Academic Program: UG

Academic Year 2026-27

Syllabus

III & IV Semester B.E.

Chemical Engineering

SHRI DHARMASTHALA MANJUNATHESHWARA COLLEGE OF ENGINEERING & TECHNOLOGY,
DHARWAD – 580 002
(An Autonomous Institute approved by AICTE & Affiliated to VTU, Belagavi)

Ph: **0836-2447465 Fax: 0836-2464638 Web:** www.sdmcet.ac.in

SDM College of Engineering & Technology, Dharwad

It is certified that the scheme and syllabus for III & IV semester of UG program in Chemical Engineering is recommended by Board of Studies of Chemical Engineering Department and approved by the Academic Council, SDM College of Engineering & Technology, Dharwad. This scheme and syllabus will be in force from the academic year 2026-27 till further revision.

Principal Chairman BoS & HoD

College Vision and Mission

SDMCET –Vision

To develop competent professionals with human values.

SDMCET – Mission

- To have contextually relevant curricula.
- To promote effective teaching learning practices supported by modern educational tools and techniques.
- To enhance research culture.
- To involve industrial expertise for connecting classroom content to real life situations.
- To inculcate ethics and impart soft skills leading to overall personality development

SDMCET- Quality Policy

- In its quest to be a role model institution, committed to meet or exceed the utmost interest of all the stake holders.

SDMCET- Core Values

- Competency
- Commitment
- Equity
- Team work and
- Trust

Vision and mission of Department

Vision

To develop proficient Chemical Engineers to meet industrial and societal needs.

Mission

1. To design the curricula in tune with industry.
2. To inculcate research culture with ethics to disseminate knowledge.
3. To collaborate with industry and academia for sustainable growth.

Program Educational Objectives (PEOs)

The Chemical Engineering UG Program at SDMCET is framed and designed such that within first few years after graduation, the graduates will be able to:

I. Analyze, design and professionally practice in the area of Chemical Engineering and allied disciplines by acquiring good knowledge of basic sciences and Chemical Engineering.

II. Create applications to solve real-life problems of Chemical Engineering in a broad range of career path to fulfill ethical, economical, environmental and social responsibilities.

III. Pursue higher studies and carry out research in Chemical Engineering and allied Engineering and Management.

IV. Work in multidisciplinary teams with good communication skills and leadership qualities to solve engineering problems and develop entrepreneurial skills.

Program Outcomes (POs)

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and

modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific outcomes (PSOs)

13. **Plant operations and Control:** Conceptualize the knowledge and information gained in mass and energy balance, thermodynamics, transport phenomena, kinetics, unit operations, process control, equipment design that can be used in design, control and optimizing the Chemical processes.
14. **Quality, Feasibility and impact studies:** Develop an integrated process and modify it attributing to economy, environmental friendly, ethics coupled with safety by applying principles of chemical engineering.
15. **Development of engineering solutions through experiments:** Apply knowledge of chemical engineering in solving both industry and academic problems using experimental methods including design of experiments and simulation to analyze, interpret and present the data.

SDM COLLEGEOF ENGINEERING AND TECHNOLOGY, DHARWAD
Department of Chemical Engineering
III Semester
Scheme of Teaching and Examinations 2026-27

Sl. No	Course	Course code	Course Title	TD/PSB	Teaching Hours/Week				Examination				
					Lecture L	Tutorial T	Practical/ Drawing P	SDA S	Duration in hours	CIE Marks	SEE Marks	Total Marks	Credits
1	ASC	22UMAC300	Engineering Mathematics-III	MA	2	2	0	0	03	50	100	100	3
2	PCC	22UCHC300	Process Calculations	CH	4	0	0	0	03	50	100	100	4
3	PCC	22UCHC301	Fluid Mechanics	CH	2	2	0	0	03	50	100	100	3
4	PCC	22UCHC302	Particulate Technology	CH	3	0	0	0	03	50	100	100	3
5	PCCL	22UCHL303	Fluid Mechanics Laboratory	CH	0	0	2	0	03	50	50	100	1
6	PCCL	22UCHL304	Particulate Technology Laboratory	CH	0	0	2	0	03	50	50	100	1
7	ETC	22UTCHC305	Chemical Engineering Drawing	CH	2	0	2	0	03	50	100	100	3
8	UHV	22UHVK306	Universal Human Values-I	CH	1	0	0	0	01	50	50	100	1
9	AEC	22UCHE321	Principles in Chemical Engineering-I	CH	1	0	0	0	01	50	50	100	1
10	ASC	22UMBA301	Mathematics	MA	3	0	0	0	-	50	-	50	Audit
11	MC	22UNSK307	National Service Scheme (NSS)	NSS	0	0	2	0	-	50	-	50	Audit
									Total			**1000**	**20**

ASC: Applied science course, **PCC:** Professional Core Course, **PCCL:** Professional Core Course laboratory, **ESC:** Engineering Science Course, **ETC:** Emerging Technology Course, **PLC:** Programming Language Course, **UHV:** Universal Human Value Course, **AEC:** Ability Enhancement Course, **SEC:** Skill Enhancement Course, **MC:** Mandatory Course, **L**: Lecture, **T**: Tutorial, **P**: Practical, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation. **MC:** Mandatory Course. This letter in the course code indicates common to all the stream of engineering. **TD**: Teaching department, **PSB**: Paper Setting Board.

National Service Scheme (NSS): All students have to register for the courses namely National Service Scheme (NSS) with the concerned course coordinator during the first week of respective semester. Activities shall be carried out between III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS activities. This course shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of degree.

AICTE activity point: Every regular student, who is admitted to the 4-year degree program, is required to earn 100 activity points in addition to the total credits earned for the program. The activity points earned by the student shall be reflected on the students VIII semester grade card. The activities to earn the points can be spread over the duration of the program. However, minimum prescribed duration should be fulfilled. Activity points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression. In case student fails to earn the prescribed activity points; VIII semester grade card shall be issued only after earning the required activity Points. Students shall be eligible for the award of degree only after the release of the VIII semester grade card.

SDM COLLEGEOF ENGINEERING AND TECHNOLOGY, DHARWAD
Department of Chemical Engineering
IV Semester
Scheme of Teaching and Examinations 2026-27

Sl. No	Course	Course code	Course Title	TD/PSB	Teaching Hours/Week				Examination				
					Lecture	Tutorial	Practical/ Drawing	SDA	Duration in hours	CIE Marks	SEE Marks	Total Marks	Credits
					L	T	P	S					
1	ASC	22UMAC400	Engineering Mathematics-IV	MA	2	2	0	0	03	50	100	100	3
2	PCC	22UCHC400	Process Heat Transfer	CH	3	0	0	0	03	50	100	100	3
3	PCC	22UCHC401	Chemical Reaction Engineering-I	CH	3	0	0	0	03	50	100	100	3
4	PCC	22UCHC402	Chemical Engineering Thermodynamics	CH	2	2	0	0	03	50	100	100	3
5	PCCL	22UCHL403	Heat Transfer Laboratory	CH	0	0	2	0	03	50	50	100	1
6	PCCL	22UCHL404	Environmental Engineering and Analysis Laboratory	CH	0	0	2	0	03	50	50	100	1
7	ETC	22UTCHC405	Pollution Control Engineering	CH	3	0	0	0	03	50	100	100	3
8	UHV	22UHVK406	Universal Human Values-II	CH	1	0	0	0	01	50	50	100	1
9	AEC	22UCHE421	Principles in Chemical Engineering-II	CH	1	0	0	0	01	50	50	100	1
10	MC	22UBEK407	Biology for Engineers	CH	1	0	0	0	01	50	50	100	1
11	ASC	22UMBA401	Mathematics	MA	3	0	0	0	-	50	-	50	Audit
12	MC	22UNSK408	National Service Scheme (NSS)	NSS	0	0	2	0	-	50	-	50	Audit
									Total			**1100**	**20**

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Total credits offered for the Second year: 40

III Semester

22UMAC300	Engineering Mathematics-III	(2-2-0)3

Contact Hours:39

Course Learning Objectives (CLOs):

1. To have an insight into Fourier series, Fourier transforms, Z-transforms. To solve algebraic, transcendental and ordinary differential equation arising in engineering applications using numerical methods.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Express** periodic function as a Fourier series and obtain the various harmonics of the Fourier series expansion for the given numerical data.			1,2
CO-2	**Transform** the given function using Fourier transforms depending on the nature of engineering applications. **Apply** Z-transform for series of mathematical conversion to mathematical framework used as digital filter. **Solve** difference equations using Z-transform.			1,2
CO-3	**Obtain** series solution of ordinary differential equations.			1,2
CO-4	**Make** use of the correlation and regression analysis to fit a suitable mathematical model for the statistical data.		1,2	
CO-5	Formulate LPP and obtain optimal solutions using different tools.		1,2	

POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Mapping Level	1.4	1.4										

Pre-requisites: 1.Differentiation of function.
2. Integration of function.
3. Statistical averages

Contents:

Unit-I

Fourier Series: Periodic functions, Dirichlet's condition. Fourier series of periodic functions of period 2π and arbitrary period. Half- range Fourier series. Practical harmonic analysis, examples from engineering field. **08Hrs.**

Unit-II

Fourier Transforms: Infinite Fourier transforms, Fourier sine and cosine transforms. Inverse Fourier transforms.(Simple problems).

Transforms and Difference Equations: Z-transform- definition, Standard Z-transforms, Damping and shifting rules, Initial value and Final value theorems (without proof) problems. Inverse Z-transform. Simple problems. Difference equations-basic definition. Application of Z-transform to solve Difference equations. **08Hrs.**

Unit-III

Special functions: Series solution of Bessel's differential equation leading to $J_n(x)$-Bessel's function of first kind, Recurrence relations, Generating function of Bessel's functions , orthogonality of Bessel's function. **08Hrs.**

Unit-IV

Curve Fitting: Curve fitting by the method of least squares- fitting the curves of the form = $\boldsymbol{ax+b; y=ax^2+bx+c; y=ax^b}$..

