Annexure-II

Curriculum and Syllabi

Master of Technology
in
Chemical Engineering

Coordinator: HOD of Chemical Engineering

Duration of Course: Two years (4 Semesters)

Department of Chemical Engineering

National Institute of Technology Durgapur
Mahatma Gandhi Road, Durgapur, West Bengal, India, Pin –713209

Department of Chemical Engineering

M. Tech. in Chemical Engineering

Full Time

Sl.No.	**Code**	**CourseTitle**	**L**	**T**	**P**	**CP**
SemesterI						
1.	CH1001	AdvancedFluid Dynamics	3	1	0	04
2.	CH1002	Environmental Engineering	3	1	0	04
3.	CH1003	ProcessModelingand Simulation	3	1	0	04
4.		Elective I	3	1	0	04
5.		Elective II	3	1	0	04
6.	CH1051	EnvironmentalEngineeringLaboratory	0	0	3	02
7.	CH1052	AdvancedComputingLaboratory	0	0	3	02
		TotalCredit				**24**

Semester II						
1.	CH2001	ProcessDynamicsand Control	3	1	0	04
2.	CH2002	AdvancedMass Transfer	3	1	0	04
3.	CH2003	AdvancedHeatTransfer	3	1	0	04
4.		Elective III	3	1	0	04
5.		Elective IV	3	1	0	04
6.	CH2051	ProcessModellingandSimulationLaboratory	0	0	3	02
7.	CH2052	Seminar I (Non-Project)	0	0	2	01
8.	CH2053	Project I	0	0	2	01
		TotalCredit				**24**
Semester III						
1.	CH3051	Project-II				11
2.	CH3052	ProjectSeminar-I				02
		TotalCredit				**13**
SemesterIV						
1.	CH4051	Project-III				11
2.	CH4052	ProjectSeminar-II and Viva Voce				03
		TotalCredit				**14**

TotalProgrammeCredit:75

PartTime

Sl. No.	Code	CourseTitle	L	T	P	CP
SemesterI						
1.	CH1001	AdvancedFluid Dynamics	3	1	0	04
2.	CH1002	Environmental Engineering	3	1	0	04
3.		Elective I	3	1	0	04
4.	CH1051	Environmental EngineeringLaboratory	0	0	3	02
Total Credit		**14**				
Semester II						
1.	CH2001	ProcessDynamicsand Control	3	1	0	04
2.	CH2002	AdvancedMass Transfer	3	1	0	04
3.		Elective III	3	1	0	04
4.	CH2052	ProcessModellingandSimulationLaboratory	0	0	3	02
TotalCredit14						
Semester III						
1.	CH1003	ProcessModellingandSimulation	3	1	0	04
2.		Elective II	3	1	0	04
3.	CH1052	AdvancedComputingLaboratory	0	0	3	02
			Total Credit			**10**
SemesterIV						
1.	CH2003	AdvancedHeatTransfer	3	1	0	04
2.		Elective IV	3	1	0	04
3.	CH2051	Seminar I (Non-Project)	0	0	2	01
4.	CH2053	Project I				01
TotalCredit10						
SemesterV						
1.	CH3051	Project II				11
2.	CH3052	ProjectSeminar I				02
TotalCredit		**13**				
Semester VI						
1.	CH4051	Project III				11
2.	CH4052	ProjectSeminarII andViva Voce				03
TotalCredit		**14**				

TotalProgrammeCredit:75

Electives

1.	CH9011	AdvancedTransportPhenomena
2.	CH9012	Biochemical and BioEngineering
3.	CH9013	Non-conventional EnergyEngineering
4.	CH9014	ProcessAnalysisand Optimisation
5.	CH9015	MultiphaseFlow
6.	CH9016	AdvancedChemicalEngineeringThermodynamics
7.	CH9017	Petroleum Refiningand Petrochemical Engineering
8.	CH9018	BioprocessandbioreactorEngineering
9.	CH9019	Novel SeparationProcesses
10.	CH9020	Bio-separationProcesses
11.	CH9021	Chemical Reactor Analysis
12.	CH9022	CombustionEngineering
13.	CH9023	CFD Applications inChemicalEngineering
14.	CH9024	Computer Process Control
15.	CH9025	ProjectEngineeringand Management
16.	CH9026	DisasterManagement
17.	CH9027	HazardAnalysisandRiskManagementin Chemical Industry
18.	CH9028	Nanotechnology
19.	CH9029	Advanced Mathematical Methods for Chemical Engineering
20.	MS9050	Economic AnalysisforSustainableIndustrialization

COMPULSORY COURSES

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CH1001	Advanced Fluid Dynamics	**3-1-0**	**4**	

Course Objectives

The course focuses on the internal flow in equipment, such as pipes, power machinery, fluid machinery and vessels, etc. The relative reactions between fluids and equipment will also be discussed in the course. The focus of the course is a central theme of modern applied mathematics. Based on mathematical concepts of gradient, divergence, vorticity and tensor, the basic properties normally ascribed to fluids such as density, compressibility and dynamic viscosity will be introduced. Then general equations, including continuous equation, momentum equation and energy equation are derived. In general, the motion of fluids is extremely complicated, including highly nonlinear phenomena like turbulence, and cannot be described exactly. Therefore the course is used to model a vast range of physical phenomena and plays a vital role in science and engineering.

Course Outcomes

On completion of this course, the students will be able to

I. Learn fundamental of different types of fluids and fluid flow mechanism in different flow regimes.

II. Recent development of fluid moving machineries and fitting accessories used in chemical industries.

III. Learn different fluid flow conditions, flow characteristics, flow equations and multiphase flow

IV. Design &analyze of different flow regimes and hydrodynamic characteristics of equipment.

V.Learn industrial and domestic applications of different condition of fluid flow and fluid transport equipment.

VI. Solve fluid flow problems of different difficulty levels through tutorials.

VII. Complete process design of flow system through assignment / group task.

Course Content

Module –I

Navier-Stoke’s equation, momentum transport

Flow characteristics of Newtonian and non-Newtonian fluid

Two phase flow: slip, hold up, flow pattern, hydrodynamic characteristics

Flow of complex mixtures (solid-liquid system) - hydrodynamic characteristics, hold up

Module-II

Packed bed; concept of sphericity; Ergun equation, modified friction factor.

