Syllabus of B. Tech. Chemical Engineering

Madan Mohan Malaviya University of Technology
Gorakhpur 273010, Uttar Pradesh

Starting Session: 2021-2022
(As per National Education Policy 2020)

VISION

To become a globally leading Chemical Engineering Department by imparting quality education through excellence in teaching, research and innovation.

MISSION

- to provide high-quality education that will prepare the students for leading roles in their professional journey.
- to contribute in the sustainable development of the nation and to improve the quality of life through education, research, professionalism and leadership.
- to work in collaboration with alumni and other technical institutes/universities/ industries/research organizations of national and international stature in order to address global challenges in the domain of Chemical Engineering.

PROGRAM EDUCATION OBJECTIVES

- to inculcate with knowledge of the fundamentals of Science and Engineering disciplines for developing the ability of students to formulate, solve and analyse the problems of Chemical Engineering.
- to assist the students in pursuit of their successful career by imparting them the lifelong skills of creative thinking and the ability to handle problems of practical relevance to society while complying with economic, environmental, ethical and safety factors.
- to impart the knowledge about contemporary technologies, practical experiences, and soft skills in multidisciplinary field for building up team spirit and leadership qualities by working on multidisciplinary projects.

PROGRAM SPECIFIC OBJECTIVES

Graduate of Chemical Engineering of Department will able to

- demonstrate the Chemical Engineering fundamentals learnt through lectures, practicals, computer aided designs, projects, and field-based training.
- apply the knowledge of Chemical Engineering in addressing the needs of society including environmental stewardship and to identify, analyse, design and develop solution for complex engineering problems of practical relevance to chemical and allied industries.

DEPARTMENT OF CHEMICAL ENGINEERING
M.M.M. UNIVERSITY OF TECHNOLOGY
GORAKHPUR

OVERALL CREDIT STRUCTURE FOR B.TECH. PROGRAM

Credit Courses			
Core Courses (CC)**		**Electives Courses (EC)****	
Category	**Min. Credits**	**Category**	**Min. Credits**
Basic Sciences & Maths (BSM)	20	Program Electives (PE)	9
Engineering Fundamentals (EF)	16	Open Electives (OE) (Other Departments)	3
Professional Skill (PS)	4		2
Program Core (PC)	66	Humanities & Social Science elective (HSSE)	
Management (M)	4		
Humanities & Social Science (HSS)	4		
Project (P)	5		
Seminar (S)	2		
Industrial Practice (IP)/ Industrial Elective (IE)	12		
Program link basic science and engineering courses (PLBSE) (To be decided by the department)	19		
Sub-total	**152**	**Sub-total**	**14**
Grand Total	**160 (minimum)**		

**** subjects to be taught for more than one branch may be scheduled both in odd and even semesters.**

1. Extracurricular Activities Courses (ECA) Two compulsory courses from the following S.No (ii) to (v) non-credit courses: (i) Induction Program (compulsory) (ii) Skill development (iii) Unity and Discipline (NCC or NSS) (iv) Sports, Cultural and Games (v) Personality Development	**Non-Credit**
***Audit Courses (AC)** Two of the Audit Courses are compulsory	**Non-Credit**

Minor Degree Courses (Optional) from any department	**Credits**
Department Minor (DM) Courses	18-20

Credit Structure for B. Tech.

Category/Semesters	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total**
Basic Sciences & Maths (BSM)	4	6	5	5	--	--	--	--	20
Engineering Fundamentals (EF)	8	4	4	--	--	--	--	--	16
Professional Skill (PS)	1	2	--	--	--	--	--	--	3
Program Core (PC)	--	--	9	18	13	14	13		66
Management (M)	--	--	--	--	2	2	--	--	4
Humanities & Social Science (HSS)	--	2	2	--	--	--	--	--	4
Humanities & Social Science Elective (HSSE)	2	--	--	--	--	--	--	--	2
Project (P)	--	--	--	--	--	2	3	--	5
Seminar (S)	--	--	--	--	--	2	--	--	2
Industrial Practice (IP)/ Industrial Elective (IE)#	--	--	--	--	--	--	--	12	12
Program link basic science and engineering courses (PLBSE)	3	5	4	4	4	--	--	--	21
Program Electives (PE)	--	--	--	--	3	3	3	--	9
Open Electives (OE) (Other Departments)	--	--	--	--	--	--	3	--	3
Total	**18**	**19**	**24**	**27**	**22**	**23**	**22**	**12**	**167**

