

List of Core Courses in aligned with all SDGs

(Core courses mapped with SDGs and syllabus)



S.N	DEPT.	SDG COURSE YEAR	SDG COURSE SEM	SUBJECT CODE	SUBJECT TITLES	SDGs
1	CY	I	I/II	U25RCY01	Engineering Chemistry	SDG 7, SDG 9, SDG 12
2	PH	I	1	U25RPH02	Physics for Data Storage and Computing	SDG 4, SDG 9
3	PH	I	1	U25RPH03	Material Science	SDG 4, SDG 7, SDG 9
4	CH	II	III	U21CH304	Environmental Science and Engineering	SDG 6, SDG 12, SDG 14
5	CH	III	VI	U21CH602	Chemical Process Industries	SDG9, SDG 12
6	CH	V	VII	U21CH703	Process Equipment Design	SDG 9, SDG 12
7	CH	II	IV	U21CH404	Process Heat Transfer	SDG 7, SDG 9, SDG 12
8	CH	III	V	U21CH502	Mass Transfer Operations	SDG 6, SDG 9, SDG 12
9	CH	III	VI	U21CH605	Chemical Reaction Engineering	SDG 9, SDG 12
10	ME	III	V	U21ME603	Heat and Mass Transfer	SDG 7, 9, 12, 13
11	ME	III	V	U21ME302	Manufacturing Technology–I	SDG 9, 12
12	ME	IV	VII	U21ME702	Industrial Engineering	SDG 8, 9, 12
13	ME	III	V	U21ME601	Finite Element Analysis	SDG 9, 12, 13
14	ME	III	V	U21ME503	Fundamentals of Automation	SDG 8, 9, 12
15	ME	IV	VII	U21ME501	Design of Machine Elements	SDG 9, 12
16	EE	II	3	U21EE304	Measurements and Instrumentation	SDG 9, SDG 11

17	EE	II	4	U21EE401	Electrical Machines II	SDG 9, SDG 11
18	EE	II	4	U21EE402	Control Systems	SDG 9, SDG 11
19	EE	II	4	U21EE403	Transmission and Distribution	SDG 7,SDG 9, SDG 11, SDG 12
20	EE	III	5	U21EE501	Power System Analysis	SDG 7,SDG 9, SDG 11, SDG 12
21	EE	III	5	U21EE502	Power Electronics and Drives	SDG 7,SDG 9, SDG 11, SDG 12
22	EE	III	5	U21EE503	Microprocessor, Microcontroller and Applications	SDG 7,SDG 9, SDG 11, SDG 12
23	EE	III	6	U21EE601	Protection and Switchgear	SDG 7,SDG 9, SDG 11, SDG 12
24	EE	III	6	U21EE604	Embedded System Design	SDG 7,SDG 9, SDG 11, SDG 12
25	BM	2	4	U21BM401	Microbiology and Pathology	SDG 3 , SDG 9
26	BM	3	6	U21BM601	Diagnostic and Therapeutic Equipment	SDG 3 , SDG 9
27	BM	4	7	U21BM707	Rehabilitation Engineering	SDG 3,SDG 10
28	CE	2	4	U21CE402	Applied Hydraulics and Hydraulic Machinery	SDG 6,SDG 9
29	CE	3	5	U21CE503	Environmental Engineering I	SDG 6,SDG 11,SDG 12
30	CE	3	6	U21CE601	Environmental Engineering II	SDG 6,SDG 11,SDG 12



SEMESTER I & II

U25RCY01	Engineering Chemistry (Common to AD, AM, BM, CB, CE, CH, CS, EC, EE, EV, IT, ME, MI, SC)	Category: BSC				
		L	T	P	J	C
		2	0	2	0	3

QP PATTERN: A

COURSE OBJECTIVES:

- To introduce the fundamentals, properties, industrial applications of polymeric materials and advanced energy storage devices
- To impart knowledge about corrosion prevention, surface treatment methods and nanomaterials
- To provide a basic understanding of semiconductor materials, microelectronics, quantum, computational chemistry and their applications

COURSE OUTCOMES:

CO 1: Apply the concepts of polymer materials and their properties in solving industrial and technological challenges	Apply
CO 2: Interpret the performance of batteries, solar cells, and supercapacitors for their effective energy storage applications	Apply
CO 3: Utilize suitable corrosion prevention methods, surface treatment techniques and nanomaterials for industrial requirements	Apply
CO 4: Apply suitable semiconductor materials, microfabrication processes and display technologies for specific applications	Apply
CO 5: Utilize quantum chemistry principles and AI-assisted techniques to model, visualize, and predict material properties	Apply

CO - PO MAPPING:

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO 1	3	2	1	-	1	-	-	1	1	-	1	1	-
CO 2	3	2	1	-	1	-	-	1	1	-	1	1	-
CO 3	3	2	1	-	1	-	-	1	1	-	1	1	-
CO 4	3	2	1	-	1	-	-	1	1	-	1	1	-
CO 5	3	2	1	-	1	-	-	1	1	-	1	1	-

SYLLABUS:

UNIT I: POLYMERIC MATERIALS

6 + 6

Polymers – Introduction – Compounding – Compression, Injection – Smart Polymers – Temperature responsive (PNIPAM), pH responsive (PAA), Light responsive (Azobenzene), 3D Printable (PLA), flexible and wearable polymers (PDMS – E-skin, RFID) – Conductive Polymers (PEDOT) – Synthesis, working and applications – Biopolymers – Classification, PEG, Alginate Hydrogel – Synthesis and applications

UNIT II: ENERGY CONVERSION AND STORAGE**6 + 6**

Batteries – Classification, LiFePO_4 – Construction, working and applications – Fuel Cells – Proton Exchange Membrane(PEM), Solid Oxide Fuel Cells (SOFC) – Green Hydrogen – Classification, production method, electrolysis – Organic photovoltaics – P3HT and PCBM – Working and applications – Solar Cells – Dye-Sensitized Solar Cells (DSSC), Supercapacitors – Electrostatic Double Layer– Working and application

UNIT III: CORROSION AND NANO SCIENCE**6 + 6**

Types of corrosion – Factors influencing corrosion – Cathodic protection, Coatings – Galvanization, Epoxy, Polyurethane, Enamel, Superhydrophobic coatings – Process and applications. Surface treatments – Carburizing, Nitriding, Cyaniding – Process and applications. Nanomaterials – Introduction, 0D (Quantum dots), 1D (nanowire, nanorods and carbon nanotubes) 2D nanomaterials (MoS_2), Size effects and quantum confinement, Synthesis – Laser ablation and Chemical Vapour Deposition (CVD), Various applications of nanomaterials

UNIT IV: SEMICONDUCTOR AND DISPLAY TECHNOLOGY**6 + 6**

Semiconductors – Perfluoropentacene, GaN – Characteristics and applications, Neuromorphic Materials – Phase-Change Memory and Memristors – Working and applications – Liquid Crystal Displays, OLED, QLED – Working and applications – Wafer Manufacturing – Purification – Czochralski and Float Zone methods – Photolithography and microfabrication

UNIT V: QUANTUM AND COMPUTATIONAL CHEMISTRY**6 + 6**

Quantum Chemistry – Basics, quantum numbers, shapes of atomic orbitals, Molecular Orbital Theory – (H_2 , O_2 , N_2), Schrödinger equation (Derivation) – Qubits and Quantum Memory, Computational Chemistry – Molecular modeling – Basic Computational Methods – Software tools – iGemdock, Chem draw, Molview, Jmol – Introduction to AI and its role in the field of Chemistry

LIST OF EXPERIMENTS

1. Estimate the viscosity of a given polymer solution using an Ostwald viscometer and determine molecular weight of the given polymer
2. Synthesis of a polymer (Bakelite / polyaniline (PANI) and assess the physical properties of the polymer
3. Potentiometric determination and comparative study of EMF in different solutions
4. Determine maximum wavelength of absorption of a given solution to verify Beer's Law and to find unknown concentration of the given sample by Spectrophotometry / Colorimetry
5. Determination of corrosion rate of Iron and its prevention by electroplating / electroless plating
6. Synthesis of ZnO / TiO_2 / Ag nanoparticles and study of their photocatalytic degradation of Methylene Blue dye
7. Recovery of Copper from waste Printed Circuit Boards (PCBs) and quantitative determination of copper content
8. Measurement of electrical conductivity of solutions using a conductometric Sensor
9. Perform molecular docking using freely available online software to investigate the binding affinity a ligand with the protein
10. Construct the 2D structure of a given compound and generate its 3D molecular model using computational tools for visualization and structural analysis

CONTACT PERIODS:**Lecture:** 30 Periods**Tutorial:** - Periods**Practical:** 30 Periods**Project:** - Periods**Total:** 60 Periods**TEXTBOOKS:**

1. Wiley India Pvt. Ltd., "Engineering Chemistry", 2nd edition, Wiley India Pvt. Ltd., New Delhi, 2013
2. S.S. Dara and S.S. Umare, "A Textbook of Engineering Chemistry", 12th edition, Chand Publishing, New Delhi, 2024

3. R.V. Gadag and A. Nityananda Shetty, "Engineering Chemistry", 3rd edition, I.K. International Publishing House, New Delhi, 2014

REFERENCES:

1. Fred W Billmeyer, "Textbook of Polymer Science", 4th edition, John Wiley & Sons, New York, 1999
2. Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen and Jack E. Lemons, "Biomaterials Science: An Introduction to Materials in Medicine", 4th edition, Academic Press, London, 2020
3. Kirby W Beard, Linden's "Handbook of Batteries", 5th edition, McGraw Hill, New York, 2019
4. John Larminie and Andrew Dicks, "Fuel Cell Systems Explained", 3rd edition, John Wiley & Sons, Chichester, 2012
5. Fontana M. G., "Corrosion Engineering", 3rd edition, McGraw-Hill Book Company, New York, 1986
6. V. Raghavan, "Materials Science and Engineering: A First Course", 6th edition, Prentice Hall of India, New Delhi, 2015
7. M.F. Ashby and D.R.H. Jones, "Engineering Materials" 2: An Introduction to Microstructures, Processing and Design, 4th edition, Elsevier, UK, 2012
8. Ira N Levine, "Quantum Chemistry", 7th edition, Pearson, Boston, 2013

SEMESTER I

U25RPH02	Physics for Data Storage and Computing (Common to AD, AM, CB, CS, IT, SC)	Category: BSC				
		L	T	P	J	C
		2	0	0	0	2

QP PATTERN: A

COURSE OBJECTIVES:

- To understand the concepts of optical and optoelectronic materials and device applications
- To examine the principles and applications of magnetic and nano devices
- To understand the principles of quantum mechanics for computing and electronic circuits and to analyze next generation quantum electronics

COURSE OUTCOMES:

CO 1:	Utilize the properties of optical materials and devices for optical data storage applications	Apply
CO 2:	Apply the properties of magnetic materials in magnetic storage devices and sensor applications	Apply
CO 3:	Apply the principles of quantum confinement, tunneling, and single electron phenomena in nanodevices	Apply
CO 4:	Use qubit concepts and Bloch sphere representation in basic quantum computing operations	Apply
CO 5:	Apply the operation of quantum gates, quantum circuits, and quantum devices in quantum computing systems	Apply

CO - PO MAPPING:

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO 1	3	1	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	1	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	2	1	-	-	-	-	-	-	-	-	-	-
CO 4	3	2	1	-	-	-	-	-	-	-	-	-	-
CO 5	3	2	1	-	-	-	-	-	-	-	-	-	-

SYLLABUS:

UNIT I: OPTICAL MATERIALS AND DEVICES **6**

Classification of optical materials – Carrier generations and recombination process – Absorption, emission and scattering of light in solids – Photodiode – Solar cell – OLED – Optical data storage techniques – Blue ray disc

UNIT II: MAGNETIC MATERIALS AND DATA STORAGE **6**

Origin of magnetic materials – Classification of magnetic materials – Ferromagnetic theory – Hysteresis – Magnetic memory devices – Magnetic tape – GMR Sensor – Magnetic bubble memories – Magstripe

UNIT III: NANODEVICES **6**

Introduction – Quantum confinement – Quantum structures: quantum wells, wires and dots – Band gap of nanomaterials – Tunneling – Single electron phenomena: Coulomb blockade – Single electron transistor – Resonant tunneling diode – Quantum cellular automata

UNIT IV: QUANTUM COMPUTING**6**

Introduction to Quantum Computing – Moore's law and its limitations – Differences between Classical and Quantum computing – Concept of qubit and its properties – Representation of qubit by Bloch sphere – Single and Two qubits

UNIT V: QUANTUM CIRCUITS**6**

Quantum devices – Qubit Gates, Single Qubit Gates: Quantum NOT Gate – Pauli – X, Y and Z Gates – Hadamard Gate – Phase Gate (or S Gate), T Gate – Multiple Qubit Gates (qualitative) – Quantum Chips

CONTACT PERIODS:

Lecture: 30 Periods **Tutorial:** - Periods **Practical:** - Periods **Project:** - Periods **Total:** 30 Periods

TEXTBOOKS:

1. S O Pillai, "Solid State Physics", New Age International Private Limited, 8th Edition, 2018
2. Vishal Sahani "Quantum Computing", McGraw Hill Education, 2007

REFERENCES:

1. M.N. Avadhanulu, P.G. Kshirsagar, and T.V.S. Arun Murthy, "A Textbook of Engineering Physics", 11th edition, S. Chand Publishing, New Delhi, 2022
2. Quantum Computing – A Beginner's Introduction, Parag K Lala, Indian Edition, Mc GrawHill, Reprint 2020
3. https://onlinecourses.nptel.ac.in/noc21_cs103/preview

SEMESTER II

U25RPH03	Material Science (Common to CH, EE, ME, MI)	Category: BSC				
		L	T	P	J	C
		2	0	0	2	3

QP PATTERN: A

COURSE OBJECTIVES:

- To provide fundamental knowledge of advanced engineering materials including superconducting, thermoelectric, and energy storage materials for modern technological applications
- To introduce the operating principles and applications of functional materials used in sensors, electronic devices, and smart systems
- To familiarize students with emerging engineering materials such as metallic glasses, shape memory alloys, nanomaterials, and carbon nanotubes for advanced engineering applications

COURSE OUTCOMES:

- CO 1:** Make use of the properties and applications of superconducting materials and superconducting devices **Apply**
- CO 2:** Determine the thermoelectric effects, thermoelectric materials, and their applications in energy conversion technologies **Apply**
- CO 3:** Develop the solid state electrolyte and calculate the battery performance of the materials **Apply**
- CO 4:** Apply characterization techniques for microstructural analysis of materials **Apply**
- CO 5:** Apply the concepts of advanced engineering materials including metallic glasses, shape memory alloys, and nanomaterials for engineering applications **Apply**

CO - PO MAPPING:

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO 1	3	2	1	-	1	-	-	1	1	-	-	2	1
CO 2	3	2	1	-	1	-	-	1	1	-	-	2	1
CO 3	3	2	1	-	1	-	-	1	1	-	-	2	1
CO 4	3	2	1	-	1	-	-	1	1	-	-	2	1
CO 5	3	2	1	-	1	-	-	1	1	-	-	2	1

SYLLABUS:

UNIT I: SUPERCONDUCTING MATERIALS

6 + 6

Superconductors – Meissner effect – Persistent current – Critical temperature – Critical magnetic field - Isotope effect – Type I, Type II superconductors – BCS theory of Superconductivity – High temperature superconductors – SQUID – Magnetic levitation

UNIT II: MATERIALS FOR THERMOELECTRICITY

6 + 6

Thermoelectric effects (Seebeck, Peltier, Thomson) – Thermoelectric figure of merit (ZT), and material properties (σ , S , κ) – Thermoelectric materials (Bi_2Te_3 , PbTe , oxides) Applications – Waste heat recovery, cooling technologies – Hybrid vehicles

UNIT III: ENERGY STORAGE MATERIALS**6 + 6**

Energy storage systems for portable electronics and electric vehicles – Li ion Batteries – Sodium ion – Potassium ion – Magnesium ion – Multivalent batteries – Solid-state batteries (ceramic & polymer electrolytes) – Supercapacitor materials (carbon-based, transition metal oxides, conducting polymers)

UNIT IV: MATERIALS FOR SENSORS AND APPLICATIONS**6 + 6**

Inductance, capacitance, and resistance in sensor operation – Piezoelectric materials – pyroelectric materials – electroactive polymers – magneto-resistive and shape memory alloys – Applications of sensors in temperature, pressure, motion, and light detection

UNIT V: NEW ENGINEERING MATERIALS**6 + 6**

Metallic glasses – Types, glass forming ability of alloys – Melt spinning process – applications – Shape memory alloys – Phases, shape memory effect – pseudoelastic effect – NiTi alloy – Applications – Nanomaterials: ball milling – chemical vapour deposition – properties and applications – Carbon nanotubes: types and applications

LIST OF PROJECTS

1. Magnetic Levitation Demo Using a Superconducting Kit
2. Simulation/Poster: Type I vs. Type II Superconductors
3. SQUID Applications in Medicine and Geophysics
4. Fabrication of a Simple Thermoelectric Generator (TEG)
5. ZT Calculation of a Thermoelectric Material
6. Waste Heat Recovery System for Industrial Exhaust
7. Comparison of Li-ion and Na-ion Battery Performance
8. Development of a Solid-State Electrolyte
9. High-Capacitance Supercapacitor Using Carbon Nanomaterials
10. Multifunctional Sensor Using Piezoelectric Material
11. Smart Glove with Embedded Sensors
12. Design of a Pyroelectric Motion Detector
13. Study of Critical Temperature of YBCO Superconductor
14. Fabrication of a Metallic Glass Ribbon via Melt Spinning (Simulation/Model)
15. NiTi Shape Memory Alloy Demonstration

CONTACT PERIODS:

Lecture: 30 Periods **Tutorial:** - Periods **Practical:** - Periods **Project:** 30 Periods **Total:** 60 Periods

TEXTBOOKS:

1. Serway, R.A. & Jewett, J.W., "Physics for Scientists and Engineers", 10th Edition, Cengage Learning, 2018
2. Budinski, K.G. & Budinski, M.K., "Engineering Materials: Properties and Selection", 10th Edition, Pearson Education, 2020

REFERENCES:

B.TECH. - CH - R2025 - CBCS

1. Kasap, S.O., "Principles of Electronic Materials and Devices", 4th Edition, McGraw Hill Education, 2018
2. Kittel, C., "Introduction to Solid State Physics", 8th Edition, Wiley, 2004
3. Cabeza, L.F. (Ed.), "Phase Change Materials and Their Applications", Springer, 2020
4. <https://archive.nptel.ac.in/courses/115/103/115103030/>

SEMESTER III

U21CH304	ENVIRONMENTAL SCIENCE AND ENGINEERING	Category: ESC				
		L	T	P	J	C
		2	0	0	2	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To study the nature and facts about environment
- To find and implement scientific, technological, economic and political solutions to environmental problems
- To study the interrelationship between living organism and environment

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the nature and facts about environment (Understand)

CO2: Implement scientific, technological, economic and political solutions to environmental problems (Apply)

CO3: Study the interrelationship between living organism and environment (Understand)

CO4: Appreciate the importance of environment by assessing its impact on the human world (Understand)

CO5: Envision the surrounding environment, its functions and its value (Understand)

CO-PO MAPPING:

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	1	-	3	3	2	3	1	-	1	1	1
CO2	2	1	1	1	-	3	3	2	3	1	-	1	1	1
CO3	2	1	1	1	-	3	3	2	3	1	-	1	1	1
CO4	2	1	1	1	-	3	3	2	3	1	-	1	1	1
CO5	2	1	1	1	-	3	3	2	3	1	-	1	1	1
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:**UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY****6**

Definition – Scope and importance of environment – Need for public awareness – Concept of a ecosystem – Structure and function of an ecosystem – Producers – Consumers and decomposers – Ecological succession – Food chains – Food webs and ecological pyramids – Introduction – Types characteristic features – Structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global – National and local levels – Hot-spots of biodiversity – Threats to biodiversity – Conservation of biodiversity – Elements of Environmental Science

UNIT II ENVIRONMENTAL POLLUTION**6**

Definition – Causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Noise pollution (e) Thermal pollution (f) Nuclear hazards – Solid waste management: causes – Effects and control measures of municipal solid wastes – Role of an individual in prevention of pollution – Disaster management: floods, earthquake – Cyclone and landslides – Pollution standards – Particulate matters 10 and 2.5 – Pollution monitoring equipment such as Ozone analyzer – High volume analyzer and continuous monitoring system for air and water

UNIT III NATURAL RESOURCES**6**

Forest resources: Use and over-exploitation, deforestation – Water resources: Use and over-utilization of surface and ground water, floods, drought – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources – Food resources: World food problems – Changes caused by agriculture and overgrazing – Effects of modern agriculture – Fertilizer – Pesticide problems – Energy resources: Growing energy needs – Renewable and non renewable energy sources – Use of alternate energy sources – Land resources: Land as a resource – land degradation – Man induced landslides – Soil erosion and desertification – Role of an individual in conservation of natural resources

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT**6**

From unsustainable to sustainable development – Urban problems related to energy – Automobile exhaust pollution and social issues – Water conservation, rain water harvesting – Environmental ethics: Issues and possible solutions – Climate change – Global warming – Acid rain – Ozone layer depletion – Nuclear accidents and holocaust – Biological – Chemical and physical conservation and reclamation of land – Environment protection act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act – environmental legislation, Environmental audit

UNIT V HUMAN POPULATION AND THE ENVIRONMENT**6**

Population growth, variation among nations – Population explosion – Family welfare program – environment and human health – Human rights – Value education – HIV / AIDS – Women and child welfare

PROJECT TOPICS:

1. Nature's value in policy and practice: Evaluating interaction between different ecosystems.
2. Demonstrate innovative waste management solutions.
3. Strategic plans to conserve natural resources: Role of an individual.
4. Chemical Engineers can save the world from climate change: Issues and possible solutions.
5. A case study on the effects of population growth, environmental pollution and poverty relationship

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: – Periods Project: 30 Periods

Total: 60 Periods

TEXT BOOKS:

1. Benny Joseph, Environmental Science and Engineering, 1st Edition, Tata McGraw-Hill, New Delhi, 2006.
2. Gilbert M. Masters, Introduction to Environmental Engineering and Science, 2nd Edition, Pearson Education, 2004.

REFERENCES:

1. Dharmendra S. Sengar, "Environmental law", 2nd Edition, Prentice hall of India Pvt. Ltd, 2007.
2. Erach Bharucha, Text book of Environmental Studies, 1st Edition, Universities Press (I), Pvt. Ltd., 2015
3. Rajagopalan, R, "Environmental Studies - From Crisis to Cure", 1st Edition, Oxford University Press, 2005.

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (Theory) (100 Marks)		Assessment II (Project) (100 Marks)			Theory Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Review I	Review II	Review III	
40	60	15	25	60	
25		25			
50					50
Total: 100					

*Role Play/ Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

SEMESTER VI

U21CH602	CHEMICAL PROCESS INDUSTRIES	Category: PCC				
		L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To introduce the fundamental concepts and principles of chemical production process including unit operation and unit process with their symbols in chemical process industries (Inorganic and Organic) and the role of chemical engineers in the industry.
- To impart knowledge on the process flow diagrams that are used to communicate the production processes in chemical process industries.
- To understand the importance of chemical process industries, and their significance in modern society.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

- CO1:** Recognize general anatomy of chemical production, the role of chemical engineers, interpret process flow diagrams used to communicate production processes involved in chemical process industries and demonstrate an understanding of the manufacturing processes of sulfur, sulfuric acid, and cement industries. (Understand)
- CO2:** Explain the basic process and steps involved in the industrial production of fertilizers (NPK) (Understand)
- CO3:** Illustrate the process of manufacture of pulp, paper, sugar and starch with the help of a process flow diagram (Understand)
- CO4:** Describe the petroleum refining process and the production of petrochemicals with the help of a process flow diagram (Remember)
- CO5:** Explain the various process steps and sequence of operations involved in the industrial production of fuels and industrial gases (Understand)

CO-PO MAPPING:

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	-	-	-	-	-	-	2	1	-	-	3	1
CO2	1	2	2	-	-	-	1	-	2	1	-	2	3	1
CO3	1	2	-	-	-	-	-	-	2	1	-	-	3	1
CO4	1	2	-	-	-	-	-	-	2	1	-	-	3	1
CO5	1	2	-	-	-	-	-	-	2	1	-	-	3	1
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:**UNIT I SULFUR, SULFURIC ACID AND CEMENT 9**

Sulfur – Raw materials Sources – Mining and production of Sulfur – Sulfuric acid – Methods of production of Sulfuric acid – Contact process – Chamber process. Cement – Properties of Cement – Methods of production – Overall factors for Cement industry.

UNIT II FERTILIZER INDUSTRY 9

Major Components of Fertilizer industries – Nitrogen industries – Ammonia – Nitric acid – Urea – Phosphorus industries - Phosphorus – Phosphoric acid – Super Phosphate – Potassium chloride – Potassium Sulphate.

UNIT III PULP, PAPER, SUGAR, AND STARCH INDUSTRIES 9

Pulp – Methods of production – Comparison of pulping processes. Paper – Types of paper products – Raw materials – Methods of production. Sugar – Methods of production – By products of the Sugar industry – Starch – Methods of production – Starch derivations.

UNIT IV PETROLEUM AND PETRO CHEMICAL INDUSTRIES 9

Petroleum – Chemical Composition – Classification of crude petroleum – Petroleum Refinery products – Petroleum Conversion processes – Pyrolysis and Cracking – Reforming Polymerization – isomerization and Alkylation – Petrochemicals – Methanol – Chloro methanol – Acetylene and ethylene – Isopropanol – Acrylonitrile – Butadiene – Chemicals from Aromatics – Benzene – Toluene and Xylene.

UNIT V FUEL AND INDUSTRIAL GASES 9

Fuel Gases – Producer gas – Water gas – Coke oven gas – Natural gas – Liquefied natural gas – Industrial gases – Carbon dioxide – Hydrogen – Nitrogen and oxygen

Contact Periods:

Lecture:	45 Periods	Tutorial:	– Periods	Practical:	– Periods	Project:	– Periods
							Total: 45 Periods

TEXT BOOKS:

1. Dryden, C.E, Outlines of Chemical technology, 2nd Edition, Affiliate East West press, 2003.
2. Moulin, J.A., M. Makkee, and Diepen, A.V., Chemical Process Technology, 1st Edition, Wiley, 2001.

REFERENCES:

1. Austin, G.T., Shreve's, Chemical Process Industries, 5th Edition McGraw-Hill, 1998.
2. SrikumarKoyikkal, Chemical Process Technology and Simulation, 2nd Edition, PHI Learning Ltd, 2001
3. McCabe W.L, Smith, J C and Harriot. P "Unit operations in Chemical Engineering", 7th Edition McGraw Hill, 2005.

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60		
Total				40	
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

SEMESTER VII

U21CH703	PROCESS EQUIPMENT DESIGN	Category: PCC				
		L	T	P	J	C
		2	0	0	2	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- Study the different aspects of process design that impact process safety
- Implement a fundamentally safer design for the operation of the entire process plant
- Assess the mechanical reliability of process equipment

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Analyse the design of a Piping System (Analyze)

CO2: Acquire the knowledge in the design and drawings of Heat Exchangers (Understand)

CO3: Understand the concept of Evaporation (Understand)

CO4: Apply the concepts involved in phase separation and design of Distillation, and Absorption Columns (Apply)

CO5: Apply the skills in mechanical design of Pressure Vessels (Apply)

CO-PO MAPPING:

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	-	1	1	1	2	2	2	2
CO2	3	3	3	3	-	-	-	1	1	1	2	2	2	2
CO3	3	3	3	3	-	-	-	1	1	1	2	2	2	2
CO4	3	3	3	3	-	-	-	1	1	1	2	2	2	2
CO5	3	3	3	3	-	-	-	1	1	1	2	2	2	2
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:**UNIT I INTRODUCTION****6+3**

Importance of Process Diagrams in Process Engineering, Process Design of piping system

UNIT II HEAT TRANSFER EQUIPMENT – I**6+3**

Process design of double pipe Heat Exchangers and Shell and Tube Heat Exchangers.

UNIT III HEAT TRANSFER EQUIPMENT – II 6+3

Process design of Condensers and Evaporators (single effect & multi-effect evaporator).

UNIT IV MASS TRANSFER EQUIPMENTS 6+3

Process design of Distillation Column and Absorption Column

UNIT V STORAGE EQUIPMENTS 6+3

Process design of Pressure Vessels and Storage Vessels.