Statistical Methods: Correlation and regression-Karl Pearson's coefficient of correlation - problems. Regression analysis- lines of regression–problems. **08Hrs.**

Unit-V

Linear and Non-Linear programming: Introduction, Mathematical formulation of a L.P.P, basic solution. Geometric (or graphical) method, Simplex method.

Non Linear Programming – Constrained extremal problems-Lagrange's multiplier method. **07Hrs.**

Reference Books:

1) **B.S. Grewal**: Higher Engineering Mathematics, Khanna Publishers, 44/e 2017.
2) **E.Kreyszig**: Advanced Engineering Mathematics, John Wiley &Sons,10/e.(Reprint).2016.
3) **Srimanta Pal et al**: Engineering Mathematics, Oxford University Press,3/e, 2016.
4) **B. V. Ramana**:"HigherEngineering Mathematics" 11/e, TataMcGraw- Hill, 2010.

22UCHC300	Process Calculations	(4-0-0) 4

Contact Hours: 52

Course Learning Objective (CLO):

1. To study and understand the importance of stoichiometry, materials and energy balances and applying these principles to industrial and theoretical problems.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to		**Mapping to POs (1-12) /PSOs(13-15)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Outline the fundamental and derived units with dimensions and calculate compositions of solutions.	1	2,3	13
CO-2	Apply ideal gas law and cubic equations of state to solve various problems related to Gaseous mixtures.	2,3	1	-
CO-3	Solve problems on steady state material balance without chemical reactions.	13	2,3	1
CO-4	Develop steady state material balance with chemical reaction and determine conversion, yield and selectivity.	13	2,3	1
CO-5	Compute ultimate and proximate analysis of fuels and perform calculations on energy balances.	2,3	1	13

POs/PSOs	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -13	PSO -14	PSO -15
Mapping Level	1.8	2.4	2.4	-	-	-	-	-	-	-	-	-	2.0	-	-

Course content:

Unit-I

Units and Dimensions: Fundamental and derived units, Conversion of units, Dimensional consistency of equations. Dimensionless groups and constants.
Basic Chemical Calculations: Concept of mole, Mole fraction. Compositions of mixtures of solids, liquids and gases. Concept of normality, molarity, molality and ppm.
10Hrs.

Unit-II

Vapour - Gas Concepts: Ideal gas law, Vapour pressure concepts and calculation for miscible and immiscible systems, Real gases, Cubic equations of state. **08Hrs.**

Unit-III

Material Balance without Reaction: General material balance equation for steady and unsteady states. Typical steady state material balances in mixing, evaporation drying distillation, absorption, extraction and crystallization. Material balances involving bypass, recycle and purging operations. **10Hrs.**

Unit-IV

Steady State Material Balance with Reaction: Principles of stoichiometry, limiting and excess reactants. Effect of inerts, fractional and percentage conversion.Yield and selectivity for multiple reactions. **12Hrs.**

Unit-V

Fuels and Combustion: Ultimate and proximate analysis of fuels. Calculations involving burning of solid, liquid and gaseous fuels.Excess air, air to fuel ratio calculations.

Energy Balance: General steady state energy balance equation. Heat capacity, enthalpy, heat of formation, reaction and combustion. Determination of heat of reaction at standard and elevated temperatures. **12Hrs.**

Reference Books:

1) Hougen, O.A., Waston, K.M. and Ragatz, R.A., “Chemical Process Principles Part – I, Material and Energy Balances”, 2/e, CBS publishers and distributors, New Delhi, 1995.
2) Himmelblau, D.M., “Basic Principles and Calculations in Chemical Engineering”, 6/e, Prentice Hall Of India, New Delhi, 1997.
3) Bhatt, B.L. and Vora, S.M., “Stoichiometry”, SI Units, 3/e, 1996, Tata McGraw Hill Publishing Ltd., New Delhi, 1996.
4) K.V. Narayanan B. Lakshmikutty, “Stoichiometry and Process calculations” Prentice Hall India Limited, New Delhi, 2006. ISBN: 978-81-203-2992-8

22UCHC301	Fluid Mechanics	(2-2-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

1. To introduce the concepts, principles, laws, observations and models of fluids at rest and in motion.
2. To provide the basis for understanding the fluid behavior, engineering design and control of fluid systems.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to		**Mapping to POs (1-12)/PSOs(13-15)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Identify the nature of fluids with fluid static properties and its measuring devices.	1	3	-
CO-2	Interpret and analyze the parameters of fluid flow and understand the mechanical energy equations.	3, 5, 13	2	1
CO-3	Derive and interpret the equations of fluid flow for liquids.	3, 5, 13	2	1
CO-4	Derive and interpret the equations of fluid flow for gases.	3, 5, 13	2	1
CO-5	Elucidate and characterize the different pipe fittings, pumps and flow measuring devices and also use dimensional analysis for solving problems.	3, 13	2	1

POs/PSOs	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -13	PSO -14	PSO -15
Mapping Level	1.4	2.0	2.8	-	3.0	-	-	-	-	-	-	-	3.0	-	-

Course content:

Unit-I

Fluid Statics and Applications: Introduction to fluid mechanics and unit operations. Nature of fluids, Fluid statics, pressure laws-pascals law and Hydrostatic equilibrium, pressure measurements-manometers (U tube manometer, Inverted manometer, differential manometer), continuous gravity decanter. **08Hrs.**

Unit-II

Fluid Flow Phenomena: Newtonian and Non-Newtonian fluids, types of flows, Shear rate, Shear stress. Flow in boundary layer-Boundary layer separation and wake formation. Basic Equations of Fluid Flow: continuity equation, Mechanical energy equation. **08Hrs.**

Unit-III

Incompressible Fluids: Laminar flow of incompressible fluids in pipes and conduits. Shear stress and Velocity distribution-Maximum and average velocity-Hagen Poiseuille and Darcy equation. Turbulent flow of incompressible fluids in pipes -Universal velocity distribution equation. Friction factor and Reynolds number relationship and friction

factor chart. Minor loses: Changes in velocity or direction-Sudden expansion and contraction. **08Hrs.**

Unit-IV

Compressible Fluids: Continuity equation, Mach number, total energy balance, velocity of sound, Ideal gas equation, adiabatic and isothermal flow equations, Flow through convergent-divergent sections, stagnation properties. **07Hrs.**

Unit-V

Transportation and Metering of Fluids: Pipes, pipe fittings, types and performance characteristics of Pumps, fans, blowers, and compressors. Measurement of flowing fluids - full bore meters, area meter, insertion meters with flow rate equations. Flow through open channels- weirs and notches. Unsteady state flow- time taken to empty the liquid from the tank.

Dimensional Analysis: Dimensional homogeneity, Rayleigh's and Buckingham-Pi methods, dimensionless numbers, models and prototypes. **08Hrs.**

Reference Books

1) McCabe and Smith, "Unit operations of Chemical Engineering" 7/e, McGraw Hill chemical engineering series. ISBN-10: 0072848235. 2017.
2) Coulson J.H and Richardson J.F, "Chemical Engineering" Vol-1 and 2, 5/e. Butterworth publications. ISBN-10: 0750644451. 1999
3) Kumar K.L., "Engineering Fluid Mechanics", 8/e, S. Chand and Co. Ltd. ISBN-10: 8121901006. 2010
4) R. K. Bansal, "A textbook of Fluid Mechanics" 2/e, Laxmi Publications. ISBN: 978813180294. 2020

22UCHC302	**Particulate Technology**	**(3-0-0) 3**

Contact Hours: 39

Course Learning Objective (CLO):

1. To study the basic principles of unit operations and its applications in process industries.

Course Outcomes (COs):

Description of the course outcome: At the end of course, the student will able to		**Mapping to POs (1-12) PSOs(13-15)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Apply the principles of particle size analysis and unit operations to solve industrial screening problems.	1,2	13	3
CO-2	Classify size reduction equipments and evaluate their performance using laws of size reduction.	1,2	13	3

CO-3	Analyze and apply the concepts of motion of particles for the design of sedimentation system.	1,2	13	-
CO-4	Analyze pressure drop through bed of solids immersed in fluids and demonstrate the knowledge of their application in filtration.	1,2	13	-
CO-5	Demonstrate the knowledge of agitation, mixing, storage and conveying of fluid-solid systems.	1	2	13

POs/PSOs	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -13	PSO -14	PSO -15
Mapping Level	3.0	2.8	1.0	-	-	-	-	-	-	-	-	-	1.8	-	-

Course content:

Unit-I

Particle Technology: Particle shape, particle size, sphericity, mixed particle size analysis. Screens – ideal and actual screens, standard screens, differential and cumulative size analysis, effectiveness of screen, specific surface of mixture of particles, number of particles in a mixture. Industrial screening equipment - grizzly, gyratory screen, vibrating screen, trommel. Sub sieve analysis techniques. **08Hrs**.

Unit-II

Size Reduction: Introduction, types of forces and characteristics of communited products, laws of size reduction, open and closed circuit grinding. Equipments for size reduction – jaw crusher, gyratory crusher, roll crushers, attrition mill, ball mill, fluid energy mill, knife cutter. **08Hrs.**

Unit-III

Motion of Particles Through Fluids: Mechanics of particle motion, equation for one dimensional motion of particles through a fluid, terminal velocity, motion of spherical particles in Stoke's region, Newton's region and intermediate region. Criterion for settling regime, cyclones and hydro cyclones.