CURRICULUM FOR B.TECH. CHEMICAL ENGINEERING PROGRAMMES

First Year, Semester I

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	BSM	BSM-101	Calculus and Linear Algebra	3	1	0	4
2.	EF	BCH-111	Chemical Process & Operation	3	1	0	4
3.	PS	BCH-112	Chemical Laboratory Skills	0	0	2	1
4	EF	BEE-104	Introduction to Electrical Engineering	2	0	0	2
5	EF	BEC-105	Introduction to Electronics Engineering	2	0	0	2
6	PLBSE	BSM-126	Applied Physics	3	0	0	3
7	HSSE**	BHM***	HSSE Elective	2	0	0	2
			Total	**15**	**2**	**2**	**17**
1.	ECA-I		Induction Program	**-**	**-**	**-**	**0**

First Year, Semester II

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	BSM	BSM-158	Differential equations and numerical methods	3	1	0	4
2.	EF	BCE101	Engineering Graphics	0	0	4	2
3.	BSM	BSM-195	Environmental Engineering Science	2	0	0	2
4.	PS	BCH-121	Process Plant Safety	1	0	2	2
5.	EF	BME-151	Technical Art	0	0	4	2
6.	HSS	BHM-151	Professional Communication	2	0	0	2
7.	PLBSE	BCH-122	Fluid Flow Operation	3	1	2	5
			Total	**11**	**2**	**12**	**19**
1.	ECA-II			**-**	**-**	**-**	**0**

BSM-101: CALCULUS AND LINEAR ALGEBRA

Course category : Basic Science and Mathematics (BSM)

Pre- requisites : Mathematics (10+2)

Contact hours/week : Lecture: 3, Tutorial: 1, Practical:0

Number of Credits : 4

Course Assessment : Continuous assessment through tutorials, assignments, Methods Quizzes and Minor test and Major Theory Examination

Course Objectives : This course provides the knowledge and understanding of

a. Differential calculus
b. Linear algebra
c. Multiple integrals
d. Vector calculus

Course Outcome : The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Use of basic differential operators in various engineering problems.
2. Solve linear system of equations using matrix algebra.
3. Use vectors to solve problems involving force, velocity, work, and real-life problems and able to analyse vectors in space
4. Evaluate and use double integral to find area of a plane region and us of triple integral
5. Able to find the volume of region in 3rd dimension
6. Application of Green, Stokes and divergences theorem

Unit -I: Differential Calculus: Limit, Continuity and Differentiability, Mean value theorems. Leibnitz theorem, Partial derivatives, Euler's theorem for homogenous function, Total derivative, Change of variable. Taylor's and Maclaurin's theorem. Expansion of function of two variables, Jacobian, Extrema of function of several variables. **[9]**

UNIT-II: Linear Algebra: Rank of Matrix, Inverse of a Matrix, Elementary transformation, Consistency of linear system of equations and their solution, Symmetric, Skew – symmetric and Orthogonal matrices, Characteristic equation, Eigenvalues, Eigen-vectors, Cayley-Hamilton theorem, Diagonalisation of matrices. **[9]**

UNIT-III: Multiple Integrals: Double and triple integrals, change of order of integration, change of variables. Application of multiple integral to surface area and volume. Beta and Gamma functions, Dirichlet integral. **[9]**

UNIT-IV: Vector Calculus: Gradient, Divergence and Curl. Directional derivatives, line, surface and volume integrals. Applications of Green's, Stoke's and Gauss divergence theorems (without Proofs). **[9]**

Textbook:

1. B.S. Grewal: Higher Engineering Mathematics; Khanna Publishers
2. B.V. Ramana: Higher Engineering Mathematics, Tata Mc. Graw Hill Education Pvt. Ltd., New Delhi.

3. R. K. Jain and Iyenger: Advanced Engineering Mathematics, Narosa Publications.
4. Erwin kreyszig: Advanced Engineering Mathematics, John Wiley & Sons.

