List of Revised Courses

Department : Chemical Engineering

Programme Name : B.Tech.

***Academic Year* : 2024-25**

List of Revised Courses

Sr. No.	Course Code	Name of the Course
01.	CHUETT1	Heat Transfer
02.	CHUETT2	Mass Transfer-I
03.	CHUETT3	Chemical Reaction Engineering-I
04.	CHUETK3	Fuel Combustion Energy Technology
05.	CHUETK4	Process Equipment Design-I
06.	CHUFTT1	Mass Transfer-II
07.	CHUFTT2	Clhemical Reaction Engineering-II
08.	CHUFTT3	Process Dynamics and Control
09.	CMT-304 (P)	Quantum Chemistry Credits

Minutes of Meetings (MoM) of Board of Studies (BoS)

Academic Year : 2023-24

School : *School of Physical Sciences*

Department : *Chemistry*

Date and Time : *Sept. 04, 2020 – 12:00 noon*

Venue : *Meeting room*

Minutes of Meeting

A meeting of Board of Studies (BoS) of Department of Chemical Engineering, School of Studies of Engineering and Technology, Guru Ghasidas Vishwavidyalaya, Bilaspur was held today (July 15, 2024) in conference hall of UGC - Malaviya Mission Teacher Training Centre, Guru Ghasidas Vishwavidyalaya, for discussion and approval of the scheme and syllabus of third year (V and VI Semester) as per NEP-2020 guidelines. Following members were present in the meeting.

1. Dr. Raghwendra Singh Thakur, Chairman-BoS , Associate Prof. and Head, Dept. of Chemical Engg.
2. Prof. (Mrs) A B Soni, External Expert Member-BoS, Professor, Dept. of Chemical Engg., NIT Raipur
3. Er. Arvind Verma, External Industry Expert, Special Invitee-BoS, Senior Manager-Process, Nu-Vista (NUVOCO Cement), Baloda Bazar (Present online)
4. Prof. Anil Kumar Chandrakar Member-BoS, Professor, Dept. of Chemical Engg.
5. Dr. Saurabh Meshram, Member-BoS, Associate Prof., Dept. of Chemical Engg.
6. Dr. Amit Jain, Invited Member, Associate Prof., Dept. of Chemical Engg.
7. Dr. Anuradha N. Joshi, Invited Member, Associate Prof., Dept. of Chemical Engg
8. Dr. Neeraj Chandraker, Invited Member, Assistant Prof., Dept. of Chemical Engg.
9. Dr. Gautam Prasad Dewangan, Invited Member, Assistant Prof., Dept. of Chemical Engg.
10. Mr. Vishnu Prasad Yadav, Invited Member, Assistant Prof., Dept. of Chemical Engg.
11. Dr. Sandeep Dharmadhikari, Invited Member, Assistant Prof., Dept. of Chemical Engg.
12. Dr. Ghoshna Jyoti, Invited Member, Assistant Prof., Dept. of Chemical Engg.
13. Dr. Pankaj Kumar, Invited Member, Assistant Prof., Dept. of Chemical Engg.
14. Dr. Satyajit Bhattacharjee, Invited Member, Assistant Prof., Dept. of Chemical Engg.

Following are resolved in the meeting.

1. The committee discussed the scheme and syllabi of B. Tech Third year session 2024-25 (V and VI semester) at length and after incorporating the changes, as identified by the BoS members, the final scheme and syllabi is approved by BoS members.
2. New course Polymer Technology-I and Polymer Technology-II was introduced in V and VI Semester, respectively.
3. Mini Project-II of 2 credits was introduced in V semester in succession of Mini Project in IV semester.
4. One project of 2 credits was also introduced in VI Semester.

Page 1 of 2

Scheme and Syllabus

SCHOOL OF STUDIES OF ENGINEERING & TECHNOLOGY
GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.)
(A Central University Established by the Central University Ordinance 2009, No. 3 of 2009)

SCHEME FOR EXAMINATION (NEP 2020) (Effective from Session 2024-25)
B. TECH. (FOUR YEAR) DEGREE COURSE, CHEMICAL ENGINEERING
THIRD YEAR, FIFTH SEMESTER

