Beer's law.(Colurimetric estimation of iron)
12. Wavelength measurement of sample through UV-Visible Spectroscopy.
13. Determination of total hardness of a water sample by the EDTA titrimetric method.
14. Determination of acidity and alkalinity of a water sample by acid titration.
15. Determination of dissolved oxygen (DO) in a water sample by Winkler's method
16. Preparation of nanomaterials by sol-gel method.

M.S.Lakshmi

TEXT BOOKS:

1. "Practical Engineering Chemistry" by K.Mukkanti, etal. B.S.Publications, Hyderabad (2011).
2. "Lab Manual on Engineering Chemistry" by Sudharani, Dhanpat Rai Publications, Co., New Delhi., (2009).

REFERENCE BOOKS:

1. "Engineering Chemistry Lab Manual" by Shuchi Tiwari (2010), SCITECH Publications.
2. "Vogel's Text Book of Quantitative Chemical Analysis", 6th Edition by G. J. Jeffery, J. Bassett, J. Mendham, R.C. Denney, Longman Scientific & Technical Publications, New York.
3. "A Text Book of Engineering Chemistry" by R. N. Goyal and H. Goel, Ane Books (P) Ltd.(2009).
4. "A Text Book on experiments and calculations Engineering" by S.S. Dara, S.Chand& Company Ltd. (2003).
5. "Instrumental methods of Chemical Analysis", GurudeepR, Chatwal Sham, K. Anand, Latest Edition (2015), Himalaya Publications.

M.S. Lakshmi

ENGLISH FOR TECHNICAL COMMUNICATION

Theory Course for B.Tech I-I — All Branches

Course Structure | B.Tech I Year — I Semester

Course Code	Course Title	L	T	Pr	P	Credits
26EN1XX	English for Technical Communication — All Branches	3	0	0	0	3

Prerequisite: Intermediate English

Course Outline

This course is designed to enhance the communication competencies of engineering students through focused practice in listening, speaking, reading, and writing skills. It aims to build proficiency in oral and written technical communication, and prepare students to meet the communication demands within and across cultures required for the engineering profession. Hence, it is a blend of academic, technical and professional communication.

Each unit has a common theme that runs across the unit to teach all the skills and language elements. Texts are interactive and engaging in nature. All the components of each unit are integrated to provide a contextualised learning experience for students. Tasks provide space for learning in the classroom with the teacher as a facilitator as well as autonomous learning. Reading texts are short and precise — not to learn by heart the contents but to develop reading sub-skills. Writing tasks mostly incorporate AI tools to help refine students' writing skills, but not rely on them completely. Grammar has to be taught remedially — no theoretical inputs are required; students need to be corrected where they frequently go wrong.

Course Objectives

To enhance communicative competencies in students to excel in academic and social skills that involve:

a. Listening to authentic texts to comprehend and respond appropriately as both audience and conversant.
b. Communicating in academic and social (formal) contexts with reasonable fluency and accuracy (neutral accent, social and grammatical appropriateness).
c. Comprehending a reading text of various types for academic (technical) and career purposes.
d. Writing for academic and professional purposes.
e. Communicating across cultures that requires a blend of cognitive, interpersonal, and linguistic skills.

Course Outcomes

CO1 Comprehend specific information, context, and central ideas from social, academic, or workplace conversations and audio-visual material. *[Understand (K2)]*

CO2 Apply appropriate social norms to bridge the gaps and collaborate effectively across diverse cultural backgrounds. *[Apply (K3)]*

CO3 Examine discourse features and speech strategies to participate effectively in group discussions, informal exchanges, and short presentations on technical and general topics. *[Analyse (K4)]*

CO4 Assess written and spoken texts to extract key ideas and produce concise, accurate summaries. *[Evaluate (K5)]*

CO5 Construct well-organised paragraphs, essays, critical reviews, and other professional documents suited to academic and workplace contexts. *[Create (K6)]*

Contents

Unit-I: Environment

Unit-II: Technology and Social Media

Unit-III: IKS / Gender Equity / Gender Sensitization Related

Unit-IV: Exploration — Technical / Professional Communication

Unit-V: Cross-Cultural Communication

Unit No	Theme	Reading	Vocabulary	Writing	Grammar (only remedial)	Listening	Speaking
1	**Environment**	Different texts related to the environment (2-3 texts with about 500 to 600 words)	Drawn from the texts — Synonyms And antonyms	Framing Sentences Paragraph Writing	Parts of Speech	Listening texts on environment: Listening for gist/main theme	Talking about nature around you / environmental issues
2	**Technology and Social Media**	Different texts related to communication on social media (2-3 texts with about 500 to 600 words)	Drawn from the texts — Homonyms Connotations	Information transfer from graph to text and text to graph Summary Writing	Articles and Prepositions Tenses and Time connectors	Listening to texts related to communication on social media — Listening for main and supporting ideas	Role-plays
3	**IKS-Related**	Different texts related to communication on Indian culture (2-3 texts with about 500 to 600 words)	Drawn from the texts — One word Substitutes Collocations	Narrating Events, letter and email writing	Degrees of comparison Direct and Indirect Speech Active and Passive Voice	Listen to texts related to communication on Indian culture — listening for predicting and inferring	Story-telling /narrating events / anecdotes
4	**Technical / Professional Communication**	Different texts related to technology and advancements (2-3 texts with about 500 to 600 words)	Drawn from the texts — Roots, prefixes and Suffixes Inferences	Report Writing	Subject-Verb Agreement	Listening texts related to technology and advancements — listening for specific information, listening for cause and effect	Debates on technology and its impact on various walks of life
5	**Cross-Cultural Communication**	Different texts related to communication across cultures (2-3 texts with about 500 to 600 words)	Drawn from the texts — Expanding Vocabulary Common Errors in Spelling	Making Notes	Correcting Common Errors Sentences	Listening to different texts on different cultures — listening for tone and attitude	Interviews(semi-formal) on cultures

Assessment Pattern

Internal Assessment: 40%

Unit-wise assessment: 5 × 10 = 50 marks

Mid-term assessments: 2 × 25 = 50 marks

External Assessment: 60%

1. Reading comprehension — unseen passages: 2 × 5 = 10 marks (tests vocabulary and reading sub-skills)
2. Writing — 2 tasks: 2 × 5 = 10 marks
3. Listening — 2 texts = 10 marks

4. Speaking — completing conversations and matching expressions as per context: 10 marks
5. Grammar — editing passages with errors: 10 marks
6. Information transfer: 10 marks

Text Books & Reference Books

Text Book:

1. Communicative English: A Skills Approach for Engineers, Orient Blackswan Pvt. Ltd, 2026

Reference Books

- Know your language skills by Prof. Venkat Reddy and Dr. K V Temuzion
- Introduction to Indian Knowledge System:Concepts and Applications by B. Mahadevan, Vinayak Rajat Bhat and Nagendra Pavana R.N., PHI Learning, 2022.

ENGLISH FOR TECHNICAL COMMUNICATION — LAB

B.Tech I Year — All Branches

Course Outline

This lab aims to help students become fluent in communicating their ideas and conversing appropriately in academic and professional contexts. By the end of the semester, the students should be able to communicate with clarity and confidence, demonstrating the professionalism required of engineers. The students will be taught the exchange of pleasantries and etiquette to be adopted both verbally and non-verbally, which includes self-grooming and politeness in conversation along with professional conduct. No theoretical inputs are to be given in the lab sessions. These are to be dedicated to the students' oral communication on the given topics.

Course Outcomes

By the end of the course, the students will have learnt:

1. **CO1** To express ideas using neutral accent and intonation. *[Apply (K3)]*
2. **CO2** To confidently participate in conversations with decorum required for the task. *[Apply (K3)]*
3. **CO3** To communicate fluently in simple English required for the context. *[Apply (K3)]*
4. **CO4** To understand and interpret classroom instructions, lectures and multimedia texts. *[Understand (K2)]*

Topics

1. Introduction to Phonetics
2. Accent neutralisation
3. Introducing self and others
4. Small talk in different contexts (formal and semi-formal — favourite topics)
5. Listening Comprehension
6. Process description (connected to the technical lab experiment processes)
7. Just a Minute (JAM) and Micro presentations (2 to 5 minutes)
8. Explaining concepts — technical text-based
9. Debates (Presenting logical arguments) and Group discussions (coming to consensus)
10. Presentation Skills

Suggested Software: Moodle (LMS)

Web Resources

1. www.esl-lab.com
2. www.englishmedialab.com
3. www.englishinteractive.net
4. https://www.britishcouncil.in/english/online
5. http://www.letstalkpodcast.com
6. https://www.youtube.com/c/mmmEnglish_Emma/featured
7. https://www.youtube.com/c/ArnelsEverydayEnglish/featured
8. https://www.youtube.com/c/engvidAdam/featured
9. https://www.youtube.com/c/EnglishClass101/featured
10. https://www.youtube.com/c/SpeakEnglishWithTiffani/playlists
11. https://www.youtube.com/channel/UCV1h_cBE0Drdx19qkTM0WNw
12. https://www.youtube.com/user/letstalkaccent/videos
13. https://www.youtube.com/c/EngLanguageClub/featured
14. https://www.youtube.com/channel/UC_OskgZBoS4dAnVUgJVexc
15. https://www.youtube.com/channel/UCNfm92h83W2i2ijc5Xwp_IA

I Year II Semester

DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS

(Common to All Branches)

T	P	T	C
3	0	0	3

COURSE OBJECTIVES

- This course is aimed to provide the learner with several methods for solving differential equations and partial differential equations.
- To prepare the student to calculate gradient, surface and volume integrals by applying standard theorems.