Fluidization: Introduction; different types of fluidization; minimum fluidization velocity; governing equation; pneumatic conveying and other industrial uses.

Basic equations of compressible flow, Application of the conservation laws of a compressible fluid to isentropic flows, flow with friction, and flows with heating or cooling. Shock and expansion waves. Nozzle and diffuser design. Measurements in compressible flow

Module-III:

Law of conservation of energy, Bernoulli's theorem, Bernoulli's equation, Assumptions of Bernoulli's equation, Application in fluid transfer systems, Flow diagram, Application to real fluids, Kinetic energy correction factor, Commercial application of B. theorem, Fluid flow measuring devices viz. orificemeter, venturimeter, rotameter, pitot tube, notches, weirs etc, working principles, Problems, Hagen-Poiseuille Eq. assumptions, friction loss in laminar flow, flow through circular pipe, Problems, Frictional loss in turbulent flow, Fanning's equation, Resistance of smooth and rough pipes. Problems

Module-IV:

Transportation of Fluid: Fluid moving machineries, Positive displacement pump, Reciprocating Pump, Piston Pump, Plunger Pump, Centrifugal Pump, performance curve of centrifugal pump, Peristaltic Pump, rotary pump, volute pump, diffuser pump, data required for installation of pump, selection criteria of different pumps, priming, cavitation, NPSH, suction lift, impeller patterns etc

Fluid flow controlling devices: Different Types of Valves: classification, working principles of Gate valve, Globe valve, Needle valve, Plug valve, Angle valve, Diaphragm valve, lift, swing, check valves, application areas.

TEXT BOOKS:

1. Unit operations of Chemical Engineering: McCabe, Smith and Harriot,TMH, 6th Edn.

REFERENCE BOOKS:

1) Introduction to Fluid Mechanics: Fox & McDonald, John wiley

2) Fluid Mechanics, A.K. Mohanty, PHI

3) Fluidization Engineering: Kunii and Levenspiel

4) Fluid Dynamics and Heat Transfer: Knudsen and Katz, MGH

5) Transport Process and Unit Operations: Geankoplis, 3 rdEdn. PHI

6) Principles of Unit Operations: Foust and Wenzel, Wiley, 1980

Course Assessment Method: The theory performance of students areevaluated.

Components	**Theory**		
	Internal		**End Semester Examination**
	Attendance and assignment	**Mid Semester Assessment**	
Marks	10	20	70
Total Marks	100		

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CH1002	Environmental Engineering	**3-1-0**	**4**	

Course Objectives

The course focuses on the internal flow in equipment, such as pipes, power machinery, fluid machinery and vessels, etc. The relative reactions between fluids and equipment will also be discussed in the course. The focus of the course is a central theme of modern applied mathematics. Based on mathematical concepts of gradient, divergence, vorticity and tensor, the basic properties normally ascribed to fluids such as density, compressibility and dynamic viscosity will be introduced. Then general equations, including continuous equation, momentum equation and energy equation are derived. In general, the motion of fluids is extremely complicated, including highly nonlinear phenomena like turbulence, and cannot be described exactly. Therefore the course is used to model a vast range of physical phenomena and plays a vital role in science and engineering.

Course Outcomes

On completion of this course, the students will be able to

IV. Learn fundamental of different types of fluids and fluid flow mechanism in different flow regimes.
V. Recent development of fluid moving machineries and fitting accessories used in chemical industries.
VI. Learn different fluid flow conditions, flow characteristics, flow equations and multiphase flow
IV. Design &analyze of different flow regimes and hydrodynamic characteristics of equipment.
V.Learn industrial and domestic applications of different condition of fluid flow and fluid transport equipment.
VI. Solve fluid flow problems of different difficulty levels through tutorials.
VII. Complete process design of flow system through assignment / group task.

Course Content

Module –I

Navier-Stoke's equation, momentum transport

Flow characteristics of Newtonian and non-Newtonian fluid

Two phase flow: slip, hold up, flow pattern, hydrodynamic characteristics

Flow of complex mixtures (solid-liquid system) - hydrodynamic characteristics, hold up

Module-II

Packed bed; concept of sphericity; Ergun equation, modified friction factor.

Fluidization: Introduction; different types of fluidization; minimum fluidization velocity; governing equation; pneumatic conveying and other industrial uses.

Basic equations of compressible flow, Application of the conservation laws of a compressible fluid to isentropic flows, flow with friction, and flows with heating or cooling. Shock and expansion waves. Nozzle and diffuser design. Measurements in compressible flow

Module-III:

Law of conservation of energy, Bernoulli's theorem, Bernoulli's equation, Assumptions of Bernoulli's equation, Application in fluid transfer systems, Flow diagram, Application to real fluids, Kinetic energy correction factor, Commercial application of B. theorem, Fluid flow measuring devices viz. orificemeter, venturimeter, rotameter, pitot tube, notches, weirs etc, working principles, Problems, Hagen-Poiseuille Eq. assumptions, friction loss in laminar flow, flow through circular pipe, Problems, Frictional loss in turbulent flow, Fanning's equation, Resistance of smooth and rough pipes. Problems

Module-IV:

Transportation of Fluid: Fluid moving machineries, Positive displacement pump, Reciprocating Pump, Piston Pump, Plunger Pump, Centrifugal Pump, performance curve of centrifugal pump, Peristaltic Pump, rotary pump, volute pump, diffuser pump, data required for installation of pump, selection criteria of different pumps, priming, cavitation, NPSH, suction lift, impeller patterns etc

Fluid flow controlling devices: Different Types of Valves: classification, working principles of Gate valve, Globe valve, Needle valve, Plug valve, Angle valve, Diaphragm valve, lift, swing, check valves, application areas.

TEXT BOOKS:

1. Environmental Impact of Mining Down CG and Stocks J. Applied Science Publishers, London, 1978. Publisher: Elsevier Science & Technology, ISBN-10: 0853347166, ISBN-13: 978-0853347163

REFERENCE BOOKS:

1. Environmental Impacts of Mining Monitoring, Restoration, and Control, MritunjoySengupta, Publisher: CRC Press (26 March 1993), ISBN-10: 0873714415, ISBN-13: 978-0873714419
2. Best Practice Environmental Management in Mining: Training Kit, Author: Environment Australia Staff, Edition: illustrated, Publisher: Australian Government - Department of the Environment and Heritage, 2002, ISBN: 0642996318, 9780642996312

Course Assessment Method: The theory performance of students are evaluated.