S. No.	Subject Code	Subject Name	Periods			Evaluation Scheme			Credits
	Theory					Marks			
			L	T	P	CIA	SEA	Total	
01.	CHUETT1	Heat Transfer	3	1	0	40	60	100	4
02.	CHUETT2	Mass Transfer-I	3	1	0	40	60	100	4
03.	CHUETT3	Chemical Reaction Engineering-I	3	0	0	40	60	100	3
04.	CHUETK1	Petroleum Refinery Engineering	3	0	0	40	60	100	3
	CHUETK2	Organic Chemical Technology							
	CHUETK3	Fuel Combustion Energy Technology							
05.	CHUETK4	Process Equipment Design-I	3	0	0	40	60	100	3
	CHUETK5	Polymer Technology-I							
	Practical								
01.	CHUELT1	Heat Transfer Lab	0	0	3	25	25	50	1.5
02.	CHUELT2	Chemical Reaction Engineering Lab	0	0	3	25	25	50	1.5
03.	CHUEPV1	Mini Project-II	0	0	4	25	25	50	2.0
		Total	15	2	10	275	375	650	22

CIA : Continuous Internal Assessment SEA : Semester End Assessment	Total Credits : 22 Total Marks : 650	Total Periods / Week 27

The CIA (Theory) will be comprised of two Class Tests (CT) worth 15 marks each, an assignment/surprise test/quiz worth 05 marks, and 05 marks for class attendance throughout the semester.

SCHOOL OF STUDIES OF ENGINEERING & TECHNOLOGY
GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.)
(A Central University Established by the Central University Ordinance 2009, No. 3 of 2009)

SCHEME FOR EXAMINATION (NEP 2020) (Effective from Session 2024-25)
B. TECH. (FOUR YEAR) DEGREE COURSE, CHEMICAL ENGINEERING
THIRD YEAR, SIXTH SEMESTER

S. No.	Subject Code	Subject Name	Periods			Evaluation Scheme (Marks)			Credits
	Theory		L	T	P	CIA	SEA	Total	
01.	CHUFTT1	Mass Transfer-II	3	0	0	40	60	100	3
02.	CHUFTT2	Chemical Reaction Engineering-II	3	0	0	40	60	100	3
03.	CHUFTT3	Process Dynamics and Control	3	1	0	40	60	100	4
04.	CHUFTK1	Process Equipment Design-II	3	0	0	40	60	100	3
	CHUFTK2	Polymer Technology-II							
	CHUFTK3	Project Engineering Economics and Management							
	CHUFTK4	MOOCS-I	-	-	-	-	-		
05.	CHUFTK5	Petrochemical Technology	3	0	0	40	60	100	3
	CHUFTK6	Waste To Energy							
	CHUFTK7	Optimization Techniques in Chemical Engineering							
	CHUFTK8	MOOCS-II	-	-	-	-	-		
06.	CHUFTO1	MOOCS-III	-	-	-	-	-	100	3
	Practical								
01.	CHUFLT1	Mass Transfer Lab	0	0	3	25	25	50	1.5
02.	CHUFLT2	Process Dynamics and Control Lab	0	0	3	25	25	50	1.5
03.	CHUFPV1	Project	0	0	6	25	25	50	2.0
		Total	15	1	12	275	375	650	24

CIA : Continuous Internal Assessment SEA : Semester End Assessment	Total Credits : 24 Total Marks : 650	Total Periods / Week 28

The CIA (Theory) will be comprised of two Class Tests (CT) worth 15 marks each, an assignment/surprise test/quiz worth 05 marks, and 05 marks for class attendance throughout the semester.

1%

B. Tech. V Semester

CHUETT1 **Heat Transfer** **[L:3, T:1]**

Objective

To provide a fundamental understanding of heat transfer by conduction, convection and radiation, and heat exchange equipment used in heat transfer with or without phase change.

Contents

Unit I : Introduction to three modes of heat transfer, Derivation of heat balance equation, Steady state one-dimensional solution for conduction heat transfer in cartesian, cylindrical and spherical geometry, Critical insulation thickness, Lumped system approximation and Biot number, Approximate solution to unsteady conduction heat transfer by the use of Heissler charts.

Unit II : Heat transfer by convection, Boundary layers, Forced convection, Natural convection, Dimensionless parameters for forced and free convection heat transfer, Correlations for forced and free convection, Estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection.

Unit III : Interaction of radiation with materials, Definitions of radiative properties, Stefan Boltzmann's law, Black and Gray body radiation, Calculation of radiation heat transfer between surfaces using radiative properties, View factors, Radiosity method.

