B.M.S. COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College Under VTU)

Department of Chemical Engineering

<table>
<tr><td>1</td><td>Name of Course</td><td colspan="4">BIOCHEMICAL ENGINEERING</td></tr>
<tr><td>2</td><td>Course Code</td><td colspan="4">11CH7DCBCE</td></tr>
<tr><td>3</td><td>Designation of the course</td><td colspan="4">Departmental Core</td></tr>
<tr><td>4</td><td>Rationale for the inclusion of the course/module in the programme</td><td colspan="4">Processing of biological materials and processing using biological agents such as cells, enzymes, or antibodies are the central domains of biochemical engineering. Success in technology of bioprocess requires integrated knowledge of governing biological properties and principles and of chemical engineering methodology which are covered by the course.</td></tr>
<tr><td>5</td><td>Semester and year offered</td><td colspan="4">Semester VII / Year IV</td></tr>
<tr><td rowspan="3">6</td><td>Total Student Learning Time(SLT)</td><td colspan="3">Face to Face</td><td>Total Guided and Independent Learning</td></tr>
<tr><td rowspan="2">L = Lecture
T = Tutorial
P = Practical</td><td>L</td><td>T</td><td>P</td><td rowspan="2">Total = 4 credits</td></tr>
<tr><td>4</td><td>0</td><td>0</td></tr>
<tr><td>7</td><td>Credit Value</td><td colspan="4">4</td></tr>
<tr><td>8</td><td>Prerequisite (if any)</td><td colspan="4">None</td></tr>
<tr><td>9</td><td colspan="5">Objectives:
1. To provide the fundamental background of biological systems
2. Emphasize areas of biochemical processes, essential to an engineer to work in the area of bio-processing.
3. To develop skills in the materials selection which can be utilized within the courses such as bioprocess equipments design, engineering experimental investigations, process design project and experimental research project throughout the program.</td></tr>
<tr><td>10</td><td colspan="5">Course outcomes:
By the end of the course, students will be able to:
CO1. Apply basic & advanced biology in bioprocess engineering.
CO2. Identify enzymes and explain the kinetics of enzyme catalysed processes.
CO3. Perform the basic analytical techniques and infer features of bioreactors.
CO4. Decide various separation procedures in the downstream processing.</td></tr>
<tr><td>11</td><td colspan="5">Transferable Skills:
→ Data searching skills
→ Report writing
→ Critical thinking and problem solving skill
→ Skills in the selection of biological materials for processing.
→ Skills to design a bioprocess
→ Skills to design equipments required in the bioprocess industry
→ Skills to guide/carryout project /research in the area of bio processing.</td></tr>
<tr><td>12</td><td colspan="5">Teaching-learning and assessment strategy:
Teaching-learning Methods
• Classroom lectures
• Lecturer-led problem-solving sessions

Direct Assessment Strategies
• Continuous internal evaluation (CIE) Test 1, Test 2 & Test 3. Best of average
• Quiz 1 & 2
• Semester End Examination (SEE)</td></tr>
</table>

	Indirect Assessment Strategies • Assignments • Lecturer Observation through presentations
13	**Synopsis:** Biochemical engineering is designed to introduce the key aspects associated with biochemical processes. Engineers working in the process industries are making increased use of biological systems for production and environmental management. To optimize these processes, the chemical engineer needs to understand the fundamentals of biological processes and their applications. The course including bioprocessing scope, applications and advantages over conventional processes, the basic structure and function of cells, including enzyme structure and function and basic molecular biology are included to understand biological processes. The course also deals with sterilization techniques, bioreactor design, and unit processes of the downstream processing of biological products.
14	**Mode of Delivery:** • Classroom lectures
15	**Assessment Methods and Types:** **Coursework** **Continuous internal assessment** • Test 1 — 20% • Test 2 — 20% • Quiz 1 &2 — 10% **Semester End Exam** — **50 %** **Assessment** — 100%

16 Content outline of the course/module and the SLT per-topic

	Details	SLT L	SLT T	SLT P	SLT Total
Unit 1	**Introduction:** Bioprocess engineering and technology. Role of a Chemical engineer in bioprocess industry. An introduction to basic biological sciences. Microbiology: Structure of cells: Prokaryotes and Eukaryotes. Classification of micro-organisms. Taxonomy, Environmental and Industrial microbiology. Biochemistry: Chemicals of Life: Lipids, Sugars, Polysaccharides, Amino acids and proteins Vitamins Biopolymers Nucleic Acids: RNA, DNA and their derivatives (Structure Biological function and Importance for life only to be studied).	13			13

	Unit 2	**Enzymes and Proteins:** structure of proteins and enzymes. Functions. Methods of Production and purification of Enzymes. Nomenclature and Classification of enzymes. Kinetics of Enzyme action: Michaelis-Menten rate equation. Derivation. **Kinetics of Enzyme action:** Reversible Enzyme. Two-substrate. Multi-complexes enzyme kinetics (Derivation of rate equations). Experimental determination of rate parameters: Batch and continuous flow experiments. Lineweaver-Burk, Eadie-Hofstee and Hanes-Woolf Plots. Batch Kinetics (Integral and Differential methods).	13			13
	Unit 3	**Enzyme Inhibition**: Effect of Inhibitors (Competitive, noncompetitive, uncompetitive, substrate and product inhibitions), Temperature and pH on the rates enzyme catalyzed reactions. Determination of kinetic parameters for various types of inhibitions. Dixon method. Enzyme immobilization· Uses. Methods of enzyme immobilization.	07			07
	Unit 4	**Growth Kinetics of Microorganisms:** Transient growth kinetics (Different phases of batch cultivation). Quantification of growth kinetics: Substrate limited growth, Models with growth inhibitors, Logistic equation, Filamentous cell growth model. continuous culture: optimum dilution rate in ideal chemostat. introduction to fed-batch . reactors	06			06
	Unit 5	**Fermentation Technology:** Ideal reactors: A review of Batch and Continuous flow reactors for bio kinetic measurements. Microbiological reactors: Operation and maintenance of typical aseptic aerobic fermentation processes. *Formulation of medium:* Sources of nutrients. Alternate bioreactor configurations. Introduction to sterilization of bioprocess equipment. **Downstream Processing:** Strategies and Steps involved in product purification. Methods of Cell disruption, Filtration, Centrifugation, Sedimentation, Chromatography, Freeze drying lyophilization. Membrane separation Technology: Reverse Osmosis,Ultra filtration, Micro filtration, Dialysis.	13			13
	Total SLT		39 hours			
17	**Main references supporting the Course:** 1. Bailey and Ollis, ***Biochemical Engineering Fundamentals,*** 2nd Edition, McGraw Hill, 1976. 2. Shuler M. L. and Kargi F., ***Bioprocess Engineering***, 2nd Edition, Prentice Hall, 2002.					
	Additional references supporting the course: 1. James Lee *Biochemical Engineering* – John Wiley, 2000 2. Pelczer, *Microbiology Concept and Application,* 5th Edition, McGraw Hill, 2001					

BMS College of Engineering, Bangalore -19

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Department of Chemical Engineering