Components	**Theory**		
	Internal		**End Semester Examination**
	Attendance and assignment	**Mid Semester Assessment**	
Marks	10	20	70
Total Marks	100		

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CH1003	**PROCESS MODELLING AND SIMULATION**	**3-1-0**	**4**	

Course Objectives:

1. To give an overview of various methods of process modelling, different computational techniques for simulation.
2. The focus shall be on the techniques themselves, rather than specific applications so that the student can take up modeling and simulation challenges in his profession.

Course Outcomes

I. Learn about fundamentals of mathematical modeling

II. Learn about mathematical modeling used in different stages in chemical processes.

III. Learn to develop modeling of different unit operations

IV. Design &analyze of different of processes

IV. Learn the analysis and solving methods of mathematical modeled equation

VI. Solve energy technology problems of different difficulty levels through tutorials

VII. Complete process model of chemical unit operations through assignment / group task

Course content

Module - I: Solutions of Algebraic Equations (12L)

Truncation error, round-off, Chopping-off error, loss of significance & propagation of error (1L)

Jacobi and Gauss-Seidel iterations, Eigen value problem, Gauss elimination, Tri-Diagonal matrix, algorithm (TDMA), Applications- heat transfer, chemical reactions, fitting straight line and polynomial etc. (7L)

Newton-Rapson method, Newton's method, application in thermodynamic property calculation, bubble point calculations equations, stability analysis of a non-isothermal CSTR (4L)

Module - II: Solutions of Differential Equations (10L)

ODEs-Euler's Method, Runge-Kutta Method, predictor-corrector method (4L)

PDEs - Orthogonal collocation and Crank-Nicholson method (4L)

Applications in chemical reaction and heat transfer (2L)

Module –III: Introduction to Mathematical Model and Simulation (6L)

Concept of Mathematical model, simulation and process analysis.Scopes and uses of simulation in process engineering.Fundamentals of model building.Classification uses of mathematical models.Formulation of mathematical models. Reviews of continuity equation - energy equation-momentum equation-equation of state-equilibrium-kinetics

Module -IV: Modeling of Batch and Continuous process (7L)

Batch heating of closes kettle. Steady-state flow processes involving non-reactive systems. Continuous heating in a stirred tank using jacket and using a coil.Mixing in flow processes. Unsteady state processes.

Module -V: Modeling of Heat and Mass Transfer (9L)

Concentration gradient across a bubble plate. Simultaneous heat and mass transfer in packed bed. Start-up of double pipe heat exchangers, shell and tube heat exchanger. Simulation of multi-component distillation column - Wang-Henke bubble point method, sum-rate method and simultaneous correction method. Diffusions and chemical reaction-catalytic reaction in packed bed reactor.

TEXT BOOKS:

1. Applied Mathematics in Chemical Engineering: Mickley TMH
2. Mathematical Methods in Chemical Engineering: S. Pushpavanam, PHI
3. Numerical methods for Mathematics, Science and Engineering: John H. Mathews, PHI
4. Applied Numerical Methods: AlkisConstantinides, McGraw Hill
5. Luyben, et al., Process modeling simulation and Control, McGraw Hill
6. Henley and Seader, Multistage separation, McGraw Hill

REFERENCE BOOKS:

Course Assessment Method: The theory performance of students are evaluated.

Components	**Theory**		
	Internal		**End Semester Examination**
	Attendance and assignment	**Mid Semester Assessment**	
Marks	10	20	70
Total Marks	100		

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CH1051	**Environmental Engineering Lab**	**0-0-3**	**2**	

Course Objectives:

Separation & Purification is an integral part of most of the chemical engineering processing. Similarly chemical & instrumental analysis of products is an integral part of chemical engineering processing, chemical engineering research and design. This laboratory course is designed to equip the postgraduate level chemical engineering students in the two most relevant domains. This course covers some of the most modern separation and purification techniques employing membrane distillation, pervaporation, micro, ultra and nano filtration. Study on streaming potential device will enlighten the students on understanding transport mechanisms of nanofiltration and help develop the relevant transport models. Quite a few sophisticated instrumental and chemical analysis methods are taught for equipping the graduate students with these modern techniques of analysis for application in process industry as well as for further research.

Course outcomes:

I. To demonstrate how to handle sophisticated analytical instruments for analysing wastewaterII. To do a deeper analysis of membrane based separation

III. To characterize industrial wastewater

IV. To improve the ability of the students to investigate a real time wastewater problem

Course Content

Syllabus (Each experimental Study will involve a minimum of three hours duration while some will involve a minimum of 5 to 8 hours)

1. Study on flat-sheet cross flow membrane module for Ultrafiltration
2. Experimental study on performance of Activated Sludge Process
3. Study on Membrane Distillation/pervaporation for water purification
4. Study of Streaming potential for nanofiltrationmodeling
5. Analysis of microbial growth using UV-Visible Spectrophotometer
6. Detection and determination of organic acidconcentration using HighPerformance Liquid Chromatography
7. Determination of Fluoride concentration by SPADNS reagent using UV- Vis Spectrophotometer
8. Study on flat sheet cross flow nano-filtration membrane module
9. Industrial wastewater analysis using ion meter
10. Analysis and measurement of COD of wastewater
11. Rapid arsenic analysis in water using spectro- photometric method

TEXT BOOKS:

REFERENCE BOOKS:

Course Assessment Method:lab performance of students are evaluated.

Components	Laboratory (Continuous Evaluation)
Marks	100
Total Marks	100

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CH1052	**Advanced Computing Lab**	**0-0-3**	**2**	

Course objective

Course outcome:

I. To demonstrate how to troubleshoot processes using mathematical techniques
II. To do a deeper analysis of a problem mathematically in order to enhance process performance
III. To forecast process information (where experimental data are not available) that help designing a process
IV. To improve the ability of the students to investigate a problem numerically

Course content:

TEXT BOOKS:

REFERENCE BOOKS:

Course Assessment Method:lab performance of students are evaluated.