Unit IV : Types of heat exchangers, General design of parallel and counter-current flow, Double pipe heat exchanger, Shell and Tube heat exchanger, Analysis and design of heat exchangers using LMTD and ε-NTU methods.

Unit V : Evaporation, Types of evaporators, Single and multiple effect evaporators, Heat transfer from condensing vapours, Heat transfer to boiling liquids. Boiling and Condensation heat transfer, Pool boiling curve.

Text Books

1. A Heat Transfer Textbook by John H. Lienhard IV and John H. Lienhard V; Phlogiston Press, Cambridge, Massachusetts, U.S.A.
2. Unit Operations of Chemical Engineering by W. L. McCabe, J. C. Smith and P. Harriot; McGraw-Hill Inc.
3. Process Heat Transfer by D. Q. Kern; McGraw-Hill International Book Company.

Reference Books

1. Fundamentals of Momentum, Heat, and Mass Transfer by J. R. Welty, C. E. Wicks, R. E. Wilson and G. L. Rorrer; John Wiley & Sons.
2. Principles of Heat Transfer by Frank Kreith, Raj M. Manglik and Mark S. Bohn; Global Engineering, Cengage Learning, Stamford, USA.
3. Fundamentals of Heat and Mass Transfer by Frank P. Incropera, David P. Dewitt, Theodore L. Bergman, Adrienne S. Lavine; John Wiley & Sons.
4. Heat Transfer-A Practical Approach by Yunus A. Cengel; McGraw-Hill Inc.

2%

B. Tech. V Semester

CHUETT2 **Mass Transfer - I** **[L:3, T:1]**

Objective

To provide the understanding of mass transfer operations and impart the understanding of separation processes such as diffusion, distillation and absorption.

Contents

Unit I : Constitutive laws of diffusion, Molecular diffusion in gases and liquids, Diffusion velocities, Convective mass transfer, Interphase mass transfer and mass transfer coefficients, Theories of mass transfer, Correlations for the convective mass transfer coefficient.

Unit II : Vapor-liquid equilibria, Volatility, Enthalpy-concentration diagrams, Solubility of gases, Principles of Equilibrium stage operation, Determination of number of ideal stages for two-component systems by graphical and absorption factor methods.

Unit III : Flash distillation, Differential distillation, Steam distillation, Continuous distillation with rectification, Reflux ratio, Minimum reflux ratio, Calculation of number of plates – McCabe Thiele method, Lewis sorel method.

Unit IV : Fenske equation, Optimum reflux ratio, Analysis of fractionating column by enthalpy concentration diagram method, Plate efficiencies, Azeotropic distillation, Extractive distillation.

Unit V : Design of packed towers, Principles of absorption, Rate of absorption, HTU method.

Text Books

1. Unit Operations of Chemical Engineering by W. L. McCabe, J. C. Smith and P. Harriot; McGraw-Hill Education.
2. Principles of Mass Transfer and Separation Processes by B. K. Dutta; PHI Learning Pvt. Ltd.
3. Mass Transfer Operations by R. E. Treybal; McGraw-Hill Education.
4. Transport Processes and Unit Operations by C. J. Geankoplis; PHI Learning Pvt. Ltd.

Reference Books

1. Diffusion - Mass Transfer in Fluid Systems by E. L. Cussler; Cambridge University Press.
2. Principles of Unit Operations by A. S. Foust, L. A. Wenzel, C. W. Clump, L. Maus and L. B. Andersen; John Wiley & Sons.

Course Outcome

Students would be able to

1. Describe the basic theories and mechanism of diffusion and convective mass transfer.
2. Identify the concepts of phase equilibrium in mass transfer as well as equilibrium stage operations.
3. Understand binary separation principles of distillation and classify various distillation operations.
4. Design plate column for distillation operation.
5. Understand binary separation principles of absorption operation and design packed column for adsorption operation.

2%

B. Tech. V Semester

CHUETT3 **Chemical Reaction Engineering - I** **[L:3, T:0]**

Objective

To impart the knowledge of the kinetics and thermodynamics of single and multiple reaction and the effect of temperature and pressure on reaction systems.

Contents

Unit I : Kinetics and thermodynamics of chemical reactions, Kinetics of homogenous reactions, Rate theories, Analysis of rate equations.