<table>
<tr><td>1</td><td>Name of Course</td><td colspan="5">PRE-PROJECT WORK</td></tr>
<tr><td>2</td><td>Course Code</td><td colspan="5">11CH7DCPPW</td></tr>
<tr><td>3</td><td>Designation of the course</td><td colspan="5">Departmental Core</td></tr>
<tr><td>4</td><td>Rationale for the inclusion of the course/module in the programme</td><td colspan="5">The pre-project work is course in chemical engineering, were the students will gain knowledge about process design for a chemical industries. They will develop the problem and conduct literature survey of a process and carry forward.</td></tr>
<tr><td>5</td><td>Semester and year offered</td><td colspan="5">Semester 7 / Year 4</td></tr>
<tr><td rowspan="3">6</td><td>Total Student Learning Time(SLT)</td><td colspan="4">Face to Face</td><td>Total Guided and Independent Learning</td></tr>
<tr><td rowspan="2">L = Lecture
T = Tutorial
P = Practical
O = Others</td><td>L</td><td>T</td><td>P</td><td>O</td><td rowspan="2">Independent study = 0 hrs

Total = 12hrs</td></tr>
<tr><td></td><td>0</td><td>12</td><td>0</td></tr>
<tr><td>7</td><td>Credit Value</td><td colspan="5">Hours of Practical=12 h</td></tr>
<tr><td>8</td><td>Prerequisite (if any)</td><td colspan="5">All the departmental subjects</td></tr>
<tr><td>9</td><td colspan="6">Objectives:
project work can be useful for:
• providing a rounded, integrated and satisfying learning experience when used alongside other approaches to learning and teaching
• enhancing student motivation by virtue of being ‘hands-on’ and grounded in real-life engineering problems
• promoting greater understanding of the value – and limitations – of theoretical knowledge by virtue of its application to practical problems
• developing a range of specific engineering knowledge and skills, sometimes including experience in industrial settings
• developing a range of generic skills and abilities that will be of value in work and other life situations
• strengthening retention of knowledge and skills which have been acquired through experience and practical activity
• enhancing students’ employment prospects because of the practical skills and experience they will have acquired
• enabling students to ‘hit the ground running’ in industry through their experience of linking theory to practice</td></tr>
<tr><td>10</td><td colspan="6">Learning outcomes:
Project based learning is also well suited to developing and assessing a wide range of generic skills and attributes relevant to the engineering students. These could include:
CO1. Identify a challenge related to process industries and/or the society with or without multidisciplinary facets.
CO2. Select a suitable method amongst the various options available through literature survey.
CO3. Formulate and report methodical approach to carry out the experiment to find a feasible solution</td></tr>
</table>

11	**Transferable Skills:** • Planning and management of work over an extended period of time • Meeting deadlines and working within other externally defined constraints • Tackling work which lacks a well-defined outcome or has a wide range of • possible answers • Utilising practical applications of theoretical learning in real-life situations • Thinking about different aspects of engineering – design, materials, manufacturing – as parts of an integrated process • Presenting and interpreting technical information in various ways • Working across discipline boundaries, often as part of a team, drawing on engineering, science, business, computer science etc as required • Applying knowledge and skills in industry or other workplace settings, considering technological, environmental and commercial issues
12	**Teaching-learning and assessment strategy:** A variety of teaching and learning strategies are used throughout the course, including: Review the learning outcomes • Identify performance criteria for each outcome • Look at alternative assessment methods • Decide which methods will best test the essential intended learning outcomes • Determine what tasks the students will undertake • Determine what outputs will be produced • Develop a method of grading the outputs • Develop an assessment schedule • Produce an assignment brief Assessment strategies include the following: • Peer Reviews • Report writing • Faculty supervision • Continuous internal evaluation (CIE) Presentations of progress report. • Semester End Examination (SSE)
13	**Synopsis:** Chemical engineering students are often expected to work effectively as teams in group projects without any formal guidance. This case study describes an approach where explicit team training was integrated closely with an existing engineering design group project. Three main aspects of the project are discussed: modification of the existing project structure to enhance the team working element, incorporation of an upfront team training session and incorporation of a final debriefing and reflection session. Student enthusiasm for this approach has been very positive.
14	**Mode of Delivery:** • Faculty supervision and guidance

15	**Assessment Methods and Types:** The assessment for this course will be based on the following: **Coursework** **100 %** **Continuous Internal Evaluation** **50 %** **Semester End Examination** **50%** **Assessment** **100 %**

16

Content outline of the course/module and the SLT per-topic

	Details	SLT				
		L	**T**	**P**	**O**	**Total**
Content of course	The project has to be assigned at the beginning of the seventh semester. The project group should complete the preliminary literature survey & plan of project and submit the synopsis at the end of seventh semester with a literature survey and plan for the experimental work to be performed with all parameters.			12		12
	Total SLT	**52**				

17

Main references supporting the Course:

1. Dryden's outlines of Chemical Technology.
2. Shreve's chemical process industries, 4^{th} edition
3. Chemical Engineers Handbook - R.H. Perry & D.W. Green, 7^{th} Edition, McGraw Hill, 1998.

Additional references supporting the course:

1. Mass Transfer Operations - Robert E, Treybal, McGraw Hill, 1981.
2. Chemical Engineering- Vol 6 - J.M. Coulson & J.F. Richardson, Pergemen Press, 1993
3. Chemical & Catalytic Reaction Engineering - James J. Carberry, McGraw Hill - 1976.
4. Unit Operations in Chemical Engineering - McCabe & Smith, 6^{th} Edition, McGraw Hall, 2001.
5. Chemical Engineering Vol. III, III Edition - Coulson & Richardson, Pergamon Press, 1998
6. "Introduction to Chemical Engineering Thermodynamics", Fifth edition, Smith J.M. and Van Ness H.C., McGraw Hill, New York, 1996.

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<table>
<tr><td>1</td><td>Name of Course</td><td colspan="4">PLANT UTILITIES AND SAFETY</td></tr>
<tr><td>2</td><td>Course Code</td><td colspan="4">11CH7DCPUS</td></tr>
<tr><td>3</td><td>Designation of the course</td><td colspan="4">Departmental Core</td></tr>
<tr><td>4</td><td>Rationale for the inclusion of the course/module in the programme</td><td colspan="4">To familiarize different plant utilities associated in Chemical plants and equipment associated with it. It also emphasizes about the safety, risk, & hazard assessment.</td></tr>
<tr><td>5</td><td>Semester and year offered</td><td colspan="4">Semester VII / Year IV</td></tr>
<tr><td rowspan="3">6</td><td>Total Student Learning Time(SLT)</td><td colspan="3">Face to Face</td><td>Total Guided and Independent Learning</td></tr>
<tr><td rowspan="2">L = Lecture
T = Tutorial
P = Practical</td><td>L</td><td>T</td><td>P</td><td rowspan="2">Total = 03 credits</td></tr>
<tr><td>3</td><td>0</td><td>0</td></tr>
<tr><td>7</td><td>Credit Value</td><td colspan="4">3</td></tr>
<tr><td>8</td><td>Prerequisite (if any)</td><td colspan="4">None</td></tr>
<tr><td>9</td><td colspan="5">Objectives:
1. The knowledge of different types of equipments used for producing and transferring utilities.
2. Thorough understanding of production of industrial gases and steam, as well as refrigeration, process safety and analysis, HAZAN and HAZOP and safety devices.
3. Risk analysis, assessment and abatement of hazards for the safe operation of processes in chemical industries.</td></tr>
<tr><td>10</td><td colspan="5">Course outcomes:
By the end of the course, students will be able to:
CO1. Identify different utilities required for chemical plants and criteria for selecting the equipments.
CO2. Apprehend process safety in order to comply with industrial & regulatory standards.
CO3. Envision and abate the types of risks involved in chemical plants using HAZAN and HAZOP analysis.</td></tr>
<tr><td>11</td><td colspan="5">Transferable Skills:
→ Data searching skills
→ Report writing
→ Critical thinking and problem solving skill
→ Economic analysis skill</td></tr>
<tr><td>12</td><td colspan="5">Teaching-learning and assessment strategy:
Teaching-learning Methods
• Classroom lectures
• Lecturer-led problem-solving sessions

Direct Assessment Strategies
• Continuous internal evaluation (CIE) Test 1, Test 2 & Test 3. Best of average
• Quiz 1 & 2
• Semester End Examination (SEE)

Indirect Assessment Strategies
• Assignments
• Lecturer Observation through presentations</td></tr>
<tr><td>13</td><td colspan="5">Synopsis:</td></tr>
</table>

Chemical industries needs chilled water, nitrogen, refrigerant and compressed air supply for processing the raw materials and storing the products at low temperature general termed as utilities. This course gives an insight to the different types of equipments used for producing and supplying these utilities. This will also give an understanding of the risk associated with handling chemicals and high pressure operations and safety measures that should be adopted to reduce hazards.