Components	**Laboratory (Continuous Evaluation)**
Marks	100
Total Marks	100

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CH2001	**Process Dynamics and Control**	**3-1-0**	**4**	

Course objectives:

1. To make the M. Tech. students understand the main ideas behind advanced multivariable controls.
2. To develop the ability to tune the control systems
3. To gain knowledge on advanced control strategies

Course Outcome

I. Determining the control structures in chemical processes

II. Understanding multiple MIMO systems and their dynamical interactions

III. Determining stability of MIMO systems

IV. Understanding adaptive and optimizing controllers

V. Determining the controller settings for MIMO systems

Course content:

Module 1: SISO control system (revisit): 10L

Control hardware; dynamics; methods of stability analysis; tuning methods; adaptive tuning method; Smith predictor

Module 2: Control structure: 5L

Degree of freedom analysis; selection of controlled variables (CVs) and manipulated variables (MVs)

Module 3: MIMO control systems: 15L

Loop interactions; Pairing of CVs and MVs; Singular value analysis; Tuning of MIMO control systems; Gain scheduling

Module 4: Advanced controls: 10L

Optimal controls; Model predictive controls; real-time optimization; Plant wide control

Module 5:Tutorials 7

Text Books / References:

1. P. K. Sarakar, Advanced Process Dynamics and Control, Prentice-Hall of IndiaPvt.Ltd.
2. D.E. Seborg, T.F. Edgar, E.A. Mellichamp, F. J. Doyle, Process Dynamics and Control, 3rd edition, John Wiley&Sons, NY.
3. B.A. Ogunnaike and W.H. Ray, 1994, Process Dynamics, Modeling, and Control, OxfordUniversity Press.

Course Assessment Method: The theory performance of students are evaluated.

Components	**Theory**		
	Internal		**End Semester Examination**
	Attendance and assignment	**Mid Semester Assessment**	
Marks	10	20	70
Total Marks	100		

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CH2002	**Advanced Mass Transfer**	**3-1-0**	**4**	

Course objectives:

- To create a detailed understanding of the binary and multicomponent mass transfer theory and operation.
- To familiarize the students with the way of approach to analyse and solve the various mass transfer phenomenon in industrial mass transfer equipment.
- To familiarize with the standard procedures for process design of equipment using multicomponent systems.

Course Outcomes

I. Learn fundamental of different types of diffusion mechanism and its industrial application.
II. Recent development of mass transfer equipment used in chemical process industries.
III. Learn different kinds of multicompoment distillation methodology and associated numerical correlations.
IV. Design &analyze of different distillation column, absorber, tray, reboiler, adsorption column functioning in prototype experimental setup.
V. Learn to find the best parametric condition through optimization by different software.
VI. Study different adsorption phenomenon with adsorption column, adsorbents-adsorbate, adsorption isotherm kinetics and thermodynamics.
VII. Complete process design of mass transfer system through assignment / group task.

Course content:

Module - I (10 L)

Fick's law of Binary Molecular diffusion, Temperature and Pressure dependence of Diffusivity, Theory of diffusion in gases at low density and binary liquids,

Unidirectional diffusion through a stagnant gas film, diffusion from a liquid droplet, diffusion of an absorbing gas into a falling liquid film, diffusion with a heterogeneous chemical reaction, Numerical problems on the aforesaid diffusion cases.

Multicomponent diffusion in gases at low density.

Module - II (10 L)

Equation of continuity for a multicomponent mixtures,

Revision of theory of Gas Absorption, Material balance on one component absorption conventional design procedure for binary systems.

Countercurrent Multistage Operation with one component transferred, Nonisothermal adiabatic Absorption and

Stripping operation

Muticomponent absorber, Process design calculation of Multicomponent Absorber/Stripper, Tray-to tray estimation following Kresmer equation, Edmister method and Horton & Franklin method

Module-III:

Introduction, Distillation processes & applications, Continuous fractional distillation, Flash distillation, Destructive distillation, Azeotropic distillation, Multi-component Distillation, Membrane distillation, Atmospheric distillation, Pressure Swing Distillation

Problems on industrial applications, Design aspects and assumptions, Problems.

Fensky-Underwood-Gilliland method, Iteration methods for design of Multi-component Distillation column.

Module-IV:

Adsorption, various adsorbents, desirable characteristics of adsorbent, commercial adsorbents and their applications, B.E.T surface area analysis, micro-pore volume, phase equilibrium, adsorption isotherm: Langmuir, Freundlich, Sips isotherm, Dubinin-Radiskhov isotherm, Dubinin-Astakhov isotherm. Adsorption kinetics, adsorption thermodynamics, Problems, Multi-component adsorption equilibrium, heat of adsorption, batch adsorption in stirred vessel, mass transfer zone and breakthrough behavior, adsorption equipments.

Text Books / References:

Course Assessment Method: The theory performance of students are evaluated.

Components	**Theory**		
	Internal		**End Semester Examination**
	Attendance and assignment	**Mid Semester Assessment**	
Marks	10	20	70
Total Marks	100		

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CH2003	**Advanced Heat Transfer**	**3-1-0**	**4**	

Course objective

- To create a detailed understanding of the heat transfer theory and operations.
- To familiarize the students with the way of approach to analyses and solve the various heat transfer phenomenon in industrial heat transfer equipment.
- To familiarize with the standard procedures for process design of equipment using heat transfer systems.

Course Outcome

I. To impart a knowledge on designing heat transfer equipments
II. To create an understanding of conservation equations and numerical solution of heat transfer problems

Course Content:

I. Design of Heat transfer equipments

1. Design of double pipe heat exchanger
2. Design of shell and tube heat exchanger
3. Design of multiple effect heat exchanger
4. Design of cooling tower
5. Design of compact heat exchanger

II. Numerical Heat Transfer

1. General conservation equations
2. Finite volume method:
    a. Discretization and basic rules
    b. 1-D, 2-D & 3-D steady-state diffusion problems. Source term linearization
    c. 1-D, 2-D & 3-D unsteady-state diffusion problems. Explicit, Implicit, Crank Nicholson schemes
    d. 1-D, 2-D & 3-D steady & unsteady convection-diffusion problems. Central difference scheme, Upwind difference scheme, Hybrid scheme, Powerlaw scheme, Quadratic upwind difference scheme
    e. Problems with coupled conservation equations

Text Books :

1. Process Heat Transfer - D Q Kern
2. Numerical Heat Transfer - S V Patankar
3. An Introduction to Computational Fluid Dynamics - H K Versteeg, W Malalasekara

Course Assessment Method: The theory performance of students are evaluated.

