

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code: **PP-501** Course Title: Pulping

2. Contact Hours: **L: 3 T: 1 P: 2/2**

3. Examination Duration (Hrs.): **Theory** **Practical**

4. Relative Weightage: **CWS** **PRS** **MTE** **ETE** **PRE**

5. Credits: 6. Semester: **Autumn** 7. Subject Area: **PCC**

8. Pre-requisite: **Nil**

9. Objective: To provide knowledge to the students regarding Fibrous Raw Material with the details of physical and chemical characteristic, storage, preparation for pulping and various types of pulping methodologies used for pulp manufacture.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction: Importance of paper, definitions of pulp, paper and paperboard; Flow sheet of complete pulp and paper making process.	1
2.	Fibrous Raw Materials for Paper Making: Plant fibers, plant kingdom, plant body and organization of fibers and other cells in plant.	1
3.	Raw Material Structure: Structure of softwoods, hardwoods, and non-woods; Pulpwood species; Cell types; Ultra structure of cell wall; Physical properties, variability, and defects of raw materials.	3
4.	Chemistry of Fibrous Raw Materials: Gross composition; Distribution of wood constituents, cellulose, hemi-cellulose, lignin, extractives, and inorganic components; Lignin-hemi-cellulose bonds; Comparison of different raw materials, Assessment of raw material for papermaking, pulping reactions.	6
5.	Preparation of Fibrous Raw Material: Transportation, procurement, handling, storage and preservation; Debarking, Depithing, chipping, screening, cleaning, and conveying operations.	5
6.	Kraft and Soda Pulping Cycle: Overview of alkaline pulping, kraft and soda pulping, standard terminologies. Description of kraft cooking process, kraft recovery cycle, composition and analysis of white liquor	4
7	Pulp Mill Operations: Batch and continuous digesters and their operations, heating systems, blowing, cold blowing, and blow heat recovery system; Process variables, dependence of time and temperature, H-factor, control parameters.	9
8	Kraft Process Modifications: Digester additives; Extended delignification processes; Modified continuous cooking, super batch, rapid displacement heating process.	5

9	Pulp Characterization: Effect of raw material on pulp quality; Evaluation of pulps, kappa number, viscosity, and drainability.	3
10	Mechanical and High yield Pulping: Classification of mechanical pulping process; Grinders, pulpstone, RMP, CRMP, TMP, and CTMP; Types of high-yield pulping processes; Neutral sulphite semi-chemical (NSSC) pulping; Cold soda, acid sulphite, bisulphite etc chemi-mechanical pulping processes Properties and end uses of mechanical pulps.	5
	Total	42

List of Experiments:

1. Microscopic study of morphological characteristics of papermaking fibers.
2. Determination of solubility of fibrous raw material in hot water, 1% NaOH, and alcohol-benzene.
3. Determination of lignin in raw material.
4. Determination of holocellulose in raw material.
5. Determination of pentosans in raw material.
6. Pulping of Raw material
7. Baur Mcnett fibre classification
8. Determination of kappa number.

Suggested Books:

S. No.	Name of Book / Authors	Year of Publication
1.	Browning B. L. "The Chemistry of Wood", John Wiley & Sons.	1981
2.	Kocurek M. J., "Pulp and Paper Manufacture, Volume 1: Properties of Fibrous Raw Materials and their Preparation for Pulping (Ed. Kocurek M. J. and Stevens C. F. B.)", TAPPI Press.	1983
3.	Gullichsen J. and Paulapuro H., "Papermaking Science and Technology, Book 3: Forest Products Chemistry (Ed. Stenius P.)", Finnish Paper Engineers' Association and TAPPI.	1998
4.	Sjostrom E., "Wood Chemistry Fundamentals and Applications", 2 nd Ed., TAPPI Press.	1993
5	Smook G. A. "Handbook for Pulp and Paper Technologists", 7 th Ed., TAPPI Press.	1989
6	Casey J. P. "Pulp and Paper Chemistry and Chemical Technology", Vol. 1, 3rd Ed., John Wiley and Sons.	1984
7	Gullichsen J. and Paulapuro H., "Papermaking Science and Technology, Book 6: Chemical Pulping (Ed. Gullichsen J and Fogelholm C-J.)", Finnish Paper Engineers' Association and TAPPI.	2009
8	Gullichsen J. and Paulapuro H., "Papermaking Science and Technology, Book 5: Mechanical Pulping (Ed. Sundholm J.)", Finnish Paper Engineers' Association and TAPPI.	2009
9	Kocurek M. J., "Pulp and Paper Manufacture, Volume 5: Alkaline Pulping (Ed. Grace T. M. and Melcolm E. W.)", TAPPI Press	1989
10	Kocurek M. J., "Pulp and Paper Manufacture, Volume 2: Mechanical Pulping (Ed. Leask R. A.)", TAPPI Press.	1987