LIST OF EXPERIMENTS

1. Design and drawing of piping system
2. Design and drawing of double pipe heat exchanger
3. Design and drawing of shell and tube heat exchanger
4. Design and drawing of condenser
5. Design and drawing of evaporator
6. Design and drawing of distillation column
7. Design and drawing of absorption column
8. Design and drawing of pressure vessel
9. Design and drawing of storage vessel

Contact Periods:

Lecture:	30 Periods	Tutorial:	- Periods	Practical:	- Periods	Project:	30 Periods
						Total:	60 Periods

TEXT BOOKS:

1. Coulson Richardson's., "Chemical Engineering Design, Vol.6, 4th Edition, Elsevier, 2005.
2. D. Q. Kern, "Process Heat Transfer" 21st Edition, McGraw Hill International Book Company, 1983.

REFERENCES:

1. Green D. W., "Perry's Chemical Engineer's Handbook," 9th Edition, McGraw Hill, 1934.
2. McCabe W.L., Smith J.C., Harriott P. Unit Operations in Chemical Engineering, 7th Edition, McGraw Hill, 2017.

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (Theory) (100 Marks)		Assessment II (Project) (100 Marks)			Theory Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Review I	Review II	Review III	
40	60	15	25	60	
25		25			
50					50
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

SEMESTER IV

U21CH404	PROCESS HEAT TRANSFER	Category: PCC				
		L	T	P	J	C
		2	1	0	2	4

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the fundamental concepts of heat transfer viz., conduction, convection, radiation
- To understand and apply the concepts of boiling, condensation and radiative heat transfer
- To develop sound practical knowledge on different types of heat transfer equipment

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the fundamental concepts of heat transfer and steady state heat conduction in solids (Understand)

CO2: Explain the convective heat transfer and heat transfer coefficients for laminar and turbulent flows (Understand)

CO3: Describe the heat transfer in boundary layer and heat transfer involving phase change (Understand)

CO4: Understand the radiative heat transfer including black body radiation and Kirchoff's law (Understand)

CO5: Calculate and use overall heat transfer coefficients in designing heat exchanger equipment (Analyze)

CO-PO MAPPING:

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	-	1	-	1	1	2	2	2	2
CO2	3	2	2	2	2	-	1	-	1	1	2	2	2	2
CO3	3	2	2	2	2	-	1	-	1	1	2	2	2	2
CO4	3	2	2	2	2	-	1	-	1	1	2	2	2	2
CO5	3	2	2	2	2	-	1	-	1	1	2	2	2	2
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS

UNIT I INTRODUCTION AND CONDUCTION

6+3

Importance of heat transfer in Chemical Engineering operations – Modes of heat transfer – One dimensional steady state heat conduction through plane and composite walls, hollow cylinder and spheres – Thermal conductivity measurement – Effect of temperature on thermal conductivity – Heat transfer in extended surfaces – Transient heat conduction

UNIT II HEAT TRANSFER BY CONVECTION

6+3

Concepts of heat transfer by convection – Natural and forced convection – Hydrodynamic and thermal Boundary layers – Analogies between transfer of momentum and heat – Reynold's analogy – Prandtl and Coulburn analogy – Dimensional analysis in heat transfer – Heat transfer coefficient for flow through a pipe – Flow past flat plate and flow through packed beds and fluidized beds

UNIT III HEAT TRANSFER BY PHASE CHANGE

6+3

Heat transfer to fluids with phase change – Heat transfer from condensing vapours – Drop wise and filmwise condensation – Nusselt equation for vertical and horizontal tubes – Condensation of super-heated vapours – Heat transfer to boiling liquids – Mechanism of boiling – Nucleate boiling and film boiling

UNIT IV EVAPORATION AND RADIATION

6+3

Evaporation – Single and multiple effect operation – Material and Energy balance in evaporators – Boilingpoint elevation – Duhring's rule – Radiation heat transfer – Black body radiation – Emissivity – Stefan – Boltzman law – Plank's law – Radiation between surfaces

UNIT V HEAT EXCHANGERS

6+3

Heat Exchangers – Classification and design – Overall and individual film coefficients – Mean temperature difference – LMTD correction factor for multiple pass exchanger – NTU and efficiency of heat exchangers

LIST OF EXPERIMENTS

1. Demo by experiment difference in thermal conductivity of a metal, polymer and refractory
2. Build a composite wall to maintain room temperature 5°C less than outer temperature
3. Energy analysis and comparison of a natural and convective drying equipment
4. Perform energy analysis or build a prototype of a 10 kg/day coconut jaggery evaporator by using microwave radiation
5. Critically analyze: solar irradiation for electricity generation in India is insufficient
6. Cross cut section of a double pipe, single / multi pass shell and tube heat exchanger
7. Perform heat energy balance for a sodium hydroxide manufacturing plant involving multi effect evaporator or a petroleum distillation column.
8. Optimize heat energy in a chemical process plant using PINCH technology
9. Design a passive cooling of an electric vehicle battery with fins
10. Critically review the list of text and reference books available for heat transfer in Library
11. Perform a literature review on recent trends in heat transfer research
12. Critically analyze the tools used in recent publications in Journal of Heat Transfer
13. Develop a virtual heat transfer lab experiment in MATLAB / python / simulink
14. Create a 2 minute 3D animation video to explain an heat transfer concept in AutoDesk / Maya / Blender
15. Write a MATLAB / SCILAB / PYTHON / OCTAVE CODE to solve ordinary or partial derivative equation involving temperature

B.TECH. – CH – R2021 – CBCS

Contact Periods:

Lecture: 30 Periods Tutorial: 15 Periods Practical: – Periods Project: 30 Periods
Total: 75 Periods

TEXT BOOKS:

1. Holman, J. P., "Heat Transfer", 10th Edition, McGraw Hill, 2010.
2. Ozisik, M. N., "Heat Transfer: A Basic Approach", 5th Edition, McGraw-Hill, 1984.

REFERENCES:

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

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (Theory) (100 Marks)		Assessment II (Project) (100 Marks)			Theory Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Review I	Review II	Review III	
40	60	15	25	60	
25		25			
					50
50					50
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course

SEMESTER V

U21CH502	MASS TRANSFER II	Category: PCC				
		L	T	P	J	C
		2	1	0	2	4

PRE-REQUISITES:

- U21CH403 - Mass Transfer I

COURSE OBJECTIVES:

- To impart the basic concept of conventional mass transfer operations
- To learn the equilibrium characteristics of two phase mass transfer processes
- To understand the hydrodynamics and modes of operations in mass transfer equipment

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand concept and determine the theoretical stages, number of transfer units and height requirements for a gas absorption process (Understand)

CO2: Identify the suitable distillation techniques, determine the number of trays for stage wise contact and determine the height of the packed tower (Apply)

CO3: Apply the ternary equilibrium diagram concepts to determine the number of stages required for separation of liquid-liquid extraction process (Apply)

CO4: Describe core principles of leaching, setting up mass balances, use graphical methods to estimate the number of ideal stages in leaching operation (Analyze)

CO5: Understand the concept of adsorption techniques, various isotherms and ion exchange process (Understand)

CO-PO MAPPING:

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	1	1	-	1	2	1
CO2	3	1	1	-	-	-	-	-	1	1	-	1	2	1
CO3	3	1	1	-	-	-	-	-	1	1	-	1	2	1
CO4	3	1	1	-	-	-	-	-	1	1	-	1	2	1
CO5	3	1	1	-	-	-	-	-	1	1	-	1	2	1
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:**UNIT I ABSORPTION****6+3**

Equilibrium and operating line concept in absorption calculations; Types of contactors – Design of packed and plate type absorbers; Operating characteristics of stage wise and differential contactors – Concepts of NTU – HTU and overall volumetric mass transfer coefficients – Multicomponent absorption – Mechanism and model of absorption with chemical reaction – Thermal effects in absorption process.

UNIT II DISTILLATION**6+3**

Design of Distillation – Stage-wise and continuous Differential contact operations – Design calculations using Ponchon-Savarit and McCabe Thiele Methods – Separation efficiency – Murphree Plate Efficiency – Point and overall efficiency interrelations – Reboilers and condensers – Open steam Distillation – Design of Packed bed distillation towers – HTU and NTU calculations

UNIT III LIQUID-LIQUID EXTRACTION**6+3**

Extraction- Theory – LLE for different systems – Effect of Pressure and Temperature on LLE – Solubility criteria – Design of Batch and continuous extraction towers for miscible and immiscible systems – Industrial Applications

UNIT IV LEACHING**6+3**

Leaching – Theory – Mechanism – Types of leaching – Solid – Liquid equilibria – Design of Batch and continuous extractors – Equipment and industrial applications.

UNIT V ADSORPTION– ION EXCHANGE AND MEMBRANE SEPARATION PROCESSES**6+3**

Adsorption – Types of adsorption – Nature of adsorbents-Adsorption hysteresis – Adsorption isotherms – Operation of adsorption columns – Design of Batch and continuous adsorbers – Principle of Ion exchange – Techniques and applications – Solid and liquid membranes – Concept of osmosis – Reverse osmosis – Electro dialysis – Ultrafiltration.

Contact Periods:

Lecture:	30 Periods	Tutorial:	15 Periods	Practical:	– Periods	Project:	30 Periods
						Total:	75 Periods

TEXT BOOKS:

1. R.E. Treybal, "Mass Transfer Operations", 3rd Edition, McGraw Hill Book Co., New York, 1981.
2. N. Anantharaman and K.M.Meera Sheriffa Begum, "Mass Transfer Theory and Practice", 4th Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2013.

REFERENCES:

1. M. Coulson and J.F. Richardson, "Chemical Engineering", Vol - II, 5th Edition, Pergamon Press, New York, 2002.
2. C.J. Geankopolis, "Transport Processes in Chemical Operations", 4th Edition, Prentice Hall of India, 2004.
3. W.L. McCabe, J.C. Smith and P. Harriot, "Unit Operations in Chemical Engg.", 7th Edition, McGraw Hill Book Co., New York, 2004.

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (Theory) (100 Marks)		Assessment II (Project) (100 Marks)			Theory Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Review I	Review II	Review III	
40	60	15	25	60	
25		25			
50					50
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

SEMESTER VI

U21CH605	CHEMICAL REACTION ENGINEERING	Category: PCC				
		L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To gain knowledge on different types of chemical reactors, the development of design equation of chemical reactors under isothermal and non-isothermal conditions
- To enable the students to learn the gas-solid catalytic and non-catalytic reactors and gas-liquid reactors.
- To impart the knowledge of reaction rate theories and reaction mechanisms to derive expressions for rate equations mass and energy balances

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Design and conduct an experimental investigation in order to determine rate equations (Analyze)

CO2: Demonstrate an ability to solve material and energy balances in order to analyse the performance of a reactor (Apply)

CO3: Demonstrate an experimental data using standard statistical methods to establish quantitative results (Apply)

CO4: Gain knowledge on the selection of reactor for the required reaction (Understand)

CO5: Gain the ability to determine experimentally the kinetics and rate constants of reactions in different types of reactors (Understand)

CO-PO MAPPING:

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	3	1	-	-	-	-	2	1	-	-	3	3
CO2	1	1	3	1	-	-	-	-	2	1	-	-	3	3
CO3	1	1	3	1	-	-	-	-	2	1	-	-	3	3
CO4	1	1	3	1	-	-	-	-	2	1	-	-	3	3
CO5	1	1	3	1	-	-	-	-	2	1	-	-	3	3
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:**UNIT I CHEMICAL KINETICS & CHEMICAL REACTION ENGINEERING 9**

Broad outline of chemical reactors; rate equations; concentration and temperature dependence; development of rate equations for different homogeneous reactions. Industrial scale reactors

UNIT II IDEAL REACTORS 9

Isothermal batch, flow, semi-batch reactors; performance equations for single reactors; multiple reactor systems; multiple reactions

UNIT III IDEAL FLOW AND NON-IDEAL FLOW 9

RTD in non-ideal flow; non-ideal flow models; reactor performance with non-ideal flow

UNIT IV GAS-SOLID, GAS-LIQUID REACTIONS 9

Resistances and rate equations; heterogeneous catalysis; reactions steps; resistances and rate equations.

UNIT V FIXED BED AND FLUID BED REACTORS 9

G/L reactions on solid catalysis; trickle bed, slurry reactors; three phase-fluidized beds; reactors for fluid-fluid reactions; tank reactors

Contact Periods:

Lecture:	45 Periods	Tutorial: – Periods	Practical: – Periods	Project: – Periods
				Total: 45 Periods

TEXT BOOKS:

1. Levenspiel O, "Chemical Reaction Engineering", 3rd Edition, Wiley Eastern Ltd., 2006.
2. Fogler.H.S., "Elements of Chemical Reaction Engineering", 4th Edition, Prentice Hall of India Ltd., 2015.

REFERENCES:

1. Smith, J.M, "Chemical Engineering Kinetics", 3rd Edition, McGraw Hill, 1981.
2. Froment. G.F. & K.B.Bischoff, "Chemical Reactor Analysis and Design", 1st Edition, John Wiley and Sons, 1979.