Sedimentation: Batch settling test, application of batch settling test to design continuous thickeners, thickener design, determination of thickener area**.** **08Hrs.**

Unit-IV

Flow of Fluids Past Immersed Bodies: Forms of Drag, Pressure drop – Ergun's, Kozeny – Carman and Burke – Plummer equations. Fluidization - minimum fluidization velocity, types of fluidization, applications of fluidization.

Filtration: Introduction, classification of filtration, batch and continuous filtration, pressure and vacuum filtration, constant pressure filtration, characteristics of filter media. Industrial filters - sand filter, filter press, leaf filter, rotary drum filter. Filter aids. **08Hrs.**

Unit-V

Agitation and Mixing: Application of agitation, agitation equipment, types of impellers, flow patterns in agitated vessels, prevention of swirling, standard turbine design, power correlation and power calculation. Mixing of solids, types of mixers- change can mixer, Muller mixer, ribbon blender, internal screw mixer, and tumbling mixer.

Storage and Conveying of Solids. **07Hrs.**

Reference Books:

1) McCabe, W. L., Smith, J. C. and Harriott, P., "Unit Operation of Chemical Engineering", 7/e, McGraw Hill International, Singapore, 2022.
2) Badger, W.L. and Banchero, J.T., "Introduction to Chemical Engineering", 3/e, McGraw Hill International, Singapore, 1999.
3) Coulson, J.M. and Richardson, J.F., "Chemical Engineering Vol.2", 5/e, Particle Technology and Separation Processes, 1998.
4) Foust, A.S. et.al, "Principles of Unit Operation", 3/e, John Wiley and Sons, New York, 1997.

22UCHL303	Fluid Mechanics Laboratory	(0-0-2) 1

Contact Hours: 26

Course Learning Objective (CLO):

1. To understand the principle, construction, working and analysis of different equipment in the fluid flow phenomena.

Course Outcomes (COs):

Description of the course outcome: At the end of the course student will be able to		**Mapping to POs (1-12)/ PSOs(13-15)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Calculate the rate of discharge for flow measuring devices and pumps and discuss results with justification	4,15	8, 10	9
CO-2	Distinguish the types of pipe fitting in pipe with friction and identify their applications and discuss the results obtained with justification	4,15	8, 10	9
CO-3	Identify the flow pattern of the fluid and evaluate the friction factor of the spiral coil and discuss the results obtained with justification	4,15	8, 10	9
CO-4	Calculate the minimum fluidization velocity and flow through packed	4,15	8,10	9

	bed and discuss the results obtained with justification			
CO-5	Calculate the energy losses in Bernoulli's set up and discuss the results obtained with justification	4, 15	8, 10	9

POs/PSOs	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -13	PSO -14	PSO -15
Mapping Level	-	-	-	3.0	-	-	-	2.0	1.0	2.0	-	-	-	-	3.0

List of Experiments:

1. Develop the characteristic curve for centrifugal pump
2. Develop the characteristic curve for positive displacement pump
3. Local velocity measurement using Pitot tube.
4. Characteristics of Orifice meter and Venturi meter
5. Weir characteristics
6. Friction factor in circular pipes
7. Coefficient of Pipe fittings
8. Flow through spiral coil
9. Significance of Reynolds number
10. Characteristics of fluidized bed.
11. Characteristics of packed Bed
12. Pressure, velocity and elevation heads in Bernoulli's theorem

Note: Minimum 10 experiments to be conducted.

Reference Books:

1) McCabe and Smith, "Unit operations of Chemical Engineering" 7/e, McGraw Hill chemical engineering series. ISBN-10: 0072848235. 2017.
2) Coulson J.H and Richardson J.F, "Chemical Engineering" Vol-1 and 2, 5/e. Butterworth publications. ISBN-10: 0750644451. 1999
3) Kumar K.L., "Engineering Fluid Mechanics", 8/e, S. Chand and Co. Ltd. ISBN-10: 8121901006. 2010
4) R. K. Bansal, "A textbook of Fluid Mechanics" 2/e, Laxmi Publications. ISBN: 978813180294. 2020
5) Fluid Mechanics Laboratory Manual

22UCHL304	Particulate Technology Laboratory	(0-0-2) 1

Contact Hours: 26

Course Learning Objectives (CLOs):

1. To get hands on experience on various unit operations by conducting experiments on size separation, size reduction, filtration etc.
2. To analyze experimental data and project in the form of a report and oral presentation.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to		**Mapping to POs (1-12)/ PSOs(13-15)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Determine the average particle diameter and screen effectiveness by sieve analysis experiments.	4, 15	10	9
CO-2	Determine the average particle diameter by sub-sieve analysis experiments.	4, 15	10	9
CO-3	Evaluate the energy consumed for the size reduction of solid samples by applying size reduction laws.	4, 15	10	9
CO-4	Compile the data from the experiments conducted and discuss the results obtained with justification and conclusion in a report	10	8,9	-

POs/PSOs	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -13	PSO -14	PSO -15
Mapping Level	-	-	-	3.0	-	-	-	2.0	1.25	2.25	-	-	-	-	3.0

List of Experiments:

1. Performance study of size reduction using Ball mill
2. Particle Size Analysis using ICI sedimentation
3. Particle Size Analysis using Beaker decantation
4. Separation of solids using Cyclone
5. Performance study of size reduction using Drop weight crusher
6. Performance study of size reduction using Jaw crusher
7. Determination of specific cake and medium resistance using Leaf filter
8. Determination of specific cake and medium resistance using Plate and frame filter

9. Screen effectiveness studies
10. Particle Size Analysis using Sieves
11. Batch Sedimentation test and thickener design
12. Particle Size Analysis using Air Elutriator

Note: Minimum 10 experiments to be conducted

Reference Books:

1) McCabe and Smith, "Unit Operations of Chemical Engineering" 7/e, McGraw Hill International, Singapore, 2022.
2) Foust A.S. et al., "Principles of Unit Operations", John Wiley and Sons

22UTCHC305 Chemical Engineering Drawing (2-0-2) 3

Contact Hours: 39

Course Learning Objective (CLO):

1. To increase competency in drawing various conventions, and sectional view in engineering drawing.
2. Demonstrate process from flow diagrams.

Course Outcomes (COs):

Description of the course outcome: At the end of course, the student will able to		**Mapping to POs (1-12)/ PSOs (13-15)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Demonstrate Symbols, proportionate equipment drawings	-	-	10
CO-2	Analyze sectional views and assembly drawing.	10	-	13

POs/PSOs	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -13	PSO -14	PSO -15
Mapping Level	-	-	-	-	-	-	-	-	-	2.0	-	-	1.0	-	-

Course Content:

Unit-I

Conventions: Equipments, piping, colour codes, materials, nuts and bolts. **04Hrs.**

Flow Diagram: Block diagram, process flow diagram, Process and Instrumentation diagram (P&ID). **04Hrs.**

Process Equipment Drawing: rotary filter, clarifier, reactor, heat exchanger (DPHE and STHE), evaporator, autoclave, distillation column (tray & packed), scrubber, jackets, coils and agitators for reactor. **04Hrs.**

Sectional Views: sectional planes, sectional lines and hatching, types of sectional views. **04Hrs.**
Pipe joint: Flanged type, Expansion and Union joint **05Hrs.**

Unit-II

Assembly Drawings:

1. Cotter Joints: Cotter joint with sleeve, Gib and Cotter joint, Socket and Spigot joint. **05Hrs.**
2. Gland & stuffing box, check valve, non-return valve, plug valve **08Hrs.**

Schematic drawings: control valve, diaphragm valve, gate valve, globe valve, ball valve, butterfly valve. **05Hrs.**

Note:

- First angle projection to be followed.
- Drafter to be used for all drawings.

Reference Books:

1) Gopal Krishna, K.R., "Machine Drawing," 2/e. Subhash Publication
2) Joshi, M.V., "Process Equipment Design" 3/e, Macmillan India publication.
3) Bhat N.D., "Machine Drawing".Charotar Publishing, 50/e, 2011
4) Vilbrant and Dryden., "Chemical Engineering Plant Design" Publisher: New York, McGraw-Hill, 1959.

22UHVK306	Universal Human Values-I	(1-0-0) 1

Contact Hours: 13

Course Learning Objectives (CLO):

1. This course provides an opportunity for the students to enhance their life skills like right understanding leading to the harmonious living in relationship with the self and family enhancing holistic development of the students.

Course Outcomes (COs):

Description of the course outcome: At the end of course the student should be able to:		Mapping to POs (1-12)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Recite and follow interpersonal relations with peers and the others	6		
CO-2	Comprehend happiness, prosperity and distinguish between body and self		6,9	

CO-3	Comprehend harmony and practice Sanyam and Svasthya		9	
CO-4	Demonstrate the values of human-human interaction and universal values such as *Nyaya*, *Visvasa*, and *Sammana*	7		
CO-5	Clearly visualize the co-relation between lack of Human Values and the prevailing problems and use tangible steps and a roadmap for moving in the cherished direction.	8	9	

Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Mapping Level	-	-	-	-	-	2.5	3	3	2	-	-	-

Course Contents:

Unit I

Introduction to Value Education: Understanding Value Education: Living a Fulfilling Life, Education for Fulfilling Life, Priority of Values over Skills, Appreciating the Need and Implications of Value Education, Guidelines for Value Education - Self-exploration – its content and process; 'Natural Acceptance', Basic Human Aspirations and their fulfillment. **04 Hrs.**

Unit II

Understanding Happiness and Prosperity: Exploring the meaning of Happiness and Prosperity, Programme for continuity of Happiness, A look at the prevailing Notions of Happiness, The programme for Happiness, Natural outcome of the programme.**02 Hrs.**

Unit III

Understanding Harmony at Various Levels: Harmony in the Self – Understanding Myself: Understanding human being as a co-existence of the sentient 'I' and the material 'Body' and the needs of Self ('I') and 'Body'- Sukh and Suvidhã, Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer). **03 Hrs.**