COURSE OUTCOMES

Upon successful completion of the course, the student will be able to:		Cognitive Level
CO1	Model simple physical problems involving rate as first order differential equations and solve the resulting equation.	K2, K3, K5
CO2	Model electrical circuits problems or vibrating systems problems as linear higher order ordinary differential equations and solve.	K2, K3, K5
CO3	Solve partial differential equations that model physical processes.	K2, K3, K5
CO4	Apply the knowledge of gradient, divergence and curl and interpret the physical meaning of different operators.	K2, K3, K5
CO5	Compute the work done against a field, circulation and flux using vector calculus methods.	K2, K3, K5

K1- Remembering, K2- Understanding, K3-Applying, K4- Analyzing, K5- Evaluating, K6- Creating

Syllabus

UNIT I: Differential equations of first order and first degree:

Exact equations and equations reducible to exact form (integrating factor), Linear differential equations – Bernoulli's equations. Orthogonal Trajectories, Applications: Newton's Law of cooling – Law of natural growth and decay- Electrical circuits.

UNIT II: Linear differential equations of higher order (Constant Coefficients):

Definitions, homogenous and non-homogenous, complimentary function, particular integral(e^{ax}, sinx cosx, x^m,$e^{ax}v(x)$, $xv(x)$), general solution, Method of variation of parameters- Wronskian. Simultaneous linear equations, Applications to L-C-R Circuit problems and Simple Harmonic motion.

UNIT III: Partial Differential Equations:

Introduction and formation of Partial Differential Equations by elimination of arbitrary constants and arbitrary functions, solutions of first order linear equations using Lagrange's method, Non-linear partial differential equations using Charpit's Method. Homogeneous Linear Partial differential equations with constant coefficients. f(D, D') z = F(x, y), with F(x, y) $=e^{ax+by}$, sin(ax+by), cos(ax+by) and $x^m y^n$

UNIT IV: Vector differentiation:

Scalar and vector point functions, vector operator Del, Gradient and applications, Directional derivative, Divergence-Solenoidal and Curl-Irrotational Field - Scalar Potential, Vector identities.

UNIT V: Vector integration:

Line integral-circulation-work done by the force, surface integral-flux, Green's theorem in a plane (without proof), Stoke's theorem (without proof), volume integral, Divergence theorem (without proof) and their applications.

TEXT BOOKS

1. Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers, 2017, 44th Edition
2. Advanced Engineering Mathematics, Erwin Kreyszig, John Wiley & Sons, 2018, 10th Edition.

REFERENCE BOOKS

1. Thomas Calculus, George B.Thomas, Maurice D.Weir and Joel Has Pearson Publishers, 2018, 14th Edition.
2. Advanced Engineering Mathematics, Dennis G.Zill and Warren S.Wright, Jones and Bartlett, 2018.
3. Advanced Modern Engineering Mathematics, Glyn James, Pearson publishers, 2018, 5th Edition.
4. Advanced Engineering Mathematics, R.K.Jain and S.R.K.Iyengar, Alpha Science International Ltd., 2021, 5thEdition (9th reprint).
5. Higher Engineering Mathematics, B.V.Ramana, McGraw HillEducation,2017.
6. Advanced Engineering Mathematics by H. K Dass, S. ChandPublications,2022, Twenty two Edition (Reprint 2022).
7. Differential Equations and Vector Calculus by S.M. Susmitha, S. K. Vali, Pen Press International, 2026
8. Numerical Python: A Practical Techniques Approach for Industry, Robert Johansson, APress, 2015.

WEB RESOURCES

1. https://mathworld.wolfram.com/First-OrderOrdinaryDifferentialEquation.html
2. https://en.wikipedia.org/wiki/Differential_equation
3. https://en.wikipedia.org/wiki/Partial_differential_equation
4. https://en.wikipedia.org/wiki/Vector_calculus
5. https://en.wikipedia.org/wiki/Vector_calculus

ASSIGNMENT MARKS AND EVALUATION

1. Assignment marks shall be awarded based on the evaluation of the assignments submitted by the students.
2. The concerned teacher shall assign a minimum of five questions from each unit, along with one application-based task from each unit.

3. Every student shall complete all the assigned questions and one specified application-based task from each unit and submit the complete solutions.
4. For each application-based task, students shall use the relevant mathematical concepts to formulate the problem and obtain its solution using the appropriate methods and techniques learned in the respective unit. The solution shall then be verified and compared with the solution generated using an AI tool. Finally, students shall interpret the results in the context of the given application and draw appropriate conclusions.
5. The final assignment mark shall be calculated as the average of the assignment marks obtained across all five units.

TASKS PRESCRIBED FOR ASSIGNMENT

(Not to be Examined/ asked in Semester-End Examinations or Mid-Examinations)

(Refer to Reference Book 7 **for model tasks and corresponding AI prompts for obtaining solutions to the tasks)**

Unit-1

Task 1: Linear Differential Equation: Drug Concentration

Apply a first-order differential equation to model the variation of drug concentration in the bloodstream when medicine is introduced at a controlled rate and simultaneously removed from the body. Given that The rate of change of drug concentration is determined by the difference between the rate of drug input and the rate of drug removal.

Task 2: Linear Differential Equation: Mixing of a Salt Solution

Apply a first-order differential equation to model the amount of salt in a well-mixed tank when a salt solution enters and the mixed solution leaves at specified rates. Given that The rate of change of the amount of salt is equal to the rate of salt entering the tank minus the rate of salt leaving the tank.

Task 3: Linear Differential Equation: Engineering Deflection

Apply a first-order differential equation to model the deflection or displacement of an engineering component subjected to a varying load or position. Given that The rate of change of deflection is related to the applied load and the current state of the component according to the given physical relationship.

Task 4: Orthogonal Trajectories: Engineering Field Lines

Apply the concept of orthogonal trajectories to obtain one family of curves that intersects a given family of engineering field lines, equipotential curves, or flow paths at right angles. Given that The slope of an orthogonal trajectory at an intersection point is the negative reciprocal of the slope of the given curve.

Unit-2

Task 1: Homogeneous Linear Differential Equation: Mechanical Vibration

Apply a higher-order homogeneous differential equation with constant coefficients to model the free vibration of a mechanical system. Given that the restoring force of the system is proportional to the displacement and the resulting motion is governed by the relationship between displacement, velocity, and acceleration.

Task 2: Non-Homogeneous Linear Differential Equation: Electrical Filter Response

Apply a non-homogeneous linear differential equation with constant coefficients to model the response of an electronic filter to a time-dependent input signal. Given that the total output response consists of a natural response determined by the circuit characteristics and a forced response produced by the applied input signal.

Task 3: Variation of Parameters: Structural Deflection

Apply the method of variation of parameters to model the deflection of a structural member subjected to a distributed or position-dependent load. Given that the loading varies along the member and the resulting deflection is governed by a higher-order linear differential equation with a non-constant forcing term.

Task 4: Simultaneous Linear Differential Equations: Coupled Thermal System

Apply simultaneous linear differential equations to model the temperature variation of two interconnected electronic components that exchange heat with each other. Given that the rate of temperature change of each component depends on its own temperature and the temperature difference between the two interconnected components.

Unit-3

Task 1: Formation of Partial Differential Equations: Surface Modelling

Apply the formation of a partial differential equation by eliminating arbitrary constants to model a family of surfaces arising in engineering design or geometrical modelling. Given that the required surface is represented by a relation containing arbitrary constants, and the partial differential equation is obtained by eliminating those arbitrary constants through partial differentiation.