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code: **PP-503** Course Title: **Chemical Recovery Process**

2. Contact Hours: **L: 3 T: 1 P: 2/2**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weightage: **CWS** 20 **PRS** 20 **MTE** 20 **ETE** 40 **PRE** 0

5. Credits: 4 6. Semester: **Autumn** 7. Subject Area: **PCC**

8. Pre-requisite: **Nil**

9. Objective: To impart knowledge of chemical recovery technology for chemicals, energy and by products from black liquor.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Introduction: Kraft and Soda recovery cycles, various terms associated with chemical Process; Impact of pulping and washing on chemical recovery process	3
2	Black Liquor Properties: Chemical, physico-chemical, thermal and polymeric properties	5
3	Black Liquor Treatment: Importance and methods of black liquor oxidation and desilication	3
4	Concentration of Black Liquor: Multiple effect evaporators (MEE), process design calculations- feeding sequence, heat transfer area optimum cycle time; Scale formation and its remedies; Instrumentation and control of MEE; Condensers- indirect and direct types, process design calculations; Steam jet ejectors- operating principle, entrainment ratio, motive steam requirement, performance factors, load calculation	10
5	Incineration of Black Liquor: Process chemistry, incineration process, recovery boilers and accessories, boiler safety, NO _x generation, material and energy balance calculations, parameters affecting thermal performance; Recovery of fume particles, ESP, calculation of corona voltage, ionic density, corona current, particle charging, migration velocity, variables affecting emission of particulate from ESP; Cogeneration with recovery boiler	9
6	Causticizing of Green Liquor: Green liquor treatment and clarification, slaking and causticizing reactions, causticization equilibrium, causticizing efficiency; White liquor clarification, mud washing and filtration equipment, soda loss in lime sludge, process design calculations for clarifiers, slakers, causticizers and mud filters; Soda, sulphur and water balance across the causticization plant	6

7	Lime Mud Reburning: Process description, lime kiln, variables affecting lime mud reburning, material and energy balance calculations, instrumentation and control	3
8	Non Conventional Recovery Systems: Process description of various unconventional recovery processes, application in medium and small scale paper mills, production of lignin derivatives from black liquor	3
	Total	42

List of Experiment:

- i. Salt cake Analysis
- ii. Available CaO in Lime Sample
- iii. Green liquor analysis
- iv. Sludge/Mud Analysis
- v. White liquor analysis
- vi. Black liquor analysis

11. Suggested books:

S. No.	Name of Authors/Book /Publisher	Year of Publication/ Reprint
1	Hough, G., "Chemical Recovery in Alkaline Pulping Processes" TAPPI Press	1985
2	Kocurek, M. J., "Pulp and Paper Manufacture, Volume 5: Alkaline Pulping (ed. Grace, T. M. and Melcolm, E. W.)", TAPPI Press	1989
3	Adams, T. N., Frederick, W. J., Grace, T. M., Hupa, M., Iisa, K., Jones, A. K. and Tran, H. N., "Kraft Recovery Boiler" TAPPI Press	1997
4	Gullichsen, J. and Paulapuro, H., "Papermaking Science and Technology, Book 6B: Chemical Pulping (ed. Gullichsen, J and Fogelholm, C-J.)", Finnish Paper Engineers' Association and TAPPI	2009

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code: **PP-505** Course Title: **Paper Properties and Stock Preparation**