BCH-111: CHEMICAL PROCESS & OPERATION

Course Category	: Departmental Core (DC)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 0
No of Credits	: 4
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes, minor test, and major theory examination
Course Objectives	: This course provides the knowledge and understanding of a. Chemical processes b. Basic concepts of unit operations c. Material, Energy and cost economics of chemical processes d. Utilities, environmental and safety aspects
Course Outcome	Students are expected to: 1. Understand basics concepts of chemical processes 2. Understand applications of unit operation 3. Able to do the basic calculation of material and energy balance 4. Able to do cost management in chemical processes 5. Understand environmental and safety aspects in process industries 6. Understand application of process utilities

Unit 1: Introduction to Chemical Processes

Basic of unit process and unit operation, homogeneous system, heterogeneous system, Unit processes: Nitration, Halogenation, Sulfonation and Sulfation, Oxidation, Hydrogenation, Hydration, Hydrolysis Esterification, Alkylation, Polymerization, Pyrolysis, Carbonization, Carbonation, Methanation. **[9]**

Unit 2: Basics of Unit Operations

Solid-solid, solid-liquid, solid-gas, liquid-liquid, liquid-gas, gas-gas separation, industrial application of separation process **[9]**

Unit 3: Engineering aspects of Chemical Processes

Material, Energy, Cost management in the Chemical process industries, Material, and products quality. **[9]**

Unit 4: Utilities, Environmental and safety aspects in process industries

Environmental and Safety aspects in process industries, Water, air, steam used in process industries. **[9]**

References

1. Shreve, R. N., & Brink Jr, J. A. (1977). Chemical Process Industries (No. 4th Edition). McGraw-Hill Book Co.
2. Coulson, J. M. (2000). Coulson & Richardson Chemical Engineering, Volume 1. disp, 10, 32.
3. Smith, R. (2005). Chemical process: design and integration. John Wiley & Sons.

BCH-112: CHEMICAL LABORATORY SKILLS

Course Category	: Professional Skill (PS)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 0, Tutorial: 0, Practical: 2
No of Credits	: 1
Course Assessment Methods	: Continuous assessment through attendance, home assignments, and practical test.
Course Objectives	This course provides the knowledge and understanding of a. Basics of Chemical Lab Practices b. Basics of Handling of non-Instrumental and Instrumental practices c. Understands engineering aspects in term of cost and benefits and Utilities
Course Outcome	Students are expected to: 1. Understand good chemical laboratory and industrial practices 2. Able apply the knowledge of non-instrumental practices in process industries 3. Able to do the basic calculation of solution preparation and selection of method 4. Able to use the basic laboratory equipment such as pH, conductivity etc 5. Able to handle common apparatus such as melting point, water bath, etc 6. Able to do the basic operation using ICT tools such as MS office, excel, etc

Unit I: Chemical Lab Practices

Good lab practices, waste disposal and managements, method of storing chemicals, solvents and glassware, procedures and maintenance of stock, purchase and distribution registers

Unit II: Non-Instrumental Handling Practices

Introduction of non-instrumental basic laboratory techniques such as sample preparation, stoichiometric calculations, solution preparation, method selections, gravimetric, volumetric

techniques, standardization methods and analysis of samples by various procedures and the use of glassware.

Unit III: Instrumental Handling Practices

Introduction of instrumental basic laboratory techniques such as the use and maintenance of analytical balance, potentiometers, pH meters, conductivity meters, mechanical shakers, melting point apparatus, water heaters, water deionisers, magnetic stirrers and hot plates etc.

Unit IV: Utilities, Environmental and safety aspects in process industries

Data analysis - MS Office, Chem Office; Literature lab safety, use of sensitive analytical instruments.

List of Experiments

1. Calibration of pH meter, pH calculation of solution
2. Preparation of different concentration solution.
3. Calibration of hotplate and mantle heater.
4. Use of direct and indirect heating instruments.
5. Calibration of weighing balance.
6. Maintenance of Chemical, instruments in working lab.
7. Use of UV spectrophotometer.
8. Calculation of lab data on Microsoft excel.