Components	**Theory**		
	Internal		**End Semester Examination**
	Attendance and assignment	**Mid Semester Assessment**	
Marks	10	20	70
Total Marks	100		

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CH-2051.	**Process Modelling and Simulation Laboratory**	**0-0-3**	**2**	

Course Objective: This course aims to provide the inputs for computer programming using c and matla. The basic principles of one and two dimensional array, concept of matrices and its operation are discussed through problem solving method.

It deals with the techniques to understand the concept of various functions and its arguments in MATLAB. Learning the syntax of matlab programming for solving Algebraic equations, GAUSS elimination, Interpolation, ODE, stiff ODE, PDE using finite volume techniques.

The specific assignments will be solved in tandem with the theory course so that the topics for problems given in the lab are already initiated in the various theory classes of earlier semester.

Course Outcome

I. To demonstrate how modelling and simulations techniques help us troubleshoot chemical processes

II. To do a deeper analysis of a problem mathematically in order to enhance process performance

III. To forecast process information (where experimental data are not available) that help designing a process

IV. To improve process control and safety

Course content:

Module I 5

1. Introduction of a Matlab programming and the environment and execution of sample programs
2. Expression evaluation
3. Conditionals and branching
4. Iteration
5. Functions
6. Arrays

Module II **5 hr**

Solution of liner and non-liner algebraic equation
System of linear and non-liner equations

Module III **10 hr**

Initial value ODES using Euler explicit and implicit technique. Non-linear ODEs
System of ODEs
System of linear and non-liner ODEs.Use of matlab inbuilt ODE45, ode23, ode113, ode15s, ode23s, ode23t, ode23tb, implicit ODEs: ode15i.

Module IV **20 hr**

The problems on Phase Equilibrium, Equation of State Determination of Bubble and Dew Point , Differential Distillation- Minimum Reflux Ratio Calculations, Numerical Integration-Trapezoidal Rule, Simpsons 1/3 and 3/8 rule, Weddles Rule 7.

Mass Transfer Problems- Rayleigh's Equation, NTU in Absorption, Determination of Drying time from batch drying data- Determination of reactor size., Milne's Method, Laplace Equation, Predictor-Corrector Methods, Heat conduction problems and chemical reaction.

PDEs (Implicit and Explicit methods) by writing own code using MATLAB programming Language
It is suggested that some problems related to continuous domain problems in engineering and their numerical solutions are given as laboratory assignments. It may be noted that some of basic numerical methods are taught in the Mathematics course.

Text Books :

1. Lindfield, George and John Penny, "Numerical Methods Using MATLAB", Prentice-Hall, 2000.

2. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India.

3. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill.

4. Byron Gottfried, Schaum s Outline of Programming with C, McGraw-Hill.

5. Seymour Lipschutz, Data Structures, Schaum s Outlines Series, Tata McGrawHill.

6. Numerical Methods and Modeling for Chemical Engineers", Wiley 1984. 2. Alan. L,.Myers and Warren. D Seider.,

7. "Introduction to Chemical Engineering and Computer Calculations", Prentice Hall, Engle Wood Cliffs (N.J), 1976

8. Computational Methods in "Chemical Engineering," Prentice Hall, 1975.

9. Kirani Singh. Y, and Chaudhuri B.B., "MATLAB

Components	Theory		
	Internal		End Semester Examination
	Attendance and assignment	Mid Semester Assessment	
Marks	10	20	70
Total Marks	100		

ELECTIVES COURSES

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CH9013	**Non-Conventional Energy Engineering**	**3-1-0**	**4**	

Course objective:

1. To make the M. Tech. students understand the different non-conventional energy source advancement and their application in worldwide.
2. To develop the ability to design energy application systems
3. To gain knowledge on environmental problems due use of conventional energy sources.

Course outcome:

I. Learn about energy technology of different conventional and non-conventional energy resource.

II. Recent worldwide energy market scenario and recent trend of using different non-conventional energy resource

III. Learn different types on renewable energy resources like solar energy, Wind energy, Geo-thermal energy, nuclear energy and bio energy and its applications.

IV. Design &analyze of different renewable energy collectors and renewable energy thermal power plants

V. Learn industrial and domestic applications of different renewable energy sources.

VI. Solve energy technology problems of different difficulty levels through tutorials

VII. Complete process design of an energy system through assignment / group task

Course content:

Module 1 :

Introduction to energy science and technology, law of conservation of energy, energy calculations, energy demand, various resources of non-conventional energy; introduction to wind energy forms and energy conversion systems; applications of wind turbine generator units, horizontal axis propeller type wind turbine generator units, three blends, horizontal axis wind turbine (WAWT), vertical axis wind turbines,

Module 2 :

Solar energy - historical review and future prospects, fundamentals and applications, Solar thermal energy conversion systems, solar collectors, solar thermal power plants, solar photovoltaic cells, V-I characteristics of a solar cell, efficiency of a solar cell; Construction and performance analysis of solar flat plate collectors. Heat losses from FPC by radiation and natural convection, overall heat loss coefficient, collector efficiency factor, tilt factors, collector heat removal factor, Hottel- Willier-Bliss equation. Solar concentrating collectors : CPC, PTC, spherical paraboloids , modes of tracking, performance analysis.

Salt gradient solar ponds: construction, operation, technical problems.

Solar drying and dehumidification: Solar cabinet dryers, convective dryers

<u>Module 3</u> :

Geo-thermal energy – history of resources and applications, hydrothermal (convective) resources, geothermal electrical power plants, vapor dominated (stream) geothermal electrical power plants, liquid dominated (hot-water) geothermal electrical power plants, liquid dominated slashed steam geothermal electrical power plant, binary cycle liquid dominated geothermal power plants, comparison of various liquid dominated geothermal systems; Other Non-conventional Energy sources - introduction and brief idea about ocean energy, tidal energy and nuclear energy systems.