2. Contact Hours: **L: 3 T: 1 P: 2/2**

3. Examination Duration (Hrs.): **Theory** **Practical**

4. Relative Weightage: **CWS** **PRS** **MTE** **ETE** **PRE**

5. Credits:

6. Semester: **Autumn**

7. Subject Area: **PCC**

8. Pre-requisite: **Nil**

9. Objective: To impart knowledge of paper properties and stock preparation for papermaking.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction: Surface and colloid chemistry interactions, fiber water systems, Electrokinetic behavior of stock, charge determination, zeta potential, cationic demand.	4
2	Structural Properties: Definitions and methods of determination of grammage, caliper, bulk, smoothness and porosity; Standardization of size.	3
3	Mechanical Properties: Definitions and methods of determination of tensile strength, tear strength, burst strength, folding endurance, and bending stiffness.	4
4	Optical Properties: Interaction of light with paper, reflectance; Definitions and methods of determination of brightness, opacity, gloss and color.	3
5	Resistance Properties: Permeation of fluid through paper, water absorbancy, Cobb test, oil absorbancy, air/gas permeability.	2
6	Refining: Mechanism of refining, variables affecting refining, controlling parameters; Types of refiner; Effect of refining on pulp and paper properties.	5
7.	Sizing: Basic surface science considerations in sizing, measurement of sizing; Types of sizing agents, rosin, AKD, ASA; Trouble-shooting of sizing problems.	4

8.	Strength Additives: Dry and wet strength additives, mechanisms of strength development, factors affecting wet and dry strength properties.	3
9.	Fillers and Dyes: Types of fillers, properties of fillers, effect of fillers on optical and mechanical properties of paper; Dyes and pigments, dyeing of paper.	3
10	Control Chemicals at the Wet End: Retention aids, drainage aids, defoamers, deflocculants and pitch controlling agents.	2
11	Approach Flow System: Description of different functions in approach flow system such as control of consistency, freeness and thick stock flow, dilution, screening and cleaning, deaeration, Fan pump.,	6
12	Sheet Structure: Consolidation of the web, fiber bonding, characterization of the sheet structure, formation, fiber orientation, relative bonded area, sheet density, anisotropy, crowding factor, formation index.	3
	Total	42

List of Experiment

1. Beating of a given pulp and preparation of hand sheets at different °SR and CSF.
2. To determine strength properties of hand sheets prepared in Experiment 1: Tensile index, Stretch, Burst index, Folding endurance, and Tear index.
3. Preparation of hand sheets from a given pulp at different dosing of sizing agents.
4. Evaluation of sizing efficiency as a function of sizing dose for the hand sheets prepared in Experiment 3.
5. Preparation of hand sheets at different dosing of fillers.
6. Evaluation of brightness and opacity as function of ash retained for the hand sheets prepared in Experiment 5.

11. Suggested books:

S. No.	Name of Authors/Book /Publisher	Year of Publication/ Reprint
1	Kocurek, M. J., "Pulp and Paper Manufacture, Volume 6: Stock Preparation (Ed. Hagemeyer, R. W. and Manson, D. W.)", TAPPI Press	1992
2	Casey J. P., "Pulp and Paper: Chemistry and Chemical Technology", Vol. 2, 3 rd Ed., John Wiley	1981
3	Gullichsen, J. and Paulapuro, H., "Papermaking Science and Technology, Book 8: Papermaking Part 1, Stock Preparation and Wet End (ed. Paulapuro, H.)", Finnish Paper Engineers' Association and TAPPI	2009

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code: **PP- 511** Course Title: **Modeling and Simulation**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3 Examination Duration (Hrs.): **Theory** **Practical**