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations	
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments		
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test			
40	60	40	60			200
Total					40	60
					100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

SEMESTER VI

U21ME603	HEAT AND MASS TRANSFER	Category: PCC				
		L	T	P	J	C
		3	0	2	0	4

PRE-REQUISITES:

- U21ME301- Engineering Thermodynamics
- U21ME304 - Fluid Mechanics and Applications

COURSE OBJECTIVES:

- To impart knowledge on mechanisms of heat transfer under steady and transient conditions
- To familiarize with the sizing and rating of heat exchangers
- To explore the basic concepts of mass transfer models

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply general conduction equation to solve steady state and transient heat transfer problems (Apply)

CO2: Utilize empirical correlations to analyze convection heat transfer problems (Analyze)

CO3: Solve radiation heat exchange problems (Apply)

CO4: Analyze heat exchangers and phase change heat transfer problems (Analyze)

CO5: Apply mass transfer principles to solve mass transfer problems (Apply)

CO – PO MAPPING:

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	1	-	1	1	-	-	2	-
CO2	3	3	2	2	-	-	1	-	1	1	-	-	2	-
CO3	3	2	1	1	-	-	1	-	1	1	-	-	2	-
CO4	3	3	2	2	-	-	1	-	1	1	-	-	2	-
CO5	3	2	1	1	-	-	-	-	-	-	-	-	2	-

SYLLABUS:**UNIT I CONDUCTION HEAT TRANSFER****9**

Thermodynamics and Heat Transfer – Heat transfer in Engineering – Mechanisms of Heat transfer – Concept of Driving potential General differential Equation of Heat conduction – Cartesian & Polar Coordinate systems – One dimensional steady state conduction – With and without heat generation – Composite systems – Critical radius of insulation – Heat transfer in fins – Introduction to transient heat conduction

UNIT II CONVECTION HEAT TRANSFER**9**

Concept of Velocity and Thermal boundary layer – Forced convection systems – Flow over surfaces – Flat plate, Cylinders and Spheres – Flow through tubes – Natural convection systems – Natural convection on a vertical flat plate and Horizontal cylinders – Case study – Reducing Heat Transfer through Surfaces

UNIT III RADIATION HEAT TRANSFER 9

Thermal Radiation – Basic relations – Radiation between two black and Gray bodies – Radiation shape factor – Shape factor Algebra – Electrical Network Analogy for Thermal Radiation systems – Radiation shields – Radiation from Gases

UNIT IV BOILING, CONDENSATION AND HEAT EXCHANGERS 9

Boiling and Condensation heat Transfer – Boiling types – Heat Transfer Correlations – Condensation types – Heat Transfer Correlations – Types of Heat Exchangers – Overall Heat Transfer Coefficient – Fouling Factor – Analysis of Heat Exchangers – LMTD method & Effectiveness NTU Method

UNIT V MASS TRANSFER 9

Analogy between Heat and Mass Transfer – Mass Diffusion – Fick's Law of Diffusion – Boundary Conditions – Steady Mass Diffusion through a Wall – Mass Convection – Mass Convection Relations – Simultaneous Heat and Mass Transfer

LIST OF EXPERIMENTS

1. Thermal conductivity measurement of pipe insulation using lagged pipe apparatus
2. Determination of heat transfer coefficient under natural convection from a vertical cylinder
3. Determination of heat transfer coefficient under forced convection from a tube
3. Experimentation and simulation of finding overall thermal conductance and temperature distribution in case of a composite wall
4. Determination of Stefan – Boltzmann constant
5. Determination of emissivity of a grey surface
6. Determination of effectiveness and overall heat transfer coefficient of Parallel/Counter flow heat exchanger
7. Simulation of Steady and Unsteady heat conduction problem using MATLAB

Contact Periods:

Lecture: 45 Periods	Tutorial: – Periods	Practical: 30 Periods	Project – Periods
			Total 75 Periods

TEXT BOOKS:

1. Cengel, Yunus A, Ghajar, Afshin J., "Heat and mass transfer", 4th edition, McGraw – Hill Education, New Delhi, 2016
2. Kothandaraman, C.P., "Fundamentals of heat and mass transfer", 4th edition, New Age International (p) limited, Publishers, New Delhi, 2012

REFERENCES:

1. Sachdeva, R C., "Fundamentals of engineering heat and mass transfer", 5th edition, New Age International (p) limited, Publishers, New Delhi, 2017
2. Rudramoorthy, R., Mayilsamy, K., "Heat and mass transfer", 2nd edition, Pearson Publishers, New Delhi, 2013
3. Incropera, Frank P. (et...al), K., "Fundamentals of heat and mass transfer", 6th edition, John Wiley & Sons, 2019

EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		Assessment II (Practical) (100 Marks)		Theory Examinations (Examinations will be conducted for 100 Marks)	Practical Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test		
40	60	75	25		
25		25			
50				50	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

SEMESTER III

U21ME302	MANUFACTURING TECHNOLOGY – I	Category: PCC				
		L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- U21CY101 - Engineering Chemistry

COURSE OBJECTIVES:

- To gain knowledge in material casting processes.
- To introduce students to foundry practices and product design considerations
- To provide an overview of sheet metal and welding processes

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain pattern design and moulding methods with their merits, demerits and applications (Understand)

CO2: Explain casting, melting processes and testing methods used in foundry practice (Understand)

CO3: Explain the principles and classifications of various welding processes (Understand)

CO4: Explain hot and cold working processes and their effects on material properties (Understand)

CO5: Explain sheet metal working processes and their industrial applications (Understand)

CO-PO MAPPING:

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	1	1	1	-	-	-	1	2	1
CO2	2	1	-	-	-	1	1	-	-	-	-	1	2	1
CO3	2	1	-	-	-	1	-	1	-	-	-	1	2	1
CO4	2	1	-	-	-	1	1	-	-	-	-	1	3	2
CO5	2	1	-	-	-	1	1	-	-	-	-	1	3	2

SYLLABUS:**UNIT I PATTERNS****9****PATTERNS AND PATTERN MAKING**

Introduction to Foundry – Steps involved in casting – Advantages – Limitations and applications of casting process. Pattern types – Allowances for pattern – Pattern materials – Color coding and storing of patterns

MOULDING: Moulding methods and processes – Materials – Equipment – Moulding sand ingredients – Essential requirements – sand preparation and control – Testing – Cores and core making – Design considerations in casting – Gating and Riser – Directional solidification in castings – Metallurgical aspects of Casting – Introduction to moulding software's

UNIT II METAL CASTING**9**

Casting Processes: Sand castings – Pressure die casting – Permanent mould casting – Centrifugal casting – Precision investment casting – Shell moulding – Continuous casting – Squeeze casting – Electro slag casting – Fettling and finishing – Defects in Castings – Casting of non – Ferrous materials

Melting – Pouring and Testing: Melting furnaces – Crucibles oil fired furnaces – Electric furnaces – Cupola – Selection of furnace – Degasification – Inoculation – Pouring techniques casting defects and Inspection of castings

UNIT III METAL JOINING

9

Basic Joining Processes: Cold welding – Diffusion bonding – Explosive welding – Ultrasonic welding – Friction welding – Forge welding – Roll welding and Hot pressure welding processes – Resistance welding (spot – Seam – Projection – Percussion – Flash types) – Atomic hydrogen arc welding – Thermit welding – Flame cutting – Use of Oxyacetylene – Modern cutting processes – Arc cutting – Robotic welding

UNIT IV FORMING PROCESSES

9

Elastic and plastic deformation – Concept of strain hardening – Operating principle – Equipment – Types – Merits – Demerits and applications of hot and cold working process – Rolling – Forging – Extrusion – Swaging – Wire and tube drawing – Load consideration of hot and cold working processes

UNIT V SHEET METAL WORKS

9

Introduction – Sheet metal characteristics – Shearing mechanisms – Formability of sheet metal – Testing methods – Basic sheet metal operations – Principle – Equipment – Types – Merits – Demerits and applications. Special forming process – Hydro forming – rubber pad forming – Metal spinning – Introduction to explosive forming – Magnetic pulse forming – Peen forming – Super plastic forming – Micro forming

Contact Periods:

Lecture: 45 Periods Tutorial: Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall of India, 2004
2. P.N.Rao – "Manufacturing Technology", 5th edition, MH Ltd., 2013

REFERENCES:

1. Serope Kalpakjian; Steven R.Schmid, "Manufacturing Engineering and Technology", 4th edition, Prentice Hall,2000
2. R.B Gupta, "Foundry Engineering" Satyaprakashan,3rd edition, Tata McGraw Hill Publishing Company Ltd,2012
3. Lal.O.P Mand Khanna A, "Text Book of Foundry Technology", 5th edition, Dhanpat Rai and Sons,2013

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60		
Total				40	
				100	

SEMESTER VII

U21ME702	INDUSTRIAL ENGINEERING	Category: HSMC				
		L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To learn how to perform time study activities and importance of lean tools
- To know the role of logistics and supply chain in modern transportation
- To learn how to construct project network

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Perform Time study activities to analyze the existing process (Understand)

CO2: Identify and reduce non-value-added activities in the process using lean tools (Understand)

CO3: Use Logistics, supply chain strategies and inventory models to solve operational problems (Apply)

CO4: Determine the shortest route to complete the project (Apply)

CO5: Apply quality tools to detect and rectify the failures in the process/products (Apply)

CO-PO MAPPING:

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	2	-	2
CO2	2	1	-	-	-	-	-	-	-	-	-	2	-	2
CO3	3	2	1	1	-	-	-	-	-	-	-	2	-	2
CO4	3	2	1	1	-	-	-	-	-	-	-	2	-	2
CO5	3	2	1	1	2	-	-	-	-	-	-	2	-	3

SYLLABUS:
UNIT I INTRODUCTION TO WORK MEASUREMENT AND PLANT LAYOUT 9

Industrial Engineering Principles – Concepts and Evaluation – Importance – Elements and Tools – Method study – Micro motion and memo motion study – work measurement – Techniques of work measurement – Time study – Plant Layout – Facility design and factors

UNIT II LEAN AND SIX SIGMA 9

Conventional Manufacturing Versus Lean Manufacturing – Principles and elements of Lean Manufacturing – 5S – Kanban – Kaizen – Value stream Mapping – PDCA Cycle. TPM – Pillars of

TPM. TQM Principles and implementation

UNIT III LOGISTICS, SUPPLY CHAIN AND INVENTORY MODELS 9

Logistics and Supply chain Management – Definition– Evaluation and importance– Procurement– Modes of Transportation – Packing and Packaging – Storage and Warehouse Management – Inventory models – Economic order quantity models – ABC analysis – Elements of JIT Systems

UNIT IV PROJECT NETWORK 9

Networks models – Shortest route – Minimal spanning tree – Maximum flow models –Project network – CPM and PERT networks – Critical path scheduling – Sequencing models

UNIT V PROCESS CAPABILITY AND SIX SIGMA 9

Process Capability studies – Seven QC Tools – FMEA – Design and Process FMEA six Sigma – Concepts – Methodology – Applications in manufacturing and service sectors

Contact Periods:

Lecture: 45 Periods Tutorial: Practical: – Periods Project – Periods
Total 45 Periods

TEXT BOOKS:

1. Martand Telsang, "Industrial Engineering and Production Management", 1st edition, S. Chand and Company, 2000
2. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th edition, First Indian Edition, Cengage Learning, 2012

REFERENCES:

1. Jain. K.C. & Aggarwal. L.N., "Production Planning Control and Industrial Management", Khanna Publishers, 2000
2. Upendra Kachru, "Production and Operations Management, text and cases", 1st edition, Excel books, 2007
3. Michael L. George, David Rowlands, Bill Kastle, What is Lean Six Sigma, McGraw Hill, 2003
4. Adam, E. E., Jr., & Swamidass, P. M. (1989). Assessing operations management from a strategic perspective. Journal of Management

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	
Total				40	
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

SEMESTER VI

U21ME601	FINITE ELEMENT ANALYSIS	Category: PCC				
		L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- U21ME305 - Mechanics of Solids
- U21MA404 - Statistics and Numerical Methods

COURSE OBJECTIVES:

- To introduce the concept of Mathematical Modelling for engineering problems
- To appreciate the use of FEM to a range of variable problems
- To impart the applications of FEM in heat transfer and fluid mechanics problems

COURSE OUTCOMES:

Upon completion of the course, the student will be able to Apply

CO1: Solve a mathematical model using the concepts of weighted residuals and boundary value problems. (Apply)

CO2: Apply the basic finite element equations for one dimensional structural and vibrational problems (Analyze)

CO3: Formulate the finite element equations for two-dimensional elements scalar problems (Analyze)

CO4: Interpret the finite element equations for 2D plane stress, plane strain and axisymmetric problems (Analyze)

CO5: Solve 1D and 2D heat transfer, fluid mechanics and isoparametric element problems (Analyze)

CO-PO MAPPING:

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	-	-	-	-	2	-
CO2	3	3	2	2	-	-	-	-	-	-	-	-	3	-
CO3	3	3	2	2	-	-	-	-	-	-	-	-	3	-
CO4	3	3	2	2	-	-	-	-	-	-	-	-	3	-
CO5	3	3	2	2	-	2	1	-	-	-	-	-	3	-

SYLLABUS:**UNIT I INTRODUCTION TO FEA****9**

Historical background – Mathematical modelling of field problems in engineering – Governing equations – Discrete and continuous models – Introduction to boundary, initial and eigen value problems – Weighted residual methods – Variational formulation of boundary value problems – Ritz technique – Basic concepts of the FEM

UNIT II ONE DIMENSIONAL FINITE ELEMENT ANALYSIS 9

One Dimensional second order equations – Discretization – Element types – Linear and higher order elements – Shape functions – Stiffness matrices and force vectors – Assembly of matrices – Solution of problems from solid mechanics Vibrational problems – Equations of motion based on weak form –Longitudinal vibration of bars –Transverse vibration of beams – Consistent mass matrices – Element equations – Solution of eigen value problems – Vector iteration methods – Normal modes – Transient vibrations

UNIT III TWO – DIMENSIONAL SCALAR VARIABLE PROBLEMS 9

Second order 2D equations involving scalar variable functions – Variational formulation – Finite element formulation – Triangular elements – Shape functions, element matrices and vectors. Application to field problems – Thermal problems – Quadrilateral elements

UNIT IV TWO – DIMENSIONAL VECTOR VARIABLE PROBLEMS 9

Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces & temperature effects – Stress calculations

UNIT V APPLICATIONS OF HEAT TRANSFER & FLUID MECHANICS USING FEA 9

One dimensional heat transfer element – Application to one-dimensional heat transfer problems – scalar variable problems in 2D – Applications to heat transfer in 2D – Application of problems in fluid mechanics in 2D Introduction to Iso – Parametric formulation

Contact Periods:

Lecture:	45 Periods	Tutorial:	– Periods	Practical:	– Periods	Project	– Periods
							Total 45 Periods

TEXT BOOKS:

1. Reddy.J.N., “An Introduction to the Finite Element Method”, 3rd edition, Tata McGraw Hill,2016
2. Seshu, P, “Text Book of Finite Element Analysis”, Prentice Hall of India,2017

REFERENCES:

1. Rao, S.S., “The Finite Element Method in Engineering”,3rd edition, Butter worth Heinemann,2018
2. Chandrupatla & Belagundu, “Introduction to Finite Elements in Engineering”,3rd edition, Prentice Hall College Div,2019
3. Cook, Robert.D., Plesha, Michael.E & Witt, Robert.J.“Concepts and Applications of Finite Element Analysis”, Wiley Student Edition,2012

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60		
Total				40	
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

SEMESTER V

U21ME503	FUNDAMENTALS OF AUTOMATION	Category: PCC				
		L	T	P	J	C
		2	0	0	2	3

PRE-REQUISITES:

- U21EEG02 – Basics of Electrical Engineering
- U21ECG04 – Basics of Electronics Engineering
- U21ME404 – Sensors and Transducers