Unit IV

Harmony in the Family- Understanding the Values in Human Relationships : Understanding the Family as the basic unit of human interaction, Understanding values in human-human relationship; meaning of Nyaya and program for its fulfillment to ensure Ubhaya –tripti; Trust (Visvasa) and Respect (Sammana) as the foundational values of relationship. **02 Hrs.**

Unit V

Understanding Intention and Competence: Distinguish between Intention and Competence, Understanding the meaning of Nine Values. **02 Hrs.**

Reference Book:

1) R.R.Gaur, R Asthana, and G.P Bagaria. **A Foundation Course in HUMAN VALUES and professional Ethics**: 2/e Revised. EXCEL BOOKS, New Delhi. 2019

22UCHE321 Principles in Chemical Engineering- I (1-0-0) 1

Contact Hours: 13

Course Learning Objective (CLO):

1. To provide knowledge to learn, understand and inculcate the principles adopted in a chemical industry.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to		**Mapping to POs (1-12)/ PSOs(13-15)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Demonstrate the knowledge of pumps, piping and fluid storage	13	8	1
CO-2	Outline different types of engineering materials and heat treatment processes	13	8	1
CO-3	Demonstrate plant layout and plant operations.	13	8	3
CO-4	Outline the industrial safety types and hazards.	8	6	3
CO-5	Outline the fire protection systems in a process industry.	8,14	6	3

POs/PSOs	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -13	PSO -14	PSO -15
Mapping Level	1.0	-	1.0	-	-	2.0	-	2.4	-	-	-	-	3.0	3.0	-

Course Content:

Unit-I

Transportation of fluids: Centrifugal pumps, slurry pumps; working and applications.
Pipes: Materials of construction, color codes, standard sizes.
Fluids storage: Petroleum products and chemicals storage. **03Hrs**

Unit-II

Engineering materials: Metals, polymers, elastomers, composites, and biomaterials. Heat treatment processes and corrosion of metals. **02Hrs**

Unit-III

Plant location and layout: Factors, amenities including ETP/STP, plant operations and automation in chemical industry. **03Hrs**

Unit-IV

Industrial hazards and safety: Types, hazardous materials; handling, storage and transportation, process safety, personal protective equipments, first aid. **02Hrs**

Unit-V

Fire: Sources of ignition, fire triangle and tetrahedron, classes of fires, fire extinguisher types and color codes, foam and fire hydrants. **03Hrs**

Reference Books:

1) Coulson and Richardson, "Unit Operations of Chemical Engineering" Vol.1.6/e, Butterworth-Heinamann (2006), ISBN-13: 978-8131204535.
2) K.S.N. Raju, "Fluid Mechanics, Heat Transfer, and Mass Transfer – Chemical Engineering Practice" A John Wiley & Sons, Inc., Publication (2010) ISBN 978-0-470-63774-6
3) Ravi Kant Pandey, "A Handbook on Industrial Safety and Fire Management" 1st edition (2017) ISBN- 976-93-36963-38-4
4) M.A. Chaudhari, "Industrial Measurements" Nirali Publications (2018).
5) Mc Cabe and Smith, "Unit operations of Chemical Engineering" 7th edition

22UMBA301	Mathematics	(3-0-0) Audit

Contact Hours: 39 Hrs.

Course Learning Objectives (CLO):

1. This course will enable students to master the basic tools of differential & integral calculus, differential equations and partial differential equations and become skilled to formulate, solve and analyze science and engineering problems.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs (1-12)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Apply** the knowledge of calculus to solve problems related to polar curves, curvature and its applications in determining the bentness of a curve.	-	-	1,2

CO-2	**Solve** multiple integration and use Beta and Gamma function to solve definite integrals	-	1,2	
CO-3	**Solve** first order linear differential equations analytically using standard methods.	-	1,2	
CO-4	**Solve** higher order differential equations with constant co efficient and variable co-efficient.	-	1,2	-
CO-5	**Learn** partial differentiation to calculate rates of change of multivariate functions. Solve problems related to composite functions and Jacobians. Solve problems on partial differential equations by method of separation of variables.	-		1,2

POs	1	2	3	4	5	6	7	8	9	10	11	12
Mapping Level	1.6	1.6	-	-	-	-	-	-		-	-	-

Prerequisites:

1. Differentiation of function
2. Integration of function

Course Content:

Unit-I

Differential Calculus: The nth order differentiation of standard functions. Leibnitz theorem (Statement only & illustrative examples), Taylor's series for single variable (Statement only & illustrative examples), Maclaurin's series for single variable (Statement only & illustrative examples).

Polar curves-angle between the radius vector and tangent (Formula & illustrative examples), angle between two curves (Formula & illustrative examples). Definition of Curvature and radius of curvature. Radius of curvature for Cartesian and polar curves (Formulas & illustrative examples) **10Hrs.**

Unit-II

Integral Calculus: Reduction formula for $\int_0^{\pi/2} sin^n xdx, \int_0^{\pi/2} cos^n xdx$ and $\int_0^{\pi/2} sin^n xcos^m xdx$ (Formula & illustrative examples). Definition of Beta and

Gamma functions (illustrative examples). Relation between Beta and Gamma functions (No Proof) (illustrative examples). Evaluation of Double integral (direct and region given), Change of variables. Evaluation of Triple integral (direct examples). **10Hrs.**

Unit-III

Ordinary Differential Equations of first order: Libnitz's Linear differential equation, Bernoulli's differential equation, Exact differential equations. Orthogonal trajectories. **05Hrs**.

Unit-IV

Differential Equations of higher order: Solution of Second order Linear ordinary differential equation with constant coefficients. Method of variation of parameters. Legendre's homogeneous equations. **08Hrs.**

Unit-V

Partial Differentiation: Definition of Partial derivative (illustrative examples), Total differentiation (illustrative examples), Differentiation of Composite functions (illustrative examples). Jacobians and its properties (No Proof) (illustrative examples).

Partial Differential Equations (PDE's): Formation of PDE's by elimination of arbitrary constants /functions. Solution of PDE by variable separable method. **06Hrs.**

Reference Books

1) **B.S. Grewal**: Higher Engineering Mathematics, Khanna Publishers, 44/e ,2017.
2) **H.K. Dass & Rajnish Verma**, Higher Engineering Mathematics,3/e, 2014.

Note: 1. Grades (i) PP (ii) NP
2. No semester End Examination
3. Audit (Bridge course).

- ✓ The mandatory non – credit courses Mathematics for III and IV semesters respectively, to the lateral entry Diploma holders admitted to III semester of BE/B.Tech., programs, shall attend the classes during the respective semesters to complete all the formalities of the course and appear for the Continuous Internal Evaluation (CIE). In case, any student fails to register for the said course/fails to secure the minimum 40% of the prescribed CIE marks, he/she shall be deemed to have secured an F grade. In such a case, the student has to fulfill the requirements during subsequent semester/s to appear for CIE.
- ✓ These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.

22UNSK307	National Service Scheme	(0-0-2) Audit

Contact Hours: 26

Course Learning Objectives:

1. Understand the community in which they work.
2. Identify the needs and problems of the community and involve them in problem-solving.
3. Develop among themselves a sense of social & civic responsibility & utilize their knowledge in finding practical solutions to individual and community problems.
4. Develop competence required for group-living and sharing of responsibilities & gain skills in mobilizing community participation to acquire leadership qualities and democratic attitudes.
5. Develop capacity to meet emergencies and natural disasters & practice national integration and social harmony.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs (1-12)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO1	Understand the importance of his / her responsibilities towards society.	12	6	8
CO2	Analyze the environmental and societal problems/issues and will be able to design solutions for the same.	12	6	8
CO3	Evaluate the existing system and to propose practical solutions for the same for sustainable development.	12	6	8,
CO4	Implement government or self-driven projects effectively in the field.	12	6	8

POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Mapping Level	-	-	-	-	-	2	-	1	-	-	-	3

Activity list:

1. Waste management– Public, Private and Govt organization.
2. Setting of the information imparting club for women leading to contribution in social and economic issues.
3. Water conservation techniques – Role of different stakeholders– Implementation.
4. Preparing an actionable business proposal for enhancing the village income

and approach for implementation.

5. Helping local schools to achieve good results and enhance their enrolment in Higher/ technical/ vocational education.
6. Developing Sustainable Water management system for rural areas and implementation approaches.
7. Contribution to any national level initiative of Government of India. For eg. Digital India, Skill India, Swachh Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme, Skill development programs etc.
8. Spreading public awareness under rural outreach programs. (minimum 2 programs).
9. Social connect and responsibilities.
10. Plantation and adoption of plants. Know your plants.
11. Organize National integration and social harmony events /workshops/ seminars. (Minimum 02 programs).
12. Govt. school Rejuvenation and helping them to achieve good infrastructure.

Students have to take up at least three activities on the above said topics and have to prepare content for awareness and technical contents for implementation of the projects and have to present strategies for implementation of the same.

Note: Activities must be unique (Not repeat) across semesters for each student.

CIE will be evaluated based on their presentation, approach and implementation strategies.