14 **Mode of Delivery:**

- Classroom lectures

15 **Assessment Methods and Types:**

Coursework

Continuous internal assessment

• Test 1	20%
• Test 2	20%
• Quiz 1 &2	10%
Semester End Exam	**50 %**
Assessment	100%

16 **Content outline of the course/module and the SLT per-topic**

	Details	SLT			
		L	T	P	Total
Unit 1	**Air**: Compressed air and types of compressor, power requirements with related calculations, performance and related calculations. **Nitrogen:** Air separation plants for nitrogen production and storage of liquid Nitrogen **Steam and Power:** Steam generation in chemical plants, fire tube boiler and water tube boiler, boiler performance and its calculation, cogeneration power plants. **Fuels: T**ypes, calculation on calorific value, proximate and ultimate analysis. Bio-fuel calculation: calorific value, steam storage and handling, piping and accessories.	12	-	-	12
Unit 2	**Refrigeration**: Different refrigeration systems and their characteristics. Coefficient of performance, power requirements and refrigeration effect- and related calculations for each type of refrigeration system. Refrigerant properties and selection, Some commonly used refrigerants and secondary refrigerants. Refrigerant properties and selection. Commonly used refrigerants and secondary refrigerants, air-conditioning systems. **Insulation:** Types of insulation, different types of insulating materials and their characteristics, selection criteria for insulating materials.	09			09
Unit 3	**Process safety**: Introduction to p**rocess safety,** Intrinsic & extrinsic safety. Hazards- toxicity, flammability, fire, explosions, ignition sources, design temperature and pressure.	06			06

	Unit 4	**<u>Process safety analysis:</u>** HAZAN and HAZOP comparison, use of HAZOP guide-words, risk analysis and estimation, safety check list. Computer based quantitative risk analysis, introduction to safety Integrity Standard IEC 61508/61511.	06			06
	Unit 5	**<u>Safety Devices</u>**: Pressure relief valves, ruptures discs, blow down systems, flare systems, flame arrestors, deflagration arrestors and explosion suppression, personal safety devices. Introduction to American Petroleum Standard API-521.	06			06
	Total SLT		39 hours			
17	**Main references supporting the Course:** 1. B. K. Sarkar, *Thermal Engineering*, 3rd edition, Tata McGraw Hill, 1998. 2. C. P. Arora, *Refrigeration and Air Conditioning*, 2nd edition, Tata McGraw Hill, 2000.					
	Additional references supporting the course: 1. K. P. Roy, *Heat Engines*, Media Promoters and Publishers, 1995. 2. Gopal Rao, M. and Marshall Sitting, *Dryden's Outlines of Chemical Technology*, 3rd Edition, Affiliated East West Press Pvt. Ltd., New Delhi, 1997.					

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Department of Chemical Engineering

1	**Name of Course**	**COMPUTER APPLICATION AND MODELING**			
2	**Course Code**	11CH7DCCAM			
3	**Designation of the course**	Departmental Core			
4	**Rationale for the inclusion of the course/module in the programme**	Process Simulation software is used to solve problems that are too complex. When solved manually, these problems are time consuming. However, with the advent of high speed computers, this computing can be done in seconds. This course helps the students to learn computation through programming and simulation tool. This course will enable user's knowledge of computer programming with chemical engineering principles.			
5	**Semester and year offered**	Semester VII / Year IV			
6	**Total Student Learning Time(SLT)**	**Face to Face**			**Total Guided and Independent Learning**
	L = Lecture T = Tutorial P = Practical O = Others	L	T	P	Independent study = 01h/week Total = 04 credits
		03	00	01	
7	**Credit Value**	4			
8	**Prerequisite (if any)**	Chemical Technology, Transport Processes, Engineering Mathematics.			

9 **Objectives:**

1. To learn computational methods with numerical techniques & its applications.
2. To solve a variety of chemical engineering problems of unit operations and its design using mathematics modeling.

10 **Course outcomes:**

By the end of the course, students will be able to:

CO1.Application of numerical methods for solving engineering problems and computer programming.

CO 2. Develop an algorithm and program to design various equipment for unit operations.

CO3. Build mathematical models for process systems using modeling concept and physical laws.

11 **Transferable Skills:**

→ Knowledge of numerical techniques.
→ Knowledge of computer programming.
→ Development of mathematical model.
→ Knowledge of simulation and learning of simulation tool.
→ Literature and data searching skills.
→ Independent study and self-learning skills.

12 **Teaching-learning and assessment strategy:**

Teaching-learning Methods

- Classroom lessons. Lectures and Power Point Presentations
- Lecturer-led problem-solving sessions
- Solving assigned problems individually and in team
- Independent study

Direct Assessment Strategies

- Continuous internal evaluation (CIE) Test 1, Test 2 & Test 3. Best of average
- Quiz

	• Lab Examination • Brainstorming • Viva Voce • Semester End Examination (SSE) **Indirect Assessment Strategies** • Assignments • Lecturer Observation through presentations • Lab practice
13	**Synopsis:** This course aims to provide step by step assistance in using computers for solving problems that cover the following area of analyses: • Material and energy balance • Fluid flow • Mass and Heat transfer • Optimization • Reaction kinetics This course deals with the development of reusable computer programs by establishing the general theoretical concepts, then determining the appropriate numerical methods applicable, testing the algorithm through manual calculations, writing and debugging the computer program based on the algorithm and finally, validating the result using statical analysis. This course also describes the fundamentals of process simulation. In chemical engineering, process simulation is needed to solve the problems related to process design, process analysis, process control and many more.
14	**Mode of Delivery:** • Classroom Lectures, Lab Sessions and Presentations.
15	**Assessment Methods and Types:**

Coursework	
Continuous internal assessment	**50%**
• Test 1	10%
• Test 2	10%
• Quiz/Assignment/Brainstorming	5%
• Practical Laboratory	25%
Semester End Examination	**50 %**
Assessment	100%

16 **Content outline of the course/module and the SLT per-topic**

	Details	SLT			
		L	T	P	Total
Topic 1	**Numerical Techniques and Applications** Non-linear algebraic equation-Newton Raphson. Ordinary Differential Equation- R-K Method. Numerical Integration-Simpson's 1/3 Rule. Curve Fitting-Least Squares. **Applications:** Vapor- Liquid equilibria for binary mixtures. Calculation of Bubble Pressure and Bubble Point. Dew Pressure and Dew point for Ideal Binary and multi-component system.	10			10

