Evaluation Reforms NEP 2020

2nd Year Bachelor of Engineering

Multidisciplinary Minor-1 (Sem.-4) Syllabus

Shroff S R Rotary Institute of Chemical Technology,

Ankleshwar

EFFECTIVE FROM A.Y. 2026-2027

Multidisciplinary Minor - I (Semester – IV)

Multidisciplinary Minor (MDC-1)

Sr.	Course code	MDC-1 (Semester-4)	Minors (Certification)	Offered by (Department of)
1	BCHMD451	Introduction to Industrial Safety	Industrial Safety	Chemical Engineering
2	BMEMD451	Boiler and Steam Utility Systems	Mechanical Aspects of Process Utilities	Mechanical Engineering
3	BEVMD451	Introduction to Environmental Management	Environmental Management	Environmental Science & Technology
4	BCOMD451	Fundamentals of Data Science	Data Science	Computer Engineering
5	BITMD451	Fundamentals of Cloud and Virtualization	Cloud computing	Information Technology
6	BEEMD451	Basics of Measuring Instruments	Industrial Instrumentation and Automation	Electrical Engineering
7	BPTMD451	Pharmaceutical Analysis	Pharmaceutical Technology	Pharmaceutical Technology
8	BGCMD451	Fundamentals of Materials Science and Engineering	Ceramics Engineering	Glass & Ceramics Technology
9	BDPMD451	Introduction to Paint and Coating Technology	Paint Technology	Dyes & Pigments Technology
10	BPRMD451	Chemistry of Polymers	Polymer Science and Engineering	Polymer & Rubber Technology

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Shroff S R Rotary Institute of Chemical Technology
B.E. Semester IV (MDC-1)
Introduction to Industrial Safety (BCHMD451)

Teaching Scheme (Hrs./week)				Credit	Examination Scheme				
L	T	P	Total		SEE	CCE	I/TW	V	Total
3	1	0	4	4	50	50	25	25	150

COURSE OVERVIEW:

Industrial safety is an essential aspect of engineering practice to ensure safe working environments and prevent accidents in industrial operations. This course introduces the basic concepts of industrial safety, including workplace hazards, risk awareness, and safety culture across different types of industries. It covers topics such as fire and explosion safety, electrical and mechanical safety, personal protective equipment, and occupational health and hygiene. Students will develop an understanding of safe work practices, safety management principles, and the responsibilities of engineers in maintaining safe and sustainable industrial environments.

COURSE CONTENT

Sr. No.	Topics	COs	Hrs. (45)
	SECTION-A		
1	**Introduction to Industrial Safety:** Importance of safety in industries, Types of industries (chemical, mechanical, electrical, construction), Basic safety terminology: hazard, risk, accident, near miss Causes of industrial accidents, Introduction to safety culture, Overview of major accidents.	1	7
2	**Workplace Hazards and Safety Measures:** Types of hazards: Physical (noise, vibration, temperature) Chemical (toxic, flammable) Electrical hazards Mechanical Hazards Personal Protective Equipment (PPE), Safety signs and symbols, Safe work practices, work permits. LOTO.	2	8
3	**Fire and Explosion Safety:** Fire triangle and fire tetrahedron Types of fire, Fire extinguishers and their use, Basics of explosion (simple understanding), types of explosion, explosion and fire mitigation.	3	8
	SECTION-B		
4	**Electrical and Mechanical safety:** Basic electrical hazards (shock, arc flash, short circuit), Causes of electrical accidents, Safe use of electrical equipment, earthing and grounding (basic concept) Hazards from moving machinery (rotating parts, cutting tools), Machine guarding (types and importance), Safe operation of machines (lathe, drilling, milling – basic awareness), Conveyor and material handling safety.	4	7

5	**Introduction to occupational health and hygiene:** Ergonomics (posture, workstation safety, repetitive strain injuries), Common health hazards (dust, fumes, noise, stress), Industrial hygiene practices, Health monitoring and medical check-ups, Workplace stress and mental health awareness, Importance of sanitation and housekeeping.	5	7
6	**Safety Management, Environment and Ethics:** Introduction to safety management systems, Environmental safety and pollution awareness, Sustainability concepts, Human factors in safety, Ethics and responsibilities of engineers, Case studies from industries.	6	8

LIST OF TUTORIAL:

1. Basic Safety Concepts
2. Industrial Accidents
3. Hazard Identification
4. PPE and Safety Signs
5. Safe Work Practices and LOTO
6. Fire Safety
7. Explosion Awareness
8. Electrical Safety
9. Mechanical Safety
10. Occupational Health and Safety Management

TEXT BOOKS:

1. Crowl, D. A., Louvar, J. F., Chemical Process Safety: Fundamentals with Applications, Prentice Hall, 3rd Ed.
2. Kletz, T., What Went Wrong? Case Histories of Process Plant Disasters, Gulf Publishing.

REFERENCE BOOKS:

1. CCPS, Guidelines for Hazard Evaluation Procedures, AIChE.
2. CCPS, Guidelines for Chemical Process Quantitative Risk Analysis, AIChE.
3. Mannan, S., Lees' Loss Prevention in the Process Industries, Elsevier.
4. CCPS, Risk Based Process Safety.

ONLINE RESOURCES:

- https://nptel.ac.in/courses/110105094

COURSE OUTCOMES:

CO1	**Explain** the basic concepts of industrial safety**,** types of industries, causes of accidents, and importance of safety culture.
CO2	**Identify** various workplace hazards and apply appropriate safety measures, PPE, and safe work practices including LOTO.
CO3	**Discuss** the fundamentals of fire and explosion safety, types of fire, extinguishing methods, and basic mitigation strategies.
CO4	**Recognize** electrical and mechanical hazards and demonstrate safe practices in handling equipment and machinery.