Reference Books:
NSS Course Manual, Published by NSS Cell, VTU Belagavi

ASSESSMENT AND EVALUATION PATTERN		
	Time Schedule	CIE (50)
Presentation: on Selected topic	Before the IA-3	50 Marks

Note: Implementation strategies of the project with report duly signed by the Department NSS Coordinator and HoD

IV Semester

22UMAC400	Engineering Mathematics-IV	(2-2-0)3

Contact Hours:39

Course Learning Objectives (CLOs):

1. To provide an insight into applications of conformal mapping, integration of complex functions and application of probability distributions in Engineering.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to		**Mapping to POs (1-12)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Construct** and use the concepts of analytic function to solve the problems arising in Engineering field.			1,2
CO-2	**Utilize** conformal transformation and complex integral to transform irregular domain onto a relatively simple domain.			1,2
CO-3	**Apply** discrete and continuous probability distributions in analyzing the probability models arising in engineering field.			1,2
CO-4	**Estimate** the correlation, covariance using joint probability distributions. **Recite** Markov chains and describe stochastic process.			1,2
CO-5	**Use** student's t-distribution, Chi-square distribution as a test of goodness of fit.			1,2

Pos	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Mapping Level	1	1	-	-	-	-	-	-		-	-	-

Pre-requisites: 1.Differentiation of function.
2.Integration of function.
3. Basic Probability theory.

Contents:

Unit-I

Calculus of complex functions: Review of function of a complex variable, limits, continuity, and differentiability. Analytic functions: Cauchy-Riemann equations in Cartesian and polar forms. Construction of analytic functions: Milne-Thomson method-Problems**.** **08Hrs.**

Unit-II

Conformal transformations: Introduction. Discussion of transformations:
w$= e^z; w = z^2, w = z + \frac{1}{z}, z \neq o$). Bilinear transformations- Problems.

Complex integration: Line integral of a complex function, Cauchy's theorem and Cauchy's Integral theorem. **08Hrs.**

Unit-III

Probability Distributions: Random variables (discrete and continuous), probability mass/density functions. Binomial, Poisson, exponential and normal distributions-problems (No derivation for mean and standard deviation)-Illustrative examples**.** **08Hrs.**

Unit-IV

Joint probability distribution: Joint Probability distribution for two discrete random variables, expectation and covariance.

Markov chains– Introduction, probability vectors, Stochastic Matrices, Fixed points and Regular stochastic matrices, Markov chains, higher transition probabilities, stationary distribution of regular Markov chains and absorbing states. **08Hrs.**

Unit-V

Sampling Theory: Introduction to sampling distributions, standard error, Type-I and Type-II errors. Test of hypothesis for means, student's t-distribution, Chi-square distribution as a test of goodness of fit. **07Hrs.**

Reference Books:

1) **B.S. Grewal**: Higher Engineering Mathematics, Khanna Publishers, 44/e 2017.
2) **E. Kreyszig**: Advanced Engineering Mathematics, John Wiley & Sons,10/e(Reprint), 2016.
3) **Peter V.O'Neil**: Advanced Engineering Mathematics, International students edition,2011.
4) **Kishor S. Trivedi**: Probabilty & Statistics with Reliabilty, Queuing, and Computer Science Applications, Prentice-Hall of India,2005.

22UCHC400	Process Heat Transfer	(3-0-0) 3

Contact Hours: 39

Course Learning Objective (CLO):

1. To understand different modes of heat transfer conduction, convection and radiation.
2. To study and analyze the performance of heat exchanger, condensers and evaporators.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to		**Mapping to POs (1-12)/ PSOs(13-15)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Solve heat transfer by conduction in solids and extended surfaces for steady state with estimation of critical insulation.	1	2	13
CO-2	Interpret and solve heat transfer by forced and natural convection	-	2	13
CO-3	Outline of evaporators and solve heat transfer by radiation.	3	2	13
CO-4	Determine heat transfer in condensation.	13	2	3
CO-5	Analyze the performance of heat exchange equipments.	13	2	3

POs/PSOs	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -13	PSO -14	PSO -15
Mapping Level	1.0	2.0	1.66	-	-	-	-	-	-	-	-	-	1.8	-	-

Course Content:

Unit-I

Conduction: Fourier's law, thermal Conductivity, analogy between heat flow and electrical flow. Heat transfer through composite walls, cylinders and spherical systems. Overall heat transfer coefficient. Types of insulation, properties and application, critical and optimum thickness of insulation. **08Hrs.**

Unit-II

Convection: Types of convection heat transfer, Forced Convection: Prandtl No., Nusselt No., correlation equations for heat transfer in laminar and turbulent flows, Reynolds and Colburn analogy, Natural Convection: vertical and horizontal surfaces, Grashof and Rayleigh numbers. **08Hrs.**

Unit-III

Extended surfaces: heat transfer in fins, fin effectiveness and efficiency.

Radiation: Radiation laws-Kirchhoff's law Stefan Boltzmann's law, Wien's law, Plank's law. black body, grey body. transmissivity, absorptivity, reflectivity, emissivity, radiation transfer between surfaces, radiation shields. **08Hrs.**

Unit-IV

Evaporation: Single and multiple effect evaporators, forward, mixed, parallel and backward feeds, types of evaporators, capacity and economy of evaporators.

Condensation: drop wise and film wise condensation, Nusselt analysis for laminar film wise condensation on a vertical plate, film wise condensation on a horizontal and vertical tube, types of condensers. **07Hrs.**

Unit-V

Heat Exchangers: classification, components of a double pipe & Shell-and Tube Heat Exchangers, standards, LMTD, correction factor and fouling. **08Hrs.**

Reference Books:

1) J. P. Holman, "Heat Transfer", 9/e, Tata McGraw-Hill. New Delhi, 2004, ISBN-13: 9780070634510
2) Rao Y.V.C., "Heat Transfer", Edition illustrated, reprint, University Press. 2001, ISBN 13: 9788173713842
3) McCabe and Smith "Unit Operations of Chemical Engineering".7/e, McGraw-Hill Education, ISBN-13: 978-0072848236
4) Coulson and Richardson, "Unit Operations of Chemical Engineering" Vol.1.6/e, Butterworth-Heinamann (2006), ISBN-13: 978-8131204535

22UCHC401	Chemical Reaction Engineering- I	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

1. To develop rate laws for homogeneous reactions.
2. To design ideal reactors for single and multiple reactions.
3. To design non-isothermal reactors.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to		**Mapping to POs (1-12)/ PSOs(13-15)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Determine rate, rate constant, activation energy and order of reaction.	-	1	-

CO-2	Analyze and interpret batch reactor data	4	-	1
CO-3	Design batch reactor, ideal PFR and MFR	4	2	13
CO-4	Analyze the performance of reactors with multiple reactions.	4	2	13
CO-5	Interpret the effect of temperature on reactor performance.	-	2	13

POs/PSOs	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -13	PSO -14	PSO -15
Mapping Level	1.5	2.0	-	3.0	-	-	-	-	-	-	-	-	1.0	-	-

Course Content:

Unit-I

Kinetics of Homogeneous Reactions: classification of reactions, Rate equation and rate of reaction. Molecularity and order of reaction Factors affecting the rate of reaction. Chemical kinetics and equilibrium constant. Arrhenius and collision theories. Elementary and non-elementary reactions. **08Hrs.**

Unit-II

Interpretation of Batch Reactor Data: Constant volume batch reactor. Analysis of total pressure data, Integral and differential methods of analysis for constant and half life and method of excess. Reversible first and second order reactions. **08Hrs.**

Unit-III

Ideal Reactors for Single Reaction: Ideal batch reactor, steady-state mixed and plug-flow reactors, space time and space velocity for flow reactors, variable volume reactions. **08 Hrs.**

Unit-IV

Multiple Reactions and Reactors: Series and parallel reactions, yield and selectivity, multiple reactors: plug and mixed flow reactors. **08 Hrs.**

Unit-V

Heat effects, Recycle Reactor with Purging: Heat of reactions, effect of temperature on heat of reaction, reactor design, effect of recycle ratio and purge ratio on conversion. **07 Hrs.**

Reference Books:

1) Octave Levenspiel, “Chemical Reaction Engineering”, 3/e, John Wiley & Sons, 2004, ISBN:978-81-265-1000-9
2) J. M. Smith, “Chemical Engineering Kinetics”, 3/e, McGraw Hill, 1981.ISBN:0-07 066574-5
3) H. Scott Fogler, “Elements of Chemical Reaction Engineering”, 3/e, Prentice Hall 2006. ISBN: 978-81-203-3416-8

22UCHC402 Chemical Engineering Thermodynamics (2-2-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

1. To relate state changes in a system to the quantity of energy in the form of heat and work transferred across its boundaries.
2. Understanding of the laws of thermodynamics and their application in the analysis of chemical and engineering problems.
3. Calculating thermodynamic properties of fluids and fluid mixtures using equations of state.
4. Determining equilibrium compositions of chemical reactions and two-phase liquid/vapor mixtures.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to		**Mapping to POs (1-12)/ PSOs(13-15)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	State thermodynamic laws, analyze and evaluate pressure, volume and temperature with equations of state for gases.	1	-	2, 13
CO-2	Evaluate the entropy changes associated with processes and analyse the fundamental equations governing thermodynamics.	1	2, 13	3
CO-3	Differentiate between ideal and non- ideal solutions and calculate the partial molar properties.	1,2,3,13	-	-
CO-4	Generate VLE data for solutions using correlations and interpret their consistency.	1,2,3,13	-	-
CO-5	Determine the conversion at equilibrium and predict the effect of controllable variables on conversion.	1,2,3,13	-	-

POs/PSOs	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -13	PSO -14	PSO -15
Mapping Level	3.0	2.4	2.5	-	-	-	-	-	-	-	-	-	2.4	-	-

Course content:

Unit-I

Basic Concepts and First Law of Thermodynamics: Types of properties, functions, reversible and irreversible processes, zeroth law of thermodynamics, first law for cyclic process, flow and non-flow processes, heat capacity.

P-V-T Behaviour: P-V-T behaviour of pure fluids, equations of state and ideal gas law, processes involving ideal gas law, Equations of state for real gases: van der Waals equation, Redlich – Kwong equation, virial equations, and principles of corresponding states. **08Hrs.**

Unit-II

Second Law of Thermodynamics: Statements, heat engines, heat pumps, concept of entropy, Carnot's principle, calculations of entropy change, Clausius Inequality, entropy and irreversibility, third law of thermodynamics.