Task 2: Lagrange's Method: Steady-State Transport/Flow

Apply Lagrange's method to obtain the solution of a first-order linear partial differential equation representing the steady-state variation of a physical quantity such as temperature, concentration, or fluid-flow intensity in a two-dimensional region. Given that the rate of variation of the physical quantity along specified characteristic directions is governed by a first-order linear partial differential equation

Task 3: Charpit's Method: Nonlinear Engineering Field Model

Apply Charpit's method to solve a nonlinear first-order partial differential equation arising in an engineering field or surface-modelling problem. Given that the relationship between the partial derivatives of the dependent variable is nonlinear and the required solution is obtained by determining suitable characteristic relations.

Task 4: Homogeneous Linear PDE with Constant Coefficients: Diffusion/Heat Distribution

Apply a homogeneous linear partial differential equation with constant coefficients to model the spatial and temporal variation of temperature or concentration in an engineering system. Given that the rate of temporal change of the physical quantity is related to its spatial variation through a linear differential equation with constant coefficients.

Unit-4

Task 1: Gradient and Directional Derivative: Temperature Variation

Apply the gradient and directional derivative to analyze the variation of temperature over a two-dimensional engineering surface. Given that the gradient of temperature points in the direction of the greatest rate of increase of temperature, while the directional derivative gives the rate of change of temperature in a specified direction.

Task 2: Divergence and Solenoidal Field: Fluid Flow

Apply divergence to analyze the flow of a fluid through a region of an engineering system. Given that the divergence of the velocity field represents the net rate at which fluid is flowing away from or into a point, and a solenoidal field has zero divergence, indicating no net source or sink within the region.

Task 3: Task 3 Curl and Irrotational Field: Fluid or Air Flow

Apply curl to analyze the rotational behavior of a fluid or air-flow field around an

engineering system. Given that the curl of the velocity field measures the local rotational tendency of the flow, while an irrotational field has zero curl.

Task 4: Scalar Potential and Vector Identities: Force Field

Apply the concept of a scalar potential to analyze a conservative force field in an engineering or physical system. Given that a conservative vector field can be represented as the gradient of a scalar potential, and its work between two points depends only on the initial and final positions.

Unit-5

Task 1: Line Integral: Fluid Circulation around an Airfoil

Apply a line integral to determine the circulation of a fluid velocity field around the boundary of an airfoil or engineering body. Given that circulation is obtained by integrating the tangential component of the velocity field along the closed path. Use Line integral and circulation.

Physical relation: , where Γ is the circulation of a fluid velocity v.

Task 2: Surface Integral: Heat Flow through an Engineering Surface

Apply a surface integral to determine the total heat flow through a surface of an engineering component. Given that the heat transferred through a surface is determined by integrating the normal component of the heat-flux vector over the surface. Use Surface integral and flux.

Physical relation: , where Q is the total heat flow through a surface, q is normal component of the heat-flux vector over the surface.

Task 3: Stokes' Theorem: Magnetic Field around a Conductor

Apply Stokes' theorem to determine the circulation of a magnetic field around a closed curve surrounding a current-carrying conductor. Given that the circulation of a vector field around a closed curve is related to the surface integral of its curl over the surface bounded by the curve. Use Stokes' theorem.

Physical relation: , B is the a magnetic field for a suitable magnetostatic situation, the curl is related to the current density by $\nabla \times B = \mu_0 J$, μ_0 is the permeability of free space, J is the current density vector.

Task 4: Divergence Theorem: Air Flow through a Ventilation Chamber

Apply the Divergence theorem to determine the net outward flow of air through the closed boundary of an enclosed ventilation chamber. Given that the total outward flux through the closed surface is equal to the volume integral of the divergence of the velocity field inside the chamber. Use Divergence theorem and volume integral.

Physical relation:, where V is air velocity field. The physical interpretation is that Net outward air flow is the total source strength inside the chamber.

I Year I Semester

LINEAR ALGEBRA AND CALCULUS

(Common to All Branches)

T	P	T	C
3	0	0	3

COURSE OBJECTIVES

- The main objective of this course is to provide the learner with variety of linear algebra techniques to solve linear systems, orthogonal representation of the quadratic surfaces and apply its knowledge in optimization problems.
- It aims further to calculate areas, surfaces and volumes in various coordinate systems.

COURSE OUTCOMES

Upon completion of the course, the student will be able to:		**Cognitive Level**
CO1	Compute rank and inverse of a matrix and hence solves linear system of equations both homogeneous and non-homogeneous.	K2,K3,K5
CO2	Calculate eigenvalues and eigenvectors and hence orthogonalize the given matrix and represent given quadratic form into canonical form.	K2,K3,K5
CO3	Find the mean value of a given function and use it to estimate the bounds of a given function.	K2,K3,K5
CO4	Compute change in the dependent variable with respect to many independent variables and Jacobians. Apply the knowledge in optimizing functions of several variables.	K2,K3,K5
CO5	Compute double and triple integrals of functions of several variables and must be able to change the coordinate systems from Cartesian to polar, spherical and cylindrical coordinates.	K2,K3,K5

K1- Remembering, K2- Understanding, K3-Applying, K4- Analyzing, K5- Evaluating, K6- Creating

SYLLABUS

UNIT I: Matrices, Eigenvalues, Eigenvectors:

Rank of a matrix by echelon form, normal form. Inverse of Non-singular matrices by Gauss-Jordan method, System of linear equations: Solving system of Homogeneous and Non-Homogeneous equations, Gauss elimination method, Jacobi and Gauss Seidel Iteration Methods. Eigenvalues, Eigenvectors and their properties.

UNIT II: Diagonalization of a matrix:

Diagonalization of a matrix, Cayley-Hamilton Theorem (without proof), finding inverse and power of a matrix by Cayley-Hamilton Theorem, Quadratic forms and Nature of the Quadratic Forms, Reduction of Quadratic form to canonical forms by Orthogonal Transformation. Singular valued Decomposition.

UNIT III: Calculus:

Mean Value Theorems: Rolle's Theorem, Lagrange's mean value theorem with their geometrical interpretation, Cauchy's mean value theorem, Taylor's and Maclaurin theorems with remainders (without proof), Problems and applications on the above theorems. Taylor's and Maclaurin series.

UNIT IV: Partial differentiation and Applications (Multi variable calculus):

Functions of several variables: Continuity and Differentiability, Partial derivatives, total derivatives, chain rule, Euler's Theorem, Taylor's and Maclaurin's series expansion of functions of two variables. Jacobians, Functional dependence, Maxima and Minima of functions of two variables without constraints and with Constraints-Method of Lagrange multipliers.

UNIT V: Multiple Integrals:

Double integrals, change of order of integration, triple integrals, change of variables from Cartesian to polar, cylindrical and spherical coordinates. Finding areas (by double integrals) and volumes (by double integrals and triple integrals).

TEXT BOOKS:

1. Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers, 2017, 44th Edition
2. Advanced Engineering Mathematics, Erwin Kreyszig, John Wiley & Sons, 2018, 10th Edition.

REFERENCE BOOKS:

1. Thomas Calculus, George B. Thomas, Maurice D. Weir and Joel Hass, Pearson Publishers, 2018, 14th Edition.
2. Higher Engineering Mathematics, B.V.Ramana, McGraw HillEducation,2017.
3. Advanced Modern Engineering Mathematics, Glyn James, Pearson publishers, 2018, 5th Edition.
4. Advanced Engineering Mathematics, Micheael Greenberg, Pearson publishers, 9th edition.
5. Higher Engineering Mathematics, H. K Das, Er. Rajnish Verma, S. Chand Publications, 2014, Third Edition (Reprint 2021).
6. Advanced Engineering Mathematics by H. K Dass, S. ChandPublications,2022, Twenty Two Edition Reprint 2022).
7. Linear Algebra and Calculus by S. M. Susmitha, S. K. Vali, Pen Press International, 2026
8. Numerical Python: A Practical Techniques Approach for Industry, Robert Johansson, APress, 2015.

WEB RESOURCES

1. https://en.wikipedia.org/wiki/System_of_linear_equations
2. https://en.wikipedia.org/wiki/Eigenvalues_and_eigenvectors
3. https://www.math.hmc.edu/calculus/tutorials/eigenstuff/
4. https://en.wikipedia.org/wiki/Quadratic_form
5. https://en.wikipedia.org/wiki/Calculus
6. https://en.wikipedia.org/wiki/Partial_derivative

7. https://www.whitman.edu/mathematics/calculus_online/section14.03.html
8. https://en.wikipedia.org/wiki/Multiple_integral
9. http://tutorial.math.lamar.edu/Classes/CalcIII/MultipleIntegralsIntro.aspx

ASSIGNMENT MARKS AND EVALUATION

1. Assignment marks shall be awarded based on the evaluation of the assignments submitted by the students.
2. The concerned teacher shall assign a minimum of five questions from each unit, along with one application-based task from each unit.
3. Every student shall complete all the assigned questions and one specified application-based task from each unit and submit the complete solutions.
4. For each application-based task, students shall use the relevant mathematical concepts to formulate the problem and obtain its solution using the appropriate methods and techniques learned in the respective unit. The solution shall then be verified and compared with the **solution generated using an AI tool**. Finally, students shall interpret the results in the context of the given application and draw appropriate conclusions.
5. The final assignment mark shall be calculated as the average of the assignment marks obtained across all five units.