CO5	**Describe** principles of occupational health, hygiene, and ergonomics, and their role in maintaining worker well-being.
CO6	**Understand** safety management systems, environmental aspects, sustainability, and ethical responsibilities in engineering practice.

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B.E. Semester IV

Boiler and Steam Utility Systems (BMEMD451)

Teaching Scheme (Hrs./week)				Credit	Examination Scheme				
L	T	P	Total		SEE	CCE	I/TW	V	Total
4	0	0	4	4	50	50	00	00	100

COURSE OVERVIEW:

This course provides a comprehensive foundation in steam engineering and industrial utility systems. Students begin by mastering the thermodynamics of steam, exploring the Rankine cycle, and heat transfer modes. The curriculum covers diverse boiler designs including fire-tube and water-tube systems along with essential mountings, combustion, and water treatment protocols.

COURSE CONTENT

Sr. No.	Topics	COs	Hrs
	SECTION-A		
1	**Fundamentals of Steam and Thermodynamics:** Steam Properties, Saturated steam, superheated steam, dryness fraction, enthalpy, and specific volume, Steam Tables and Mollier Chart, Thermodynamic Cycles: Introduction to Rankine Cycle, heat transfer modes: Conduction, Convection and Radiation.	1	10
2	**Boiler Systems:** Types of boilers, fire-tube & water-tube, components, mountings, accessories, combustion systems, feed water treatment, and boiler blow down.	2	10
3	**Boiler Performance Assessment:** Boiler Testing: Boiler efficiency using Direct (Input-Output) and Indirect (Heat Loss) methods, Heat Balance Sheet: Accounting for various losses like dry flue gas, moisture in fuel, radiation and Efficiency testing and efficiency improvement techniques.	3	10
	SECTION-B		
4	**Steam Distribution & Piping:** Steam piping design: Sizing of steam pipelines, pressure drop calculations, and thermal insulation, pipe insulation techniques, pressure reducing valves (PRV), and safety valves, Stress analysis in steam distribution and piping.	4	10
5	**Steam Utilization & Condensate Recovery:** Steam trapping systems: types and selection, flash steam recovery,	5	10

	condensate handling systems, and heat exchangers.		
6	**Energy Audit, and Safety:** Energy Conservation: Waste heat recovery from blow down and flue gases; Cogeneration, Topping and Bottoming cycles, Regulations: Introduction to the Indian Boiler Regulations (IBR) or relevant national codes, boiler inspection procedures, and safety protocols.	6	10

LIST OF PRACTICALS/TUTORIALS: N/A

TEXT BOOKS:

1. Boiler Operation Engineering by P. Chattopadhyay, Tata McGraw Hill.
2. Steam Power Engineering by Vinayak N. Kulkarni and B.B. Kumbharde.

REFERENCE BOOKS:

1. Boilers: Control and Instrumentation by K.C. Lindsley.
2. Power Plant Engineering by P.K. Nag.
3. Steam Plant Operation by Everett B. Woodruff.
4. Steam Boiler Operation by James J. Jackson, Prentice-Hall

ONLINE RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc21_me94/preview
2. https://vit.digimat.in/nptel/courses/video/112107216/L07.html

COURSE OUTCOMES:

CO1	**Analyze** steam properties and thermodynamic cycles using steam tables and Mollier charts.
CO2	**Classify** boiler types and specify essential mountings, accessories, and water treatment methods.
CO3	**Evaluate** boiler efficiency and heat losses using direct and indirect testing methods.
CO4	**Design** steam piping systems by calculating optimal sizing, pressure drops, and insulation.
CO5	**Optimize** steam utilization through effective steam trapping and condensate recovery systems.
CO6	**Perform** energy audits and cogeneration analysis while ensuring compliance with IBR safety codes.

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Shroff S R Rotary Institute of Chemical Technology
B.E. Semester IV (MDC-1)
Introduction to Environmental Management (BEVMD451)

Teaching Scheme (Hrs./week)				Credit	Examination Scheme				
L	T	P	Total		SEE	CCE	I/TW	V	Total
3	1	0	4	4	50	50	25	25	150

COURSE OVERVIEW:

- This course introduces the basic scientific and conceptual foundations required for understanding environmental systems and management.
- It focuses on fundamental environmental processes, environmental quality concepts, population–environment relationships, and basic environmental assessment approaches necessary for environmental engineers.

COURSE CONTENT

Sr. No.	Topics	COs	Hrs. (45)
	SECTION-A		
1	**Earth system and environmental components:** Origin and evolution of earth, structure of Earth, Layers of atmosphere and their functions Solar radiation and Earth energy balance, Weather vs climate, Natural environmental processes, interrelationship between environmental components.	1	10
2	**Environmental basics and Geographic Information System (GIS):** Composition of atmosphere, Composition and properties of natural water, Soil composition and properties, Nutrient cycles in environmental systems, basic concept of remote sensing, Applications of GIS in environmental monitoring	2	10
3	**Population, Urbanization and Environment:** Population growth trends and environmental implications, urbanization and environmental challenges, Resource demand and environmental stress, Basic concepts of carrying capacity, Environmental impacts of human activities.	3	10
	SECTION-B		
4	**Environmental Standards:** Standards and Guidelines of Environmental Parameters, Basic indicators of air quality, basic indicators of water quality, soil quality indicators.	4	10
5	**Environmental Monitoring**: Purpose and importance of environmental monitoring, Types of environmental monitoring, Basic sampling & Interpretation. Introduction to OCEMS.	5	10
6	**Basic Environmental Assessment Approaches**: Concept of Environmental assessment, Introduction to environmental impact identification, Environmental baseline studies, Environmental indices and indicators, Role of environmental assessment in management.	6	10