References

1. Willard, H. H; Merritt, L. L; Dean, J. A; Instrumental Methods of analysis, CBS Publishers and Distributors, Shahdara, Delhi, 6th edition, 1986.
2. Margaret-Ann Armour, Hazardous Laboratory Chemicals Disposal Guide, 2 nd Edition, 1996
3. Hein, M; Peisen, J.P, Miner, R. L, Foundations of College Chemistry in the Laboratory, John Wiley and Sons, 2011

BEE-104 INTRODUCTION TO ELECTRICAL ENGINEERING

Course category	:	Engineering Fundamentals (EF)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 2, Tutorial: 0, Practical: 0
Number of Credits	:	2
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, Minor tests and Major Theory Examination.
Course Objectives	:	This course provides the knowledge and understanding of a. Basic properties of electrical elements b. Fundamental behavior of AC circuits c. Transformer d. Magnetic circuits
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Understand the basic properties of electrical elements
2. To solve problem based on basic electrical circuits & DC network theorems.
3. Understand the fundamental behaviour of AC circuits
4. To solve AC circuit problems.
5. Understand principle of transformer
6. Application of magnetic circuits in transformer

UNIT I: D C Circuit Analysis:

Circuit Concepts: Concepts of network, Active and passive elements, Voltage and current sources, Concept of linearity and linear network, Unilateral and bilateral elements, R, L and C as linear elements, Source transformation, Kirchhoff's laws, Loop and nodal methods of analysis, Star-delta transformation. **6**

UNIT II: Network Theorems **6**

Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem.

UNIT III: Single-Phase AC Circuits

AC fundamentals: Sinusoidal, square and triangular waveforms – Average and effective values, Form and peak factors, Concept of phasor, phasor representation of sinusoidally varying voltage and current, Analysis of series, parallel and series-parallel RLC Circuits, Resonance in series and Parallel circuit **6**

UNIT IV: Magnetic Circuit & Single-Phase Transformers

Magnetic circuit, concepts, analogy between electric & magnetic circuits, B-H curve, Hysteresis and eddy current losses. **6**

Single Phase Transformer: Principle of operation, Construction, EMF equation, Power losses, Efficiency.

Text Books:

1. Fundamentals of Electric Circuits, C.K. Alexander and M.N.O. Sadiku; TATA McGraw-Hill.
2. Principles of Electrical Engineering, V. Del Toro; Prentice Hall International.
3. Electrical and Electronics Technology, Edward Hughes; Pearson.
4. Basic Electrical Engineering, D P Kothari, I.J. Nagarath; Tata McGraw Hill
5. Electrical Technology, B. L. Thareja and A. K. Thareja; S. Chand.

BEC-105 **INTRODUCTION TO ELECTRONICS ENGINEERING**

Course category : Engineering Fundamentals (EF)

Pre-requisite Subject : Nil

Contact hours/week : Lecture: 2, Tutorial:0, Practical: 0

Number of Credits : 2

Course Assessment methods : Continuous assessment through tutorials, attendance, home assignments, quizzes, viva voce and minor and major theory Examination

Course Objectives : This course provides the knowledge and understanding of

a. Electronics devices and semiconductor sensors
b. Electronics circuits
c. Measuring principals of circuits
d. Test methods for circuits

Course Outcomes : The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.

1. Able to identify schematic symbols and understand the working principles of electronic devices, e.g., Diode, Zener Diode
2. Able understand the semiconductor sensors, BJT, JFET and MOSFET etc.
3. Able to understand the working principles of electronic circuits e.g., Rectifiers, Clipper, Clamper, Amplifiers and Operational Amplifiers etc.
4. Able to understand methods to analyse and characterize circuits.
5. Able to understand the functioning and purposes of Measuring equipment such as multi-meter, CROs and function generator sets.
6. Able to rig up and test small electronics circuits.

UNIT-I **6**

Semiconductor materials and properties: electron-hole concepts, Basic concepts of energy bands in materials, Intrinsic and extrinsic semiconductors, p-n junction diode, V-I characteristics of p-n junction diode, Shockley equation of diode. Diode Applications in rectifier, clipper, and clamper circuits. Breakdown mechanism and characteristics (Zener and avalanche), Zener diode application.

UNIT-II **6**

Basic construction, transistor action, CB, CE and CC configurations, input/output characteristics, Biasing of transistors, comparison of biasing circuits, Concept of early effect, Ebers-Moll model. Applications of BJT as an amplifier and switch, Graphical analysis of CE amplifier, concept of voltage gain, current gain, h- parameter model (low frequency).

UNIT-III **6**

JFET: Basic construction, transistor action, concept of pinch off, input and transfer characteristics, characteristic equation CG, CS and CD configurations, fixed & self-biasing. MOSFET: depletion and enhancement type MOSFET-construction, operation, and characteristics. Concept and applications of CMOS circuits.