COURSE OBJECTIVES:

- To understand the necessity of automation in industries
- To learn the drives and actuators used in an automation environment
- To apply the concepts of PLC and SCADA in industries

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Identify the different components of an automation system (Understand)

CO2: Illustrate hydraulic and pneumatic sequencing circuits (Understand)

CO3: Interface the given I/O device with an appropriate PLC module (Understand)

CO4: Develop PLC programs using ladder logic and other programming languages for industrial automation applications. (Apply)

CO5: Implement SCADA systems by interfacing with PLCs for monitoring and control applications. (Apply)

CO-PO MAPPING:

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	2	3	1	-	3	-
CO2	2	1	-	-	-	-	-	-	2	3	1	-	3	-
CO3	2	1	-	-	-	1	-	-	2	3	1	-	3	-
CO4	3	2	1	1	2	1	-	-	2	3	1	-	3	-
CO5	3	2	1	1	1	1	-	-	-	-	-	-	3	-

SYLLABUS:**UNIT I INTRODUCTION TO AUTOMATION****6**

Needs and benefits of Industrial Automation – Automation Hierarchy – Basic Components of Automation System – Description of each component – Types of Automation System Fixed Programmable – Flexible – Different systems for Industrial Automation PMC – SCADA – HMI – DCS – Drives

UNIT II HYDRAULICS AND PNEUMATICS**6**

Hydraulic Actuators: Types and Construction of Cylinders, Cushioning – Flow Control and Pressure Control Valves – Pneumatic Properties of Air – Perfect Gas Laws – Compressor – FRL Unit – Quick Exhaust Valves and Pneumatic Actuators – Electro Pneumatic Systems – Elements – Ladder Diagrams

UNIT III PLC FUNDAMENTALS**6**

Building Blocks of PLC: CPU, Memory organization, Input–output modules (discrete and analog), Special I/O Modules – Power Supply – Fixed and Modular PLC – their types – Redundancy in PLC modules – I/O module selection criteria – Interfacing different I/O devices with appropriate I/O modules

UNIT IV PLC PROGRAMMING AND APPLICATIONS**6**

PLC I/O addressing – PLC programming instructions: Relay type instructions: On delay off delay retentive – Counter instructions – Comparison instructions – Data handling Instructions – Arithmetic instructions – PLC programming language – Functional Block Diagram – Instruction List – Structured text – Sequential Function Chart – Ladder Programming – Simple Programming examples using ladder logic Language based on relay – Timer counter – Logical – Comparison – Arithmetic and data handling instructions – PLC based applications – Motor sequence control – Traffic light Control elevator control – Conveyor system – Stepper motor control – Reactor control

UNIT V SUPERVISORY CONTROL AND DATA ACQUISITION SYSTEM**6**

Introduction to SCADA – typical SCADA architecture/ block diagram – Benefits of SCADA – Various editors of SCADA – Interfacing SCADA system with PLC Typical connection diagram – Object linking and embedding for Process Control architecture – Steps in creating SCADA screen for simple object – Steps for linking SCADA object with PLC ladder program using OPC – Applications of SCADA: Traffic light control – Water distribution – Pipeline control

Contact Periods:

Lecture:	30 Periods	Tutorial:	– Periods	Practical	– Periods	Project	30 Periods
							:
							Total 60 Periods

J Component – Suggested projects: One micro – Project is planned to be undertaken by a student group that needs to be assigned to them in the beginning of the semester – In any case – The number of students in the group should not exceed four

The micro project could be industry application – Based internet – Based – Workshop based laboratory based or field based – Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation on it before the submission – The total duration of the micro project should not be less than 30 hours during the course, the student ought to submit micro – project by the end of the semester

A suggested list of micros – Projects is given here, similar micro–project could be added by the faculty member concerned:

- Automatic Street light controller:** Prepare a PLC based system to control the street light as per the intensity of natural light
- Automatic agriculture irrigation system:** Prepare a PLC based system to control drip irrigation
- Railway gate automation:** Prepare a PLC and SCADA based system to open or close the prototype railway gate automatically
- Home automation:** Implement the versatile automation system for home that can automate any three home appliances
- Bottle filling station:** Prepare a PLC and SCADA based system for prototype bottle filling station
- Troubleshoot a Faulty Equipment/ Kit available related to automation in any laboratory**

TEXT BOOKS:

- Frank D. Petruzella, "Programmable Logic Controllers". 5th edition, McGraw Hill, 2019
- Stuart A Boyer, "SCADA: Supervisory Control and Data Acquisition". 4th edition, International Society of Automation, 2016

REFERENCES:

1. Madhuchhanda Mitra, "Programmable Logic Controllers and Industrial Automation: An Introduction". Penram International Publishing, 2017
2. Jon Stenerson, "Industrial Automation and Process Control", 3rd edition, Pearson, 2022
3. David Bailey, Edwin Wright, "Practical SCADA for Industry", 2nd edition, Elsevier, 2003

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (Theory) (100 Marks)		Assessment II (Project) (100 Marks)			Theory Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Review I	Review II	Review III	
40	60	15	25	60	
25		25			
50					
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

SEMESTER V

U21ME501	DESIGN OF MACHINE ELEMENTS	Category: PCC				
		L	T	P	L	C
		3	0	0	0	3

PRE-REQUISITES:

- U21ME305 – Mechanics of Solids

COURSE OBJECTIVES:

- To familiarize the various steps involved in design of machine elements
- To understand the principle involved to satisfy functional and strength requirements
- To learn to use standard practices and standard data

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply the principles of stress analysis to explain the different types of stresses developed in machine members under load. (Apply)

CO2: Design shafts, keys, and couplings for power transmission systems. (Apply)

CO3: Select and design suitable bearings for mechanical applications. (Apply)

CO4: Design energy storing elements such as springs and flywheels. (Apply)

CO5: Design temporary and permanent joints for mechanical systems. (Apply)

CO-PO MAPPING:

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	-	1	-
CO2	3	2	1	1	-	-	-	-	-	-	-	-	2	1
CO3	3	2	1	1	-	-	-	-	-	-	-	-	2	1
CO4	3	3	1	1	-	-	-	-	-	-	-	-	2	2
CO5	3	3	1	1	-	-	-	-	-	-	-	-	2	2

SYLLABUS:**UNIT I STRESSES IN MACHINE MEMBERS 9**

Introduction to the design process – Factors influencing machine design – Selection of materials based on mechanical properties – Preferred numbers – Direct – Bending and Torsional stress – Impact and shock loading – Eccentric loading – Design of curved beams – Theories of failure

UNIT II DESIGN OF SHAFTS AND COUPLINGS 9

Design of shafts based on strength, rigidity and critical speed – Design of keys – Key ways and splines – Design of rigid and flexible couplings

UNIT III DESIGN OF BEARINGS 9

Sliding contact and rolling contact bearings – Design of hydrodynamics journal bearings – Selection of rolling contact bearings

UNIT IV DESIGN OF ENERGY STORING ELEMENTS 9

Design of springs: helical springs – Leaf springs – Design of flywheels considering stresses in rims and arms

UNIT V DESIGN OF TEMPORARY AND PERMANENT JOINTS

9

Threaded fasteners – Design of bolted joints including eccentric loading – Knuckle joints and Cotter joints – Design of welded joints – Design of riveted joints

Contact Periods:

Lecture: 45 Periods Tutorial: Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Bhandari V, "Design of Machine Elements", 4th edition, Tata McGraw–Hill Book Co, 2016
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett "Mechanical Engineering Design", 9th edition, Tata McGraw Hill, 2011

REFERENCES:

1. Shigley J.E and Mischke C.R., "Mechanical Engineering Design", Tata McGraw Hill, 2003
2. Bhandari V.B., "Design of Machine Elements", Tata McGraw Hill, 2007
3. Sundararajamoorthy T. V, Shanmugam. N, "Machine Design", Anuradha Publications, Chennai, 2003
4. Orthwein W, "Machine Component Design", Jaico Publishing Co, 2003
5. Ugural A.C, "Mechanical Design – An Integral Approach", McGraw Hill, 2004

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	
Total				40	
				60	
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.



SEMESTER III

U21EE304	MEASUREMENTS AND INSTRUMENTATION	Category: PCC				
		L	T	P	J	C
		2	0	2	0	3

PRE-REQUISITES:

- U21PH201: Materials Science

COURSE OBJECTIVES:

- To acquire the knowledge on measurements and instrumentation systems
- To understand the working of various electrical and electronic instruments, storage and display devices
- To apply the concept of instrumentation in sensors and transducers

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the functional elements and types of instruments (Understand)

CO2: Summarize the concept of electrical and electronic instruments (understand)

CO3: Apply various comparative methods to measure the electrical parameters (Apply)

CO4: Illustrate the working of various storage and display devices (Understand)

CO5: Infer the concept of sensors and transducers for various applications (Apply)

CO-PO MAPPING:

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1	1	1	-	1	1	1	-	1	2	-
CO2	3	1	1	1	1	-	-	1	1	1	-	1	2	-
CO3	3	1	1	1	1	-	-	1	1	1	-	1	2	-
CO4	3	1	1	1	1	-	-	1	1	1	-	1	2	-
CO5	3	1	1	1	1	-	-	1	1	1	-	1	2	-
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:

UNIT I MEASUREMENT SYSTEMS

6

Functional elements of instrument – Standards of measurements – Static and dynamic characteristics – Errors in measurement – Calibration

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UNIT II	ELECTRICAL AND ELECTRONIC INSTRUMENTS	6
Construction and working principle of moving coil and moving iron instruments – Dynamometer type wattmeter – Single phase induction type energy meter – Digital voltmeters: Integrating type, successive approximation – Instrument transformer		
UNIT III	COMPARATIVE METHOD OF MEASUREMENTS	6
DC potentiometers: Crompton's and Duo Range type – AC potentiometers – DC bridges: Wheatstone, Kelvin's double bridge – AC bridges: Maxwell and Schering bridge		
UNIT IV	STORAGE AND DISPLAY DEVICES	6
X-Y recorder – Cathode Ray Oscilloscope, Digital Storage Oscilloscope – Data loggers – Hard disk drive – Solid state drive		
UNIT V	SENSORS AND TRANSDUCERS	6
Hall effect sensors – Proximity sensors – Temperature sensors – Soil and moisture sensors – Classification of transducers – RTD, Strain gauge, LVDT, Piezoelectric, Thermoelectric – Sensor fusions		

LIST OF EXPERIMENTS (Indicative)

1. Calibration of single-phase energy meter
2. Measurement of low / medium resistance using Kelvin's double bridge / Wheat stone's bridge
3. Measurement of Capacitance and Inductance using AC bridges
4. Measurement of EMF using potentiometer
5. Measurement of temperature using sensors
6. Study of measuring instruments and storage devices

Contact Periods:

Lecture: 30 Periods	Tutorial: – Periods	Practical: 30 Periods	Project – Periods
			Total 60 Periods

TEXT BOOKS:

1. Sawhney A.K., "A Course in Electrical and Electronic Measurement and Instrumentation", 18th edition, Dhanpat Rai & Co., 2015
2. Albert D Helfrick and William D Cooper, "Modern Electronic Instrumentation and Measurement Techniques", 1st edition, Pearson India Education, 2016

REFERENCES:

1. Stout M.B., "Basic Electrical Measurements", Revised Edition, Prentice Hall of India Pvt Ltd., 2018
2. Gupta J.B., "A Course in Electronics and Electrical Measurements and Instrumentation", 14th Edition, S.K.Kataria & Sons, Delhi, 2014
3. Patranabis D., "Sensors and Transducers", 2nd edition, PHI Learning, 2013


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SEMESTER IV

U21EE401	ELECTRICAL MACHINES – II	Category: PCC				
		L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- U21EE302: Electrical Machines - I

COURSE OBJECTIVES:

- To acquire the knowledge on construction and operating principles of various AC machines
- To understand the starting and speed control of AC motors
- To apply AC motors, generators and special electrical machines for various applications

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

- CO1: Interpret the constructional details, principle and performance of alternators (Understand)
 CO2: Acquire the knowledge of synchronous motors and its applications (Understand)
 CO3: Infer the operation and performance of three phase induction motors (Understand)
 CO4: Analyze the performance characteristics of AC motors by various testing methods (Apply)
 CO5: Explain the construction and operating principles of single phase induction motors and special machines (Understand)

CO-PO MAPPING:

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	1	1	-	-	-	-	1	2	-
CO2	3	2	1	1	1	-	-	-	-	-	-	1	2	-
CO3	3	2	1	1	1	1	-	-	-	-	-	1	2	-
CO4	3	2	1	-	1	-	-	1	-	-	-	1	2	-
CO5	3	2	1	-	1	-	1	-	-	-	-	1	2	-
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:

UNIT I SYNCHRONOUS GENERATOR 9

Construction and types – EMF equation – Armature reaction – Voltage regulation – EMF and MMF methods – Parallel operation – Two reaction theory for salient pole alternator – Slip test

UNIT II SYNCHRONOUS MOTOR 9

Principle of operation – Starting methods – Torque equation – Effect of varying field current and load – V and Inverted V curves – Synchronous condenser – Hunting – Damper winding

UNIT III THREE PHASE INDUCTION MOTOR 9

Construction – Types – Principle of operation – Slip – Torque Equation – Torque-Slip characteristics – Cogging and crawling – Equivalent circuit – Power flow diagram – Losses and efficiency – No load and blocked rotor tests – Double cage induction motors – Induction generator – Submersible motor

UNIT IV STARTING AND SPEED CONTROL OF INDUCTION MOTOR

9

Starters – Types – DOL, star-delta, auto transformer and rotor resistance starter – Soft starters – Speed control – Number of poles, cascaded connection and V/f Control – Slip power recovery scheme – Braking

UNIT V SINGLE PHASE INDUCTION MOTORS AND SPECIAL MACHINES

9

Construction – Double field revolving theory – Starting methods – Capacitor start – Capacitor run induction motor – Shaded pole induction motor – Equivalent circuit – Servo motor – Stepper motor – Linear induction motor – Applications

Contact Periods:

Lecture:	45 Periods	Tutorial:	- Periods	Practical:	- Periods	Project:	- Periods
						Total:	45 Periods

TEXT BOOKS:

1. Stephen J Chapman, "Electric Machinery Fundamentals", 4th edition, McGraw - Hill Education Pvt. Ltd, 2010
2. Kothari D P and Nagrath I J, "Electric Machines", 5th edition, McGraw - Hill Publishing Company Ltd, 2017