LIST OF TUTORIAL:

1. Earth System & Origin of Earth
2. Atmosphere & Its Functions
3. Solar Radiation & Energy Balance
4. Environmental Components Interaction
5. Water, Soil & Air Basics
6. GIS & Remote Sensing Basics
7. Population & Environment
8. Urbanization & Environmental Challenges
9. Environmental Standards & Indicators
10. Environmental Monitoring & Assessment

TEXT BOOKS:

1. J. Glynn Henry and Gary W. Heinke, Environmental Science and Engineering, 2nd Edition, Prentice Hall, 1996, ISBN: 978-0133981322.
2. Gilbert M. Masters and Wendell P. Ela, Introduction to Environmental Engineering and Science, 3rd Edition, Pearson Education, 2007, ISBN: 978-0137848584.
3. A. K. De, Environmental Chemistry, 6th Edition, New Age International Publishers, 2001 (reprint), ISBN: 978-8122412482.
4. Gerard Kiely, Environmental Engineering, 1st Edition, McGraw-Hill, 1997, ISBN: 978-0071164245.
5. R. C. Gaur, Basic Environmental Engineering, 2nd Edition, New Age International Publishers, 2008, ISBN: 978-8122426366.

REFERENCE BOOKS:

1. Benny Joseph, Environmental Studies, 2nd Edition, Tata McGraw-Hill Education, 2009, ISBN: 978-0070151345.
2. C. S. Rao, Environmental Pollution Control Engineering, 2nd Edition, New Age International Publishers, 2006, ISBN: 978-8122418354.
3. P. Venugopala Rao, Principles of Environmental Science and Engineering, 2nd Edition, Prentice Hall of India, 2006, ISBN: 978-8120329331.
4. Stanley E. Manahan, Environmental Chemistry, 9th Edition, CRC Press, 2010, ISBN: 978-1439884034.
5. William P. Cunningham and Mary Ann Cunningham, Environmental Science: A Global Concern, 14th Edition, McGraw-Hill Education, 2015, ISBN: 978-0073383293.

ONLINE RESOURCES:

- https://nptel.ac.in/

COURSE OUTCOMES:

CO 1	**Describe** the basic structure and functioning of Earth's environmental systems.
CO 2	**Explain** interactions between human activities and environmental processes.
CO 3	**Interpret** fundamental concepts of environmental quality and environmental indicators.
CO 4	**Identify** basic environmental problems associated with population growth and urbanization.
CO 5	**Understand** the fundamentals of environmental monitoring and data interpretation.
CO 6	**Apply** basic environmental assessment concepts for environmental management.

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B.E. Semester IV

Fundamentals of Data Science (BCOMD451)

Teaching Scheme (Hrs./week)				Credit	Examination Scheme				
L	T	P	Total		SEE	CCE	I/TW	V	Total
3	0	2	5	4	50	50	25	25	150

PREREQUSITE:

A basic understanding of mathematics (especially statistics and linear algebra) to analyse data effectively. Students should have foundational knowledge of programming, preferably in Python or similar languages, for data handling and implementation.

COURSE CONTENT:

Sr. No.	Topics	COs	Hrs (45)
	SECTION-A		
1	**Introduction to Data Science:** Definition, scope, and importance of Data Science, Data Science lifecycle (CRISP-DM), Types of data: structured, semi-structured, unstructured, Data sources: databases, APIs, web scraping, Applications in engineering domains.	**1**	**5**
2	**Data Preprocessing & Feature Engineering:** Data cleaning techniques, Handling missing values (mean, median, mode, KNN), Outlier detection (Z-score, IQR method) , Data transformation and normalization, Feature encoding (Label encoding, One-hot encoding), Feature selection methods (filter & wrapper methods).	**2**	**8**
3	**Statistical Foundations for Data Science:** Descriptive statistics, Probability theory basics , Probability distributions, Sampling techniques and central limit theorem , Hypothesis testing, Correlation and covariance.	**3**	**9**
	SECTION-B		
4	**Exploratory Data Analysis (EDA):** Univariate and multivariate analysis, Correlation analysis and heatmaps, Data visualization for EDA, Pattern identification and insights.	**4**	**8**
5	**Data Handling using Python :** NumPy: arrays, vectorization, broadcasting, Pandas: DataFrames, indexing, grouping, merging, Data manipulation and aggregation.	**5**	**9**
6	**Case Studies & Applications :** Financial data analysis, Healthcare data analytics, Industrial data analysis.	**6**	**6**

LIST OF PRACTICALS:

1. Practical on Data Acquisition and Dataset Handling.
2. Practical on Data Preprocessing Techniques.
3. Practical on Outlier Detection and Treatment.
4. Practical on Feature Engineering and Data Transformation.
5. Practical on Descriptive Statistical Analysis.
6. Practical on Probability and Distribution Analysis.
7. Practical on Hypothesis Testing and Statistical Inference.
8. Practical on Exploratory Data Analysis (EDA).
9. Practical on Data Manipulation using Python Libraries.
10. Mini Project

TEXT BOOKS:

1. Joel Grus, Data Science from Scratch: First Principles with Python, O'Reilly Media.
2. Wes McKinney, Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Jupyter, O'Reilly Media.