TASKS PRESCRIBED FOR ASSIGNMENT

(Not to be Examined/ asked in Semester-End Examinations or Mid-Examinations)

(Refer to Reference Book 7 **for model tasks and corresponding AI prompts for obtaining solutions to the tasks**

Unit-1

Task 1: Linear Equations: Electrical Circuit Analysis

Apply the theory of systems of linear equations to analyse a basic electrical circuit containing multiple branches, Resistors, DC battery with unknown currents.

Task 2: Linear Equations: Traffic Flow

Apply the theory of systems of linear equations to Model the flow of vehicles through a network of interconnected roads or junctions. Represent the unknown traffic flows by variables and formulate the corresponding conservation equations.

Task 3: Linear Equations: Chemical Equation Balancing

Apply the theory of systems of linear equations to Represent a chemical reaction involving several reactants and products as a system of homogeneous linear equations to balance the chemical equation.

Task 4: Eigenvalues and Eigenvectors: One-Mass Vibration System

Apply Eigenvalues and Eigenvectors by Considering a single-degree-of-freedom mass–spring vibration system consisting of a mass attached to a spring, with or without damping to determine the **natural vibration characteristics of the system**.

Unit-2

Task 1: Diagonalization: Simple Coupled System

Apply matrix diagonalization to a simple coupled system($X'(t)=AX$, where A is matrix) and use the diagonal form to simplify the calculation of the system response.

Task 2: Cayley–Hamilton Theorem: Matrix Powers

Apply the Cayley–Hamilton Theorem to find the inverse and powers of a matrix and interpret their use in a simple state-transition/ network problem ($X_{n+1}=AX_n$) where A is matrix.

Task 3: Quadratic Forms: Nature of an Engineering Function

Represent a two-variable energy function Q(x, y) as a quadratic form, determine its nature, and reduce the quadratic form to canonical form using an orthogonal transformation.

Task 4: Singular Value Decomposition: Simple Data Analysis

Apply Singular Value Decomposition to a small data matrix and use the dominant singular values to identify the most significant information in the data A (in matrix).

Unit-3

Task 1: Mean Value Theorem: Vehicle Motion

Apply Rolle's Theorem and Lagrange's Mean Value Theorem to analyze the motion of a vehicle, relating displacement, average velocity, and instantaneous velocity over a specified time interval.

Task 2: Cauchy's Mean Value Theorem: Fuel Consumption

Apply Cauchy's Mean Value Theorem to determine an instant at t= c which the rate of change of distance travelled with respect S(t) to fuel consumed F(t) equals the average fuel efficiency over a journey.

Task 3: Taylor's Theorem: Sensor Reading

Apply Taylor's Theorem to approximate the output of a nonlinear temperature sensor V(T) near a reference temperature T=a and estimate the approximation error.

Task 4: Maclaurin Series: Small-Angle Calculation

Apply the Maclaurin series of a trigonometric function to approximate the value used in a simple engineering small-angle f(θ) calculation and compare the approximation obtained at θ=a using different numbers of terms.

Unit-4

Task 1: Derivatives and Total Derivative: Temperature Distribution

Apply partial derivatives and the total derivative to analyze the variation of temperature at different positions in a two-dimensional surface and determine the rate of change of temperature along a specified path.

Task 2: Taylor Series of Two Variables: Approximation of Surface Data

Apply Taylor's series for two variables to approximate the value of a surface-dependent engineering quantity near a reference point and compare the approximation with its actual value.

Task 3: Maxima and Minima: Design Optimization

Apply partial derivatives to determine the maximum or minimum value of an engineering quantity, such as the dimensions of a container or component, subject to a practical design requirement.

Task 4: Lagrange Multipliers: Constrained Optimization

Apply the method of Lagrange multipliers to optimize an engineering quantity subject to a constraint, such as maximizing the performance of a component with a fixed amount of

material.

Unit-5

Task 1: Double Integrals: Area of an Irregular Region

Apply double integration to determine the area of a land plot or engineering surface bounded by given curves and interpret the calculated area in the context of the application.

Task 2: Double Integrals: Volume of a Storage Tank

Apply double integration to determine the volume of a storage tank or container whose base region and variable height are described mathematically, and interpret the resulting storage capacity.

Task 3: Triple Integrals: Volume of a Solid Component

Apply triple integration to determine the volume of a three-dimensional engineering component bounded by given surfaces and verify the result using its geometrical properties, wherever possible.

ENGINEERING PHYSICS

(For Mechanical, Civil, Metallurgical and Allied Branches of Engineering)

L	T	Credits
3	0	3

Course Objectives

1. To provide knowledge on wave optics concepts such as interference, diffraction, and polarization with relevant engineering applications.
2. To introduce the fundamentals of crystallography and X-ray diffraction methods for understanding crystal structures and material characterization.
3. To equip students for the basic principles of quantum mechanics and quantum computing, including quantum states, tunneling, superposition and secure communication.
4. To familiarize students with concepts of dielectric and magnetic materials and their applications in energy storage devices.
5. To impart knowledge on the principles of ultrasonics and non-destructive testing methods for defect detection and quality inspection.

Course Outcomes (COs)

CO	Course Outcome Statement	Cognitive Level
CO1	Examine the principles of interference, diffraction and polarization and utilize optical analysis techniques in engineering applications.	K3 (Apply)
CO2	Able to analyze crystal structures, diffraction patterns and material characterization using X-ray diffraction methods.	K4 (Analyze)
CO3	Interpret the concepts of quantum mechanics and quantum computing and apply for secure communication systems.	K3 (Apply)
CO4	Analyze the significant concepts of dielectric and magnetic materials that leads to potential applications in the emerging micro devices.	K4 (Analyze)
CO5	Evaluate ultrasonic testing and non-destructive testing methods for defect identification and quality assessment.	K5 (Evaluate)

UNIT–I: WAVE OPTICS

10Hrs

Interference: Superposition Principle – Coherence – Types of Interference – Thin-film interference (reflection geometry) – Newton's rings – Determination of wavelength and refractive index.

Diffraction and Optical Surveying: Fresnel and Fraunhofer diffraction – Fraunhofer's diffraction due to single slit, double slit & N-slits (qualitative) – Diffraction Grating and grating spectrum – Dispersive and Resolving power of a grating.

Polarization: Types of polarization – Nicol's prism – Half-wave and Quarter-wave plates.

UNIT–II: CRYSTALLOGRAPHY AND MATERIAL CHARACTERIZATION 09Hrs

Crystallography: Space lattice – Basis – Unit cell – Lattice parameters – Crystal systems and Bravais lattices, Co-ordination number and packing fraction of SC, BCC and FCC structures.

Material Characterization: Miller indices – Inter-planar spacing between successive (h k l) planes – Bragg's law – X-ray Diffractometer – Crystal structure determination by Laue's method.

UNIT-III: QUANTUM MECHANICS & QUANTUM COMPUTING 10Hrs

Quantum Mechanics: de Broglie concept of matter waves – Heisenberg's uncertainty principle – Wave function – Postulates of quantum mechanics–Schrödinger's time dependent and time-independent wave equations–Particle in a one-dimensional potential well– Quantum tunnelling (basic idea).

Quantum Computing: Introduction to quantum computing – Classical bits vs qubits – Superposition and entanglement – Basic quantum operations – Hadamard gate – Pauli-X gate – Idea of quantum measurement.

UNIT–IV: DIELECTRICS & MAGNETIC MATERIALS 09Hr

Dielectric Materials: Introduction – Basic definitions – Types of polarizations – Electronic and Ionic polarisations (quantitative) – Orientational and Space Charge Polarisations (qualitative) – Internal field in solids – Clausius-Mossotti relation.

Magnetic Materials and Energy Conversion: Introduction- Basic definitions, classification of magnetic materials – Dia, Para, Ferro, Ferri, and Anti-ferro,–Weiss theory of ferromagnetism,- Hysteresis– Soft & Hard magnetic materials.

UNIT–V: ULTRASONICS AND NON-DESTRUCTIVE TESTING 10Hrs

Ultrasonics: Introduction – Characteristics of ultrasonic waves – Production of ultrasonic waves by magnetostriction and piezoelectric methods – Detection - Acoustic grating – Applications.