Unit II : Interpretation of batch reactor data, Irreversible reactions, Total pressure method of kinetic studies, Analysis of complex rate equations, Complex reactions, Chain reactions, Variable volume reactions, Rate constants and equilibrium.

Unit III : Ideal batch reactors, Steady state mixed flow reactor, Steady state plug flow reactor, Size comparison of single reactors, Multiple-reactor system.

Unit IV : Introduction to multiple reaction, Qualitative treatment of product distribution and reactor size for parallel reactions, Reversible first order reactions in series.

Unit V : Temperature and pressure effects on single reaction, General graphical design procedure, Optimum temperature progression, Heat effects on adiabatic and non-adiabatic operations.

Text Books

1. Chemical Reaction Engineering by O. Levenspiel; John Wiley & Sons.
2. Elements of Chemical Reaction Engineering by H. S. Fogler, PHI Learning Pvt. Ltd.

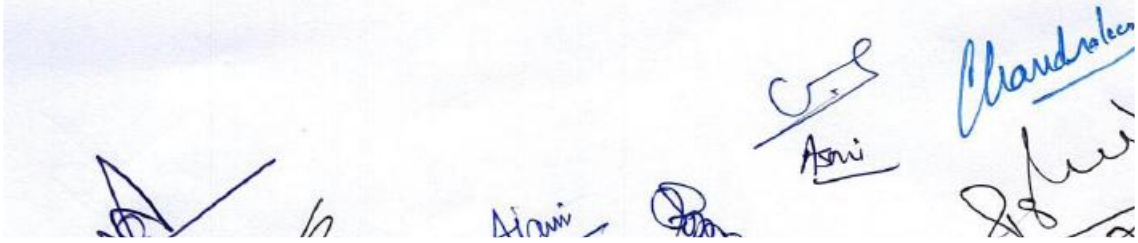
Reference Books

1. Reaction Kinetics for Chemical Engineers by S. M. Walas; Butterworths Publishers.
2. Chemical and Catalytic Reaction Engineering by J. J. Carberry; Dover Publications.
3. Chemical Reactor Analysis and Design by G. F. Froment, K. B. Bischoff and J. D. Wilde; John Wiley & Sons.

Course Outcome

Students would be able to

1. Develop rate of reaction for homogeneous reactions.
2. Interpret batch reactor data and analyse rate equations.
3. Design ideal reactors for single reactions.
4. Describe different aspects of design for multiple reactions.
5. Explain the effect of temperature and pressure on reaction rate.



2%

B. Tech. V Semester

CHUETK3 Fuel Combustion Energy Technology **[L:3, T:0]**

Objective

To understand the basics of various types of solid, liquid and gaseous fuels, basic principles of their combustion processes, its appliances, the fundamentals of the applied sciences dealing with various types of conventional and non-conventional energy resources.

Contents

Unit I : Solid Fuel : Origin, Composition, Classification, Properties & characterization of coal, Coal washing & storage, Carbonization, Briquetting, Gasification.

Liquid Fuel : Origin, Composition and classification, Properties & characterization of liquid fuels from petroleum.

Gaseous Fuel : Classification of gaseous fuel, Natural gas, LPG, Refinery gas, Producer gas, Water gas.

Unit II : Combustion Process and Calculations : General Principles of combustion, Flame, Draught, Limits of inflammability, Types of combustion Process like surface, submerged, pulsating, slow combustion, Fundamentals of various combustion calculations with numerical examples.

Unit IV : Energy Conservation and Biomass energy: Energy consumption pattern in various sectors, Various ways of energy conservation in various process industries, Energy efficient conversion devices, General principles with applications and technology of Biomass energy.

Unit V : Non – Conventional Energy Technologies : General principles with applications and technology of Geothermal energy, Wind energy, Nuclear energy, Hydal energy, Tidal energy, Ocean energy.

Text Books

1. Elements of Fuel Combustion & Energy Engineering by S. N. Saha; Dhanpat Rai Publishing Company.
2. Fuels and Combustion by S. Sarkar; Universities Press.

Reference Books

1. Elements of Fuel & Combustion Technology by O. P. Gupta; Khanna Publishing.
2. Fundamentals of Thermal Radiation for Energy Utilization in Fuel Combustion by S. Shan, Z. Zhou and Y. Zhang; Zhejiang University Press, Springer.