	Topic 2	**Unit Operations** Flash Vaporization for multi-component system. Design of Adiabatic Batch Reactor. Absorption & Distillation Columns: Calculations for Plate and Packed Columns.	07			07
	Topic 3	**Design** Design of Adiabatic PFR, Adiabatic CSTR and Combinations. **Design:** Double Pipe Heat Exchanger (Area, Length and Pressure drop). Shell & Tube Heat Exchanger (Area, Number of tubes, Pressure drop.	08			08
	Topic 4	**Fundamentals of Modeling** Models and model building, principles of model formulations, precautions in model building, Fundamental laws: Review of shell balance approach, continuity equation, energy equation, equation of motion, transport equation of state equilibrium and Kinetics, classification of mathematical models	07			07
	Topic 5	**Mathematical Modeling** Basic tank model – Level V/s time. Batch Distillation – Vapor composition with CSTRs in series time	07			07
		Lab work **Programing** 1. Non-linear algebraic equation- Newton Raphson (Specific volume of binary mixture) 2. Ordinary Differential Equation- R-K Method ($dCa/dt=kCa^2$) 3. Numerical Integration- Simpson's 1/3 Rule (Batch Reactor to find time) 4. Curve Fitting-Least Square (Nre vs f) 5. Calculation of Bubble Point and Dew Point for Ideal multi-component system 6. Flash Vaporisation for multi-component system 7. Design of Adiabatic Batch Reactor, PFR 8. Adiabatic Flame Temperature 9. Double pipe heat exchanger (Area, Length and Pressure drop) Distillation Column (Bubble cap) **Simulation** 1. Introduction to suggested software available (flow sheeting) 2. Simulations Studies of flash drum, Distillation Column, CSTR, PFR, Heat Exchanger. 3. Simulation Studies of pump, compressor, cyclone, heater. 4. Process simulation study involving mixing, reactor, distillation, heat exchanger for any of the following: a) Ethylene Glycol from Ethylene oxide b) Atmospheric distillation of crude oil c) Propylene Glycol from Propylene oxide d) Aromatic stripper with recycle stream (Benzene, Toluene, Xylene) e) Styrene from Ethyl Benzene	3hrs /week			
		Total SLT	39 hours (Theory)			

17	**Main references supporting the Course:** 1. M. Shanthakumar ***Computer based Numerical Analysis***, KPS Publisher, First Edition, 1987. 2. Myers, A.L and Seider W.D., ***Introduction to Chemical Engineering and Computer Calculations***, Prentice Hall – 1976. 3. William. L Luyben, ***Process Modeling Simulation and Control for Chemical Engineering***, 2^{nd} Edition., McGraw Hill, 1990.
	Additional references supporting the course: 1. H. Scott Fogler ***Elements of Chemical Reaction Engineering***, 2^{nd} Edition, Prentice Hall, 2001. 2. Smith J. M. and H. C. Vanness ***Introduction to Chemical Engineering Thermodynamics***, 5^{th} Edition, McGraw Hill, 1996.

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1	**Name of Course**	CHEMICAL PROCESS EQUIPMENT DESIGN AND DRAWING			
2	**Course Code**	11CH7DCPED			
3	**Designation of the course**	Departmental Core			
4	**Rationale for the inclusion of the course/module in the programme**	Process equipment design and drawing course collates the acquired core chemical engineering knowledge to solve process industry problems or requirements. The detail calculation, drawing and specification are a translation from engineering aspect of equipment requirement to various phases like fabrication, erection and/or operation in a process industry.			
5	**Semester and year offered**	Semester VII / Year IV			
6	**Total Student Learning Time(SLT)**	**Face to Face**			**Total Guided and Independent Learning**
	L = Lecture T = Tutorial P = Practical O = Others	L	T	P	Total = 04 credits
		03	00	01	
7	**Credit Value**	4			
8	**Prerequisite (if any)**	Knowledge of core chemical engineering aspects in terms of energy & mass transfer principles and various unit operations. Team work and data acquisition skills are essential			

9 **Objectives:**

1. To select suitable type & design of chemical process equipment for given problem using the data from the literature.
2. To enhance the understanding between engineering disciplines (chemical, mechanical, control, environmental) and to improve the economic and safety aspects of equipment design and operation.
3. Able to design & draw the chemical equipments required to make certain products.

10 **Course outcomes:**

By the end of the course, students will be able to:

CO1. Congregate data from the literature, Handbook, Code book etc.
CO2. Analyze, interpret, and design the heat and mass transfer equipments.
CO3. Decide on the incorporation of inherent safety standards.
CO4. Draft the equipments as per the design.

11 **Transferable Skills:**

→ Literature and data searching skills
→ Written communication and drawing skills
→ Critical thinking and problem solving skills
→ Time management skills
→ Teamwork skills
→ Analysis and decision-making skills

12 **Teaching-learning and assessment strategy:**

Teaching-learning Methods

- Classroom lessons. Lectures and Power Point Presentations
- Lecturer-led problem-solving sessions

- Solving assigned problems individually and in team
- Independent study

Direct Assessment Strategies

- Continuous internal evaluation (CIE) Test 1, Test 2 & Test 3. Best of average
- Quiz 1
- Drawing Examination
- Semester End Examination (SSE)

Indirect Assessment Strategies

- Assignments
- Lecturer Observation through presentations
- Lab practice
- Brainstorming

13 **Synopsis:**

This course deals with selection and design of chemical process equipment. Introduction to a range of process equipment such as heat and mass transfer equipments. The reason for this course is that the student can make equipment selection decisions in designing "fit for purpose" units in chemical process plants. In order to appreciate the depth and gain the skills involved with the detailed design of equipment, the student will do detailed studies in aspects of equipment design for several process units like Heat exchanger, Condensers, Evaporators, Distillation column, Packed column and rotary Dryer. These designs will encompass aspects of design criteria specification, materials selection, the importance of relevant design standards and legal requirements, detailed mechanical design and drawing. Further industrial exposure to process equipments will help students to realize the sizes of the equipment according to industrial requirement and to design different process equipments used in various chemical industries like Oil & Gas, Power Plant, Pharmaceutical, Chemical, Fertilizer, Food Processing Industries, etc.

14 **Mode of Delivery:**

- Classroom Lectures, Lab Sessions and Presentations.

15 **Assessment Methods and Types:**

Coursework

Continuous internal assessment

• Test 1	10%
• Test 2	10%
• Quiz/Assignment/Brainstorming	5%
• Practical Laboratory	25%
Semester End Examination	**50 %**
Assessment	100%

16 **Content outline of the course/module and the SLT per-topic**

	Details	**SLT**			
		L	**T**	**P**	**Total**

	Topics	Introduction to design, Phases of design – problem analysis, data acquisition, material selection, different country safety aspects (standard code IS, BIS, ANSI, ASTM, BS, DIN), possible and plausible design etc. **Double pipe heat exchanger (DPHE)** Introduction to hairpin design, various components of DPHE, multiple and fractional hairpins. Process and mechanical design of DPHE. Drawing of sectional front view and side view with detailed specification. **Shell and Tube heat exchanger (STHE)** Introduction to various STHE design, tube side and shell side pass, various components of STHE. Process and mechanical design of STHE. Drawing of sectional front view and tube sheet with detailed specification. **Condensers – Horizontal and vertical** Introduction to Horizontal and vertical condenser design and their differences. Process and mechanical design of condenser. Drawing of sectional view and tube distribution / arrangement with detailed specification. **Evaporator – Single effect** Introduction to single and multiple effect evaporator and design aspects of single effect evaporator with various components involved. Process and mechanical design of evaporator. Drawing of sectional front view and top view with tube arrangement with detailed specification. **Bubble-cap Distillation column** Introduction to no of stages, top & bottom heads, various plate designs and various other components involved. Process and mechanical design of distillation column. Drawing of full sectional front view, bubble cap, and top view with bubble cap distribution with detailed specification. **Packed-bed Absorption column** Introduction to no of stages, top & bottom heads, various packing designs and components of one transfer unit/ stage. Process and mechanical design of absorption column. Drawing of full sectional front view, liquid distributor, packing restrainer/ hold down plate and gas distributor, with detailed specifications. **Rotary Dryer** Introduction to dryers and their components. Process and mechanical design of dryer. Drawing of full length sectional front view with geared rotary system with support legs and side view with detailed specification.	39	0	0	39
		Drawing of the design	3hrs/week			