REFERENCES:

1. Gupta B R, "Fundamental of Electric Machines" 3rd edition, New Age International Publishers, Reprint 2015.
2. Bimbhra P S, "Electrical Machinery", 2nd edition, Khanna Publishers, 2017
3. Gupta J B, "Theory and Performance of Electrical Machines", 2nd edition, S K Kataria & Sons Publishers, 2016

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER IV

U21EE402	CONTROL SYSTEMS	Category: PCC				
		L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- U21MA102: Calculus and Linear Algebra, U21EE201: Electric Circuit Analysis

COURSE OBJECTIVES:

- To impart knowledge on system modeling and response
- To understand the behavior of the system in time domain and frequency domain
- To design controllers and compensators for closed loop systems

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

- CO1: Determine the transfer function of electrical and mechanical system (Understand)
 CO2: Solve the Linear Time Invariant (LTI) systems in time domain (Apply)
 CO3: Analyze frequency response of the LTI systems using different types of plots (Apply)
 CO4: Interpret the stability of LTI systems using Routh Hurwitz criterion, Root locus and Nyquist stability criterion (Apply)
 CO5: Implement the controllers and compensators for closed loop systems (Apply)

CO-PO MAPPING:

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	1	-	-	1	1	1	-	1	2	-
CO2	3	2	2	1	1	-	-	1	1	1	-	1	2	-
CO3	3	2	2	1	1	-	-	1	1	1	-	1	2	-
CO4	3	2	2	1	1	-	-	1	1	1	-	1	2	-
CO5	3	2	2	1	1	-	-	1	1	1	-	1	2	-
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:

UNIT I SYSTEM MODELING

9

Elements – open and closed loop systems – Transfer function – Electrical systems – Mechanical systems: Translational and rotational system – Electrical analogy – Block diagram reduction – Signal flow graph

UNIT II TIME RESPONSE ANALYSIS

9

Time response - Standard test signals – order and type – Time response of first order systems – Step response of second order system – Time domain specifications – Steady state errors – Error constants


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UNIT III FREQUENCY RESPONSE ANALYSIS

9

Frequency Response – Bode plot – Polar plot – Determination of closed loop response from open loop response – Frequency domain specifications – Correlation between time and frequency domain specification

UNIT IV STABILITY ANALYSIS

9

Stability – Characteristics equation – necessary and sufficient conditions for stability – BIBO stability – Routh Hurwitz's criterion – Construction of root locus – Effect of pole-zero addition on the root locus – Relative stability – Nyquist stability criterion

UNIT V COMPENSATOR DESIGN AND CONTROLLER

9

Need for compensator and controllers – Design procedure – Lag network and lead network using bode plot – Controller – P, PI, PID controller

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods
Total 45 Periods

TEXT BOOKS:

1. Nagrath, I J., & Gopal, M, "Control Systems Engineering", 6th edition, New Age International Publishers, 2017
2. Ogata, K. "Modern Control Engineering", 5th edition, Upper Saddle River, NJ: Prentice Hall, 2015

REFERENCES:

1. Richard C. Dorf & Bishop, R H "Modern Control Systems", 13th edition, Pearson Prentice Hall, 2017
2. Nise, N S "Control Systems Engineering", 8th edition, John Wiley & Sons, 2018
3. Golnaraghi, F., & Kuo, B, "Automatic Control Systems", 1st edition, McGraw-Hill Education, 2018

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I(100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / MiniProject / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60		
Total				200	100
				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.


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SEMESTER IV

U21EE403	TRANSMISSION AND DISTRIBUTION	Category: PCC				
		L	T	P	J	C
		2	0	2	0	3

PRE-REQUISITES:

- U21EE301: Electromagnetic Theory

COURSE OBJECTIVES:

- To acquire the knowledge on electrical supply systems and performance of transmission lines
- To understand the concept of insulators, cables and performance parameters
- To apply the concepts of electrical and mechanical design for overhead lines

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Interpret the structure of electric supply and distribution system (Understand)

CO2: Determine the line parameters in overhead transmission lines (Apply)

CO3: Identify the performance of short and medium transmission lines (Apply)

CO4: Solve sag and tension of overhead line for different weather conditions (Apply)

CO5: Summarize the types of insulators and cables (Understand)

CO-PO MAPPING:

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	1	1	1	1	1	-	1	-	2
CO2	3	2	1	1	1	-	-	1	1	1	-	1	-	2
CO3	3	2	1	1	1	-	-	1	1	1	-	1	-	2
CO4	3	2	1	1	1	1	1	1	1	1	-	1	-	2
CO5	3	2	1	1	1	-	1	1	1	1	-	1	-	2
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:

UNIT I ELECTRICAL SUPPLY SYSTEM

6

Structure of power system – Operating level voltages – Generation, transmission and distribution – AC and DC distributors – Indian grids – Electricity de-regulation – DISCOMs

UNIT II ELECTRICAL DESIGN OF OVERHEAD LINES

6

Parameters of single and three phase transmission lines with single and double circuits – Resistance, Inductance and Capacitance of solid, stranded and bundled conductors – Symmetrical and unsymmetrical spacing – Skin and proximity effect

UNIT III PERFORMANCE OF TRANSMISSION LINES

6

Performance of transmission lines – Short line and medium line – Equivalent circuits, Phasor diagram, voltage regulation and transmission efficiency – Surge impedance loading, Ferranti effect

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UNIT IV MECHANICAL DESIGN OF OVERHEAD LINES

6

Line supports – Dampers – Spacers – Types of towers, tower spotting and conductor types – Corona – Critical voltages – Stress and sag calculation – Effects of wind and ice loading

UNIT V INSULATORS AND CABLES

6

Types of insulators – String efficiency – Construction of cables – Power factor and heating of cables – DC cables – Fault identification

LIST OF EXPERIMENTS (Indicative)

1. AC and DC distribution calculations – Different topology
2. Compute inductance and capacitance of a three phase transmission line parameters
3. Modeling of short and medium transmission line
4. Calculation of sag in overhead transmission line
5. Calculation of potential distribution over string insulator

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods
Total 60 Periods

TEXT BOOKS:

1. Kothari D.P. and Nagarath I.J., "Power System Engineering", 3rd edition, McGraw-Hill Publishing Company Ltd., New Delhi, 2019
2. Mehta V.K. and Rohit Mehta, "Principles of Power System", 6th edition, S.Chand, New Delhi, 2014

REFERENCES:

1. Gupta B.R., "Power System Analysis and Design", 7th revised edition, S. Chand, New Delhi, 2014
2. Gupta J.B., "Transmission and Distribution", 10th edition, S.K. Kataria & Sons, New Delhi, 2015
3. Singh S.N., "Electric Power Generation, Transmission and Distribution" 2nd edition, PHI Learning, Pvt., Ltd., 2011

EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		Assessment II (Practical) (100 Marks)		Theory Examinations (Examinations will be conducted for 100 Marks)	Practical Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test		
40	60	75	25		
25		25			
50				50	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.



SEMESTER V

U21EE501	POWER SYSTEM ANALYSIS	Category: PCC				
		L	T	P	J	C
		2	1	0	0	3

PRE-REQUISITES:

- U21EE403: Transmission and Distribution

COURSE OBJECTIVES:

- To acquire the knowledge on power systems components, power flow analysis and faults
- To understand the concept of various faults and stability analysis
- To apply the concept of fault and stability analysis for power system structures

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Model the single line diagram with per unit quantities (Understand)

CO2: Illustrate the load flow analysis using numerical methods (Understand)

CO3: Calculate the fault current in the power system under balanced condition (Apply)

CO4: Determine the fault current in the power system under unbalanced condition (Apply)

CO5: Outline the power system stability using swing equation and equal area criteria (Apply)

CO-PO MAPPING:

POs \ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	1	1	-	-	-	-	-	1	-	3
CO2	3	2	2	2	1	1	-	-	-	-	-	1	-	3
CO3	3	2	2	2	1	1	-	-	-	-	-	1	-	3
CO4	3	2	2	2	1	1	1	-	-	-	-	1	-	3
CO5	3	2	2	2	1	1	1	-	-	-	-	1	-	3
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:

UNIT I MODELING OF POWER SYSTEMS

6 + 3

Need for system planning and operational studies – Power system components – per unit quantities – p.u. impedance and reactance diagram – Primitive parameters – Construction of Y-bus and Z-bus using inspection method – Case studies

UNIT II POWER FLOW ANALYSIS

6 + 3

Classification of buses – Development of power flow model – Newton-Raphson and Gauss-Seidel load flow methods – Q-limit check for voltage-controlled buses

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UNIT III SYMMETRICAL FAULT ANALYSIS**6 + 3**

Importance of short circuit analysis – Assumptions in fault analysis – Analysis using Thevenin's theorem – Analysis using simulation tools

UNIT IV UNSYMMETRICAL FAULT ANALYSIS**6 + 3**

Symmetrical components – Sequence impedances – Sequence networks analysis of single line to ground, line to line and double line to ground faults using Thevenin's theorem and Z-bus matrix – Analysis using simulation tools

UNIT V STABILITY ANALYSIS**6 + 3**

Classification of power system stability – Swing equation – Swing curve – Power angle equation – Equal area criterion – Critical clearing angle and time – Classical step-by-step solution of swing equation

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: - Periods Project: - Periods
 Total: 45 Periods

TEXT BOOKS:

1. Nagarath I.J and Kothari D.P., "Modern Power System Analysis", 4th edition, Tata McGraw-Hill Education, 2011
2. John J. Grainger and Stevenson Jr. W.D., "Power System Analysis", 6th reprint, McGraw-Hill Education, 2010

REFERENCES:

1. Hadi Saadat, "Power System Analysis", 21st reprint, Tata McGraw-Hill Education, 2010
2. Kundur P., "Power System Stability and Control", 10th reprint, Tata McGraw-Hill Education, 2010
3. Murty P.S.R., "Power System Analysis", 2nd edition, BSP Books Pvt. Ltd, Elsevier, 2017

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60		
Total					100

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.


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SEMESTER V

U21EE502	POWER ELECTRONICS AND DRIVES	Category: PCC				
		L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- U21EE303: Analog Electronics and applications, U21EE401: Electrical Machines – II

COURSE OBJECTIVES:

- To acquire the knowledge of power semiconductor switches and its characteristics
- To understand the concept of control and working of various power converters
- To acquire the knowledge in the characteristics of electric motor drives

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

- CO1:** Describe the construction of switching devices and its characteristics (Understand)
CO2: Explain the concept of AC-DC and DC-DC power conversion techniques (Understand)
CO3: Explain the operation of inverter and AC – AC conversion techniques (Understand)
CO4: Analyze the operation of the converter/chopper fed DC drive (Understand)
CO5: Analyze the operation and performance of AC drives (Understand)

CO-PO MAPPING:

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	1	-	-	-	1	1	-	1	3	-
CO2	3	2	2	-	2	1	1	-	1	1	-	1	3	-
CO3	3	2	1	-	2	-	-	-	1	1	-	1	3	-
CO4	3	2	1	-	-	-	-	-	-	-	-	1	3	-
CO5	3	2	1	-	-	-	-	-	-	-	-	1	3	-
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:

UNIT I POWER SEMI-CONDUCTOR DEVICES

9

Semiconductor devices: SCR, TRIAC, BJT, MOSFET, IGBT – Construction and characteristics – GaN-SiC devices – Triggering – Commutation circuits – Snubber circuit

UNIT II PHASE-CONTROLLED CONVERTERS AND DC TO DC CONVERTERS

9

Single phase and three phase half and fully controlled converters – Dual converters – Choppers – Control strategy – Four quadrant operation – Buck-Boost converter – Resonant Converters

UNIT III INVERTERS AND AC TO AC CONVERTERS

9

Single phase and three phase voltage source inverters (120° and 180° mode) – PWM techniques – Current source inverter – Multilevel inverters – Phase shifting transformer – Single phase AC voltage controllers and cycloconverters

UNIT IV DC DRIVES

9

Electric drives – Equations governing motor load dynamics – Selection of motor – Single and three phase converter fed separately excited DC motor drive – Four quadrant operation of drives

UNIT V AC DRIVES

9

Stator voltage control – V/f control – Rotor resistance control – Static Scherbius drive – Self-control of synchronous motor – V3F drives – Applications

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods
Total: 45 Periods

TEXT BOOKS:

1. Rashid M.H., "Power Electronics: Circuits, Devices and Applications", 4th edition, Pearson Education, New Delhi, 2017
2. Gopal K. Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House, 2018
3. Bimal K. Bose, "Modern Power Electronics and AC Drives", Pearson Education, 2015

REFERENCES:

1. Singh M.D. and Khanchandani K.B., "Power Electronics", 2nd edition, McGraw Hill India, 2013
2. Bimbhra P.S., "Power Electronics", 6th reprint edition, Khanna Publishers, 2018
3. John Hindmarsh and Alasdain Renfrew, "Electrical Machines and Drives System", Elsevier, 2012
4. Shaahin Felizadeh, "Electric Machines and Drives", CRC Press (Taylor and Francis), 2013

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60		
Total					
				40	
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.