4. Relative Weightage: **CWS** **PRS** **MTE** **ETE** **PRE**

5. Credits: 6. Semester: **Autumn** 7. Subject Area: **PEC**

8. Pre-requisite: **Nil**

9. Objective: To introduce the concepts of modeling and simulation and their application to industrial processes.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction to process modeling and simulation	3
2.	Fundamentals of modeling techniques, classification of models, physical models, deterministic models and probabilistic models, empirical models; Development of algorithms and flow-charts for solving practical problems.	6
3.	Modeling of reactors- batch, CSTR, CSTR bioreactors	3
4.	Modeling of separation process such as distillation, filtration, sedimentation, extraction, and screening classification; Modeling of evaporation; Examples from pulp and paper	6
5.	Simulation of discrete and continuous system, Monte-Carlo methods, system identification, simulation for econometric models, random number generation methods, application of simulation to industrial problems.	7
6.	Iterative convergence method for solution of non linear equations, numerical	6

	integration of ODE, finite difference approximation of partial differential equations and their solutions	
7.	Introduction to process simulators-ASPEN PLUS, DYN SIM, g-PROMS, WINGEMS; Application to simulation to industrial processes	11
	Total	42

11. Suggested books

S. No.	Name of Authors/Book/Publisher	Year of Publication/ Reprint
1.	Luyben W. L., "Process Modeling Simulation and Control for Chemical Engineers", 2 nd ed., McGraw Hill.	1990
2.	Babatunde A. O. and Ray W. H., "Process Dynamics, Modeling and Control", Oxford University Press.	1994
3.	Jana A.K., "Process Simulation and Control using ASPEN", Prentice Hall	2009
4.	Denn M.M., "Process Modeling" Longman.	1986
5.	Johnson, R. A. and Wichern, D. W., "Applied Multivariate Statistical Analysis" 5 th ed., Pearson Education.	2002
6.	Edgar, T. F., Himmelblau, D. M. and Lapidus, L. S., "Optimization of Chemical Processes", McGraw Hill.	2001
7.	Levin D.R., "Using Process Simulators in Chemical Engineering- A Multimedia Guide for Core Curriculum", 2 nd ed. Wiley.	2003

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code: **PP-513** Course Title: **Processes Optimization**

2. Contact Hours: **L: 3 T:1 P: 0**

3. Examination Duration (Hrs.): **Theory** **Practical**

4. Relative Weightage: **CWS** **PRS** **MTE** **ETE** **PRE**

5. Credits: 6. Semester: **Autumn** 7. Subject Area: **PEC**

8. Pre-requisite: **Nil**

9. Objective: To introduce various techniques of optimization and their application to chemical processes.

10. Details of Course:

S.No.	Contents	Contact Hours
1.	Introduction: Optimization and calculus based classical optimization techniques.	5
2.	One Dimensional Minimization Methods: Elimination methods- equally spaced points method, Fibonacci method and golden section method; Interpolation methods- quadratic interpolation and cubic interpolation, Newton and quasi-Newton methods.	6
3.	Linear Programming: Graphical representation, simplex and revised simplex methods, duality and transportation problems.	7
4.	Multivariable Non-Linear Programming: Unconstrained- univariate method, Powell's method, simplex method, rotating coordinate method, steepest descent method, Fletcher Reeves method, Newton's method, Marquardt's method and	9

	variable metric (DFP and BFGS) methods; Constrained- complex method, feasible directions method, GRG method, penalty function methods and augmented Lagrange multiplier method.	
5.	Dynamic Programming: Multistage processes- acyclic and cyclic, suboptimization, principle of optimality and applications.	4
6.	Geometric Programming (GP): Differential calculus and Arithmetic-Geometric inequality approach to unconstrained GP; Constrained GP minimization; GP with mixed inequality constraints and Complementary GP.	6
7.	Emerging Optimization Techniques: Genetic algorithm, simulated annealing, particle swarm and ant colony optimization.	5

11. Suggested books:

S. No.	Name of Authors/Book /Publisher	Year of Publication/Reprint
1.	Edgar T.F., Himmelblau D.M. and Lasdon L.S., "Optimization of Chemical Processes", 2nd Ed., McGraw Hill.	2001
2.	Beveridge G.S.G. and Schechter R.S., "Optimization: Theory and Practice", McGraw Hill.	1970
3.	Rao S.S., "Engineering Optimization Theory and Practice", 4th Ed., Wiley.	2009

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Paper Technology**

1. Subject Code: **PP-515** Course Title: **Advance Numerical Methods and Statistics**

2. Contact Hours: **L: 3 T: 1 P: 0**

3. Examination Duration (Hrs.): **Theory** **Practical**

4. Relative Weightage: **CWS** **PRS** **MTE** **ETE** **PRE**

5. Credits: 6. Semester: **Autumn** 7. Subject Area: **PEC**

8. Pre-requisite: **Nil**

Objective: To introduce the students to the numerical methods for solving engineering problems and mathematical tools of probability theory and statistics.