REFERENCE BOOKS:

1. Trevor Hastie, Robert Tibshirani, The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Springer.
2. Jure Leskovec, Anand Rajaraman, Mining of Massive Datasets, Cambridge University Press.
3. Jake VanderPlas, Python Data Science Handbook: Essential Tools for Working with Data, O'Reilly Media.

ONLINE RESOURCES:

1. https://www.kaggle.com
2. https://www.geeksforgeeks.org/data-science/
3. https://scikit-learn.org
4. https://pandas.pydata.org

COURSE OUTCOMES:

CO1	**Understand** fundamental concepts and lifecycle of Data Science.
CO2	**Apply** data preprocessing and feature engineering techniques.
CO3	**Use** statistical methods for data analysis.
CO4	**Perform** exploratory data analysis to extract insights.
CO5	**Implement** data handling using Python tools.
CO6	**Analyze** real-world datasets and interpret results.

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B.E. Semester IV

Fundamentals of Cloud & Virtualization (BITMD451)

Teaching Scheme (Hrs./week)				Credit	Examination Scheme				
L	T	P	Total		SEE	CCE	I/TW	V	Total
3	0	2	5	4	50	50	25	25	150

PREREQUISITE:

Basic knowledge of Computer Fundamentals. Understanding of Operating Systems (process, memory, file system). Basics of Computer Networks (LAN, WAN, Internet concepts). Introductory knowledge of Database Management Systems (DBMS). Familiarity with basic programming concepts.

COURSE CONTENT:

Sr. No.	Topics	COs	Hrs (45)
	SECTION-A		
1	**Introduction to Cloud Computing:** Evolution of Cloud Computing System Models for Distributed and Cloud Computing, Roots of Cloud Computing, Desired Features of Cloud Computing, Challenges and Risks, Benefits and Disadvantages of Cloud Computing, Layers and Types of Cloud; Desired Features of a Cloud.	1	8
2	**Cloud Infrastructure:** Infrastructure as a Service (IaaS); On-demand Provisioning; Elasticity in Cloud; Platform as a Service (PaaS); Software as a Service (SaaS); XaaS Examples of IaaS, SaaS, and PaaS , Types of Cloud: Public, Private and Hybrid Clouds.	2	5
3	**Virtualization:** Cloud Resource Virtualization - Introduction to virtualization Different approaches to virtualization Hypervisors Machine Image Virtual Machine (VM) Process VM vs System VM Resource Virtualization: Server, Storage, Network Full Virtualization vs Para Virtualization Operating System Support for Virtualization Virtual Machine (resource) Provisioning and Manageability VM Placement, VM Migration	3	9
	SECTION-B		
4	**Architectural Design:** Architectural Design of Compute and Storage Clouds, Layered Cloud Architecture Development, Design Challenges, Inter Cloud Resource Management, Resource Provisioning, and Platform Deployment, Global Exchange of Cloud Resources. Administrating the Clouds, Cloud Management Products, Emerging Cloud Management Standards.	4	8

5	**Cloud Security:** Cloud Security: Security Overview, Cloud Security Challenges, and Risks, Software-as-a-Service Security, Cloud computing security architecture: Architectural Considerations, General Issues Securing the Cloud, Securing Data, Data Security, Application Security, Virtual Machine Security, Identity and Presence, Identity Management and Access Control, Autonomic Security Establishing Trusted Cloud computing, Secure Execution Environments, and Communications, Identity Management and Access control Identity management, Access control, Autonomic Security Storage Area Networks, Disaster Recovery in Clouds.	**5**	**9**
6	**Case-Studies:** Cloud-Based Case-Studies: Amazon EC2 (Virtualization), S3 (Storage), VPC (Virtual Private Cloud), IAM (Security), Cloud Watch (Deployment, Management service).	**6**	**6**

LIST OF PRACTICALS:

1. Study and comparison of Traditional Computing, Grid Computing, and Cloud Computing models.
2. Study of Cloud Deployment Models – Public, Private, and Hybrid Cloud with real-world examples.
3. Study and comparison of Cloud Service Models – IaaS, PaaS, and SaaS.
4. Deployment of a simple web application using a Platform as a Service (PaaS) platform.
5. Installation of a virtualization tool (VirtualBox/VMware) and creation of a Virtual Machine.
6. Study and comparison of Full Virtualization and Para-Virtualization techniques.
7. Demonstration of Virtual Machine operations such as snapshot, cloning, and migration.
8. Design and analysis of layered Cloud Architecture for a sample cloud application.
9. Study and implementation of basic Cloud Security concepts such as authentication and access control.
10. Case study of cloud services: Amazon EC2, S3, VPC, IAM, and CloudWatch.

TEXT BOOKS:

1. Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Cloud Computing: Principles and Paradigms, Wiley
2. Dan C Marinescu, Cloud Computing Theory and Practice, MK Elsevier

REFERENCE BOOKS:

1. Rajkumar Buyya, C. Vecchiola& S. Thamarai Selvi , Mastering Cloud Computing, McGraw Hill Publication
2. Miller Michael, "Cloud Computing: Web-Based Applications that Change the Way You Work and Collaborate Online", Pearson Education India
3. Anthony T. Velte, Toby J. Velte, Robert Elsenpeter, Cloud Computing – A Practical

Approach, Tata McGraw Hill Education

ONLINE RESOURCES:

1. https://www.geeksforgeeks.org/cloud-computing/cloud-computing/
2. https://www.tutorialspoint.com/cloud_computing/cloud_computing_virtualization.htm
3. https://www.javatpoint.com/cloud-computing-architecture

COURSE OUTCOMES:

CO1	**Illustrate** the principles and paradigm of Cloud Computing
CO2	**Explore** the Service Models.
CO3	**Understand** the role of Virtualization Technology.
CO4	**Categorize** the Architectural Designs, and Manage the Resources of a cloud.
CO5	**Apply** security aspects, design and build a cloud service.
CO6	**Study** different tools for implementing cloud in Real-time scenario

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B.E. Semester IV

Basics of Measuring Instruments (BEEMD451) [MDC-1]

Teaching Scheme (Hrs./week)				Credit	Examination Scheme				
L	T	P	Total		SEE	CCE	I/TW	V	Total
3	0	2	5	4	50	50	25	25	150

COURSE OVERVIEW: This course introduces the fundamentals of measurement systems, sensors, and transducers, including their characteristics and selection for industrial applications. It covers instrumentation signals, signal conditioning, and devices used for accurate data transmission. The course also provides a basic understanding of control systems, process control loops, and control actions. Finally, it familiarizes students with industrial automation concepts through PLC and DCS architectures and their applications in process industries.

COURSE CONTENT

Sr. No.	Topics	COs	Hrs (45)
	SECTION-A		
1	**Measurement System & Transducers:** Typical measurement system: block diagram and functions, Sensors and transducers: definition, classification, Selection criteria of transducers. Primary and secondary transducers, Static characteristics (accuracy, sensitivity, repeatability).	1,2	6
2	**Industrial Sensors:** Capacitive, Inductive, and Resistive sensors, Working principles and applications, Basic comparison of sensors, Factors affecting sensor performance, Industrial applications of sensors.	2,3	6
3	**Instrumentation Signals & Devices:** Standard instrumentation signals (4–20 mA, 0–10 V), P to I and I to P converters: principle and uses, Transmitters and Differential Pressure Transmitters (DPT), Signal conditioning basics, Noise and interference in signals.	4	10
	SECTION-B		
4	**Control Systems Basics:** Concept of control system, Open loop and closed loop control, Elements of a control loops, Basic control actions (ON-OFF, P, PI, PID), Stability and response (basic idea).	5	8
5	**Process Control Loops:** Temperature, Flow, Pressure, Level control loops, Basic operation and industrial applications, Control valves and actuators (intro), Block diagrams of process control loops, Industrial examples of control systems.	5	7
6	**Fundamental of PLC & DCS:** Introduction to PLC: basic architecture and applications, Introduction to DCS: architecture and features, Comparison of PLC and DCS with respect to functions, applications and controlling, Input/output modules and communication basics, applications in process industries.	6	8

TEXT BOOKS:

1. A Course in Electrical and Electronic Measurements and Instrumentation – A.K. Sawhney.
2. Industrial Instrumentation and Control – S.K. Singh
3. Process Control: Principles and Applications – Surekha Bhanot
4. Programmable Logic Controllers – W. Bolton
5. Distributed Control Systems – L.K. Erickson
6. Instrumentation Devices and Systems – C.S. Rangan

REFERENCE BOOKS:

1. Instrumentation Reference Book – Walt Boyes
2. Measurement, Instrumentation and Sensors Handbook – John G. Webster
3. Handbook of Modern Sensors: Physics, Designs, and Applications – Jacob Fraden
4. Fundamentals of Industrial Instrumentation and Process Control – William C. Dunn

ONLINE RESOURCES:

1. NPTEL – Measurement & Instrumentation Course
2. NPTEL – Transducers for Instrumentation Course
3. NPTEL – Industrial Automation and Control Course
4. https://www.youtube.com/@RealPars
5. https://www.youtube.com/@InstrumentationTools

COURSE OUTCOMES

CO1	Define measurement system elements and classify sensors and transducers, including primary and secondary types.
CO2	Explain static characteristics of transducers (accuracy, sensitivity, repeatability) and factors affecting sensor performance.
CO3	Select appropriate industrial sensors (capacitive, inductive, resistive) for given applications based on working principles and operating conditions.
CO4	Analyze standard instrumentation signals and the operation of P/I, I/P converters and differential pressure transmitters in measurement systems.
CO5	Construct and interpret basic control loop diagrams (temperature, flow, pressure, level) and evaluate control actions.
CO6	Differentiate PLC and DCS architectures, I/O modules, and communication systems for specific industrial control applications.

UPL University of Sustainable Technology
Shroff S R Rotary Institute of Chemical Technology
B.E. Semester IV
Pharmaceutical Analysis (BPTMD451)

Teaching Scheme (Hrs./week)				Credit	Examination Scheme				
L	T	P	Total		E	M	I	V	Total
3	0	2	5	04	50	50	25	25	150

COURSE OVERVIEW: This course introduces the principles and applications of instrumental techniques used in pharmaceutical analysis. It covers spectroscopic, chromatographic, and advanced analytical methods for drug identification, quantification, and quality control, along with basic concepts of method validation and good laboratory practices.

COURSE CONTENT:

Sr. No.	Topics	COs	Hrs (45)
	SECTION-A		
1	**Introduction to Instrumental Analysis** • Fundamentals of analytical chemistry • Classification of instrumental methods • Calibration methods: external and internal standards • Validation parameters: accuracy, precision, sensitivity, specificity • Good Laboratory Practices (GLP) • Analytical Method Validation (as per USP and ICH guidelines): Accuracy, Precision, Limit of Detection (LOD), Limit of Quantification (LOQ), Linearity, Range, Robustness, Ruggedness	1	7
2	**Spectroscopic Techniques – I** • UV-Visible Spectroscopy • Principle (Beer-Lambert Law) • Instrumentation and applications • Infrared (IR) Spectroscopy • Principle and functional group identification • Instrumentation and applications • Polarimetry: Theory, instrumentation and applications	2	8
3	**Spectroscopic Techniques – II** • **Nuclear Magnetic Resonance (NMR) Spectroscopy:** 1H-NMR: Principle, Precessional frequency, Chemical shift, Spin-spin coupling, Coupling constant, Instrumentation ; Introduction to 13C NMR; Applications of NMR	3	8
	SECTION B		
4	**Spectroscopic Techniques – II** • **Mass Spectrometry:** Basic principles & brief outline of instrumentation. Ion formation, molecular ion, meta stable ion,	4	7

	fragmentation process in relation to molecular structure & functional groups.		
5	**Chromatographic Techniques** • Principles of chromatography • Paper chromatography • Thin Layer Chromatography (TLC) • High Performance Liquid Chromatography (HPLC) • Gas Chromatography (GC) • Applications in pharmaceutical analysis	5	10
6	**Hyphenated Techniques:** • GC-MS, LC-MS, LC-MS/MS • Applications in impurity profiling, bioanalysis, and drug development	6	5

TEXT BOOKS:

1. Instrumental Methods of Chemical Analysis, E. W. Ewing, McGraw Hill, New York. 4th Ed, 1975
2. Instrumental Methods of Analysis, B. K. Sharma, Goel Publishing house.
3. Elementary Organic Spectroscopy, Y.R. Sharma, S.Chand & company Ltd. New Delhi 2008
4. Principles of Instrumental Analysis by Douglas Skoog,2nd Edition,1980.
5. Fundamentals of Molecular Spectroscopy by Colin N Banwell and Elaine M McCash , McGraw Hill, 4th edition, 2016.
6. Instrumental Methods of Analysis 7th Edition by Willard, CBS PUBLICATION,7th Edition,2004
7. Spectroscopy of Organic Compounds by P S Kalsi, New Age International Publishers,6th Edition, 2004.
8. Introduction to Spectroscopy by Donald L. Pavia, Gary M. Lampman, and George S. Kriz
9. Organic Spectroscopy by William Kemp 3rd edition.

PRACTICALS (Any Ten):

1. Apparatus used in Analytical techniques
2. Calibration and verification of analytical balance and volumetric glassware.
3. Separation of amino acids or plant pigments using Paper Chromatography
4. Separation and identification of compounds using Thin Layer Chromatography (TLC)**.**
5. Estimation of Total Hardness of Water by EDTA Method
6. Preparation of standard solutions and construction of calibration curve using UV-Visible spectrophotometry.
7. Estimation of drug concentration by Beer-Lambert Law using UV-Visible spectrophotometer. $A=\varepsilon bc$
8. To determine λ_{max} and concentration of unknown solution of $KMnO_4$ using Colorimeter.
9. Identification of functional groups of organic compounds using IR spectroscopy.
10. Instrumentation and Working Principle of solutions IR Spectroscopy (Virtual Lab)
11. Demonstration/Study of High Performance Liquid Chromatography (HPLC)
12. Demonstration/Study of Gas Chromatography (GC)

ONLINE RESOURCES:

NPTEL (National Programme on Technology Enhanced Learning)	Analytical Chemistry courses
SWAYAM Portal	Pharmaceutical and Chemical Engineering courses
AICTE e-Kumbh / e-ShodhSindhu	Video lectures on Analytical techniques.
Open-access journals	Google Scholar, PubMed for pharmaceutical analysis topics

COURSE OUTCOMES:

CO1	Understand the fundamentals of analytical chemistry, classification of instrumental methods, calibration techniques, and Good Laboratory Practices (GLP).
CO2	Apply analytical method validation parameters (accuracy, precision, LOD, LOQ, linearity, range, robustness, ruggedness) as per USP and ICH guidelines.
CO3	pply principles and instrumentation of spectroscopic techniques such as UV-Visible, IR, and Polarimetry for qualitative and quantitative pharmaceutical analysis.
CO4	Interpret structural information using advanced spectroscopic methods such as ^{1}H-NMR and basic ^{13}C-NMR, including chemical shift and spin-spin coupling.
CO5	Analyze pharmaceutical compounds using chromatographic techniques (Paper, TLC, HPLC, GC) for separation and identification.
CO6	Understand principles and applications of Mass Spectrometry and hyphenated techniques (GC-MS, LC-MS, LC-MS/MS) in drug development, impurity profiling, and bioanalysis.

UPL University of Sustainable Technology
Shroff S. R. Rotary Institute of Chemical Technology
B.E. Semester IV
Fundamentals of Materials Science and Engineering (BGCMD451)

Teaching Scheme (Hrs./week)				Credit	Examination Scheme				
L	T	P	Total		E	M	I	V	Total
3	0	2	5	04	50	50	25	25	150

COURSE OVERVIEW: To introduce students to the basic principles of ceramic materials, their structure, processing methods, properties, and applications, enabling them to understand the importance of ceramics in traditional and advanced technological fields.