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**SEMESTER V**

U21EE503	MICROPROCESSOR, MICROCONTROLLER AND APPLICATIONS	Category: PCC				
		L	T	P	J	C
		2	0	2	0	3

PRE-REQUISITES:

- U21EE303: Analog Electronics and Applications

COURSE OBJECTIVES:

- To acquire the knowledge on digital processor 8085 and controller 8051
- To understand the assembly language programming, memory and peripheral interfacing with processors and controllers
- To apply the controllers and processors for various practical applications

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Describe the architecture, memory organization, interrupts and timing diagram of 8085 microprocessor (Understand)

CO2: Develop the assembly language program using mnemonics of 8085 microprocessor (Apply)

CO3: Illustrate the interfacing of 8085 with various peripheral devices (Apply)

CO4: Explain the architecture, memory organization of 8051 microcontroller (Understand)

CO5: Utilize 8051 microcontroller for real time applications (Apply)

CO-PO MAPPING:

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	-	-	-	-	2	2	-	-	2	-
CO2	3	2	2	1	-	-	-	-	2	2	-	1	2	-
CO3	3	2	2	1	-	-	-	-	2	2	-	1	2	-
CO4	3	2	2	1	-	-	-	-	2	2	-	1	2	-
CO5	3	2	2	1	-	-	-	-	2	2	-	1	2	-
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:**UNIT I 8085 PROCESSOR**

6

Evolution – Architecture of 8085 – Pin details – I/O and memory mapping – Interrupts – Machine cycles and Timing diagrams

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UNIT II PROGRAMMING WITH 8085 PROCESSOR	6
Addressing modes – Instruction format – Instruction set – Assembly Language Programs – Applications	
UNIT III PERIPHERAL INTERFACING OF 8085 MICROPROCESSOR	6
Architecture, Pin configuration and interfacing of ICs: 8255, 8259, 8254, 8279, A/D and D/A converters with 8085 microprocessor	
UNIT IV 8051 MICROCONTROLLER	6
Architecture of 8051 – Pin details – Memory Organization – I/O Ports – Timers – Serial Port – Interrupts – Timing diagrams	
UNIT V PROGRAMMING WITH 8051 CONTROLLER	6
Addressing modes – Instruction set – Assembly Language Programming – Interfacing of Relay and Sensors – KEIL IDE	

LIST OF EXPERIMENTS (Indicative)

1. Assembly Language Programs using 8085
2. ADC and DAC interfacing with 8085
3. Assembly Language Programs using 8051
4. Stepper Motor Control using 8051
5. Assembly Language Programs – KEIL IDE

Contact Periods:

Lecture: 30 Periods	Tutorial: – Periods	Practical: 30 Periods	Project	– Periods
			Total	60 Periods

TEXT BOOKS:

1. Ramesh S. Gaonkar, "Microprocessor Architecture: Programming and Applications with the 8085", Penram International Publishing, Prentice Hall of India, New Delhi, 2011
2. Muhammed Ali Mazidi, Janice Gillispie Mazidi and Rolin D. Mckinlay, "The 8051 Microcontroller and Embedded Systems", 2nd edition, Pearson Education India, New Delhi, 2011

REFERENCES:

1. Douglas V Hall, "Microprocessors and Interfacing: Programming and Hardware", 2nd edition, Tata McGraw Hill, New Delhi, 2010
2. Subrata Ghoshal, "8051 Microcontroller: Internals, Instructions, Programming and Interfacing", 2nd edition, Pearson Education India, New Delhi, 2014
3. Kenneth J Ayala, "The 8051 Microcontroller Architecture Programming and Application", 3rd edition, Penram International Publishers


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SEMESTER VI



U21EE601	PROTECTION AND SWITCHGEAR	* Category: PCC				
		L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- U21EE403: Transmission and Distribution

COURSE OBJECTIVES:

- To acquire the characteristics and functions of protective devices
- To understand the protection of apparatus using relays and circuit breakers
- To illustrate the types of relays and circuit breakers for power system protection

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Illustrate the protection schemes and its standards (Understand)

CO2: Classify the types of protective relays (Understand)

CO3: Select different types of protective schemes for alternator, transformer, bus bar, substation and motor protection (Apply)

CO4: Explain the theory of arc interruption (Apply)

CO5: Outline the circuit breaker for various applications (Understand)

CO-PO MAPPING:

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	-	1	-	-	-	-	-	1	-	3
CO2	3	1	1	-	1	1	1	-	-	-	-	1	-	3
CO3	3	2	1	-	1	1	1	-	-	-	-	1	-	3
CO4	3	2	1	-	-	1	-	-	-	-	-	1	-	3
CO5	3	1	1	-	-	1	1	-	-	-	-	1	-	3
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:

UNIT I PROTECTION SCHEMES AND STANDARDS

9

Principles and need for protective schemes – Nature, causes and types of faults – Zones of protection – Primary and backup protection – Essential qualities of protection – Classification of protection schemes – Introduction to IEC standards for earthing (TT, TN, IT) – IEC standards for MCB and MCCB

UNIT II PROTECTIVE RELAYS

9

Requirement of relays – Universal relay – Torque equation – Electromagnetic relays: Over current, Directional, Differential, Distance, Negative sequence and Frequency relays – Earth fault relays – Static and Numerical relays

UNIT III APPARATUS AND LINE PROTECTION	9
Alternator, Transformer, Bus bar, Transmission line and Motor protection schemes – Static protection of EHV lines	
UNIT IV THEORY OF CIRCUIT INTERRUPTION AND INSULATION COORDINATION	9
Principles of arc extinction – Arc control devices – DC and AC Circuit breaking – Recovery voltage and restriking voltage – Current chopping – Capacitance current breaking – Arc suppression coil – Insulation coordination – Determination of line insulation – Insulation levels of substation	
UNIT V CIRCUIT BREAKERS	9
Circuit breakers : Oil, Air break, Air blast, Sulphur hexafluoride, Vacuum – Fuses – Types – Selection – Discrimination – HVDC breakers – Rating – Testing of circuit breakers	

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods
 Total: 45 Periods

TEXT BOOKS:

1. Sunil S. Rao, "Switchgear and Protection", 13th edition, Khanna Publishers, New Delhi, 2014
2. Anderson P.M., "Power System Protection", 1st edition, A John Wiley and Sons Inc., Publication, 2014

REFERENCES:

1. Badri Ram and Vishwakarma B.H., "Power System Protection and Switchgear", 2nd edition, New Age International Pvt. Ltd., 2011
2. Paithankar Y.G. and Bhide S.R., "Fundamentals of power system protection", 2nd edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2010
3. Wadhwa C.L., "Electrical Power Systems", 6th edition, New Age International Pvt. Ltd., 2010
4. <https://archive.nptel.ac.in/courses/108/107/108107167/>

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200*	
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course


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SEMESTER VI

U21EE605	EMBEDDED SYSTEM DESIGN LABORATORY	Category: PCC				
		L	T	P	J	C
		0	0	2	2	2

PRE-REQUISITES:

- U21EE503: Microprocessor, Microcontroller and Applications

COURSE OBJECTIVES:

- To develop assembly language program using ARM instruction set
- To understand the interfacing devices with ARM board
- To configure ARM Board and transmit data to PC

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

- CO1: Explain ARM instruction set and gain the knowledge how assembly language works (Understand)
- CO2: Develop and implement the program written in ARM assembly language instructions Apply)
- CO3: Acquire knowledge about devices and buses used in embedded systems (Understand)
- CO4: Understand the functioning of hardware devices and interfacing them with ARM board (Understand)
- CO5: Conduct and test on STM32 evaluation board using software tool/compiler (Apply)

CO-PO MAPPING:

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	-	-	1	2	2	-	1	2	-
CO2	3	2	1	1	1	-	-	1	2	2	-	1	2	-
CO3	3	2	1	1	1	-	-	1	2	2	-	1	2	-
CO4	3	2	1	1	1	-	-	1	2	2	-	1	2	-
CO5	3	2	1	1	1	-	-	1	2	2	-	1	2	-
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

LIST OF EXPERIMENTS

1. Installation of software for embedded development, troubleshooting issues, installing packages
2. STM32 GPIO peripheral programming
 - a. LEDs, Buttons
 - b. Using GPIO interrupts to respond to user button press
3. Configuration of clock system to generate different peripheral and system frequency
4. Configuration of UART in polling method to send data from STM32 MCU to PC

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5. Interface audio sensor to STM32 board using ADC
6. Design of a coherent sensor signal sampling methodology to implement a data logger

Project:

Implementation of Embedded processor/controller for real time application

Contact Period:

Lecture: – Periods Tutorial: – Periods Practical: 30 Periods Project: 30 Periods
 Total: 60 Periods

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (Practical) (100 Marks)		Assessment II (Project) (100 Marks)			Practical Examinations (Examinations will be conducted for 100 Marks)
Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test	Review I	Review II	Review III	
75	25	15	25	60	
25		25			
					50
50					50
Total: 100					



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SEMESTER IV

U21BM401	MICROBIOLOGY AND PATHOLOGY	Category: PCC				
		L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- U21BM301 - Human Anatomy and Physiology

COURSE OBJECTIVES:

- To familiarize with the basics of cell culture, staining and smearing
- To identify the morphology of microorganisms
- To explore the different diseases and disorders

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Perform staining procedure and identify the growth of microorganism in a given culture (Understand)

CO2: Outline the structure and morphology of microorganisms (Apply)

CO3: Explain the cause and pathogenesis of disease (Understand)

CO4: Outline the pathophysiology of disorders and compare the relation among disorders (Understand)

CO5: Characterize the hormonal disease and explain the metabolic effect of cancer (Understand)

CO-PO MAPPING:

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	3	1	-
CO2	2	-	-	-	-	-	-	-	-	-	-	-	1	-
CO3	2	-	-	-	-	-	-	-	-	-	-	2	1	-
CO4	2	-	-	-	-	-	-	-	-	-	-	2	1	-
CO5	2	-	-	-	-	-	-	-	-	-	-	2	-	-
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:**UNIT I INTRODUCTION TO MICROBIOLOGY 9**

Microscopy – Light microscope – Phase contrast and Electron microscopes – Sterilization techniques – Culture methods – Isolation and maintenance – Culture media – Selective and enrichment media – Staining techniques – Acid-fast staining – Growth curve and generation time

UNIT II MORPHOLOGICAL STUDIES 9

Fr Morphology, structure and classification: bacteria and virus – Pathogenesis and pathology of viral infections – Routes of infection and spread – Endogenous and exogenous infections – Plaque assay – T4 Phages and lambda stages

UNIT III IMMUNOPATHOLOGY 9

Normal human microflora – Host – Parasitic interaction – Exo and Endotoxins – Natural and artificial immunity – Auto-immune disorders – Antigen and antibody reactions – Immunological techniques: immune diffusion, immuno electrophoresis, RIA and ELISA, Monoclonal antibodies

UNIT IV DISORDERS OF KIDNEY AND PLASMA PROTEINS 9

Acute and chronic renal failure – Proteinuria and nephritic syndrome – Acute and chronic liver failure
Hypoalbuminaemia – Hypogammaglobulinaemia – Hypergammaglobulinaemia

UNIT V DISORDERS OF HORMONES AND METABOLIC ASPECTS OF CANCER 9

Congenital adrenal hyperplasia – Hyperthyroidism – Hypothyroidism – Pathogenesis of cancer – Tumour markers – α -Fetoprotein (AFP) – Carcinoembryonic antigen (CEA) – Para proteins – Enzymes as tumour markers and Carbohydrate antigen (CA) markers

Contact Periods:

Lecture: 45 Periods	Tutorial: - Periods	Practical: – Periods	Project – Periods
			Total 45 Periods

TEXT BOOKS:

1. Ramzi S Cotran, Vinay Kumar & Stanley L Robbins, "Pathologic Basis of Diseases", 7th Edition, WB, Saunders Co. 2015
2. Ananthanarayanan and Panicker, "Textbook of Microbiology", 10th Edition, Orient blackswan, 2017

REFERENCES:

1. Prescott, Harley and Klein, "Microbiology", 10th Edition, McGraw Hill, 2017

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60		
Total					
				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

SEMESTER VI

U21BM601	DIAGNOSTIC AND THERAPEUTIC EQUIPMENT	Category: PCC				
		L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- U21BM302 - Biomedical Sensors and Instrumentation

COURSE OBJECTIVES:

- To infer the working of devices for diagnosis and treatment of cardiac and neuro emergency
- To explain the techniques used for the analysis and support of respiratory action and waste removal
- To interpret the various sensory measurements and imaging techniques that hold clinical importance

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Illustrate the working of equipment used for cardio and neuro care (Understand)

CO2: Explore equipment used for analysis and support of muscular and neurological equipment (Understand)

CO3: Illustrate the methods to measure the parameters related to respiratory and urinary system failure (Apply)

CO4: Describe the measurement techniques of sensory responses (Understand)

CO5: Summarize the principle of ultrasonic, thermography and its applications in medicine (Understand)

CO-PO MAPPING:

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	-	-	2	-	-	-	-	-	3	-
CO2	3	2	1	2	-	-	2	-	-	-	-	-	3	-
CO3	2	2	2	2	3	-	2	-	-	-	-	-	3	-
CO4	3	2	3	2	-	-	2	-	-	-	-	-	3	-
CO5	3	2	1	2	-	-	-	-	-	-	-	-	3	-
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:**UNIT I CARDIAC AND NEUROLOGICAL EQUIPMENT****9**

Heart rate monitor – Holter monitor – Pacemaker – Defibrillator – Evoked Potential – Visual auditory and somatosensory – MEG (Magneto Encephalogram) – Brain stimulation treatment – Biotelemetry

UNIT II MUSCULAR AND BIOMECHANICAL EQUIPMENT**9**

Recording and analysis of EMG waveforms – Fatigue characteristics – Muscle stimulators – Nerve stimulators – Nerve conduction velocity measurement – EMG bio feedback instrumentation- Diathermy – Electrosurgical equipment – Cryotherapy – Static measurement – Load Cell – Pedobarograph – Dynamic measurement – Velocity – Acceleration – Gait

UNIT III RESPIRATORY AND UROLOGY EQUIPMENT 9

Spirometer – Pneumotachometer – Whole body Plethysmograph – Intra alveolar and thoracic pressure measurements – Apnoea Monitor – Ventilator modes and working – Heart lung machine – working – Haemodialysis – Peritoneal dialysis – Principle and equipment

UNIT IV SENSORY EQUIPMENT 9

Psychophysiological Measurements – Polygraph – Basal skin resistance (BSR) – Galvanic skin resistance (GSR) – Sensory responses – Audiometer – Pure tone – Speech – Eye Tonometer – Applanation Tonometer – Hearing aids

UNIT V ULTRASONIC AND THERMOGRAPHY TECHNIQUE 9

Tissue Reaction – Application of ultrasound as diagnostic tool – Cardiology – Obstetrics and Gynaecology – Ophthalmology – Thermography – Recording and clinical application

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods
Total: 45 Periods

TEXT BOOKS:

1. John G Webster, "Medical Instrumentation Application and Design", 4th Edition, Wiley India Pvt Ltd, 2015
2. Joseph J Carr and John M Brown, "Introduction to Biomedical Equipment Technology", 2nd Edition, Pearson education, 2012

REFERENCES:

1. Myer Kutz, "Standard Handbook of Biomedical Engineering and Design", 2nd Edition, McGraw Hill, 2003
2. Khandpur R S, "Handbook of Biomedical Instrumentation", 3rd Edition, Tata McGraw-Hill, 2014
3. Geddes LA and Baker LE, "Principles of Applied Biomedical Instrumentation", 3rd Edition, Tata McGraw Hill, 2008
4. Leslie Cromwell, Fred J Weibell, Erich A Pfeiffer, "Biomedical Instrumentation and Measurement", 2nd Edition, Prentice Hall of India, 2015