10. Details of Course:

S.No.	Contents	Contact Hours
1.	Newton-Raphson and iterative methods for finding roots of a non-linear equation(s), In one and two variables. LU-decomposition, Jacobi, Gauss-Seidel and SOR method for a system of linear equations.	6
2.	Newton's forward, backward, Straling's, Lagrange's and Newton's divided difference formula; Review of various numerical differentiation formulae and some numerical integration formulae, Trapezodial, Simpson's and Gauss-Legendre Quadrature formulae.	6
3.	Euler, Modified Euler, second and fourth order Runge-Kutta methods for solving initial value problems; Finite difference approximations to two-point boundary value problems.	4
4.	Numerical solution of parabolic and elliptic partial differential equations using finite difference approach; Method of weighted residuals such as collocation, least square and Galerkin's method.	6
5.	Review of concept of probability; Random variable, discrete and continuous probability distributions, moments and moment generating functions. Some special distributions such as binomial, Poisson, negative binomial, Geometric, Uniform, Normal, Exponential, Gamma, Beta, Weibull, Log normal and Pearsons; Sampling techniques, Sampling distributions.	11
6.	Bivariate distributions, Independence, Correlation and Regression. Point and interval estimation. Testing of hypothesis; Analysis of variance and concept of design of experiment.	11

11. Suggested books:

S. No.	Name of Authors/Book /Publisher	Year of Publication/ Reprint
1.	Hog R.V. and Craig A., "Introduction to Mathematical Statistics", 5 th edition, Pearson Education	2006
2.	Rao C.R., "Linear Statistical Inference and its Application" 2 nd Edition, Wiley Eastern, Springer	2005
3.	Conte S.D. and Carl de Boor., "Elementary Numerical Analysis", McGraw-Hill	2000
4.	Jain M.K., Iyenger, S.R.K. and Jain R.K., Numerical Methods for Scientific and Engineering Computations, New Age International Pvt. Ltd.	2001

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE:

Department of Paper Technology

1. Subject Code: **PP-521**

Course Title: **Process Automation**

2. Contact Hours: **L: 3 T: 0 P: 2/2**

3. Examination Duration (Hrs.): **Theory**

3

Practical

0

4. Relative Weightage: **CWS**

20

PRS

20

MTE

20

ETE

40

PRE

0

5. Credits:

3

6. Semester: **Autumn**

7. Subject Area: **PEC**

8. Pre-requisite: **Nil**

9. Objective: To impart knowledge of measurement and instrumentation sensors, control concepts and automation techniques, and their applications to pulp and paper technology.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction: Importance of instrumentation and control in process industries; on and offline measurements of process variables in various section of paper industry; classification of transducers, selection criteria of transducers; static characteristics and errors;	6
2.	Process Parameters and Measurement: Working principles for the measurement of flow, level, pressure, temperature related to the paper industry.	6
3.	Process Parameters and Measurement: Working principles for the measurement of consistency, moisture, and basis weight related to the paper industry.	6
4.	Modes of Control Action: Overview of the control system, classification of process control strategies, transient response; two position control, multi-position control, proportional (P), integral (I), derivative (D), PI, PD, and PID controllers; feed-forward, feedback, cascade and ratio control systems.	6
5.	Industrial Control Systems: Block diagram and architecture of, electronic, microprocessor, programmable and distributed control systems; PLC and	6

	DCS based systems and their advantages and limitations, Application of PLC and DCS based system, advanced control systems.	
6.	Output Devices: Graphical recorders, display devices, electro-pneumatic converters and pneumatic control valves.	6
7.	Applications in Pulp and Paper Industry: Concept of instrumentation and piping diagram Piping and instrument diagram for digester, lime-kiln, bleach plant, evaporators, washing and paper machine.	6
	Total	42

List of Experiments:

1. To study and measurement of temperature using RTD (pt-100).
2. To design and test analog signal condition Circuits.
3. To design and test digital signal condition Circuits.
4. To study and test liquid level control system using different control modes (P, I, PI and PID)
5. To study and test flow control system using different control modes (P, I, PI and PID)
6. To study and test temperature control system using different control modes (P, I, PI and PID)
7. Performance a various type of controller to control the temperature of an oven using different control modes (P, I, D, PI and PID)
8. To study the Response of the various simulated liner system.