<u>Module 4</u>

Bio-mass energy - introduction, various resources and applications, processes, thermo-chemical-bio-chemical and hybrid-bio-gas-plant; Bio ethanol, Bio diesel, H_2 production and algal biofuel. Fuel Cells - introduction, types of fuel cells, working principles, electrolyte, membrane, catalyst, use etc.; Fuel from waste materials

Waste : Solid, liquid, gas and their effects. Treatment technologies: Physical, Chemical, Advanced and Integrated treatment systems.

Reference Book:

1. Non-conventional Energy Sources by G.D. Rai
2. Non-Conventional Energy Resources by B Khan
3. S.P.SUKHATME : Solar Energy

Course Assessment Method: The theory performance of students are evaluated.

Components	**Theory**		
	Internal		**End Semester Examination**
	Attendance and assignment	**Mid Semester Assessment**	
Marks	10	20	70
Total Marks	100		

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CH9014	**Process analysis and optimization**	**3-1-0**	**4**	

Course Objective:

1. To formulate chemical engineering problems in mathematical terms by employing the appropriate microscopic and macroscopic balances.
2. To determine and apply the appropriate methods used to solve the resulting governing equations, namely linear and nonlinear algebraic equations, ordinary differential equations, and partial differential equations.
3. To assess when numerical methods are needed for the solution of governing equations
4. To solve them accordingly using mathematical software packages.
5. To identify and interpret the differences between model predictions and experimental results

Course Outcome:

I. Conceptualization of a chemical process and its needs

II. Solving material and heat balance for a large-scale process

III. Understanding process synthesis

IV. Solving optimal design and control problems simultaneously

V. Real time optimization techniques and their implementations

Course Content:

UNIT	Contents	Hrs.
I	Cramer's rule, Inverse of matrix, Gauss elimination, Gauss Jordan method, LU decomposition, Gauss Seidel method, error analysis, Linear regression	9
II	Bisection method, successive substitution method, Newton-Raphson method, Secant method	6
III	Eigen values, Eigen vectors and its application in solving differential equations	5
IV	Multi-variable optimization algorithms: Unidirectional search, Direct search methods, Gradient based methods. Constrained optimization algorithms: Kuhn-Tucker conditions, Transformation methods	8

V	Sensitivity analysis, Direct search for constrained minimization, Linearized search techniques, Feasible direction method, Generalized reduced gradient method, Gradient projection method	6
VI	ODE- Initial Value Problem, Boundary Value Problem Specialized algorithms: Integer programming, Geometric programming Nontraditional optimization algorithms: Genetic algorithms, Simulated annealing, Global optimization.	6

Text Book:

1. T.F. Edgar and D.M. Himmelblau," Optimization Techniques for Chemical Engineers", McGraw-Hill, New York, 1985.
2. S.S.Rao, ”Engineering Optimization Theory and Practice”, Third edition, New Age International Publishers, India.
3. S. K. Gupta, "Numerical Techniques for Engineers", New Age International Publishers, 3rd edition, 2015
4. Deb K., Optimization for engineering design, Algorithms and examples, Prentice Hall of India, New Delhi, 2005.
5. Mathematical Methods in Chemical & Environmental Engineering: Ajay K.Ray, Thomson Learning, 2000.

REFERENCE:

1. K. Deo, "Optimization Techniques", Wiley Eastern, 1995.

2. R.Panneerselvam, “Operation Research”, Second edition, PHI Learning private Ltd, New Delhi, India.

3. Prem Kumar Gupta and D.S.Hira, ”Problems in Operations Research (Principles and Solutions)”, S.Chand and company Ltd. New Delhi, India.

Course Assessment Method: The theory performance of students are evaluated.

Components	Theory		
	Internal		End Semester Examination
	Attendance and assignment	Mid Semester Assessment	
Marks	10	20	70
Total Marks	100		

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CH9015	**Multiphase Flow**	**3-1-0**	**4**	

Course Objective:

The course will give a general introduction to the underlying concepts of multiphase flows and different approaches to model such flows under different conditions. The course opens with real life examples of such flow and its importance in process industries with multiphase contactors.

Course Outcome:

I. To learn fundamental of multiphase flow, differentflow patterns and flow pattern maps.

II. To learn transport mechanism of multiphase flow and industrial application of multiphase flow.

III. To learn different flow models in multiphase flow.

IV. Design & stability analyze of different types of multiphase flow.

V. Learn measurement techniques for multiphase flow.

VI. Solve multiphase flow problems of different difficulty levels through tutorials

VII. Complete process design of multiphase flow system through assignment / group task

Course content:

Module I:

Two phase flow: Gas/Liquid and Liquid/liquid systems: Flow patterns in pipes, analysis of two phase flow situations, Prediction of holdup and pressure drop or volume fraction, Bubble size in pipe flow, Lockchart-Martinelli parameters, Bubble column and its design aspects, Minimum carryover velocity. holdup ratios, pressure drop and transport velocities and their prediction.

Module II:

Flow patterns - identification and classification - flow pattern maps and transition - momentum and energy balance - homogeneous and separated flow models -correlations for use with homogeneous and separated flow models - void fraction and slip ratio correlations - influence of pressure gradient - empirical treatment of two phase flow - drift flux model - correlations for bubble, slug and annular flows Introduction to three phase flow,

Module III:

Dynamics of gas-solid liquid contactors (agitated vessels, packed bed, fluidized bed, pneumatic conveying, bubble column, trickle beds), Flow regimes, pressure drop, holdup, distributions, mass and heat transfer, reactions, Applications of these contactors

Module IV:

Measurement techniques in multiphase flow: Conventional and novel measurement techniques for multiphase systems (Laser Doppler anemometry, Particle Image Velocimetry)
TEXT BOOKS/REFERENCES: 1. Clift, R., Weber, M.E. and Grace, J.R., Bubbles, Drops, and Particles, Academic Press, New York, 1978. 2. Y. T. Shah, Gas-Liquid-Solid reactors design, McGraw Hill Inc, 1979 3. Fan, L. S. and Zhu, C., Principles of Gas-solid Flows, Cambridge University Press, 1998 4. Govier, G. W. and Aziz. K., "The Flow of Complex Mixture in Pipes", Van Nostrand Reinhold, New York, 1972. 5. Wallis, G.B., "One Dimensional Two Phase Flow", McGraw Hill Book Co., New York, 1969. 6. Crowe, C. T., Sommerfeld, M. and Tsuji, Y., Multiphase Flows with Droplets and Particles, CRC Press, 1998 7. Kleinstreuer, C., Two-phase Flow: Theory and Applications, Taylor & Francis, 2003 Rhodes, M., Introduction to Particle Technology, John Wiley & Sons, New York. 1998.