UNIT-IV **6**

Basics of semiconductor sensors and integrated circuits (IC). Operational Amplifiers: Concept of ideal operational amplifiers, ideal op-amp parameters, inverting, non-inverting and unity gain amplifiers, adders, difference amplifiers, integrators. Electronics Instruments: Working principle of digital voltmeter, digital multimeter, cathode ray oscilloscope (CRO).

List of Books:

1. Robert L. Boylestand / Louis Nashelsky “Electronic Devices and Circuit Theory”, Latest Edition, Pearson Education.
2. H S Kalsi, “Electronic Instrumentation”, Latest Edition, TMH Publication.
3. George Kennedy, “Electronic Communication Systems”, Latest Edition, TMH.
4. David A. Bell, “Electronic Devices and Circuits”, Latest Edition, Oxford University Press.
5. Jacob Millman, C.C. Halkias, Staya brataJit, “Electronic Devices and Circuits”, Latest Edition, TMH.

6. David A. Bell, Electronic Instrumentation and Measurements, Latest Edition, Oxford University Press India.

BSM-126: APPLIED PHYSICS

Course Category:	Program link basic science and engineering courses (PLBSE)
Pre-requisite Subject:	Physics at 12^{th} standard
Contact hours/week:	Lecture: 3, Tutorial:0, Practical: 0
No of Credits:	3
Course Assessment Methods:	Continuous assessment through tutorials, attendance, home assignments, quizzes and one minor test, one major theory.

Course Objectives: This course provides the knowledge and understanding of

a. Principal of relativity
b. Principals of optics and photochemistry
c. Optical instruments and fibres
d. Nanomaterial and nano-physics

Course Outcomes: The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Basics principle of relativity and its application in Chemical Engineering.
2. Use of the principles of optics in the in the analysis of the problems of photochemistry and chemical engineering.
3. Principles of optical instruments,
4. Gain knowledge of laser and optical fibre and their applications.
5. Basic Principles of nanomaterials and biophysics
6. Application of nanophysics in Chemical Engineering.

UNIT-I

Relativistic Mechanics: Inertial and Non-inertial Frames of reference, Galilean transformation, Michelson-Morley Experiment, Postulates of special theory of relativity, Lorentz Transformation, Length contraction, Evidences of length contraction, Time dilation, Evidences for time dilation, Relativistic velocity transformation, Relativistic variation of mass with velocity, Evidence of mass variation with velocity, Relativistic kinetic energy, Mass energy equivalence, Examples from nuclear physics, Relativistic energy-momentum relation. 9

UNIT-II : Optics:

Interference: Interference of light, Interference in thin films (parallel and wedge shaped film), Newton's rings. Refractive index and wavelength determination. 9

Diffraction: Fresnel and Fraunhofer class of diffraction. Resultant of n-hormonic waves, Single, double and N- Slit Diffraction, Diffraction grating, Grating spectra, dispersive power.

Polarization: Phenomena of double refraction, Nicol prism, Production and analysis of plane, circular and elliptical polarized light, Retardation Plate, Polarimeter

UNIT-III: Optical Instruments and Modern Optics 9

Optical Instruments: Principle, construction and working of microscope and telescope Rayleigh's criterion and resolving power of microscope, telescope and grating.

Laser: Spontaneous and stimulated emission of radiation, population inversion, concept of 3 and 4 level Laser, construction and working of Ruby, He-Ne lasers and laser applications.

Fiber Optics: Fundamental ideas about optical fiber, Propagation mechanism, Acceptance angle and cone, Numerical aperture, Propagation Mechanism and communication in fiber Single and Multi Mode Fibers, step index and graded index fiber..

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UNIT-IV : Nanomaterials and Biophysics

Nanomaterials: Nanoscience and nanotechnology, significance of nanoscale, fabrication of nanomaterials, quantum size effect in metal and semiconductor nanoparticles, different types of nanostructures, quantum wells, quantum wires, and quantum dots, unusual properties of nanomaterials, creation and uses of buckyballs, carbon nanotubes, types of carbon nanotubes, applications of nanomaterials..

Biophysics: Principle of Chromatography, different techniques of chromatography, Basic Principles of NMR, Classical Description of NMR and NMR Parameters, applications of NMR, Basic principle of MRI, applications of MRI, Biomaterials, types of biomaterials and their applications, biomedical compatibility.