Non-Destructive Testing (NDT): Introduction-pulse echo system through transmission and reflection modes– Applications.

Textbooks:

1. Avadhanulu, M.N., Kshirsagar, P.G., & Murthy, T.V.S.A., A textbook of engineering physics, S. Chand Publishing (2019)
2. P.K. Palanisamy, Engineering physics, Scitech Publications (2015)

Reference Books:

1. Pandey, B.K., & Chaturvedi, S., Engineering physics, Cengage Learning (2021)
2. Bhattacharya, D.K., & Tandon, P., Engineering physics, Oxford University Press (2015)
3. Srinivasan, M. R., Engineering physics, New Age International (2009)

Web Resources:

1. NPTEL. (n.d.). National Programme on Technology Enhanced Learning. https://nptel.ac.in
2. MIT OpenCourseWare. (n.d.). Physics courses. https://ocw.mit.edu
3. Georgia State University. (n.d.). HyperPhysics. http://hyperphysics.phy-astr.gsu.edu
4. PhET Interactive Simulations. (n.d.). University of Colorado Boulder. https://phet.colorado.edu
5. American Concrete Institute. (2021). ACI 228.2R: Nondestructive test methods for evaluation of concrete in structures. https://www.concrete.org

ENGINEERING PHYSICS LAB
(For Mechanical and Allied Branches of Engineering)

P	C
3	1.5

LIST OF EXPERIMENTS

(Any **TEN** of the following listed experiments)

(Out of which any **TWO** experiments may be conducted in virtual mode)

List of Engineering Physics Experiments

1. Determination of the Wavelength of a Given Laser Source and Grating Element Using a Plane Transmission Grating.
2. Young's modulus of given material of wooden scale by non –uniform bending method.
3. Study the variation of magnetic field along the axis of a current carrying circular coil by Stewart & Gee's method.
4. Determination of ultrasonic velocity in a given liquid.
5. Determination of dielectric constant of given capacitor by charging and discharging method.
6. Study the variation of B versus H by magnetizing the magnetic material (B-H curve).
7. Estimation of Planck's constant using photoelectric effect.
8. Determination of Rigidity modulus of material of a wire-dynamic method (Torsional pendulum).
9. Verification of Brewster's Law.
10. Determination of thickness of thin object by wedge method.
11. Determination of radius of curvature of given plano convex lens by forming Newton's rings.
12. Determination of wavelengths of different spectral lines in mercury spectrum using diffraction grating in normal incidence configuration.
13. Determination of the resolving power of telescope.
14. Sonometer: Verification of laws of stretched string.
15. Determination of Acceleration due to gravity and Radius of gyration using Compound pendulum.
16. Determination of frequency of electrically maintained tuning fork by Melde's experiment
17. Determination of temperature coefficients of a thermistor.
18. Determination of Hall voltage and Hall coefficients of a given semiconductor using Hall effect

References:

1. S. Balasubramanian, M.N. Srinivasan "A Text Book of Practical Physics"- S Chand Publishers, 2017.

V-Lab: vlab.co.in

APPLIED PHYSICS

(For ECE, EEE and Allied Branches of Engineering)

L	T	Credits
3	0	3

Course Objectives

1. To provide knowledge on wave optics concepts such as interference, diffraction, and polarization with relevant engineering applications.
2. To familiarize students with concepts of dielectric and magnetic materials and their applications in energy storage devices.
3. To equip the students for basic principles of quantum mechanics and quantum computing, including quantum states, tunneling, superposition and secure communication.
4. To impart knowledge on electromagnetic field theory and its applications.
5. To study the energy band formation, carrier density, conductivity, and Fermi level in semiconductors, along with drift-diffusion currents and the Hall effect.

Course Outcomes (COs)

CO	Course Outcome Statement	Cognitive Level
CO1	Examine the principles of interference, diffraction and polarization and utilize optical analysis techniques in engineering applications.	K3 (Apply)
CO2	Analyze the significant concepts of dielectric and magnetic materials that leads to potential applications in the emerging micro devices.	K4 (Analyze)
CO3	Interpret the concepts of quantum mechanics and quantum computing and apply for secure communication systems.	K3 (Analyze)
CO4	Apply Maxwell's equations and electromagnetic field concepts for antenna-based systems.	K3 (Apply)
CO5	Able to analyze the electrical conductivity and charge transport behaviour of semiconductors using band theory.	K4 (Analyze)

UNIT–I: WAVE OPTICS

10Hrs

Interference: Superposition Principle – Coherence – Types of Interference – Thin-film interference (reflection geometry) – Newton's rings – Determination of wavelength and refractive index.

Diffraction and Optical Surveying: Fresnel and Fraunhofer diffraction – Fraunhofer's diffraction due to single slit, double slit & N-slits (qualitative) – Diffraction Grating and grating spectrum – Dispersive and Resolving power of a grating.

Polarization: Types of polarization – Nicol's prism – Half-wave and Quarter-wave plates.

UNIT–II: DIELECTRICS & MAGNETIC MATERIALS

09Hr

Dielectric Materials: Introduction – Basic definitions – Types of polarizations – Electronic and Ionic polarisations (quantitative) – Orientational and Space Charge Polarisations (qualitative) – Internal field in solids – Clausius-Mossotti relation.

Magnetic Materials and Energy Conversion: Introduction- Basic definitions, classification of magnetic materials – Dia, Para, Ferro, Ferri, and Anti-ferro,–Weiss theory of ferromagnetism,- Hysteresis– Soft & Hard magnetic materials.

UNIT-III: QUANTUM MECHANICS AND QUANTUM COMPUTING

10Hrs

Quantum Mechanics: de-Broglie concept of matter waves – Heisenberg's uncertainty principle – Wave function – Postulates of quantum mechanics – Schrödinger's time dependent and time-independent wave equations –Particle in a one-dimensional potential well – Quantum tunnelling (basic idea).

Quantum Computing: Introduction to quantum computing – Classical bits vs qubits – Superposition and entanglement – Basic quantum operations – Hadamard gate – Pauli-X gate – Idea of quantum measurement.

UNIT-IV: INTRODUCTION TO EM THEORY

09Hrs

Introduction – Wave Equation in differential form in free space – Vector Analysis – Divergence and Curl of electric field and magnetic field (static) – Gauss' divergence theorem – Stokes' theorem – Derivations of the four Maxwell Equations and their significance. Maxwell's equations in vacuum, Energy transport and Poynting Vector.

UNIT–V: SEMICONDUCTORS

10Hrs

Semiconductors: Formation of energy bands – Classification of solids - Intrinsic semiconductors – Density of charge carriers – Electrical conductivity – Fermi level – extrinsic semiconductors: density of charge carriers – dependence of Fermi energy on carrier concentration and temperature – Drift and diffusion currents – Einstein's equation – Hall effect – Hall coefficient – Applications of Hall effect.

Textbooks

1. Avadhanulu, M.N., Kshirsagar, P.G., & Murthy, T.V.S.A., A textbook of engineering physics, S. Chand Publishing (2019)
2. P.K. PalaniSamy, Engineering Physics, SciTech Publications (2019)

Reference Books

1. D. K. Bhattacharya & PoonamTandon, Engineering Physics, Oxford Press (2015)
2. S. O. Pillai, Solid State Physics, New Age International (2005)
3. Nielsen & Chuang, Quantum Computation & Quantum Information, Cambridge (2010)
4. D. J. Griffiths, Introduction to Electrodynamics, Cambridge (2023)

Web Resources & NPTEL Links

- NPTEL – nptel.ac.in
- MIT Open CourseWare – ocw.mit.edu
- HyperPhysics – hyperphysics.phy-astr.gsu.edu
- Feynman Lectures – feynmanlectures.caltech.edu
- PhET Simulations – phet.colorado.edu

APPLIED PHYSICS LAB

(For ECE and Allied Branches of Engineering)

P	C
3	1.5

LIST OF EXPERIMENTS

(Any 10 of the following listed experiments)

(Out of which any **TWO** experiments may be conducted in virtual mode)

List of Applied Physics Experiments

1. Determination of thickness of thin object by wedge method.
2. Determination of radius of curvature of a given plano convex lens by forming Newton's rings.
3. Determination of wavelengths of different spectral lines in mercury spectrum using diffraction grating in normal incidence configuration.
4. Determination of resolving power of telescope.
5. Determination of dielectric constant of given capacitor by charging and discharging method.
6. Study the variation of B versus H by magnetizing the magnetic material (B-H curve).
7. Determination of temperature coefficients of a thermistor.
8. Determination of wavelength of Laser and grating element.
9. Estimation of Planck's constant using photoelectric effect.
10. Determination of the Resistivity of semiconductor by four probe method.
11. Determination of the energy gap of a semiconductor using p-n junction diode.
12. Study the variation of magnetic field along the axis of a current carrying circular coil by Stewart & Gee's Method
13. Determination of Hall voltage and Hall coefficient of a given semiconductor using Hall Effect.
14. Determination of Acceleration due to gravity and Radius of gyration using Compound pendulum.
15. Determination of magnetic susceptibility by Kundt's tube method
16. Verification of Brewster's law.
17. Sonometer: Verification of laws of stretched string.
18. Determination of frequency of electrically maintained tuning fork by Melde's apparatus.