Course Assessment Method: The theory performance of students are evaluated.

Components	**Theory**		
	Internal		**End Semester Examination**
	Attendance and assignment	**Mid Semester Assessment**	
Marks	10	20	70
Total Marks	100		

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CH 9018	**Bioprocess And Bioreactor Engineering**	3-1-0	4	

Course Objective:

1) To identify the difference in reaction engineering behavior between enzyme catalyzed reaction and life cell catalyzed reaction

2) To illustrate the mechanism of enzyme catalyzed reaction in both free and immobilized form and to recognize different factors affecting the rates.

3) To analyze biochemical rate laws in global perspectives.

4) To analyze parametric sensitivity, instability etc.

5) To design industrial bioreactor and develop scale-up and control strategies.

Course outcome:

I. Learn fundamentals of bioprocess and biochemical reactions

II. Identify reaction mechanism

III. Design and analyze various reactors

IV. Compare performances and select type of reactor and reactor assembly

V. Learn industrial applications of reactors

VI. Solve reactor problems of different difficulty levels through tutorials

VII. Complete process design of a reactor through assignment / group task

Course content:

Module I:

Introduction to the kinetics of Bioprocess; Enzyme kinetics; Cell growth kinetics; Kinetics of metabolic product synthesis by cells; Introduction of segregated and non-segregated models; Kinetics of immobilized enzymes and cells.

Module II:

Background of bioreactors, Type of bioreactors – Airlift bioreactors, Airlift pressure cycle bioreactors, Loop bioreactor, Stirred tank bioreactors, Fluidized bed bioreactors, Trickle bed bioreactor, Bubble column fermenter, Design equations for CSTR fermenter, Two stage reactors, Reactors with non ideal mixing, Parametric sensitivity, Multiplicity in Biosystems, Global and local stability analyses of Bioreactors.

Module III:

Bioreactor controlling probes, Characteristics of bioreactor sensors, Temperature measurement and control, DO measurement and control, pH/redox measurement and control, Deteection and prevention of the foam, Biosensors.

Module IV:

Downstream processing in bioprocesses; Industrial application of bioprocesses.

Text books:

1. J. E. Bailey, D. F. Ollis, Biochemical Engineering Fundamentals, Second Edition, Mc. Graw Hill Inc., Singapore, 1986.
2. H. W. Blanch, D. S. Clark, Biochemical Engineering, Special Indian Edition, Marcel Dekker Inc. New York, 2007.
3. M. L. Shuler, F. Kargi, Bioprocess Engineering - Basic Concepts, Second Edition, Prentice Hall of India Private Ltd., New Delhi, 2002.

Reference books:

4. P. M. Doran, Bioprocess Engineering Principles, Academic Press, California, 2009.
5. J. Nielsen, J. Villadsen, G. Liden, Bioreaction Engineering, Second Edition, Springer, 2007.
6. N. C. Price and L. Stevens, Fundamentals of Enzymology: The cell and Molecular Biology of Catalytic Proteins, Third Edition, Oxford University Press, Oxford, 2006.
7. D. G. Rao, Introduction to Biochemical Engineering, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2008.

Course Assessment Method: The theory performance of students are evaluated.

Components	Theory		
	Internal		End Semester Examination
	Attendance and assignment	Mid Semester Assessment	
Marks	10	20	70
Total Marks	100		

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CH 9019	**Novel Separation Processes**	**3-1-0**	**4**	

Course objective

1. To impart knowledge of recent advancement in research and development in novel separation processes.
2. Advancement towards membrane materials for particular separation of mixture.
3. Different transport mechanism in different types membranes.
4. Knowledge on preparation and characterization of membrane

Course Outcome

I. Learn fundamentals of membrane separation processes and current market scenario

II. Classify and characterize membrane separation processes

III. Principles and methodologies of separation and transport of molecules through membrane

IV. Learn latest development in both theory and applications

V. Working out solutions to exercise problems through tutorials

VI. Complete process design of separation through assignment / group task

Course content:

	Sl. No	**Course outline**	Lecture hrs
1		**Membrane Separation Processes**	6
	1	Types of membranes and membrane characterization	
	2	Membrane modules and motion of molecules through membrane	
	3	Classification & characterization of Membrane Separation Processes	
2		**Reserve Osmosis (RO)**	6
	1	Fundamentals of RO, Osmotic Pressure	
	2	Models of Solvent and solute Transport through membrane – Fluxes, Rejection and Separation factor	
	3	Mechanism of salt rejection by CA membrane	
	4	Concentration Polarization by RO	
	5	Membrane Separator unit design – applications of RO	
3		**Nano-filtration (NF)**	3
	1	Fundamentals of NF	

	2	Models and Types of transport mechanism in NF membranes	
	3	Applications of NF	
4		***Ultra-filtration (UF)***	6
	1	*Models and Types of transport in UF membranes*	
	2	*Membranes for UF – Fouling and concentration Polarization in UF*	
	3	*Applications of UF*	
	4	*Separation schemes using UF*	
	5	*Dia-filtration – process design – batch, continuous, multistage*	
5		***Micro-filtration (MF)***	4
	1	*Membranes for MF – transport mechanism*	
	2	*Applications of MF*	
6		***Dialysis***	3
	1	*Solute transport in dialyzer – analysis of dialysis operation*	
	2	*Mode of dialysis*	
	3	*Hemo-dialysis – dialysis equipment - applications*	
7		***Electro –dialysis (ED)***	3
	1	*Types of ED – ion transport fundamentals*	
	2	*Resistances and voltages in ED cells – power requirement*	
	3	*ED membranes and cells*	
	4	*Problems of ED operation*	
	5	*Plant design and process cost*	
8		**Liquid membrane**	2
	1	Nature and types of available liquid membranes	