COURSE CONTENT:

Sr. No.	Topics	COs	Hrs. (45 hrs.)
	SECTION-A		
1	**Introduction to Ceramic Materials** • Definition and classification of ceramics • Historical evolution of ceramic materials • Traditional ceramics vs. advanced ceramics • Importance of ceramics in modern technology • Basic raw materials used in ceramics (clay, feldspar, quartz, alumina etc.) • Overview of ceramic industries (structural ceramics, refractories, glass, advanced ceramics)	1	08 hrs.
2	**Structure and Composition of Ceramics** • Atomic bonding in ceramic materials (ionic and covalent bonding) • Crystal structure of ceramics • Amorphous vs. crystalline materials • Defects in ceramic structures (point defects and vacancies) • Phase concept and simple phase diagrams • Role of composition in determining ceramic properties	1,2	07 hrs.
3	**Ceramic Raw Materials and Their Characteristics** • Natural ceramic raw materials: clay minerals, feldspar, silica, limestone • Basic mineralogy of clay • Physical and chemical properties of ceramic raw materials • Beneficiation and preparation of raw materials • Role of additives and binders in ceramic processing • Quality control of raw materials.	2,3	08 hrs.
	SECTION-B		

4	**Basic Ceramic Processing Techniques**
	• Powder preparation and mixing
	• Forming methods:
	  • Slip casting
	  • Pressing
	  • Extrusion
	  • Injection molding (overview)
	• Drying of ceramic bodies
	• Basic principles of sintering
	• Introduction to kiln firing
		3,4	08 hrs.

5	**Properties of Ceramic Materials** • Mechanical properties (strength, hardness, brittleness) • Thermal properties (thermal expansion, thermal shock resistance) • Electrical properties (insulating behavior) • Chemical resistance and durability • Factors affecting ceramic properties	4,5	07 hrs.
6	**Applications of Ceramics in Engineering and Technology** • Structural ceramics (tiles, bricks, sanitary ware) • Refractories and high-temperature materials • Electrical and electronic ceramics • Bioceramics and medical applications • Ceramic coatings and composites • Emerging applications of advanced ceramics	5,6	07 hrs.

TEXT BOOKS:

1. Elements of ceramics ,Norton F.H, Longman higher education, 2nd Ed, 2001
2. Introduction to ceramics, Barsoum, Institute of Physics Publishing (gb) 2002
3. Introduction to Ceramics, Kingery W.D,. Wiley New York :, 2nd Ed, 1976
4. Material Science ,Smith, Mcgraw Hill Higher Education, 4th Ed,2005
5. Industrial ceramics ,Singer & Singer, , Oxford &Ibh (From Technip), 1st Ed.,2008

LIST OF PRACTICALS:

1. Identification of ceramic raw materials
2. Plasticity test of clay
3. Preparation of a simple ceramic body
4. Demonstration of slip casting or pressing
5. Observation of sintered ceramic samples
6. Determination of drying shrinkage of clay bodies
7. Water absorption and apparent porosity test of fired ceramics
8. Measurement of firing shrinkage of ceramic samples
9. Thermal shock resistance test of ceramic materials
10. Determination of modulus of rupture of ceramic specimens

ONLINE RESOURCES:

Introduction to Ceramic Materials (Wiley sample)	Foundational overview of ceramics, structures, classifications, and properties.
Ceramic Materials: Processes, Properties and Applications	Covers wide range of ceramic types, processing and applications.
An Introduction to Ceramic Engineering Design (e-book)	Good for basic engineering perspectives on ceramics.
Introduction to Ceramics (AZoM article)	Good conceptual overview of ceramic materials, bonding, properties, and production steps.
DoITPoMS Materials Science (Open online educational site)	Materials science tutorials useful for basics of structure, bonding, and processing.

COURSE OUTCOMES:

CO1	Understand the basic nature and classification of ceramic materials.
CO2	Explain structure–property relationships in ceramics.
CO3	Identify common ceramic raw materials and their roles.
CO4	Understand basic ceramic processing techniques.
CO5	Recognize engineering applications of ceramic materials.
CO6	Select suitable ceramic materials and processing routes for elementary engineering and industrial applications.

UPL University of Sustainable Technology
Shroff S. R. Rotary Institute of Chemical Technology
B.E. Semester IV
Introduction to Paint and Coating Technology (BDPMD451)

Teaching Scheme (Hrs./week)				Credit	Examination Scheme				
L	T	P	Total		SEE	CCE	I/TW	V	Total
3	0	2	5	4	50	50	25	25	150

COURSE OVERVIEW:
The main objective of this subject is to study the synthesis of various types of dyes and pigments used in chemical industries.

COURSE CONTENT:

Sr. No.	Topics	COs	Hrs (45)
	SECTION-A		
1	**Unit I: Basics of Paints and Coatings** • Definition and purpose of paints and coatings • Functions: protection and decoration • Types of coatings (basic classification) • Components of paint: pigment, binder, solvent, additives • General applications of paint	1	08
2	**Unit II: Raw Materials** • Basic idea of pigments and their role • Introduction to binders (resins) • Role of solvents • Common additives (driers, stabilizers, etc.) • Simple relation between materials and properties	2	08
3	**Unit III: Formulation and Application** • Basic concept of paint formulation • Simple manufacturing steps (mixing, grinding) • Methods of application: brush, spray, roller • Drying and curing (basic idea) • Safety and handling precautions	3	08
	SECTION-B		
4	**Unit IV: Basic Paint Preparation** • Preparation of simple paint (demonstration/practice) • Observation of mixing and dispersion • Study of basic properties (appearance, consistency)	4	07
5	**Unit V: Application and Testing** • Surface preparation (cleaning, sanding) • Application using brush/spray • Basic tests: drying time, adhesion, visual inspection	5	07
6	**Unit VI: Defects and Industrial Practices** • Common defects: peeling, cracking, blistering	6	07

	• Simple causes and remedies • Basic industrial practices in painting • Importance of quality control		

TEXT BOOKS:

1. Outlines of Paint Technology, III Ed. By W.M.Morgans,
2. Organic Coatings: Science and Technology, by Z.W.Wicks, F.N.Jones and S.P.Pappas, WileyInterscience 2007
3. Basics of Paint Technology, Part I & II, by V.C. Malshe & Meenal Sikchi 2004

List of Practicals (Any Ten):

1. To prepare a water-based paint using basic ingredients.
2. To understand the formulation of oil-based paint.
3. To study the effect of proper and improper pigment dispersion.
4. To determine the viscosity of paint using a simple method.
5. To observe and record the drying time of a coating.
6. To study the importance of surface cleaning and preparation before coating.
7. To apply paint using a brush and observe film formation.
8. To apply paint using a roller and compare with brush coating.
9. To evaluate the adhesion of paint film on a surface.
10. To compare the gloss and appearance of different coatings.
11. To assess the hardness of a paint film using a simple method.
12. To identify common paint defects and understand their causes.