Thermodynamic Properties of Pure Fluids: Types of thermodynamic Properties, Work function, Gibbs free energy. Fundamental property relations: Exact differential equations, Maxwell's equations, equations for U and H, entropy- heat capacity relations, Clapeyron equation, Gibbs-Helmholtz equation, fugacity and fugacity coefficient, determination of fugacity of pure fluids. **08Hrs.**

Unit-III

Properties of Solutions: Partial molar properties, Gibbs-Duhem equation, chemical potential, fugacity in solutions, Henry's law and dilute solutions, activity in solutions, activity coefficients, property changes of mixing, excess properties. **08Hrs.**

Unit-IV

Phase Equilibria: Criteria of phase equilibria and stability, phase equilibria in single and multicomponent systems, Duhem's theorem, vapor-Liquid equilibria, ideal and nonideal solutions, VLE at low pressures, VLE correlations, G-D equation for VLE, consistency tests, VLE at high pressures, liquid-liquid equilibrium. **08Hrs.**

Unit-V

Chemical Reaction Equilibria: Reaction stoichiometry, criteria of chemical reaction equilibrium, equilibrium constant and standard free energy change, effect of temperature and pressure on equilibrium constants and other factors affecting equilibrium conversion, liquid phase reactions, heterogeneous reaction equilibria, phase rule for reacting systems. **07Hrs.**

Reference Books:

1) Smith, J.M. and Vanness, H.C., "Introduction to Chemical Engineering Thermodynamics", 8/e, McGraw Hill, New York, 2018.
2) Narayanan, K.V., "Textbook of Chemical Engineering Thermodynamics", Prentice Hall of India Private Limited, New Delhi, 2001.
3) Rao, Y.V.C., "Chemical Engineering Thermodynamics", New Age International Publication, Nagpur, 2000.

4) Sandler and Stanley, “Chemical, Biochemical and Engineering Thermodynamics”, 4/e, John Wiley, 2007. ISBN 0471661740.

22UCHL403 Heat Transfer Laboratory (0-0-2)1

Contact Hours: 26

Course Learning Objectives (CLOs):

1. To study the phenomena of conduction, convection and radiation effects in different equipments and know the rate of heat transfer.
2. To study the working, construction and analyze the efficiency and performance of heat exchangers.

Course Outcomes (COs):

Description of the course outcome: At the end of the course student will be able to		**Mapping to POs (1-12) / PSOs (13-15)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Demonstrate and outline the heat transfer coefficient and the performance of DPHE and Cross flow heat exchanger.	4,15	8, 10	9
CO-2	Determine the thermal conductivity of solids and liquids.	4,15	8, 10	9
CO-3	Elucidate and examine the effects of radiation using Stefan Boltzmann apparatus.	4,15	8, 10	9
CO-4	Evaluate the performance and efficiency of extended surfaces and packed bed heat exchanger and recognize the boiler characteristics.	4,15	8, 10	9
CO-5	Evaluate the performance and efficiency of the unsteady process, helical coil and jacketed vessel heat exchangers and recognize the boiler characteristics.	4,15	8, 10	9

POs/PSOs	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -13	PSO -14	PSO -15
Mapping level	-	-	-	3.0	-	-	-	2.0	1.0	2.0	-	-	-	-	3.0

List of Experiments:

1. Heat transfer coefficient of Double pipe heat exchanger.
2. Heat Transfer coefficient of Cross flow heat exchanger.
3. Thermal conductivity of liquid
4. Thermal conductivity of solid through lagged pipe.
5. Emissivity determination
6. Stefan – Boltzmann constant using Stefan-Boltzmann apparatus
7. Heat Transfer coefficient and efficiency of Extended surfaces
8. Heat transfer coefficient and Reynolds number effect in vertical Packed bed condenser
9. Heat Transfer coefficient through helical coil
10. Heat Transfer coefficient through Natural and forced convection in a jacketed vessel
11. Biot number in Unsteady state heat transfer
12. Thermal performance of Evaporator

Note: Minimum 10 experiments to be conducted

Reference Books:

1) J.P. Holman, “Heat Transfer”, 9/e, Tata McGraw-Hill. New Delhi, ISBN-13: 9780070634510. 2004
2) Rao Y.V.C., “Heat Transfer”, Reprint, University Press, ISBN 13: 9788173713842. 2001
3) McCabe and Smith “Unit Operations of Chemical Engineering”.7/e, McGraw-Hill Education, ISBN-13: 978-0072848236. 2005
4) Coulson and Richardson, “Unit Operations of Chemical Engineering” Vol.1. 6/e, Butterworth-Heinamann (2006), ISBN-13: 978-8131204535. 1999
5) Heat Transfer Laboratory Manual

22UCHL404 Environmental Engineering and Analysis Laboratory (0-0-2)1

Contact Hours: 26

Course Learning Objective (CLO):

1. To introduce and learn the concept of environmental contamination by determining the various parameters of liquid, gas and soil to analyze, design and implement the system to solve the pollution problems.

Course Outcomes (COs):

Description of the course outcome: At the end of the course student will be able to		**Mapping to POs (1-12) / PSOs (13-15)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Demonstrate and characterize the different waste water parameters.	4,15	8, 10	9
CO-2	Demonstrate and characterize the different components of air and gaseous parameters.	4,15	8, 10	9
CO-3	Comprehend the use of instruments in measuring the different parameters	4,15	8, 10	9

POs/PSOs	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -13	PSO -14	PSO -15
Mapping Level	-	-	-	3.0	-	-	-	2.0	1.0	2.0	-	-	-	-	3.0

List of Experiments:

1. Determination of pH, alkalinity and DO of water sample
2. Determination of COD and BOD of waste water
3. Estimate the number of bacteria by MPN count/ Coliform Test /Bacterial measurement of waste water
4. Volatile, Fixed, Filterable and Dissolved solid analysis of waste water
5. Measurements of particulate matter and gaseous elements in ambient air
6. Moisture content in liquid sample using KF Auto Titrator
7. Concentration of elements using Flame Photometer
8. Turbidity measurement of water sample using Turbidity meter
9. Viscosity measurement of given oil using Red Wood Viscometer
10. End point of titration using mV Titrator.
11. Determination of calorific value of solid fuels using Bomb Calorimeter
12. Analysis of elements using UV spectrophotometer and calibration chart

Note: Minimum 10 experiments to be conducted

Reference Books:

1) C. S. Rao “Environmental Pollution Control Engineering" 2/e, New Age International 2006. ISBN: 81-224-1835-X
2) Metcalf and Eddy - "Waste Water Engineering Treatment Disposal Reuse” 4/e,

Tata McGraw Hill, 2003.
3) Jaffery, G.H., Basset, J., et. al., "Vogel's Text book of Quantitative Inorganic Analysis" 5/e, ELBX, 1998.
4) Skoog, D.A., "Principles of Instrumental Analysis" 3/e, Saunders College publishing 1985.
5) Environmental Engineering and Analysis Laboratory Manual

22UTCHC405 Pollution Control Engineering (3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs):

1. To create awareness on the various environmental pollution aspects and issues and give a comprehensive insight into natural resources, ecosystem, and biodiversity.
2. To understand the different parameters, treatment methods and control techniques of various environmental pollution.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to		**Mapping to POs (1-12)/ PSOs(13-15)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Outline the importance of the environment and its impact, standards and legislation of environment	-	3, 14	6, 7, 8
CO-2	Interpret various waste water parameter and develop and design the different methods of waste water treatment techniques	3, 14	6, 7	-
CO-3	Develop and design the different waste water treatment techniques for Industries	3, 14	6, 7	-
CO-4	Identify the sources and effects of different types of air pollutants, their prevention and design of control techniques in industries	3, 14	6, 7	-
CO-5	Illustrate the different methods for handling and disposal of solid waste and control measures of noise pollution in industries	3, 14	6, 7	-

POs/PSOs	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -13	PSO -14	PSO -15
Mapping Level	-	-	2.8	-	-	1.8	1.8	1.0	-	-	-	-	-	2.8	-

Course content:

Unit-I

Introduction: Importance of Environment for Mankind. Types of pollution, Damages from environmental pollution, impact of climate change, Need of environmental standards legislation and acts, functions of central and state boards, EIA, EIS and EMP, water and air indices, Recent trends in waste minimization and management, LCA, zero discharge concept. **07Hrs.**

Unit-II

Sampling and Analysis of Waste Water and Treatment: Water resources. Wastewater classification. Types of water pollutants. Waste water sampling, Methods of Analysis: DO, BOD, COD, TOC, Nitrogen, Phosphorus, Trace Elements and Alkalinity. Waste water treatment: preliminary, primary, secondary. Design of sedimentation tanks and biological treatment processes (Activated sludge process and Trickling filters). **09Hrs.**

Unit-III

Advance Waste Water and Sludge Treatment: Significance of Tertiary or Advanced wastewater Treatment, Adsorption on Activated Carbon, Ion Exchange, Reverse Osmosis, Electro dialysis cell. Advanced bioreactors. Sludge treatment and disposal. Industrial Case studies. **08Hrs.**

Unit-IV

Air Pollution and Treatment: Definition, Sources, Classification, Properties of air pollutants, Effects of air pollution on health vegetation and materials. Air pollution sampling and analysis. Air pollution meteorology. Control methods and equipment's for particulates and gaseous pollutants. Selection design and performance analysis of air pollution control equipment: gravity settling chambers, cyclone separator, ESPs, filters and wet scrubbers. Adsorption, absorption and condensation. Industrial case studies **08Hrs.**

Unit-V

Solid Waste Treatment and Noise Pollution: Sources and Classification, Effect on public health, properties, soil microbiology, 5R's of Solid Waste, Integrated Solid waste management, Disposal Methods-compositing, sanitary landfill, briquetting/gasification and incineration. Hazardous and biomedical waste. Noise pollution: Definition, Sources, Effects of Noise, Noise sampling and Measurement, Approaches for Noise Control. **07Hrs.**

Reference Books:

1) C. S. Rao “Environmental Pollution Control Engineering" 2/e, New Age International 2006. ISBN: 81-224-1835-X
2) S.P. Mahajan, "Pollution Control in Process Industries", Tata McGraw Hill.
3) Metcalf and Eddy, "Waste Water Engineering Treatment Disposal Reuse” Tata McGraw Hill, 4/e, 2003.
4) Frank Kreith and George Tchobanoglous- “Hand book of Solid waste Management”, Tata Mc-Graw Hill, 2/e.