11. Suggested Books:

S. No.	Name of Book / Authors	Year of Publication
1.	Coughanour D.R., 2 nd Ed., "Process System Analysis and Control", McGraw Hill.	2009
2.	Eckman D.P., 'Industrial Instrumentation' John Wiley & Sons.	2010
3.	Gullichsen J. and Paulapuro H., "Papermaking Science and Technology, Book 14: Process Control (ed. Lieviskä K.)", Finnish Paper Engineers' Association and TAPPI.	2009
4.	Kocurek M. J., "Pulp and Paper Manufacture, Volume 10: Mill-wide Process Control and Information Systems (Ed. Kocurek M. J. and Stevens, C. F. B.)", TAPPI Press	1993
5.	Lavigne J.R., "Introduction to Paper Industry Instrumentation" Miller Freeman.	1996

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE:

Department of Paper Technology

1. Subject Code: **PP-523**

Course Title: **Process Instrumentation & Control**

2. Contact Hours: **L: 3 T: 0 P: 2/2**

3. Examination Duration (Hrs.): **Theory**

3

Practical

0

4. Relative Weightage: **CWS**

20

PRS

20

MTE

20

ETE

40

PRE

0

5. Credits:

3

6. Semester: **Autumn**

7. Subject Area: **PEC**

8. Pre-requisite: **Nil**

9. Objective: To provide knowledge about measurement of various parameters and instrumentation. Control concepts and automation techniques, and their applications to pulp and paper technology.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction: Importance of instrumentation in process industries; block diagram; Transducers, their classification and selection criteria; on and offline measurements.	4
2.	Static Characteristics of Instruments: Accuracy, precision, sensitivity, reproducibility, drift, threshold, hysteresis, resolution, repeatability, stability, linearity, span and range, live zero, and errors with examples.	3
3	Process Parameters and Measurement: Working principles for the measurement of flow, level, pressure, temperature using mechanical, electrical, ultrasonic methods and their advantages and disadvantages of these measurement methods with reference to process parameters.	10
4.	Signal Conditioning: Analog and digital signal conditioning units used in measurements; signal isolation and signal transmitter.	4
5.	Control Block: Block diagram of different control systems like pneumatic, electronic digital, PLC, DCS and their brief description.	3

6.	Modes of Control Action: Overview of the control system, classification of process control strategies, transient response; two position control, multi-position control, proportional (P), integral (I), derivative(D), PI, PD, and PID controllers; feed-forward, feedback, cascade and ratio control systems.	6
7.	Output Devices: Graphical recorders, display devices, electro-pneumatic converters and pneumatic control valves.	6
8.	Applications in Pulp and Paper Industry: Concept of instrumentation and piping diagram Piping and instrument diagram for digester, lime-kiln, bleach plant, washing and paper machine.	6
	Total	42

List of Experiments:

1. To study and measurement of temperature using RTD (pt-100).
2. To design and test analog signal condition Circuits.
3. To design and test digital signal condition Circuits.
4. To study and test liquid level control system using different control modes (P, I, PI and PID)
5. To study and test flow control system using different control modes (P, I, PI and PID)
6. To study and test temperature control system using different control modes (P, I, PI and PID)
7. Performance a various type of controller to control the temperature of an oven using different control modes (P, I, D, PI and PID)
8. To study the Response of the various simulated liner system.