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

SEMESTER VII

U21BM707	REHABILITATION ENGINEERING	Category: PCC				
		L	T	P	J	C
		3	0	2	0	4

PRE-REQUISITES:

- U21BM301 – Human Anatomy and Physiology
- U21BM603 – Biomechanics

COURSE OBJECTIVES:

- To identify the engineering concepts that can be applied in rehabilitation medicine and the role of engineers in various rehabilitation disciplines
- To illustrate the different types of therapeutic exercise technique
- To interpret the various orthotic devices and prosthetic devices to overcome orthopedic problems

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Summarize the principles of rehabilitation system (Understand)

CO2: Identify various exercises involved in rehabilitation process (Apply)

CO3: Analyze rehabilitation management in communication (Analyze)

CO4: Apply restoration techniques in rehabilitation (Apply)

CO5: Contrast the effectiveness of rehabilitation (Analyze)

CO-PO MAPPING:

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	-	-	1	-	-	-	-	-	1	1	-
CO2	3	2	1	-	-	1	-	-	-	-	-	1	1	1
CO3	3	2	1	-	1	1	-	-	-	-	-	1	1	-
CO4	3	2	2	-	1	-	-	-	-	-	-	1	1	1
CO5	3	2	3	-	1	1	-	-	-	-	-	1	1	1
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:**UNIT I PRINCIPLE OF REHABILITATION ENGINEERING****6**

Introduction to rehabilitation – Epidemiology of rehabilitation – Health – Levels of prevention – Preventive rehabilitation – Diagnosis of disability – Functional diagnosis – Importance of psychiatry in functional diagnosis – Impairment – disability – handicap – Primary and secondary disabilities – Clinical practice of rehabilitation engineering – Design based on human ability

UNIT II THERAPEUTIC EXERCISE TECHNIQUE**6**

Co-ordination exercises – Frenkels exercises – Relaxation exercises – Strengthening exercises – Types of contraction – Mobilization exercises – Endurance exercises

UNIT III MANAGEMENT OF COMMUNICATION**6**

Impairment – Aphasia – Types of aphasia – Treatment of aphasic patient – Augmentative communication – General form of communication – Types of visual aids – Hearing aids

UNIT IV ORTHOTIC, PROSTHETIC DEVICES AND RESTORATION TECHNIQUES**6**

General orthotics – Classification of orthotics – Functional and regional General principles of orthosis – Calipers – FO – AFO – KAFO – HAFO – Body powered prosthetics – Myoelectric controlled prosthetics – Functional electrical stimulation systems – Restoration of hand function – Restoration of standing and walking

UNIT V CASE STUDY**6**

Geriatric Rehabilitation – Visual and auditory challenges faced by geriatrics and methods to overcome those challenges– Pediatric rehabilitation – Visual and auditory challenges faced by cerebral palsy – Muscular dystrophy and autism children – Methods to overcome those challenges

LIST OF EXPERIMENTS (INDICATIVE)

1. Analyze lateral trunk control using rehametrics.
2. Observe the cognitive analysis on dynamic and static balance.
3. Real time monitoring of shoulder range of motion.
4. Record the anteroposterior centre of mass displacement.
5. Design, development and interfacing of EMG controlled prosthetics / bionic arm.
6. Study of hip flexion and adduction.

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods
Total: 60 Periods

TEXT BOOKS:

1. S Sunder, "Textbook of Rehabilitation", 4th Edition, Jaypee Brothers Medical Publishers private limited, New Delhi, 2019
2. Joseph D. Bronzino, "The Biomedical Engineering Handbook", 3rd Edition, Taylor and Francis, 3 volume set, 2006

REFERENCES:

1. Rory A. Cooper, Hisaichi Ohnabe and Douglas A. Hodson, "An Introduction to Rehabilitation Engineering", 1st Edition, CRC Press, 2014
2. Marion A. Hersh and Michael A. Johnson, "Assistive Technology for Visually impaired and blind people", 1st Edition, Springer Verlag, 2014

EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		Assessment II (Practical) (100 Marks)		Theory Examinations (Examinations will be conducted for 100 Marks)	Practical Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test		
40	60	75	25		
25		25			
50				50	

SEMESTER IV

U21CE402	APPLIED HYDRAULICS AND HYDRAULIC MACHINERY	Category: PCC				
		L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- U21CE302: Fluid Mechanics

COURSE OBJECTIVES:

- To study various hydraulic engineering problems like open channel flows and hydraulic machineries
- To learn the fundamentals of uniform and non-uniform flow in open channel
- To impart the knowledge on various types of turbines and pumps

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Design a most economical section of various channels in uniform flow (Apply)

CO2: Summarize the concept of gradually varied flows in steady state conditions (Apply)

CO3: Solve non-uniform flow problems and hydraulic jump phenomenon in open channel flow (Apply)

CO4: Design and study the performance of various types of turbines (Apply)

CO5: Design and select pumps for different hydraulic applications (Apply)

CO-PO MAPPING:

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	-	-	-	1	-	-	1	-	2	3	-
CO2	3	3	2	-	-	-	1	-	-	1	-	2	3	-
CO3	3	3	2	-	-	-	1	-	-	1	-	2	3	-
CO4	3	3	2	-	-	-	1	-	-	1	-	2	3	-
CO5	3	3	2	-	-	-	1	-	-	1	-	2	3	-
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:

UNIT I OPEN CHANNEL FLOW

9

Open channel flow: Definition, classification – Chezy's and Manning's equation – Flow through rectangular, Trapezoidal and Circular channels – Hydraulically most efficient channel section – Specific energy and specific force

UNIT II GRADUALLY VARIED FLOW

9

Nonuniform flow – Dynamic equation for gradually varied flow – Flow profiles in prismatic channels – Direct and standard step method – Computation of the length of the backwater curve and afflux

UNIT III RAPIDLY VARIED FLOW

9

Rapidly Varied Flow – Applications of momentum equation for RVF – Hydraulic Jump – Types – Rapidly varied unsteady flows (positive and negative surges)

UNIT IV TURBINES

9

Impact of Jet on flat and curved plates – Classification of Turbines – Pelton wheel – Francis turbine – Kaplan turbine – Specific Turbines – Characteristic Curves of turbine

UNIT V PUMPS

9

Classification of Pumps – Centrifugal pump – Work done – Minimum speed to start the pump – NPSH Multistage pump – Characteristic Curves – Reciprocating pump – Negative slip

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods
 Total 45 Periods

TEXT BOOKS:

1. Chandramouli P.N., "Applied Hydraulic Engineering", 2nd edition Yes Dee Publishing Pvt. Ltd., 2017
2. Modi P.N and Seth., "Hydraulics and Fluid Mechanics including Hydraulic Machines", 7th edition Standard Book House New Delhi, 2018
3. Subramanya K., "Flow in open channels", 2nd edition Tata McGraw Hill, New Delhi, 2019

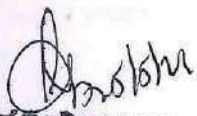
REFERENCES:

1. Bansal, R.K., "Fluid Mechanics and Hydraulics Machines", 5th edition, Laxmi Publications Pvt. Ltd, New Delhi, 2019
2. Ven Te Chow., "Open Channel Hydraulics", 2nd edition, McGraw Hill, New York, 2009
3. Ramamrutham, S., "Hydraulics, Fluid Mechanics and Fluid Machines", 4th edition, Dhanpat Rai and Sons, Delhi, 2011
4. Rajput, R. K., "A Text Book of Fluid Mechanics and hydraulic Machines", 5th edition, S. Chand & Co., New Delhi, 2015

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations	
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments		
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test			
40	60	40	60			
Total					200	100
					40	60
					100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided.


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U21CE503	ENVIRONMENTAL ENGINEERING I	Category: PCC				
		L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To learn the process of water supply and distribution
- To explore the various water treatment techniques
- To gain the knowledge on planning and implementation of water supply projects

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Calculate the water demand for a water supply project (Apply)

CO2: Perform the tests on water quality parameters (Apply)

CO3: Design the water treatment units (Apply)

CO4: Identify the various techniques in advanced water treatment methods (Understand)

CO5: Plan the water supply for a city (Apply)

CO-PO MAPPING:

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	2	-	-	1	1	1	-	-	-	1	-	1
CO2	-	-	2	-	2	1	1	1	-	-	-	-	-	-
CO3	2	-	2	-	-	1	1	1	-	1	-	1	-	1
CO4	-	-	-	-	-	1	1	-	-	-	-	-	-	-
CO5	1	-	2	-	-	1	1	-	-	-	1	1	-	1
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:

UNIT I WATER DEMAND AND CONVEYANCE SYSTEM

9

Water demand – design period – population forecasting methods. sources of water – hydrological concepts – ground water and its development. Conveyance of water – intake structures. pipe materials – corrosion – laying of pipes – pipe appurtenances.

UNIT II CHARACTERISTICS OF WATER

9

Physical, Chemical and Microbiological quality parameters. Drinking water quality criteria and standards. conventional contaminants and emerging contaminants – Impact on human health and Environment

UNIT III CONVENTIONAL TREATMENT UNITS AND DESIGN

9

Process, Mechanism and Design of conventional treatment units: Aeration, Screening, Sedimentation, Coagulation and Flocculation, Filtration and Disinfection

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UNIT IV ADVANCED TREATMENT UNITS

9

Process and Mechanism of an advanced treatment units: Water softening, Adsorption and Ion exchange processes, Electro coagulation, Desalination, Membrane filtration, Reverse osmosis, Electrodialysis, Treatment of specific contaminants: Fluoride, Nitrate, Iron, Manganese and Arsenic etc.

UNIT V PLANNING AND MAINTENANCE OF WATER SUPPLY PROJECTS

9

Water distribution system – House service connection – storage reservoirs – plumbing system in a building. Planning: rural, urban and metropolitan water supply project and its implementation. Operation and maintenance: water supply to buildings, rural, urban and metropolitan

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: 0 Periods Project - Periods
 Total 45 Periods

TEXT BOOKS:

1. Garg, S.K. "Water Supply Engineering", Vol. 24th edition, Khanna Publishers, New Delhi, 2021
2. Punmia, B. C., Ashok Jain and Arun Jain, "Water Supply Engineering", 18th edition, Laxmi Publications (P) Ltd., New Delhi, 2014

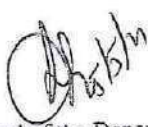
REFERENCES:

1. "Manual on Water Supply and Treatment", CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1999

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60		
Total					200
					40
					60
					100

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided.


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SEMESTER VI

U21CE601	ENVIRONMENTAL ENGINEERING II	Category: PCC				
		L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- U21CE503: Environmental Engineering I

COURSE OBJECTIVES:

- To provide Knowledge of sources and flow rates of wastewater and characteristics of Municipal waste water
- To introduce new developments in the field of waste water treatment
- To prepare students for higher studies and research in the field of wastewater treatment technology

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Outline the quality and quantity of wastewater (Apply)

CO2: Design the primary wastewater treatment technologies (Apply)

CO3: Design the secondary wastewater treatment technologies (Apply)

CO4: Infer decentralized wastewater treatment approach for sustainability (Apply)

CO5: Perform the sludge treatment (Apply)

CO-PO MAPPING:

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	1	2	-	-	2	2	1	-	-	-	-	-	-
CO2	1	2	2	-	-	2	2	1	-	1	-	2	-	1
CO3	1	2	2	-	1	2	2	1	-	1	-	-	-	1
CO4	1	2	2	-	1	2	2	1	-	1	-	2	-	1
CO5	-	1	1	-	-	2	2	1	-	-	-	-	-	-
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:

UNIT I INTRODUCTION OF WASTE WATER

9

Components of Wastewater Flows – Wastewater Sources & Flow rate – Variations in Flow rates & Strength – Characteristics of Wastewater – Quantity of Wastewater, review of sewer design considerations – Minimum Size of Sewer – Limiting Velocities – Peak Factor Sewage Pumping, Location, Capacity, Pumping Station Design.

UNIT II PRIMARY TREATMENT OF WASTEWATER

9

Physical Unit Operations – Functions and design – Screening, Grit Removal, Oil & Grease Removal, Primary Sedimentation tanks and its types – Construction, operation and maintenance of treatment units

UNIT III SECONDARY TREATMENT OF WASTEWATER

9

Microbial Growth Processes – Suspended & Attached processes – Activated Sludge Process –

Trickling Filters, Secondary Clarification tank – Aerated Lagoons – Oxidation Ditch – Anaerobic Lagoons – UASB – Septic Tank – Anaerobic Baffled Reactor.

UNIT IV DISPOSAL OF WASTE WATER AND DECENTRALIZED WASTEWATER TREATMENT

9

Standards for Disposal – Methods – dilution – Self-purification of surface water bodies – Oxygen sag curve – Streeter Phelps Model – Stream Classification – Effluent Standards for Discharge into Surface Water & on Land. Concept of decentralized wastewater treatment systems – Case studies with sustainability approaches.

UNIT V SLUDGE TREATMENT

9

Solid Sources – Characteristics & Quantities – Sludge Pumping – Introduction to mass balance approach – Treatment – Thickening – Stabilization – Design of Sludge Digester – Conditioning, Dewatering, Drying, Ultimate Disposal of Sludge Solids – Treatment of waste water using Nanotechnology.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: 0 Periods
Total: 45 Periods

TEXT BOOKS:

1. Modi, P. N., "Sewage Treatment and Disposal & Waste Water Engineering", Vol II., 23rd edition, Standard book house since 1960, Revised edition January 2020.
2. Santosh kumar Garg, "Sewage Waste Disposal and Air Pollution Engineering - Environmental Engineering" (Volume – 2), 18th edition, Khanna Publishers, 2021 Edition.
3. Manual on sewerage and sewage Treatment (Second Edition) prepared by the expert committee, constituted by the Government of India, Central Public Health, and Environmental Engineering Organization (CPHEEO), Ministry of Urban Development, New Delhi, December 1993.

REFERENCES:

1. Metcalf & Eddy, "Wastewater Engineering: Treatment and Reuse", 4th Edition, Tata McGraw Hill (2nd Edition), year 2012, (ISBN: 0070495394 / 9780070495395).
2. Peavey, H.S. Rowe, D.R., and Tchobanoglous, "Environmental Engineering", 2nd edition, McGraw-Hill 46 Book Company, Revised edition January 2020.

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided.


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