COURSE OUTCOMES:

CO1	Recall basic terms related to paints and coatings
CO2	Describe functions and importance of coatings.
CO3	Identify different raw materials used in paints.
CO4	Explain basic formulation and application methods.
CO5	Apply simple techniques for paint preparation and testing.
CO6	Recognize common coating defects and suggest remedies.

UPL University of Sustainable Technology
Shroff S R Rotary Institute of Chemical Technology
B.E. Semester IV
Chemistry of Polymers (BPRMD451)

Teaching Scheme (Hrs./week)				Credit	Examination Scheme				
L	T	P	Total		SEE	CCE	I/TW	V	Total
3	0	2	5	4	50	50	25	25	150

COURSE OVERVIEW:

This course introduces the fundamental chemistry of polymeric materials, including polymer structure, classification, polymerization mechanisms, and morphology. It provides understanding of structure–property relationships, kinetics of polymerization, copolymerization techniques, and modern polymerization methods. The course enables students to understand how molecular architecture and morphology influence polymer properties and applications.

COURSE CONTENT

Sr. No.	Topics	COs	Hrs (45)
	SECTION-A		

1	**Introduction to Polymer Chemistry:**
	• Monomers and polymer formation
	• Functionality of monomers
	• Degree of polymerization
	• Molecular weight concepts
	• Classification of polymers
	  ○ Natural and synthetic polymers
	  ○ Thermoplastics and thermosets
	  ○ Elastomers and fibers
	• Thermal transitions in polymers
	  ○ Glass transition temperature (Tg)
	  ○ Melting temperature (Tm)
	  ○ Criteria for rubberiness
		1	08

2	**Polymerization Mechanisms and Kinetics** • Types of polymerization- Addition polymerization, Condensation polymerization • Kinetics of polymerization- Initiation, Propagation, Termination • Chain growth polymerization • Step growth polymerization • Molecular weight development in polymerization	2	08

3	**Copolymerization** • Introduction to copolymerization • Monomer reactivity ratios • Significance of reactivity ratios Types of copolymers: • Random copolymers • Alternating copolymers • Azeotropic copolymerization • Block copolymers • Graft copolymers Applications and advantages of copolymerization.	3	08
	SECTION-B		
4	**Polymerization Techniques and Modern Methods** Polymerization techniques: • Bulk polymerization • Solution polymerization • Suspension polymerization • Emulsion polymerization Modern polymerization methods: • Metallocene catalyzed polymerization • Living polymerization techniques • Newer catalytic systems in polymer chemistry Advantages and industrial applications of different polymerization techniques.	4	07
5	**Polymer Morphology and Crystallinity** Concept of intermolecular order (Morphology) Polymer structures: • Amorphous polymers • Crystalline polymers • Semi-crystalline polymers Orientation states in polymers Factors affecting crystallinity: Chain structure, Molecular weight, Temperature and cooling rate, Copolymerization Crystalline transitions in polymers. Effect of morphology on polymer properties: • Mechanical properties • Thermal properties • Optical properties • Barrier properties.	5	07

6	**Advanced Polymer Concepts** • Introduction to advanced polymer materials • Specialty polymers and high-performance polymers • Conducting polymers and biodegradable polymers • Polymer blends and polymer composites • Basic applications of polymers in packaging, biomedical, automotive and electronics industries	6	07

TEXTBOOKS

1. Principles of Polymerization – George Odian
2. Polymer Chemistry – Paul C. Hiemenz and Timothy P. Lodge
3. Polymer Science and Technology – Joel R. Fried

REFERENCE BOOKS

1. Textbook of Polymer Science – Fred W. Billmeyer Jr.
2. Introduction to Polymer Science and Technology – Robert O. Ebewele
3. Fundamentals of Polymer Science – Michael M. Coleman and Paul C. Painter

List of Practical:

1. Bulk polymerization of styrene and study of polymer formation.
2. Emulsion polymerization of styrene or vinyl acetate.
3. Determination of intrinsic viscosity of polymer solution and estimation of molecular weight.
4. Determination of glass transition temperature (Tg) of a polymer sample.
5. Study of polymer Crystallinity using density method.
6. Preparation and identification of phenol-formaldehyde resin (Bakelite).
7. Preparation of nylon-6,6 by interfacial polymerization.
8. Study of copolymer formation and properties.
9. Identification of different polymer samples by simple tests.
10. Study of thermal behavior of polymers.

COURSE OUTCOMES

CO-1	Understand basic concepts of polymer chemistry such as monomers, functionality, and degree of polymerization and classification of polymers.
CO-2	Explain mechanisms and kinetics of addition and condensation polymerization.
CO-3	Analyze different types of copolymers and evaluate monomer reactivity ratios.
CO-4	Understand various polymerization techniques such as bulk, solution, suspension and emulsion polymerization.
CO-5	Explain polymer morphology including amorphous and crystalline structures and factors affecting Crystallinity.
CO-6	Relate polymer structure and morphology with physical, thermal and mechanical properties of polymers.