22UHVK406 Universal Human Values-II (1-0-0) 1

Contact Hours: 13

Course Learning Objectives (CLO):

1. This course provides an opportunity for the students to enhance their life skills like right understanding leading to the harmonious living in relationship with the society and environment enhancing holistic development of the students.

Course Outcomes (COs):

Description of the course outcome: At the end of course, the student should be able to:		Mapping to POs (1-12)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Recite and follow interpersonal relations with peers and the society.	6		
CO-2	Demonstrate the concept of harmony in nature and need of self-regulation.		6,9	
CO-3	Recite and follow Natural Acceptance and Differentiate between Intention and Competence.		9	
CO-4	Differentiate between the characteristics and activities of different orders existing in Nature and demonstrate the role of human beings in mutual fulfillment with all the orders of Nature.	7		
CO-5	Visualize and involve in the strategic preparation for Universal Human Order.	8	9	

POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Mapping level	-	-	-	-	-	2.5	3	3	2	-	-	-

Course Contents:

Unit-I

Harmony in the Society: Understanding Universal Human Order: Understanding Human Goal, Appraisal of the Current Status, The Way Ahead, Dimensions of Human Order. **02Hrs.**

Unit-II

Harmony in the Nature: Nature as Collection of Units: Understanding the harmony in the Nature, Interconnectedness and mutual fulfillment among the four orders of nature – recyclability and self-regulation in nature, Understanding existence as co-existence (Sah-astitva) of mutually interacting units in all-pervasive space, Dependence of the Human Being on the Other Three Orders. **03Hrs.**

Unit-III

Harmony in Existence: Understanding Co-existence at Various Levels: Existence as Units in Space, Understanding Submergence, Existence as Co-existence – Units Submerged in Space, Development in the Existential Sense, Expression of Co-existence at Different Levels, Understanding Role of Human Being in Existence.**03Hrs.**

Unit-IV

Ethical Human Conduct and Professional Ethics in the Light of RightUnderstanding: Universal Values Naturally Emerging from the Right Understanding, Definitiveness of Ethical Human Conduct, Development of Human Consciousness, Implications of Value-based Living, Profession – in Context with the Comprehensive Human Goal, Ensuring Ethical Competence, Issues in Professional Ethics – The Current Scenario, Prevailing Approaches towards, Promotion of Professional Ethics – their Inadequacy, Inherent Contradictions and Dilemmas and Their Resolution. **03Hrs.**

Unit-V

Holistic Development towards Universal Human Order: Visualization of Comprehensive Human Goal, Vision for Holistic Technologies, Production Systems and Management Models, Journey towards Universal Human Order-The Road Ahead. **02Hrs.**

Reference Book:

1) R.R. Gaur, R Asthana, and G.P Bagaria. **A Foundation Course in HUMAN VALUES and professional Ethics**: 2/e Revised. EXCEL BOOKS, New Delhi. 2019

22UCHE421 Principles in Chemical Engineering- II (1-0-0) 1

Contact Hours: 13

Course Learning Objective (CLO):

1. To provide knowledge to learn, understand and inculcate the principles and practices adopted in a chemical process industry.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to		**Mapping to POs (1-12)/ PSOs (13-15)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Outline the chemical process industry with roles and responsibilities of various designates	13, 6	8, 9	1
CO-2	Prioritize process selection, conversions, vessels and columns used in unit operations and specific utilities in a chemical plant	13	8	1
CO-3	Outline the fundamentals of process control and instrumentation and AIML in a chemical process industry	5, 13	8	2
CO-4	Outline the basics of pilot plant and scale up along with the technology towards process sustainability.	7, 8	6	3
CO-5	Outline the basic principles of plant economics and overall quality of the process	8,14	6	3

POs/PSOs	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -13	PSO -14	PSO -15
Mapping Level	1.0	2.0	1.0	-	3.0	2.33	3.0	2.4	2.	-	-	-	3.0	3.0	-

Course Content:

Unit-I

Chemical Industry and Engineering: Chemical Industry an overview, chemical processing, Chemical engineers in different roles. **02Hrs.**

Unit-II

Process plant: Process selection, different chemical conversions, outline of unit processes, unit operations and principles. **03 Hrs.**

Unit- III

Introduction to control and measurements: Importance and applications of process control, instrumentation and measurements. Modeling, simulation and AIML in chemical engineering. Chemical Industry 4.0 and 5.0 **03Hrs.**

Unit-IV

Process sustainability: pilot plant and scale up, carbon capture and storage, bioremediation, linear v/s circular economy. **03Hrs.**

Unit-V

Plant economics principles: Process economics, competing processes, quality control, quality assurance, total quality management. **02Hrs.**

Reference Books:

1) Max Peters and Timmerhaus, Plant Design and Economics for Chemical Engineers, 5thedn. 2004; Mc Graw Hill.
2) M Gopala Rao and Marshall Sittig, Dryden's Outlines of Chemical Technology, 3rdedn. East West Press.
3) Perry's Chemical Engineers Hand book, 7th edition, Mc Graw Hill
4) M.A. Chaudhari, "Industrial Measurements" Nirali Publications (2018).
5) Uche Nnaji, Introduction to Chemical Engineering, Scrivener Publishing, 2019, Wiley.

22UBEK407	Biology for Engineers	(1-0-0) 1

Contact Hours: 13

Course Learning Objective (CLO):

1. Gain a fundamental understanding of basic biological concepts and their relevance to engineering applications.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to		**Mapping to POs (1-12) /PSOs(13-15)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Demonstrate an understanding of the diverse applications of biomolecules.	1	2,3	-
CO-2	Demonstrate an understanding of the architecture and functioning of the brain, eye, and heart as integral systems in the human body.	2,3	1	-

CO-3	Demonstrate an understanding of the structure, functions, and bioengineering approaches related to the lungs, kidneys, muscular system, and skeletal system.	-	2,3	1
CO-4	Demonstrate an understanding of the nature-inspired materials and mechanisms.	-	2,3	1
CO-5	Demonstrate an understanding of the latest trends in bioengineering.	2,3	1	-

POs/PSOs	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -13	PSO -14	PSO -15
Mapping Level	1.8	2.4	2.4	-	-	-	-	-	-	-	-	-	-	-	-

Course content:

Unit-I

Biomolecules and their applications: Carbohydrates, Nucleic acids, Proteins, lipids, and Enzymes. **03Hrs**.

Unit-II

Human organ systems and bio designs - 1: Brain as a CPU system, Eye as a Camera system, Heart as a pump system. **03Hrs.**

Unit-III

Human organ systems and bio-designs - 2: Lungs as purification system, Kidney as a filtration system, Muscular and Skeletal Systems as scaffolds. **02Hrs.**

Unit-IV

Nature-bioinspired materials and mechanisms: Echolocation, Photosynthesis, Bird flying (GPS and aircrafts), Shark skin (Friction reducing swim suits), Kingfisher beak (Bullet train). Human Blood substitutes. **03Hrs.**

Unit-V

Trends in bioengineering: Bioprinting techniques and materials, 3D printing of ear, bone, and skin. Electrical tongue and electrical nose in food science, Bioimaging and Artificial Intelligence for disease diagnosis. **02Hrs.**

Reference Books:

1) Human Physiology, Stuart Fox, Krista Rompolski, McGraw-Hill eBook. 16/e Edition, 2022
2) Biology for Engineers, Thyagarajan S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Barathi S., and Jaganthan M.K., Tata McGraw-Hill, New Delhi, 2012.
3) Biomedical Instrumentation, Leslie Cromwell, Prentice Hall 2011.

4) Biology for Engineers, Sohini Singh and Tanu Allen, Vayu Education of India, New Delhi, 2014.
5) Bioremediation of heavy metals: bacterial participation, by C R Sunilkumar, N Geetha A. C. Udayashankar Lambert Academic Publishing, 2019.
6) Electronic Noses and Tongues in Food Science, Maria Rodriguez Mende, Academic Press, 2016

22UMBA401	Mathematics	(3-0-0) Audit

Contact Hours: 39 Hrs.

Course Learning Objectives (CLOs):

1. This course will enable students to use Laplace transform to solve differential equations. Analyze and Solve system of linear equation. Understand the concept of vector differentiation and vector integration.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to		**Mapping to POs(1-12)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Transform** the given function using Laplace transforms and study their properties.	-	-	1,2
CO-2	**Apply** Laplace transform to solve differential equations.	-	-	1,2
CO-3	**Compute** the solution of system of equations. Evaluate Eigen values and Eigen vectors for a matrix.	-	1,2	
CO-4	**Study** vector calculus and **compute** gradient, divergence, curl of a single valued function**.**	-		1,2
CO-5	**Study** vector integration and **evaluate** Line integrals, Surface integrals and Volume integrals	-		1,2

POs	1	2	3	4	5	6	7	8	9	10	11	12
Mapping Level	1.2	1.2	-	-	-	-	-	-		-	-	-

Pre-requisites:

1. Differentiation of function
2. Integration of function.
3. Elementary row transformation of matrix.
4. Vector algebra.