	2	Separations factor – applications	
	3	Liquid membranes on solid membranes (facilitated transport)	
9		***Pervaporation (PV)***	4
	1	*Theory of PV – parameter study*	
	2	*Classification of PV – air heated PV, Osmotic distillation, thermo-pervaporation*	
	3	*Advantages and disadvantages of PV*	
	4	*Application of PV*	
10		***Gas Separation***	3
	1	*Membrane gas separation*	
	2	*Industrial applications*	
		Total	40

Text book/References:

1. Separation Processes – C. J. King
2. Synthetic membranes – P. M. Bungay, H. K. Lonsdale, M. N. de Pinho
3. MembraneTechnology and Applications, 2nd edition –Baker
4. Membrane Separation Processes – KaushikNath
5. Membrane Hand Book – W. Ho and K. K. Sirkar
6. Membrane Separation Process – P. Mears, Elsevier, 1970
7. Progress in Separation and Purification – E. S. Perry & C. J. Van Oss
8. Industrial Processing with membranes – R. E. Lacey& S Loeb
9. Reverse Osmosis – S. Sourirajan
10. Ultrafiltration Handbook – M. Cheryan
11. Principles of Mass Transfer and Separation Processes – B. K. Dutta
12. Transport Processes and Separation Process Principles – C. J. Geankoplis

Course Assessment Method: The theory performance of students are evaluated.

Components	**Theory**		
	Internal		**End Semester Examination**
	Attendance and assignment	**Mid Semester Assessment**	
Marks	10	20	70
Total Marks	100		

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CH 4052	**Dissertation**	**0-0-0**	**20**	

Course Objectives

1. To develop the capacity of students in correlating theoretical knowledge into practical systems either to perform creative works or to perform analysis and hence to suggest solutions to problems, pertaining to environmental domain.
2. Foster collaborative learning skills.
3. Develop self-directed inquiry and life-long skills.
4. To enhance the communication skills of the students by providing opportunities to discuss in groups and to present their observations, findings and report in formal reviews both in oral and written format.
5. The student will write and defend their Dissertation Proposal.

Course Outcomes

On completion of this course, the students will be able to

1. Submit adissertation synopsis comprising of the application and feasibility of the dissertation.
2. Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health care, safety and sustainability.
3. Work and communicate efficiently in multidisciplinary teams.
4. Identify, formulate, and solve environmental problems.
5. Develop an understanding of professional and ethical responsibility.

Course Content

Dissertation is the report of summarized M.Tech project work. Students are expected to design and develop a complete system or make an investigative analysis of a technical problem in the relevant area. The student has to fix his topic, complete preliminary studies like literature survey, field measurements in the third semester. The progress of project work also included in the dissertation in case of third semester. In fourth semester students need to submit the complete report of the research work.

Mode of Evaluation:

The dissertation of the project work is evaluated by the concerned supervisor and the internal evaluating committee in the third semester. In case fourth semester, the project work will be evaluated by the concerned supervisor, external examiner and internal evaluating committee separately.

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
EST 3052/EST 4052	**Seminar/Seminar& Viva-voce**	**0-0-0**	**5**	

Course Objectives

To develop the capacity of students in correlating theoretical knowledge into practical systems either to perform creative works or to perform analysis and hence to suggest solutions to problems, pertaining to environmental engineering domain.

1. Foster collaborative learning skills.
2. Develop self-directed inquiry and life-long skills.
3. To enhance the communication skills of the students by providing opportunities to discuss in groups and to present their observations, findings and report in formal reviews both in oral and written format.

Course Outcomes

On completion of this course, the students will be able to

1. Submit a project synopsis comprising of the application and feasibility of the project.
2. Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health care, safety and sustainability.
3. Demonstrate, presented and communicate effectively.

Course Content

Project work for M. Tech thesis is of duration of four semesters and is expected to be completed in the fourth semester. Each student is expected to design and develop a complete system or make an investigative analysis of a technical problem in the relevant area. Along with dissertation report student have to present the relevant thesis work before the evaluating committee in both third and fourth semesters. In third Semester students are expected to do field excursion, conducting of experiments and numerical modelling of obtained data and in fourth semester students suppose to present the complete thesis work.

Mode of Evaluation:

The presentation of the project work is evaluated by the concerned supervisor and the internal evaluating committee in the third semester. In case fourth semester, the project work will be evaluated by the concerned supervisor, external examiner and internal evaluating committee separately.

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CH2053/ CH 3051/CH4051	**Project I, Project II& Project III**	**0-0-2**	**1**	

Course Objectives

1. To develop the capacity of students in correlating theoretical knowledge into practical systems either to perform creative works or to perform analysis and hence to suggest solutions to problems, pertaining to environmental engineering domain.
2. Foster collaborative learning skills.
3. Develop self-directed inquiry and life-long skills.
4. To enhance the communication skills of the students by providing opportunities to discuss in groups and to present their observations, findings and report in formal reviews both in oral and written format.

Course Outcomes

On completion of this course, the students will be able to

1. Understand the research trend the relevant domain of research work.
2. Identify his potential and interest in the innovation world.
3. Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health care, safety and sustainability.

Course Content

Project work for M. Tech thesis is of duration of four semesters begin from first semester and is expected to be completed in the fourth semester. Each student is expected to design and develop a complete system or make an investigative analysis of a technical problem in the relevant area. The project work is included of identifying research topic, literature review, preliminary investigation, field excursion, conducting of experiments, numerical modelling to validate experimental data, interpretation of results and report writing. The course content of ‘Project I’ is Research topic determination and literature review and ‘Project II’ contain literature review and preliminary and primary investigation of the thesis work.

Mode of Evaluation:

Continuous evaluation is carried out by supervisor and marks are awarded by the concerned supervisor and internal evaluation committee.

Components	Assessment by Supervisor and Internal Evaluating Committee
Marks	100
Total Marks	100