	Total SLT	39 hours (Theory)
17	**Main references supporting the Course:** 1. Donald Q. Kern, *Process Heat transfer*, McGraw Hill, 1997 2. Robert E, Treybal, *Mass transfer operations*, McGraw Hill, 1981	
	Additional references supporting the course: 1. R. H. Perry and.W. Green, *Chemical Engineers Handbook- 7th Edition*, McGraw Hill, 1998 2. J. M. Coulson & J. F. Richardson, *Chemical Engineering – volume 6*, Pergemen press, 1993 3. *Shell and Tube heat exchanger* – IS Code (IS 4503), BIS New Delhi, 1969 4. S. D. Dawande*Process design and equipment - volume 2*, Central Techno publication, 3rd edition, 2003	

B.M.S. COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College Under VTU)

Department of Chemical Engineering

<table>
<tr><td>1</td><td>Name of Course</td><td colspan="4">COMPOSITE MATERIALS</td></tr>
<tr><td>2</td><td>Course Code</td><td colspan="4">11CH7IECP1</td></tr>
<tr><td>3</td><td>Designation of the course</td><td colspan="4">Institutional Elective</td></tr>
<tr><td>4</td><td>Rationale for the inclusion of the course/module in the programme</td><td colspan="4">The knowledge about the lightweight materials formed by combining reinforcing fibers in a polymer, ceramic, or metal matrix are required for various applications in industries. The use of composites has grown significantly in the following industries viz. aerospace, automotive, biotechnology, construction, electronics, marine, and sporting goods.</td></tr>
<tr><td>5</td><td>Semester and year offered</td><td colspan="4">Semester VII / Year IV</td></tr>
<tr><td rowspan="3">6</td><td>Total Student Learning Time(SLT)</td><td colspan="3">Face to Face</td><td>Total Guided and Independent Learning</td></tr>
<tr><td rowspan="2">L = Lecture
T = Tutorial
P = Practical</td><td>L</td><td>T</td><td>P</td><td rowspan="2">Total =4 credits</td></tr>
<tr><td>4</td><td>0</td><td>0</td></tr>
<tr><td>7</td><td>Credit Value</td><td colspan="4">4</td></tr>
<tr><td>8</td><td>Prerequisite (if any)</td><td colspan="4">Material science, Nano technology and Polymer processing</td></tr>
<tr><td>9</td><td colspan="5">Objectives:
1. Understand the different preparation methods and applications of modern composite materials.
2. The mechanical properties, electrical properties, linear elastic analysis of composite materials for the stiffness and strength of anisotropic fiber-reinforced composites are studied.</td></tr>
<tr><td>10</td><td colspan="5">Course outcomes:
By the end of the course, students will be able to:
CO 1. Classify composite materials based on the applications.
CO 2. Distinguish between mechanical and chemical techniques for fabrication and synthesis of composite materials.
CO3. Comprehend the fabrication techniques for reinforced composite materials for industrial applications.</td></tr>
<tr><td>11</td><td colspan="5">Transferable Skills:
→ Knowledge of processing techniques for synthesizing composite materials
→ Independent study and self-learning skills
→ Analysis and decision making skills
→ Academic / Technical writing and presentation skills
→ Oral / Written communication skills</td></tr>
<tr><td>12</td><td colspan="5">Teaching-learning and assessment strategy:
Teaching-learning Methods
• Classroom lectures and power point presentations
• Collaborative and co-operative learning
• Independent study
Direct Assessment Strategies
• Continuous internal evaluation (CIE) Test 1, Test 2 & Test 3. Best of average
• Quiz 1 & 2
• Brainstorming sessions
• Semester End Examination (SEE)</td></tr>
</table>

	Indirect Assessment Strategies • Assignments • Lecturer observation during presentations • Participation of students during interactive discussion
13	**Synopsis:** Composite Materials are being used in all engineering streams because of their properties such as light-weight, high strength-to-weight and stiffness-to-weight ratios, corrosion resistance, nonmagnetic, nonconductive, and they can tailor the material system (fibers and resins) and shape for specific applications. Composite materials have been used for bridges, piers, retaining walls, airport facilities, storage structures exposed to salts and chemicals, chemical and water treatment plants, and many other structures.
14	**Mode of Delivery:** • Classroom lectures, overhead presentations
15	**Assessment Methods and Types:** **Coursework** **Continuous internal assessment** • Test 1 — 20% • Test 2 — 20% • Quiz 1 & 2 — 10% **Semester End Examination** — **50%** **Assessment** — 100%
16	**Content outline of the course/module and the SLT per-topic**

	Details	SLT			
		L	T	P	Total
UNIT I	**Synthesis and fabrication:** Synthesis and fabrication of advanced and future materials with emphasis on ceramic, semiconducting and super-conducting materials with superior structural, optical and electrical properties. **Techniques:** Techniques for preparation of ultra-pure, ultra-fine powders: metal of oxides, nitrides, carbides etc., with very well defined characteristics and superior properties.	13			13
UNIT II	**Processing Techniques:** Sintering, hot pressing, hot isostatic pressing, tape-casting, sol-gel processing for the formation of monolithic ceramics. Composites (ceramic, ceramic metal, as well as metal matrix), SiO_2, glasses from above powders.	06			06
UNIT III	**Processing techniques based on reaction methods:** Chemical vapor deposition (CVD), vapor phase epitaxy, plasma-enhanced chemical vapor deposition (PECVD), chemical vapor infiltration (CVI). Self propagating high temperature synthesis (SHS) for the preparation of monolithic ceramics, composites, coating, thin films, whiskers and fibers and semi conducting materials such as Si and Gallium arsenide.	07			07

	UNIT IV	**Synthesis and processing**: Synthesis and processing of mixed ceramic oxides with high temperature super conducting properties. **Reinforcement:** Reinforcement additives, fillers for polymer composite, master batch & compounding.	13			13
	UNIT V	**Polymer composite:** Fiber reinforced composites, stress–strain modulus relationship and nano composites. Characteristics & applications in marine, aerospace, building & computer industry. Manufacturing methods, hand layouts, filament winding, pultrusion, SMC, DMC.	13			13
	Total SLT		39 hours			
17	**Main references supporting the Course:** 1. W.D. Kingrey, *Introduction to Ceramics*, 2nd edition, John Wiley and sons, New York. 2. M.N. Rahaman, *Chemical processing and sintering*, 2nd edition, Marcel Dekker Inc., New York.					
	Additional references supporting the course: 1. James T. Schockel Ford, *Introduction to Material Science for Engineering*, McMillan Publications. 2. Krishna K. Chawla, *Composite Materials*, 3rd edition, Springer publishing house, 2012.					