Asni

10%

B. Tech. V Semester

CHUETK4 Process Equipment Design - I **[L:3, T:0]**

Objective

To understand the mechanical and process design methods for various process vessels, head and shells used in process or chemical industries

Contents

Introduction : Concept of design pressure, Design temperature and allowable stress, Different types of welding joints, Joint efficiency.

Design of Pressure Vessel : Design of shell and head subjected to internal and external pressure, Design of various heads like flat plates, flanged, dished, hemispherical, ellipsoidal and conical, Shell design for external pressure with & without stiffening rings, Tall vessels

Design of Reaction Vessel : Design of jacketed and non-jacketed pressure vessel.

Design of Storage Tank and Various Supports : Types of storage tanks and their capacity, Design of various types of roofs, Leg support, Skirt support, Saddle support.

Text Books

1. Introduction to Chemical Equipment Design : Mechanical Aspects by B. C. Bhattacharya; CBS Publishers & Distributors Pvt. Ltd.
2. Process Equipment Design by L. E. Brownell and E.H. Young; John Wiley & Sons.
3. Process Equipment Design by M. V. Joshi and V. V. Mahajani; MacMillan India Ltd.
4. Chemical Engineering by J. M. Coulson and J. F. Richardson, Vol.-I; MacMillan, New York.
5. Process Equipment Design Volume 1 by S. D. Dawande; Dennet & Co.

Reference Books

1. Perry's Chemical Engineers' Handbook by D. W. Green and R. H. Perry, McGraw Hill Publication.
2. IS Codes.

Course Outcome

Students would be able to

1. Understand the basics of pressure vessel design.
2. Design the shell and head of pressure vessel.
3. Design the reaction vessel, storage vessels and their supports.

CO-PO Mapping

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	1	-	-	-	-	-	-	-	-	3	-	-
CO2	3	2	2	1	3	-	-	-	-	-	-	-	3	2	-
CO3	3	2	1	1	3	-	-	-	-	-	-	-	3	2	-

Weightage : 1-Weak, 2-Moderate, 3-Strong

2%

B. Tech. VI Semester

CHUFTT1 **Mass Transfer - II** **[L:3, T:0]**

Objective

To provide basic knowledge of mass transfer operations and understand the mass transfer in LLE, leaching, drying, crystallization, adsorption and humidification operation.

Contents

Unit I : Humidification operations, Humidity chart and its use in measurement of humidity, Calculations of humidification operations, Adiabatic humidification, Design of cooling towers.

Unit II : Leaching, Equipment, Principles of leaching, Calculation of number of ideal stages, Stage efficiency.

Unit III : Liquid- Liquid Extraction, Principles of extraction, Panchon-Savorit method, Counter-current extraction using reflux, Application of McCabe method.

Unit IV : Crystallization, Yield of crystals, Heat effects in crystallization process, Supersaturation, Nucleation and crystal growth, Applications.

Unit V : Principles of drying, Mechanism and theory of drying, Calculation of drying time.

Text Books

1. Principles of Mass Transfer and Separation Processes by B. K. Dutta; PHI Learning Pvt. Ltd.
2. Mass Transfer Operations by R. E. Treybal; McGraw Hill Education.
3. Transport Processes and Unit Operations by C. J. Geankoplis; PHI Learning Pvt. Ltd.

Reference Books

1. Principles of Unit Operations by A. S. Foust, L. A. Wenzel, C. W. Clump, L. Maus and L. B. Andersen; John Wiley & Sons.

Course Outcome

Students would be able to

1. Understand the humidification operation and cooling tower design.
2. Solve the problems related to leaching and have acquaintance with the leaching equipment.
3. Explain the basics of extraction, and solve related problems.
4. Demonstrate the principle of crystallization and calculations.
5. Identify the basics mechanisms of drying and drying time.

CO-PO Mapping

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	1	-	-	-	-	-	-	-	-	3	1	-
CO2	3	1	1	1	-	-	-	-	-	-	-	-	3	2	-
CO3	3	1	1	1	-	-	-	-	-	-	-	-	3	2	-
CO4	3	1	1	1	-	-	-	-	-	-	-	-	3	1	-
CO5	3	1	2	1	-	-	-	-	-	-	-	-	3	2	-

Weightage : 1-Weak, 2-Moderate, 3-Strong

1%

B. Tech. VI Semester

CHUFTT2 **Chemical Reaction Engineering - II** **[L:3, T:0]**

Objective

To impart fundamental knowledge of non-ideal flow pattern, age distribution, fluid-particle reaction, fluid-fluid reaction behaviour and basics of catalyst and their method of synthesis.