References:

1. S. Balasubramanian, M.N. Srinivasan "A Text Book of Practical Physics"- S Chand Publishers, 2017.

V-Lab: vlab.co.in

ADVANCED PHYSICS

(For CSE and Allied Branches of Engineering)

L	T	Credits
3	0	3

Course Objectives

1. To provide knowledge on wave optics concepts such as interference, diffraction, and polarization with relevant engineering applications.
2. To explain various electron theories and interpret the effect of temperature on Fermi-Dirac distribution function and provide basic knowledge of quantum mechanics.
3. To understand the basic concepts of Laser light sources and quantum computing applications.
4. To study the energy band formation, carrier density, conductivity, and Fermi level in semiconductors, along with drift-diffusion currents and the Hall effect.
5. To impart knowledge on low temperature physics and superconductivity and their applications.

Course Outcomes (COs)

CO	Course Outcome Statement	Cognitive Level
CO1	Examine the principles of interference, diffraction and polarization and utilize optical analysis techniques in engineering applications.	K3 (Apply)
CO2	Interpret the effects of temperature on Fermi energy and apply the concepts of quantum mechanics.	K3 (Apply)
CO3	Analyze the operation of various laser systems and to explain modern computational systems like Quantum Computing.	K4 (Analyze)
CO4	Able to analyze the electrical conductivity and charge transport behaviour of semiconductors using band theory.	K4 (Analyze)
CO5	Apply the concepts of low-temperature physics and superconductivity in modern technological applications and intelligent systems.	K3 (Apply)

UNIT–I: WAVE OPTICS 10Hrs

Interference: Superposition Principle – Coherence – Types of Interference – Thin-film interference (reflection geometry) – Newton's rings – Determination of wavelength and refractive index.

Diffraction and Optical Surveying: Fresnel and Fraunhofer diffraction – Fraunhofer's diffraction due to single slit, double slit & N-slits (qualitative) – Diffraction Grating and grating spectrum – Dispersive and Resolving power of a grating.

Polarization: Types of polarization – Nicol's prism – Half-wave and Quarter-wave plates.

UNIT–II: FREE ELECTRON THEORY & QUANTUM MECHANICS 09Hrs

Classical free electron theory – merits and demerits – Quantum free electron theory – equation for electrical conductivity – Fermi-Dirac statistics – Fermi level and variation with temperature.

Quantum Mechanics: de-Broglie concept of matter waves – Heisenberg's uncertainty principle – Wave function – Schrödinger's time dependent and time-independent wave equations – Particle in a one-dimensional potential well – Quantum tunnelling (basic idea).

UNIT–III: QUANTUM PHOTONICS & QUANTUM COMPUTING 10Hrs

Lasers: Principles of Absorption – Spontaneous and Stimulated Emission – Population Inversion – Three level and Four level laser systems – Construction and working of Ruby and He-Ne Laser – Applications (qualitative).

Quantum Computing: Introduction to quantum computing – Classical bits vs qubits – Superposition and entanglement – Basic quantum operations – Hadamard gate – Pauli-X gate – Idea of quantum measurement.

UNIT–IV: SEMICONDUCTORS 10Hrs

Semiconductors: Formation of energy bands – Classification of solids - Intrinsic semiconductors – Density of charge carriers – Electrical conductivity – Fermi level – extrinsic semiconductors: density of charge carriers – dependence of Fermi energy on carrier concentration and temperature – Drift and diffusion currents – Einstein's equation – Hall effect – Hall coefficient – Applications of Hall effect.

UNIT–V: LOW TEMPERATURE PHYSICS & SUPERCONDUCTIVITY 09Hrs

Low Temperature Physics: Introduction – Low temperature and its importance – Properties of materials at low temperatures – Liquefaction of gases (basic concept only) – Liquid Nitrogen and liquid Helium (basic properties and uses).

Superconductors: Properties – Critical parameters – Meissner effect – Type-I and Type-II superconductors – BCS theory – Cooper pairs and energy gap – DC and AC Josephson effect – Applications (qualitative only): SQUIDs, magnetic levitation and lossless power transmission.

Textbooks

1. Avadhanulu, M.N., Kshirsagar, P.G., & Murthy, T.V.S.A., A textbook of engineering physics, S. Chand Publishing (2019)
2. P.K. PalaniSamy, Engineering Physics, SciTech Publications (2019)

Reference Books

1. D. K. Bhattacharya & Poonam Tandon, Engineering Physics, Oxford Press, 2015
2. B. K. Pandey & S. Chaturvedi, Engineering Physics, Cengage Learning, 2021
3. S. O. Pillai, Solid State Physics, New Age International (2019)
4. Nielsen & Chuang, Quantum Computation & Quantum Information, Cambridge (2010)

Web Resources & NPTEL Links

- NPTEL – nptel.ac.in
- MIT OpenCourseWare – ocw.mit.edu
- HyperPhysics – hyperphysics.phy-astr.gsu.edu
- PhET Simulations – phet.colorado.edu
- Library of Congress – loc.gov/rr/scitech/selected-internet/physics.html

ADVANCED PHYSICS

(For CSE, IT and Allied Branches of Engineering)

P	C
3	1.5

LIST OF EXPERIMENTS

(Any 10 of the following listed experiments)

(Out of which any **TWO** experiments may be conducted in virtual mode)

List of Advanced Physics Experiments

1. Determination of the Wavelength of a Given Laser Source and Grating Element Using a Plane Transmission Grating.
2. Determination of radius of curvature of a given plano convex lens by forming Newton's rings.
3. Determination of wavelengths of different spectral lines in mercury spectrum using diffraction grating in normal incidence configuration.
4. Determination of resolving power of telescope.
5. Determination of dielectric constant of given material.
6. Study the variation of B versus H by magnetizing the magnetic material (B-H curve).
7. Determination of temperature coefficients of a thermistor.
8. Determination of wavelength of Laser and grating element.
9. Estimation of Planck's constant using photoelectric effect.
10. Determination of the Resistivity of semiconductor by four probe method.
11. Determination of the energy gap of a semiconductor using p-n junction diode.
12. Study the variation of magnetic field along the axis of a current carrying circular coil by Stewart & Gee's Method
13. Determination of Hall voltage and Hall coefficient of a given semiconductor using Hall Effect.
14. Determination of Acceleration due to gravity and Radius of gyration using Compound pendulum.
15. Determination of magnetic susceptibility by Kundt's tube method
16. Verification of Brewster's law.
17. Sonometer: Verification of laws of stretched string.
18. Determination of frequency of electrically maintained tuning fork by Melde's apparatus.

References:

1. S. Balasubramanian, M.N. Srinivasan "A Text Book of Practical Physics"- S Chand Publishers, 2017.

V-Lab: vlab.co.in

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY – GURAJADA, VIZIANAGARAM

B.Tech. R26 Regulations

Environmental Science

COURSE CODE	COURSE NAME	CATEGORY	L - T - P	CREDITS
	Environmental Science	MC (Non-credit)		0

Pre-requisite: None.

Course Outline

This mandatory non-credit course develops an informed understanding of the natural systems on which human activity depends and of the pressures that engineering places on them. It covers ecosystems and natural resources, biodiversity, pollution and its control, and the social and legal framework of environmental protection, and closes with the issues most directly relevant to an information technology graduate — electronic waste, the energy and water footprint of data centres, and the practice of green computing. The emphasis throughout is on the student's own field observation and case analysis rather than on memorisation.

Course Objectives

1. To create awareness of the structure and function of ecosystems and of the sustainable use of natural resources.
2. To develop an understanding of biodiversity, its value and the causes and consequences of its loss.
3. To impart knowledge of the sources, effects and control of environmental pollution.
4. To familiarise students with environmental legislation, impact assessment, and the specific environmental responsibilities of the information technology sector.