B.M.S. COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College Under VTU)

Department of Chemical Engineering

<table>
<tr><td>1</td><td>Name of Course</td><td colspan="4">PROCESS ENGINEERING ECONOMICS</td></tr>
<tr><td>2</td><td>Course Code</td><td colspan="4">11CH8DHSS2</td></tr>
<tr><td>3</td><td>Designation of the course</td><td colspan="4">Departmental Core</td></tr>
<tr><td>4</td><td>Rationale for the inclusion of the course/module in the programme</td><td colspan="4">Knowledge of basic economics is required for all engineering disciplines. In chemical engineering, where plants are designed and built by chemical engineers, plant and process economics plays a vital role in the commercial success of the venture.</td></tr>
<tr><td>5</td><td>Semester and year offered</td><td colspan="4">Semester VIII / Year IV</td></tr>
<tr><td rowspan="3">6</td><td>Total Student Learning Time(SLT)</td><td colspan="3">Face to Face</td><td>Total Guided and Independent Learning</td></tr>
<tr><td rowspan="2">L = Lecture
T = Tutorial
P = Practical
O = Others</td><td>L</td><td>T</td><td>P</td><td rowspan="2">Total = 03 credits</td></tr>
<tr><td>03</td><td>00</td><td>00</td></tr>
<tr><td>7</td><td>Credit Value</td><td colspan="4">3</td></tr>
<tr><td>8</td><td>Prerequisite (if any)</td><td colspan="4">None</td></tr>
<tr><td>9</td><td colspan="5">Objectives:
1. To learn basic economic concepts.
2. To understand and apply these concepts in the project works undertaken and to chemical engineering situations by solving problems.</td></tr>
<tr><td>10</td><td colspan="5">Course outcomes:
By the end of the course, students will be able to:
CO1. Envision the basic concepts of plant location, design and report writing.
CO2. Apply economic concepts to solve chemical engineering problems.
CO3 Solve problems on profitability and replacement analysis.</td></tr>
<tr><td>11</td><td colspan="5">Transferable Skills:
→ Knowledge of basic economics
→ Understanding of key economic concepts
→ Problem solving skills in plant related economics
→ Economic concepts related to the chemical plants</td></tr>
<tr><td>12</td><td colspan="5">Teaching-learning and assessment strategy:
Teaching-learning Methods
• Classroom lectures
• Lecturer-led problem-solving sessions
• Solving assigned problems individually and in team
Direct Assessment Strategies
• Continuous internal evaluation (CIE) Test 1, Test 2 & Test 3. Best of average
• Quiz 1 and 2
• Semester End Examination (SEE)
Indirect Assessment Strategies
• Assignments
• Lecturer observation during class</td></tr>
<tr><td>13</td><td colspan="5">Synopsis: This course is designed to teach the basics of economics and financial decision making. Key economic concepts like the time value of money, profitability, depreciation, taxes and general design principles will integrate the engineer’s basic knowledge into an idea of how commercial process plants operate. This course aims to provide step by step assistance in using basic economic principles in the areas of time value of money, depreciation and taxes, alternatives and replacements, and financial</td></tr>
</table>

	statements and analysis.
14	**Mode of Delivery:** Classroom lectures
15	**Assessment Methods and Types:** **Coursework** **Continuous internal assessment** • Test 1 — 20% • Test 2 — 20% • Quiz 1 & 2 — 10% **Semester End Examination** — 50% **Assessment** — 100%
16	**Content outline of the course/module and the SLT per-topic**

	Details	SLT L	SLT T	SLT P	SLT Total
Unit 1	**Introduction to Process Engineering Economics**: Factors affecting plant location, Factors affecting plant layout. Product and process layout. Factors affecting design of a chemical plant. Report writing methods Feasibility report, research report and design report.	10	-	- -	10
Unit 2	**Costing:** Types of costs, Components of product cost. Cost and profit margins. Problems on costing involving simple components of cost and calculations.	09			09
Unit 3	**Depreciation:** Definition and types. Straight line method. Textbook declining balance method, Double declining balance method. Sum of years digits method, Unit of production method. Problems to illustrate concepts and formulae of depreciation and examples from Peter's/Timmerhaus. Impact of depreciation on taxes. Interest rates Simple compound effective and nominal interest and continuous interest Illustrative problems on the above topic.	11			11
Unit 4	**Profitability , replacement and alternatives:** Methods of evaluating profitability, Payback method, Internal Rate of return Capitalized costs, Net present value, Problems must be worked to illustrate these concepts. Methods of replacements and theory underlying the same. Problems involving capitalized costs. Methods of selection among alternatives and theory underlying the same. Incremental investments. Simple problems to illustrate concepts.	06			06
Unit 5	**Financial Statements:** Balance Sheet, Income Statement, Profit and Loss statement, Break –even analysis, Concept of breakeven point and chart, Simple problems in breakeven point.	03			03
	Total SLT	39 hours (Theory)			

17 Main references supporting the Course:

1. Max S. Peters, Klauss D. Timmerhaus, *Plant Design and Economics for Chemical Engineers*, McGraw Hill, 4th edn. 2000.

Additional references supporting the course

1. James L. Riggs. David D, *Engineering Economics*, Bedworth, 4th Edition, McGraw Hill, 1996.

B.M.S. COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College Under VTU)

Department of Chemical Engineering

<table>
<tr><td>1</td><td>Name of Course</td><td colspan="4">TRANSPORT PHENOMENA</td></tr>
<tr><td>2</td><td>Course Code</td><td colspan="4">11CH8DCTRP</td></tr>
<tr><td>3</td><td>Designation of the course</td><td colspan="4">Departmental Core</td></tr>
<tr><td>4</td><td>Rationale for the inclusion of the course/module in the programme</td><td colspan="4">While momentum, heat and mass transfer developed independently as branches of classical physics long ago, their unified study (Transport phenomena) has found its place as one of the fundamental engineering sciences. This development continues to grow and find applications in chemical engineering and in its new extended fields such as biotechnology, microelectronics, nano technology, and polymer science.</td></tr>
<tr><td>5</td><td>Semester and year offered</td><td colspan="4">Semester VIII / Year IV</td></tr>
<tr><td rowspan="3">6</td><td>Total Student Learning Time(SLT)</td><td colspan="3">Face to Face</td><td>Total Guided and Independent Learning</td></tr>
<tr><td rowspan="2">L = Lecture
T = Tutorial
P = Practical</td><td>L</td><td>T</td><td>P</td><td rowspan="2">Total = 04 credits</td></tr>
<tr><td>4</td><td>0</td><td>0</td></tr>
<tr><td>7</td><td>Credit Value</td><td colspan="4">4</td></tr>
<tr><td>8</td><td>Prerequisite (if any)</td><td colspan="4">Fluid Mechanics, Heat Transfer, Mass Transfer</td></tr>
<tr><td>9</td><td colspan="5">Objectives:
1. To familiarize the concepts of boundary conditions for momentum, heat and mass transfer operations.
2. To comprehend the velocity distribution, temperature profiles and concentration distributions.</td></tr>
<tr><td>10</td><td colspan="5">Course outcomes:
By the end of the course, students will be able to:
CO 1.Infer, analyze and solve problems for steady state operation for momentum, heat & mass transfer.
CO 2.Analyze steady state shell momentum, energy & mass balances for laminar flow across various boundary conditions.
CO 3.Apply equation of changes in various co-ordinate systems.
CO 4.Infer analogies between momentum, heat and mass transport.</td></tr>
<tr><td>11</td><td colspan="5">Transferable Skills:
→ Skills to frame the macroscopic balances
→ Skills to analyze a system including mass, momentum and heat transfer operation simultaneously
→ Skills to solve numerical problems
→ Skills to solve analytical problems</td></tr>
<tr><td>12</td><td colspan="5">Teaching-learning and assessment strategy:
Teaching-learning Methods
• Classroom lectures
• Lecturer-led problem-solving sessions
• Solving assigned problems individually and in team
Direct Assessment Strategies
• Continuous internal evaluation (CIE) Test 1, Test 2 & Test 3. Best of average
• Quiz 1 and 2
• Semester End Examination (SEE)</td></tr>
</table>