Contents

Unit I : Basics of non-ideal flow, Age distribution of fluid, RTD, Conversion in non-ideal flow reactors, Models for non-ideal flow, Chemical reaction and dispersion, Tank in series.

Unit II : Mixing of fluids, Self-mixing of single fluid, Degree of segregation, Early and late mixing, Mixing of two miscible fluids.

Unit III : Fluid particle reactions, Unreacted core model, Diffusion through gas film, Ash layer control, Chemical reaction control, Shrinking core model for spherical particles and their rate controlling steps.

Unit IV : Fluid-fluid reactions, Kinetic study of various regimes like mass transfer and reaction, Film conversion parameter, Application of reactive and extractive system.

Unit V : Catalysis, Properties of catalysts including homogeneous and heterogeneous catalysts, Preparation of catalyst, Adsorption on solid surface, Steps in catalytic reactions synthesizing.

Text Books

1. Elements of Chemical Reaction Engineering by H. S. Fogler; PHI Learning Pvt. Ltd.
2. Principles of Reaction Engineering by S.D. Dawande; Central Techno Publications.
3. Chemical Reaction Engineering by O. Levenspiel; John Wiley & Sons.

Reference Books

1. Chemical Engineering Kinetics by J. M. Smith; McGraw Hill Education.
2. Chemical Engineering by J. M. Coulson and J. F. Richardson, Vol.-4; MacMillan, New York.

Course Outcome

Students would be able to

1. Understand the fundamental of non-ideal flow pattern and RTD.
2. Learn the fundamentals of mixing of fluids.
3. Understand the various models used in fluid particle system.
4. Understand the kinetics of fluid-fluid particle system.
5. Learn the fundamental of catalyst synthesis and their applications.

CO-PO Mapping

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	3	-	-	-	-	-	-	-	3	2	-
CO2	3	2	2	1	-	1	-	-	-	-	-	-	3	-	-
CO3	3	2	1	1	-	-	-	-	-	-	-	-	3	-	-
CO4	2	2	2	1	3	1	-	-	-	-	-	-	3	-	-
CO5	3	3	2	2	3	1	-	-	-	-	-	-	3	2	-

Weightage : 1-Weak, 2-Moderate, 3-Strong

10%

B. Tech. VI Semester

CHUFTT3 Process Dynamics and Control **[L:3, T:1]**

Objective

To provide a comprehensive understanding of process control principles, techniques, and applications in chemical engineering.

Contents

Unit I : Laplace transform technique used to convert functions, facilitating the analysis and design of control systems.

Unit II : Linear open loop system, The first and second order systems and their transient response Interacting and non-interacting systems, Linearization, Transportation lag.

Unit III : Linear closed loop system-control system, block diagram, closed loop transfer function, Controllers, Transient response of closed loop systems.

Unit IV : Pneumatic controller mechanism, baffle nozzle, proportional controller mechanism, Proportional integral control, Proportional derivative control value, PID control, Final control element, Control valve, Feed forward control, Controller tuning.

Unit V : Stability concept, Routh stability criterion, Nyquists stability criterion, Root locus technique, introduction to frequency response, Bode diagram, Bode stability criterion, Gain and phase margins, Fuzzy Logic Control.

Text Books

1. Process Systems Analysis and Control by D. R. Coughanowr and S. E. LeBlanc; McGraw-Hill Education.
2. Chemical Process Control: An Introduction to Theory and Practice by G. Stephanopoulos Pearson Education.

Reference Books

1. Process Dynamics and Control by D. E. Seborg, T.F. Edgar, D. A. Mellichamp and F. J. Doyle III; John Wiley & Sons.

Course Outcome

Students would be able to

1. Demonstrate an understanding of the importance of process control in chemical plants and different control systems.
2. Apply Laplace transformations and transfer functions to analyze simple systems, including linearization and response of systems with dead time.
3. Analyze and evaluate the response of linear open loop and closed loop systems, including stability and transient response.
4. Utilize root locus and stability criteria to determine system stability and transient response characteristics.
5. Design and tune control systems using frequency response techniques, and understand the basics of advanced controllers and artificial intelligence.