Course Content:

Unit-I

Laplace Transforms: Definition and Properties. Laplace transform of elementary functions. Laplace transform of $e^{at}f(t)$ Laplace transform of $t^n f(t)$, Laplace transform of $\frac{f(t)}{t}$, Laplace transforms of Periodic functions and unit-step function–problems. **08Hrs.**

Unit-II

Inverse Laplace Transforms: Inverse Laplace transform -problems with standard, Convolution theorem (without proof) to find the inverse Laplace transform and problems. Solution of linear differential equations using Laplace transform. **08Hrs.**

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Unit-III

Elementary Linear Algebra: Rank of a matrix - Row Echelon form. Test for consistency for system of linear equations. Solution of system of linear equations – Gauss-elimination method (consistency), Gauss-Seidel iterative method. Eigen values and Eigen vectors- Rayleigh's power method. **08Hrs.**

Unit-IV

Vector Calculus: Vector Differentiation: Scalar point function and vector point functions. Gradient, Directional Derivative; Curl and Divergence-physical interpretation. Solenoidal and irrotational vectors. Illustrative problems. **08Hrs.**

Unit-V

Vector Integration: Line integrals, Surface integrals and Volume integrals. Green's theorem, Gauss divergence theorem and Stoke's theorem (only statements).**07Hrs.**

Text Books

1) **B.S. Grewal**: Higher Engineering Mathematics, Khanna Publishers,44/e, 2017.
2) **Rajesh Verma & H.K. Dass,** Higher Engineering Mathematics, 3/e, 2014.

Note: 1. Grades (i) PP (ii) NP

2. No semester End Examination

3. Audit (Bridge course)

- ✓ The mandatory non–credit courses Additional Mathematics I and II prescribed for III and IV semesters respectively, to the lateral entry Diploma holders admitted to III semester of BE/B.Tech., programs, shall attend the classes during the respective semesters to complete all the formalities of the course and appear for the Continuous Internal Evaluation (CIE). In case, any student fails to register for the said course/fails to secure the minimum 40 % of the prescribed CIE marks, he/she shall be deemed to have secured an F grade. In such a case, the student has to fulfill the requirements during subsequent semester/s to appear for CIE.
- ✓ These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.

22UNSK408	National Service Scheme	(0-0-2) Audit

Contact Hours: 26

Course Learning Objectives:

1. Understand the community in which they work.
2. Identify the needs and problems of the community and involve them in problem-solving.
3. Develop among themselves a sense of social & civic responsibility & utilize their knowledge in finding practical solutions to individual and community problems.
4. Develop competence required for group-living and sharing of responsibilities & gain skills in mobilizing community participation to acquire leadership qualities and democratic attitudes.
5. Develop capacity to meet emergencies and natural disasters & practice national integration and social harmony.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs (1-12)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO1	Understand the importance of his / her responsibilities towards society.	12	6	8
CO2	Analyze the environmental and societal problems/issues and will be able to design solutions for the same.	12	6	8
CO3	Evaluate the existing system and to propose practical solutions for the same for sustainable development.	12	6	8,

CO4	Implement government or self-driven projects effectively in the field.	12	6	8

POs	1	2	3	4	5	6	7	8	9	10	11	12
Mapping Level	-	-	-	-	-	2	-	1	-	-	-	3

Activity list:

1. Waste management– Public, Private and Govt organization.
2. Setting of the information imparting club for women leading to contribution in social and economic issues.
3. Water conservation techniques – Role of different stakeholders– Implementation.
4. Preparing an actionable business proposal for enhancing the village income and approach for implementation.
5. Helping local schools to achieve good results and enhance their enrolment in Higher/ technical/ vocational education.
6. Developing Sustainable Water management system for rural areas and implementation approaches.
7. Contribution to any national level initiative of Government of India. For eg. Digital India, Skill India, Swachh Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme, Skill development programs etc.
8. Spreading public awareness under rural outreach programs. (minimum 2 programs).
9. Social connect and responsibilities.
10. Plantation and adoption of plants. Know your plants.
11. Organize National integration and social harmony events /workshops/ seminars. (Minimum 02 programs).
12. Govt. school Rejuvenation and helping them to achieve good infrastructure.

Students have to take up at least three activities on the above said topics and have to prepare content for awareness and technical contents for implementation of the projects and have to present strategies for implementation of the same.

Note: Activities must be unique (Not repeat) across semesters for each student.

CIE will be evaluated based on their presentation, approach and implementation strategies.

Reference Books:
NSS Course Manual, Published by NSS Cell, VTU Belagavi

ASSESSMENT AND EVALUATION PATTERN		
	Time Schedule	CIE (50)
Presentation: on Selected topic	Before the IA-3	50 Marks

Note: Implementation strategies of the project with report duly signed by the Department NSS Coordinator and HoD

CIE and SEE Evaluation (from 2022-23 batch)

Courses with LTP 3-0-0 and 4-0-0 or 2-2-0/3-2-0

Continuous Internal Evaluation (CIE):

- Two Internal Assessment and one Improvement test each of 20 marks and one hour duration.
- Two higher scores from three tests are taken representing 40 marks.
- Question Paper pattern for Internal Assessment: 3 questions of 10 marks each with maximum of two sub divisions. Q.3 is compulsory and one question to be answered from Q.1 and Q.2.
- Course Teacher Assessment (CTA): Minimum two components such as quiz, seminar, written assignment, any technical activity related to course each of 5marks. Total CTA marks-10
- CIE=40 (from tests) +10(from CTA) =50 marks

Semester End Examination (SEE):

- SEE is conducted for100 marks with 3 hours duration. It is reduced to 50 marks.
- Question Paper pattern for SEE: Five units with built in choice. Each question with maximum of three sub divisions.
- Two questions are to be set from each unit with built in choice, for example Q1 or Q2 in unit –I, Q 3 or Q 4 in unit-II and so on.
- A total of 5 full questions to be answered choosing one full question from each unit. All five units are to be answered compulsorily.
- Each question is of 20 marks.
- The Question paper is to be set for duration of 3 hours both for 3 and 4 credits courses.
- The Question paper is to be set for 100 marks for 3 and 4 credits courses.

ASC(IC)/PCC with LTP 2-0-2, 3-0-2 and 2-2-2

Continuous Internal Evaluation (CIE):

Theory CIE component:

- Two Internal Assessment and one Improvement test each of 20 marks and one hour duration.
- Two higher scores from three tests are taken representing 40 marks.
- Question Paper pattern for Internal Assessment: 3 questions of 10 marks each with maximum of two sub divisions. Q.3 is compulsory and one question to be answered from Q.1 and Q.2.

Course Teacher Assessment (CTA): Totally based on conduction of experiments as set by the course teacher.

Laboratory component assessment:

- 5 marks: for conduction, regularity, involvement, journal writing, etc. Minimum 75% of attendance is compulsory. If the performance is not satisfactory in laboratory the student shall be detained and required to reregister for the course as a whole when ever offered next.
- 5 marks: Lab Test. A Lab test as per the class time table has to be conducted at the end for50 marks and scale down to 5 marks.
- CIE for integrated course =40 (from IA tests) +10 (from CTA i.e. lab component) =50 marks.
- There will not be any remuneration for Final Lab Test since it is CTA of integrated course.
- Copy of the Marks list to be sent to the concerned course instructor immediately after the completion of test for that batch. Original Marks list to be maintained in the department.
- CIE=40(from tests) +10(from CTA i.e. lab component) =50 marks

Semester End Examination (SEE):

- SEE is conducted for100 marks with 3 hours duration. It is reduced to 50 marks.
- Question Paper pattern for SEE: Five units with built in choice. Each question with maximum of three sub divisions.
- Two questions are to be set from each unit with built in choice, for example Q1 or Q2 in unit –I, Q 3 or Q 4 in unit-II and so on.
- A total of 5 full questions to be answered choosing one full question from each unit. All five units are to be answered compulsorily.
- Each question is of 20 marks.
- The Question paper is to be set for duration of 3 hours both for 3 and 4 credits courses.

- The Question paper is to be set for 100 marks for 3 and 4 credits courses.

AEC/HSMS/UHV Courses with LTP 1-0-0:
Continuous Internal Evaluation (CIE)

- Two Internal Assessment and one Improvement test each of 20 marks and one hour duration.
- Two higher scores from three tests are taken representing 40 marks.
- Question Paper pattern for Internal Assessment: MCQ 20 questions
- Course Teacher Assessment (CTA): Minimum two components such as quiz, seminar, written assignment, any technical activity related to course etc. each of 5marks. Total CTA marks-10
- CIE=40(from tests) +10(from CTA) =50 marks

Semester End Examination (SEE):

- SEE is conducted for 50 marks of 1 hour duration. There will be 50 MCQs.
- Question Paper pattern for SEE: The question paper will contain 12 MCQ questions drawn from each Unit.
- Students have to answer maximum of 10 questions from each unit.
- All five units are to be answered compulsorily.

For NSS/Physical Education & Yoga Audit Courses with LTP 0-0-2
Continuous Internal Evaluation (CIE)

- All students have to register for any one course in each semester of III to IV with concerned course instructor.
- The department must make a faculty coordinator for the above audit courses and the details of the students must be maintained.
- The concerned course instructor must define the set of activities and its schedule of the conduction in NSS, PE and Yoga by taking approval from Dean Academic Program.
- The course instructor has to conduct the events as per the schedule and maintain the attendance for the same. 75% attendance is mandatory.
- The course instructor must assess the students by conducting the MCQ test for 50 marks to be conducted during the improvement test for other courses.
- The course instructor must send the marks and attendance register to the respective departments.
- The faculty coordinator of the department must maintain the same and arrange for sending the marks to CoE.