	Indirect Assessment Strategies • Assignments • Lecturer observation during class
13	**Synopsis:** Long regarded as a rather mathematical subject, transport phenomena is most important for its physical significance. The essence of the subject is the careful and compact statement of the conversion principles, along with the flux expressions, with emphasis on the similarities and differences among the three transport processes considered. Often, specialization to the boundary conditions and physical properties in a specific problem provide useful insight with minimal effort. Nevertheless, the language of transport phenomena is mathematics, and familiarity with ordinary differential equations and elementary vector analysis is assumed. The course includes three closely related topics: fluid dynamics, heat transfer, and mass transfer. Fluid dynamics involves the transport of momentum, heat transfer deals with transport of energy, and mass transfer if concerned with the transport of mass of various chemical species.
14	**Mode of Delivery:** • Classroom lectures
15	**Assessment Methods and Types:** **Coursework** **Continuous internal assessment** • Test 1 — 20% • Test 2 — 20% • Quiz 1 & 2 — 10% **Semester End Examination** — 50% **Assessment** — 100%

16 Content outline of the course/module and the SLT per-topic

	Details	SLT L	SLT T	SLT P	SLT Total
Unit 1	**Introduction to the transport operations** Basics laws of transport operations Effect of T and P on transport properties of fluids.	08	-	- -	08
Unit 2	**Shell momentum balances and velocity distributions in laminar flow**: Boundary conditions; Different cases- Flow over a flat plate, Flow through a circular tube, Flow through an annulus, Flow between parallel plates, Flow through a slit	14			14
Unit 3	**Steady state shell energy balances,** boundary conditions Heat conduction through compound walls Overall heat transfer coefficients. HT with internal heat generation by electrical source, HT with nuclear heat source, HT in a cooling film, HT by forced and free convection	14			14

	Unit 4	**Concentration Distributions in Laminar Flow:** Steady state Shell mass balances. General boundary conditions applicable to mass transport problems of chemical engineering. Diffusion through stagnant gas and liquid films. Equimolar counter diffusion. **Concentration Distributions in Laminar Flow**: Diffusion with homogeneous and heterogeneous reaction. Diffusion into falling film – Forced convection mass transfer.	09			09
	Unit 5	**Analogies between Momentum, Heat and Mass Transport:** Reynold's, Prandtl's and Chilton & Colburn analogies. **Equations of Change:** Equation of continuity, Equation of motion, Navier – Stokes equation, Euler's equation.	07			07
	Total SLT		52 hours (Theory)			
17	**Main references supporting the Course:** 1. Bird, Stewart and Lightfoot, '**Transport Phenomena'**, Academic Press, 1994.					
	Additional references supporting the course: 1. Welty, Wikes and Watson, '**Momentum Heat and Mass Transport',** John Wiley – 4th Ed.,, 2000. 2. Foust et al John Wiley, '**Principles of Unit Operations in Chemical engineering',** 1990.					

B.M.S. COLLEGE OF ENGINEERING, BANGALORE-19

(Autonomous College Under VTU)

Department of Chemical Engineering

<table>
<tr><td>1</td><td>Name of Course</td><td colspan="4">WASTEWATER TREATMENT AND ENGINEERING</td></tr>
<tr><td>2</td><td>Course Code</td><td colspan="4">11CH8IECK1</td></tr>
<tr><td>3</td><td>Designation of the course</td><td colspan="4">Institutional Elective</td></tr>
<tr><td>4</td><td>Rationale for the inclusion of the course/module in the programme</td><td colspan="4">The course offered by the Department of chemical engineering as Institutional elective. Students will understand the fundamentals and importance of wastewater and its contaminants, effects, treatments and disposal with its management ethically.</td></tr>
<tr><td>5</td><td>Semester and year offered</td><td colspan="4">Semester VIII / Year IV</td></tr>
<tr><td rowspan="3">6</td><td>Total Student Learning Time(SLT)</td><td colspan="3">Face to Face</td><td>Total Guided and Independent Learning</td></tr>
<tr><td rowspan="2">L = Lecture
T = Tutorial
P = Practical</td><td>L</td><td>T</td><td>P</td><td rowspan="2">Total = 04 credits</td></tr>
<tr><td>4</td><td>0</td><td>0</td></tr>
<tr><td>7</td><td>Credit Value</td><td colspan="4">4</td></tr>
<tr><td>8</td><td>Prerequisite (if any)</td><td colspan="4">Pollution control & Engineering</td></tr>
</table>

9 **Objectives:**

1. The unscientific disposal of wastewater/effluents due to increase industrial and urban development, wastewater/effluent generation, treatment, disposal and its effects on the environment requires special considerations and approach.
2. Sewage/Sullage/Effluent treatment is the process of removing contaminants from wastewater and household sewage, both runoff (effluents) and domestic.
3. The wastewater includes foreign matter with fine and coarse matter with physical, chemical and biological contaminants requires the physical and chemical operations and biological process with primary, secondary and advanced treatment options depending on the disposal options.
4. The objective is to produce an environmentally safe fluid waste stream (or treated effluent) and solid waste (or treated sludge) suitable for disposal or reuse usually as farm fertilizers
5. Now using advanced technology it is now possible to reuse sewage/effluent for various secondary purposes some time for drinking.

10 **Course outcomes:**

By the end of the course, students will be able to:

- CO 1. Cognize the different regulatory standards with design criteria for environmental parameters
- CO 2. Learn the wastewater treatment criteria based on the regional requirement.
- CO 3. Comprehend the reaction kinetics, reactor selection and its process analysis.
- CO 4. Design the treatment plant based on the fundamentals studies, bench scale and pilot plant studies.

11 **Transferable Skills:**

→ Knowledge of basic concepts of wastewater and its effect on the environment.
→ Knowledge of contaminants in the influents and it understanding the tests/parameter characterization.
→ Literature and data searching skills.
→ Bench and Pilot plant concepts.
→ Independent study and self-learning skills.
→ National and International standards for Environmental Parameter.
→ Academic / Technical writing and presentation skills

12 **Teaching-learning and assessment strategy:**

Teaching-learning Methods

- Classroom lectures

	• Lecturer-led problem-solving sessions • Solving assigned problems individually and in team **Direct Assessment Strategies** • Continuous internal evaluation (CIE) Test 1, Test 2 & Test 3. Best of average • Quiz 1 and 2 • Semester End Examination (SEE) **Indirect Assessment Strategies** • Assignments • Lecturer observation during class
13	**Synopsis:** Institutional elective course cover topics on Basic of wastewater engineering, Quantitative and Qualitative analysis of sewage, Rural water supply and sanitary conditions, Storm and Sewer Design, Sewerage and sewerage equipment, Sewage discharge criteria, Wastewater Treatment of microbiology with fundamental process analysis and reaction kinetics. Various unit operations and unit process for treatment of wastewater, solid (sludge) handling and its disposal using various options.
14	**Mode of Delivery:** • Classroom lectures, PPT
15	**Assessment Methods and Types:** **Coursework** **Continuous internal assessment** • Test 1 — 20% • Test 2 — 20% • Quiz 1 & 2 — 10% **Semester End Examination** — 50% **Assessment** — 100%

16 Content outline of the course/module and the SLT per-topic

	Details	SLT			
		L	**T**	**P**	**Total**
Unit 1	Objectives of wastewater treatment. Flow measurements and Composition. Characterization -properties and analysis of wastewater. Rural wastewater systems: waste treatability studies-a bench scale and pilot scale. Effluent standards for discharge to water bodies and land applications- state and central	08			08
Unit 2	Microbiology of waste treatment- Growth and inhibition of bacteria. Kinetics of Biological growth Batch culture substrate limited growth, Cell growth and substrate utilization. Effects of endogenous metabolism & kinetics Manod's and Michaclis menton kinetics and their applications. Determination of kinetic coefficients.	12			12