Course Outcomes

CO	Course Outcome — At the end of the course, the student will be able to	Knowledge Level (K)
CO1	Explain the structure and function of ecosystems and evaluate patterns of natural-resource use for sustainability.	K3
CO2	Describe the values of biodiversity, the threats to it and the methods of conservation, with reference to Indian biodiversity hotspots.	K2
CO3	Analyse the sources, effects and control measures of air, water, soil, noise and solid-waste pollution.	K4
CO4	Explain climate change, sustainable development and the social issues associated with environmental degradation.	K3
CO5	Apply environmental legislation, impact-assessment principles and e-waste and green-computing practices to information technology contexts.	K4

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	1	1	1	3	3	2	1	1	1	-	2
CO2	2	2	1	1	1	3	3	2	1	1	1	-	2
CO3	2	3	2	2	1	3	3	2	1	1	1	-	2
CO4	2	2	2	1	1	3	3	3	2	2	1	-	3
CO5	2	2	2	2	2	3	3	3	2	2	2	1	3

Correlation levels: 3 = High, 2 = Medium, 1 = Low, – = Not applicable.

Syllabus

UNIT	CONTENTS	Contact

		Hours
UNIT – I	**Ecosystems and Natural Resources:** Multidisciplinary nature of environmental studies; scope and importance; need for public awareness. Ecosystem — concept, structure and function; producers, consumers and decomposers; energy flow, food chains, food webs and ecological pyramids; ecological succession; forest, grassland, desert and aquatic ecosystems. Natural resources — forest, water, mineral, food, energy and land resources; over-exploitation, deforestation, dams and their effects; conflicts over water; renewable and non-renewable energy; the role of the individual in the conservation of resources.	**7**
UNIT – II	**Biodiversity and its Conservation:** Introduction to biodiversity — genetic, species and ecosystem diversity; biogeographical classification of India; value of biodiversity — consumptive, productive, social, ethical, aesthetic and option values; India as a mega-diversity nation; biodiversity hotspots; threats to biodiversity — habitat loss, poaching, man–wildlife conflict and invasive species; endangered and endemic species of India; conservation of biodiversity — in-situ and ex-situ methods, protected area network.	**6**
UNIT – III	**Environmental Pollution and Waste Management:** Definition, causes, effects and control measures of air, water, soil, marine, noise and thermal pollution; nuclear hazards. Solid waste management — causes, effects and control of urban and industrial wastes; the 4R principle; sanitary landfill, composting and incineration. Electronic waste — composition, hazardous constituents, informal recycling and its health effects, recovery of materials, and the E-Waste (Management) Rules; the role of an individual in the prevention of pollution; disaster management — floods, earthquakes, cyclones and landslides.	**7**
UNIT – IV	**Social Issues, Climate Change and Sustainable Development:** From unsustainable to sustainable development; urban problems related to energy; water conservation, rainwater harvesting and watershed management; resettlement and rehabilitation of displaced people. Climate change — greenhouse effect, global warming, acid rain, ozone layer depletion; international responses — the UNFCCC, the Paris Agreement and India's Nationally Determined Contributions; the Sustainable Development Goals; carbon footprint and life-cycle assessment; consumerism and waste products; environmental ethics and equity.	**6**
UNIT – V	**Environmental Legislation, EIA and Green Computing:** Environment Protection Act; Air (Prevention and Control of Pollution) Act; Water (Prevention and Control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act; issues in the enforcement of environmental legislation; environmental impact assessment — objectives, process and public consultation. Human population and environment — population growth, human health, HIV/AIDS, and the role of information technology in environment and human health. Green computing — energy efficiency in data centres, PUE, cooling and water use, virtualisation and consolidation, sustainable procurement, and the carbon footprint of large-scale computation. Field work — visit to a local area to document environmental assets or a polluted site, and study of common plants, insects and birds.	**6**
	Total	**32**

Evaluation: There shall be no external examination for this mandatory non-credit course. The student shall be declared to have passed on securing 40% or more in the internal assessment, comprising two internal tests (50%), the field-work report and its presentation (30%), and an assignment or case study (20%). In case of failure, a re-examination shall be conducted for 30 marks as provided in the R26 Academic Regulations. A field visit and a written field report are compulsory.

Learning Resources

Text Books

1. Bharucha, E. (2021). Textbook of environmental studies for undergraduate courses (3rd ed.). Universities Press (UGC).

2. Kaushik, A., & Kaushik, C. P. (2018). Perspectives in environmental studies (6th ed.). New Age International.
3. Joseph, B. (2017). Environmental studies (3rd ed.). McGraw Hill Education India.

Reference Books

1. Rajagopalan, R. (2016). Environmental studies: From crisis to cure (3rd ed.). Oxford University Press.
2. Odum, E. P., & Barrett, G. W. (2004). Fundamentals of ecology (5th ed.). Cengage Learning.
3. Miller, G. T., &Spoolman, S. E. (2018). Environmental science (16th ed.). Cengage Learning.
4. Ministry of Environment, Forest and Climate Change. (2022). E-Waste (Management) Rules. Government of India.

Web Resources

1. Ministry of Environment, Forest and Climate Change, Government of India. https://moef.gov.in/
2. Central Pollution Control Board — standards, reports and e-waste resources. https://cpcb.nic.in/
3. United Nations — Sustainable Development Goals. https://sdgs.un.org/goals
4. UNFCCC — climate change process and the Paris Agreement. https://unfccc.int/
5. The Energy and Resources Institute (TERI) — research and policy resources. https://www.teriin.org/
6. NPTEL — courses in Environmental Studies and Sustainable Development. https://nptel.ac.in/

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY – GURAJADA, VIZIANAGARAM

B.Tech. R26 Regulations

NSS / NCC / Scouts and Guides / Community Service

COURSE CODE	COURSE NAME	CATEGORY	L - T - P	CREDITS
	NSS / NCC / Scouts and Guides / Community Service	MC (Non-credit)	0 - 0 - 2	0

Pre-requisite: None.

Course Outline

This mandatory non-credit course develops civic responsibility, discipline and social awareness through organised service and training activity. Students register for one of the recognised streams — National Service Scheme, National Cadet Corps, Scouts and Guides, or an approved community-service programme — and participate through the semester in regular parades or service activities, awareness campaigns and at least one camp or field visit. Assessment is based on participation, activity records and a reflective report rather than a written examination.

Course Objectives

1. To develop a sense of civic and social responsibility through organised community service.
2. To inculcate discipline, leadership, teamwork and physical fitness.
3. To create awareness of national integration, public health, environmental and disaster-response issues.
4. To provide practical experience of working with communities and identifying local problems that engineering can address.

Course Outcomes

CO	Course Outcome — At the end of the course, the student will be able to	Knowledge Level (K)
CO1	Explain the organisation, objectives and code of conduct of the chosen service or training stream.	K2
CO2	Participate effectively in regular activities, parades, drills or service work with discipline and punctuality.	K3
CO3	Conduct awareness campaigns on health, environment, literacy, road safety or digital literacy in a local community.	K3
CO4	Document field and camp activities systematically and reflect on the social relevance of engineering practice.	K4

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	1	1	-	-	3	2	3	3	2	-	-	2
CO2	1	1	1	-	-	3	3	3	3	2	-	-	2
CO3	1	1	2	-	1	3	2	3	3	3	-	-	2
CO4	1	1	1	-	-	3	3	3	3	3	-	-	3

Correlation levels: 3 = High, 2 = Medium, 1 = Low, – = Not applicable.

Syllabus

UNIT	CONTENTS	Contact Hours
UNIT – I	**Orientation and Organisation:** History, objectives, motto, emblem and organisational structure of NSS, NCC and Scouts and Guides; code of conduct and discipline; regular activities and special camping programmes; rights and duties of a volunteer or cadet; national integration and the constitutional values underlying voluntary service.	**6**
UNIT – II	**Discipline, Drill and Physical Training:** Foot drill and parade (NCC stream); yoga, physical fitness and personal hygiene; first aid and basic life support; time management and personality development; leadership qualities, group dynamics and team building; map reading and field craft (NCC stream) or organisational skills for service projects.	**8**
UNIT – III	**Community Service and Awareness Campaigns:** Adopted village or neighbourhood survey; identification of local problems; campaigns on health and hygiene, sanitation, blood donation, literacy, road safety, anti-drug awareness, gender sensitisation and digital literacy; tree plantation and campus cleanliness drives; Swachh Bharat and allied national programmes.	**8**
UNIT – IV	**Environment, Disaster Response and Special Camp:** Environmental awareness and conservation activity; waste segregation and e-waste collection drives; disaster management — preparedness, response and the role of volunteers; participation in at least one special camp, field visit or National Integration Camp; rural or urban community interaction.	**6**
UNIT – V	**Documentation, Reporting and Reflection:** Maintenance of the activity diary and attendance record; photographic and written documentation of campaigns; preparation of a report on one service project undertaken — problem identified, action taken, beneficiaries and outcome; group presentation; reflective note on the social relevance of the student's engineering discipline.	**4**
	Total	**32**

Evaluation: There shall be no external examination for this mandatory non-credit course. Attendance shall be counted towards aggregate attendance, and the student shall be declared to have passed only on securing 40% or more in the internal assessment, which is based on participation and regularity (40%), activity record and documentation (30%), and the project report and presentation (30%). In case of failure, a re-examination shall be conducted for 30 marks as provided in the R26 Academic Regulations.