11. Suggested Books:

S. No.	Name of Books / Authors	Year of Publication
1.	Andrew W.G., "Applied Instrumentation in the Process Industries", Vol. I, 3 rd Ed., Gulf Publishing Company.	1993
2.	Lavigne J.R., "Introduction to Paper Industry Instrumentation" Miller Freeman.	1996
3.	Andrew W.G., "Applied Instrumentation in the Process Industries", Vol. II, 3 rd Ed., Gulf Publishing Company.	1993
4.	Eckman D.P., "Industrial Instrumentation", John Wiley.	2010
5.	C.D. Johnson, <i>Process Control Instrumentation Technology</i> , Prentice Hall of India, 3 rd ed., New Delhi , ISBN No: 0137-14783X.	2009
6.	Ghosh A.K., "Introduction to Instrumentation and Control", 4 th Ed., Prentice Hall of India.	2005

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE:

Department of Paper Technology

1. Subject Code: **PP-525**

Course Title: **Computer Based Control System**

2. Contact Hours: **L: 3 T: 0 P: 2/2**

3. Examination Duration (Hrs.): **Theory**

3

Practical

0

4. Relative Weightage: **CWS**

20

PRS

20

MTE

20

ETE

40

PRE

0

5. Credits:

3

6. Semester: **Autumn**

7. Subject Area: **PEC**

8. Pre-requisite: **Nil**

9. Objective: Modern Process control, the nature of data handling and processing task for controlling parameter is changing very rapidly. Recent trends in the development of automatic controls in all industries by using computer control system.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction: Introduction to process control and computer based control, Terminology & Definitions, Block diagrams of control system, Industrial control, Process control & its objectives, Developments in control, Examples of control System	6
2.	Process Parameters and Measurement: Working principles for the measurement of consistency, moisture, and basis weight related to the paper industry.	6
3.	Block diagrams of Control Systems: Analog and digital control, electronic control, PC based, direct digital, programmable, centralized & distributed based, fuzzy and neural based control system.	6
4.	Modes of Control Action: Overview of the control system, classification of process control strategies, transient response; two position control, multi-position control, proportional (P), integral (I), derivative (D), PI, PD, and PID controllers; feed-forward, feedback, cascade and ratio control systems.	6

5.	Control Valves: Functions of control valves (CV), types, selection, application, and Comparison of different of control valves, actuators	6
6.	Programmable Logical Controllers and SCADA: PLC over relay control, PLC overview, PLC features and benefits, PLC applications, supervisor control and data acquisition (SCADA), hardware and software architecture, bus structure, input output modules.	6
7.	Distributed Control Systems: Introduction to DCS, centralized vs distributed control advantages of DCS, selections of DCS, requirement of DCS for plant, maintenance, design and development, DCS for manager and supervisors, comparison between PLC and DCS	6
	Total	42

List of Experiments:

1. To study and measurement of temperature using RTD (pt-100).
2. To study and test liquid level control system using different control modes (P, I, PI and PID)
3. To study and test flow control system using different control modes (P, I, PI and PID)
4. To study and test temperature control system using different control modes (P, I, PI & PID)
5. Performance a various type of controller to control the temperature of an oven using different control modes (P, I, D, PI and PID)
6. To study the Response of the various simulated liner system.

11. Suggested Books:

S. No.	Name of Book / Authors	Year of Publication
1.	Coughanour D.R., 2 nd Ed., "Process System Analysis and Control", McGraw Hill.	1991
3.	C.D. Johnson, <i>Process Control Instrumentation Technology</i> , Prentice Hall of India, 3 rd ed., New Delhi, ISBN No: 0137-14783X.	2009
4.	Krishan Kant, <i>Computer Based Industrial Control</i> , Prentice Hall of India, New Delhi,	2002
5.	B.G.Liptek, <i>Process Measurement and Analysis by, Instrument Engineers Handbook</i> , fourth Edition, ISBN 0-8493-1083-0 (v-1), CRC Press, (ISA)	2009
6.	Kocurek M. J., "Pulp and Paper Manufacture, Vol.10: Mill-wide Process Control and Information Systems (Ed. Kocurek M. J. and Stevens, C. F. B.)", TAPPI Press	1993
7.	Lavigne J.R., "Introduction to Paper Industry Instrumentation" Miller Freeman.	1996