	Unit 3	Fundamentals of process analysis, Reaction Kinetics. Reaction Kinetics, Mass balance analysis. Reactors and their hydraulic characteristics Reactor selection & kinetics - Batch, Plug flow Reactor selection & kinetics - Completely stirred tank Reactor selection & kinetics - packed and fluidized bed reactor	12			12
	Unit 4	Sewerage System- Design of sanitary sewer. Sewerage System- Design of storm water sewers, Physical and Chemical treatment of wastewater, Screens, Comminuters, Grit chambers, Sedimentation Chemical treatment	10			10
	Unit 5	Biological treatment process. Activated sludge process-standard type and modifications. Aerators. Trickling filter, Aerated lagoon, Stabilization ponds Treatment disposal of sludge- Sludge characteristics, Concentration. Anaerobic sludge digestion. Aerobic Sludge digestion, Sludge conditioning, Dewatering and drying. Incineration and wet oxidation.	10			10
	Total SLT		52 hours (Theory)			
17	**Main references supporting the Course:** 1. Metcalf and Eddy – Wastewater Engineering. 2. Eckenfelder and O Conner- Biological waste treatment 3. Gaudy and Gaudy- Microbiological for environmental Scientist and engineers McGraw Hill 1980. 4. Gaudy-Advanced Waste water Treatment.					
	Additional references supporting the course 1. Journal of Water Research. 2. ASCE Journal of Environmental Engineering. 3. Indian Journal of Environmental Health					

BMS College of Engineering, Bangalore -19

(Autonomous College under VTU)

Department of Chemical Engineering

<table>
<tr><td>1</td><td>Name of Course</td><td colspan="4">Final-PROJECT WORK</td></tr>
<tr><td>2</td><td>Course Code</td><td colspan="4">C H 8 D C F P W</td></tr>
<tr><td>3</td><td>Designation of the course</td><td colspan="4">Departmental Core</td></tr>
<tr><td>4</td><td>Rationale for the inclusion of the course/module in the programme</td><td colspan="4">The final-project work is course in chemical engineering, were the students will gain knowledge about process design for a chemical industries. The problem developed in the pre-project work is executed to obtain the final results. The content studied will be presented in the form of final report and defend their degree</td></tr>
<tr><td>5</td><td>Semester and year offered</td><td colspan="4">Semester VIII / Year IV</td></tr>
<tr><td rowspan="3">6</td><td>Total Student Learning Time(SLT)</td><td colspan="3">Face to Face</td><td>Total Guided and Independent Learning</td></tr>
<tr><td rowspan="2">L = Lecture
T = Tutorial
P = Practical
O = Others</td><td>L</td><td>T</td><td>P</td><td rowspan="2">Total = 24 hrs/week</td></tr>
<tr><td>0</td><td>0</td><td>12</td></tr>
<tr><td>7</td><td>Credit Value</td><td colspan="4">12</td></tr>
<tr><td>8</td><td>Prerequisite (if any)</td><td colspan="4">All core subjects</td></tr>
<tr><td>9</td><td colspan="5">Objectives:
1. Identification and formulation of a relevant problem
2. Identify the current status of the problem in the research world
3. Design the methodology of solving the problem
4. Acquire, analyse and infer obtained data for the dissertation</td></tr>
<tr><td>10</td><td colspan="5">Course outcomes:
By the end of the course, students will be able to:
CO 1. Seek the relevant literature
CO 2. Deduce the experimental methodology for the chosen problem
CO 3. Data acquitions and interpretation
CO 4. Use modern tools
CO 5. Communicate and convey effectively</td></tr>
<tr><td>11</td><td colspan="5">Transferable Skills:
These include:
→ Planning and management of work
→ Meeting deadlines and working with defined constraints
→ Practical applications of theoretical learning in real-life situations
→ Presenting and interpreting technical information in various ways
→ Working across multi discipline areas often as part of a team
→ Applying knowledge and skills considering technological, environmental and commercial issues</td></tr>
</table>

12	**Teaching-learning and assessment strategy:** **Teaching-learning Methods** • Group discussions • Guide-led problem identification • Conduct experiments and analysis **Direct Assessment Strategies** • Continuous internal evaluation (CIE) Test 1, Test 2 & Test 3. Best of average • Quiz 1 and 2 • Semester End Examination (SEE) **Indirect Assessment Strategies** • Assignments • Lecturer observation during class Assessment strategies include the following: • Peer Reviews • Report writing • Faculty supervision • Continuous internal evaluation (CIE) Presentations of progress report. • Semester End Examination (SSE)
13	**Synopsis:** Final project work students are often expected to work effectively as teams in group projects with formal guidance. This case study describes an approach where explicit team training was integrated closely with an existing engineering design group project. Three main aspects of the project are discussed: modification of the existing project structure to enhance the team working element, incorporation of an upfront team training session and incorporation of a final debriefing and reflection session. . In this course each student is required to submit a Project Report on the designing of a Chemical Plant. The Report will consist of important chapters such as the following : - Introduction - Literature Survey - Selection of the Process and Process Details with justification of selection. - Thermodynamic and kinetic Considerations - Material Balances with Flow Sheet - Physico-Chemical data and Properties - Energy Balane with Flow Sheets - Process Design of Equipments and Optimum Conditions of Operation (Design of a minimum of two process equipments must be undertaken) - Fabrication drawing of one of the major equipments - Instrumentation & Process Control, Plant Layout, Safety, Precaution, etc. - Cost Estimation - Site Selection and Conclusion. Research and development projects are studied.
14	**Mode of Delivery:** • Faculty supervision and guidance

15	**Assessment Methods and Types:** **Coursework** **Continuous internal assessment** • Presentation 1 & 2 — 25% • Report — 25% **Semester End Examination** — 50% **Assessment** — 100%

16	Content outline of the course/module and the SLT per-topic					
		Details	SLT			
			L	T	P	Total
	Content of course	The students in a group will be assigned an experimental, design, a case study or an analytical problem, to be carried out under the supervision of a guide. The project has to be assigned at the beginning of the seventh semester. The project group should complete the preliminary literature survey & plan of project and submit the synopsis at the end of seventh semester. The project work should be carried out and completed at the end of eighth semester.			24	24
	Total SLT		52			

17 **Main references supporting the Course:**

1. Peters, M.S. and Timmerhaus, K.D., Plant design and economics for chemical engineers, McGraw-Hill, 1980.
2. Dryden's outlines of Chemical Technology.
3. Shreve's chemical process industries, 4th edition
4. Chemical Engineers Handbook - R.H. Perry & D.W. Green, 7th Edition, McGraw Hill, 1998.

Additional references supporting the course:

1. Mass Transfer Operations - Robert E, Treybal, McGraw Hill, 1981.
2. Chemical Engineering- Vol 6 - J.M. Coulson & J.F. Richardson, Pergemen Press, 1993
3. Chemical & Catalytic Reaction Engineering - James J. Carberry, McGraw Hill - 1976.
4. Unit Operations in Chemical Engineering - McCabe & Smith, 6th Edition, McGraw Hall, 2001.
5. Chemical Engineering Vol. III, III Edition - Coulson & Richardson, Pergamon Press, 1998
6. "Introduction to Chemical Engineering Thermodynamics", Fifth edition, Smith J.M. and Van Ness H.C., McGraw Hill, New York, 1996.
7. Himmelblau D.M., "Basic Principles and Calculations in Chemical Engineering", 6th Edn. Prentice Hall of India, New Delhi 1997