Learning Resources

Text Books

1. Directorate General NCC. (2020). NCC cadet handbook — Common subjects (All wings). Directorate General of NCC, Ministry of Defence.
2. Ministry of Youth Affairs and Sports. (2018). National Service Scheme manual. Government of India.
3. Bharat Scouts and Guides. (2019). The Bharat Scouts and Guides handbook. National Headquarters, Bharat Scouts and Guides.

Reference Books

1. Chaturvedi, T. N. (2012). Social service and youth development. Indian Institute of Public Administration.
2. National Disaster Management Authority. (2016). National disaster management plan. Government of India.
3. Gandhi, M. K. (1962). Village swaraj. Navajivan Publishing House.
4. Ministry of Environment, Forest and Climate Change. (2022). E-waste (Management) Rules. Government of India.

Web Resources

1. National Service Scheme — Ministry of Youth Affairs and Sports. https://nss.gov.in/
2. National Cadet Corps — Ministry of Defence. https://indiancc.gov.in/
3. The Bharat Scouts and Guides. https://www.bsgindia.org/
4. MY Bharat — Mera Yuva Bharat youth volunteering platform. https://mybharat.gov.in/
5. National Disaster Management Authority — preparedness resources. https://ndma.gov.in/
6. Swachh Bharat Mission — Government of India. https://swachhbharatmission.ddws.gov.in/

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY – GURAJADA, VIZIANAGARAM

B.Tech. R26 Regulations

Universal Human Values and Professional Ethics

COURSE CODE	COURSE NAME	CATEGORY	L - T - P	CREDITS
	Universal Human Values and Professional Ethics	HSMC	2 - 0 - 0	2

Pre-requisite: None. The course follows the AICTE Universal Human Values framework and presumes no prior study of ethics or philosophy.

Course Outline

This course invites students to examine, for themselves, what they really want to be, rather than to accept a set of prescribed values. Its method is self-exploration — proposals are offered for verification against the student's own natural acceptance and experience, never for belief. Beginning with the individual, the course moves outward through the family, society, nature and existence, showing harmony at each level, and closes by drawing out the implications for professional conduct, engineering ethics and the design of humane technology. It is meant to complement technical education, not to compete with it.

Course Objectives

1. To help students distinguish between values and skills and to understand the need for both in a fulfilling life.
2. To facilitate the process of self-exploration and the development of a holistic perspective on life through natural acceptance and experiential validation.
3. To develop an understanding of harmony at the levels of the individual, family, society, nature and existence.
4. To enable students to apply this understanding to professional conduct, ethical decision making and humane technology.

Course Outcomes

CO	Course Outcome — At the end of the course, the student will be able to	Knowledge Level (K)
CO1	Explain the need for value education and apply the process of self-exploration to distinguish natural acceptance from preconditioning.	K3
CO2	Analyse the co-existence of the Self and the Body and identify the requirements for harmony within the human being.	K4
CO3	Evaluate relationships in the family and society on the basis of trust and respect, and articulate the components of a universal human order.	K5
CO4	Explain the mutual fulfilment among the four orders of nature and the holistic co-existence in existence.	K3
CO5	Apply ethical principles and professional codes of conduct to real engineering and information technology case situations, including AI and data ethics.	K4

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	1	-	-	-	2	2	3	2	2	1	-	2
CO2	1	1	-	-	-	2	2	3	2	2	1	-	3
CO3	1	1	1	-	-	3	2	3	3	2	1	-	2
CO4	1	1	1	-	-	3	3	3	2	2	1	-	2

CO5	2	2	2	1	1	3	3	3	3	3	1	1	3

Correlation levels: 3 = High, 2 = Medium, 1 = Low, – = Not applicable.

Syllabus

UNIT	CONTENTS	Contact Hours
UNIT – I	**Introduction to Value Education:** Understanding value education — the need, the basic guidelines, the content and the process; self-exploration as the process for value education; natural acceptance and experiential validation as the mechanism of self-verification; continuous happiness and prosperity as the basic human aspiration; the current scenario — the state of happiness and prosperity in society today; the method to fulfil the basic human aspirations — understanding and living in harmony at various levels; the role of right understanding, relationship and physical facility.	**7**
UNIT – II	**Harmony in the Human Being:** Understanding the human being as the co-existence of the Self ("I") and the Body; distinguishing the needs of the Self (happiness) and of the Body (physical facility); the Body as an instrument of the Self; understanding the characteristics and activities of the Self and harmony within it; harmony of the Self with the Body — sanyam and health, the correct appraisal of physical needs, the meaning of prosperity; programmes to ensure sanyam and health; the effect of food, exercise and lifestyle; digital habits, attention and well-being.	**7**
UNIT – III	**Harmony in the Family and Society:** Understanding harmony in the family as the basic unit of human interaction; the meaning of values in human relationships; trust (vishwas) as the foundational value, and the difference between intention and competence; respect (samman) as the right evaluation, and the consequences of over-evaluation, under-evaluation and other-evaluation; the other feelings — affection, care, guidance, reverence, glory, gratitude and love; comprehensive human goals — samadhan, samridhi, abhay and sah-astitva; the five dimensions of a universal human order.	**6**
UNIT – IV	**Harmony in Nature and Existence:** Understanding harmony in nature; the four orders of nature — material, plant or bio, animal and human — and their interconnectedness, self-regulation and mutual fulfilment; the recyclability and self-regulation inherent in nature; the human being as the order responsible for its own conduct; understanding existence as co-existence of mutually interacting units in all-pervading space; the holistic perception of harmony at all levels of existence and its implications for sustainability.	**6**
UNIT – V	**Implications: Professional Ethics and Humane Practice:** The natural acceptance of human values; definitiveness of ethical human conduct; a basis for humanistic education, humanistic constitution and universal human order; competence in professional ethics — holistic technologies, production systems and management models. Professional ethics in practice — engineering ethics, codes of conduct of professional bodies, conflict of interest, confidentiality, safety and risk, whistle-blowing; intellectual property, plagiarism and academic integrity; ethics of data, privacy and artificial intelligence; case studies — industrial disaster, product-failure and data-misuse cases; strategies for a humane transition at the level of the individual, the organisation and society.	**6**
	Total	**32**

Mode of conduct: The course is to be conducted in a dialogue mode rather than as a lecture. Every proposal is to be offered for the student's own verification, never for acceptance on authority. Practice sessions and self-reflection exercises form an integral part of the course, and the internal assessment shall give weight to participation and to the quality of self-reflection alongside written work.

Learning Resources

Text Books

1. Gaur, R. R., Asthana, R., & Bagaria, G. P. (2019). A foundation course in human values and professional ethics (2nd rev. ed.). Excel Books.

2. Gaur, R. R., Asthana, R., &Bagaria, G. P. (2019). Teachers' manual for a foundation course in human values and professional ethics (2nd rev. ed.). Excel Books.

3. Harris, C. E., Pritchard, M. S., Rabins, M. J., James, R., & Englehardt, E. (2018). Engineering ethics: Concepts and cases (6th ed.). Cengage Learning.

Reference Books

1. Nagaraj, A. (1998). Jeevan Vidya: Ek Parichaya. Jeevan Vidya Prakashan.

2. Govindarajan, M., Natarajan, S., & Senthilkumar, V. S. (2013). Engineering ethics (including human values). PHI Learning.

3. Schumacher, E. F. (2011). Small is beautiful: A study of economics as if people mattered. Random House.

4. Gandhi, M. K. (1927). The story of my experiments with truth. Navajivan Publishing House.

Web Resources

1. AICTE — Universal Human Values resources and teacher training material. https://www.aicte-india.org/
2. UHV Resource Portal — course material, videos and teachers' manuals. https://www.uhv.org.in/
3. NPTEL — courses in Ethics in Engineering Practice and Human Values. https://nptel.ac.in/
4. National Digital Library of India. https://ndl.iitkgp.ac.in/
5. Institution of Engineers (India) — professional code of ethics. https://www.ieindia.org/
6. UNESCO — Recommendation on the ethics of artificial intelligence. https://www.unesco.org/