Books & References

1. *Introduction to Special* theory Relativity-*Robert* Resnick, Wiley Eastern Ltd.
2. Statistical Mechanics and Properties of Matter- *E S R Gopal*, John Wiley and Sons
3. Quantum Mechanics: Theory and Applications- Ajoy Ghatak, *Tata McGraw-Hill*
4. *Optics*- Ajoy Ghatak, *Tata McGraw-Hill*
5. *Optics*- N. Subrahmanyam, Brij Lal, M.N. Avadhanulu, S. Chand
6. ***Fiber optics and laser*** Principles and Applications-Anuradha De, ***New Age*** International
7. Concepts of Modern Physics-Arthur Beiser, ***Tata McGraw-Hill***
8. Biophysics by Vasantha Pattabhi N. Gautham, Kluwer Academic Publishers New York, Boston, Dordrecht, London, Moscow.

9. Engineering Physics by B. K. Pandy and S. Chaturvedi, 2edition Cengage Learning Pvt. Limited, India.

BMS-158: DIFFERENTIAL EQUATIONS AND NUMERICAL METHODS

Course category	:	Basic Science and Mathematics (BSM)
Pre- requisites	:	Math (10+2)
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	:	4
Course Assessment	:	Continuous assessment through tutorials, assignments, Methods Quizzes and Minor test and Major Theory
Course Objectives	:	This course provides the knowledge and understanding of a. Ordinary differential equation b. Partial differential equation c. Numerical techniques d. Numerical integration
Course Outcome	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course 1. To solve the ordinary differential equations 2. Application of partial differential equation in real life problems 3. To solve the partial differential equations using Lagrange and charpit's method. 4. To interpolate a curve using Gauss, Newton's interpolation formula. 5. Able to solve engineering problems using numerical integration 6. To inculcate the habit of mathematical thinking and lifelong learning.

UNIT-I 9

Differential Equations: Linear differential equations with constant coefficients ($n^{th} order$), complementary function and particular integral. Simultaneous linear differential equations, solution of second order differential equations by changing dependent and independent variables, Method of variation of parameters, Applications of differential equations to engineering problems

UNIT-II 9

Partial Differential Equations: Partial differential equations of the first order, Lagrange's solution, Charpit's general method of solution, Partial differential equations of the second order: Constant coefficient and reducible to constant coefficient, Classification of linear partial differential equations of second order.

UNIT-III 9

Numerical Techniques: Solution of polynomial equations by Bisection, Regula-Falsi and Newton-Raphson's methods. Interpolation: Newton's forward and backward interpolation formulae, Lagrange's and Newton's divided difference methods for unequal intervals.

UNIT-IV 9

Solution of Linear and Differential equations and Numerical Integration: Solution of linear equations by Crout's method and Guass-Siedel method. Solution of ordinary Differential equations by Euler's, Picard's and Fourth order Runge-Kutta methods. Numerical Integration by Trapezoidal, Simpson's one-third and Simpson's three-eight rules.

Textbook:

1. B.S. Grewal: Higher Engineering Mathematics; Khanna Publishers
2. B.V. Ramana: Higher Engineering Mathematics, Tata Mc. Graw Hill Education Pvt. Ltd., New Delhi.
3. R. K. Jain and Iyenger: Advanced Engineering Mathematics, Narosa Publications.
4. Erwin kreyszig: Advanced Engineering Mathematics, John Wiley & Sons.

BCE-101: ENGINEERING GRAPHICS

Course Category:	Engineering Fundamentals (EF)
Pre-requisite Subject:	Nil
Contact hours/week:	Lecture: 0, Tutorial:0, Practical: 4
No of Credits:	2
Course Assessment Methods:	Continuous assessment through tutorials, attendance, home assignments, quizzes and practical examination
Course Objectives:	This course provides the knowledge and understanding of a. Orthographic projections b. Projections of solids c. Sectional views of solids d. Isometric views of solids
Course Outcomes:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course: 1. How Engineering Drawing helps to sketch the imagination? 2. Able to effectively practice the different scales for drawings. 3. Effectively analyze the geometrical shapes and to be able to draw. 4. Know about out solids and discuss about their classification. 5. Able to draw sectional view of objects 6. Able to draw isometric views of objects

UNIT-I: CONIC SECTIONS AND ORTHOGRAPHIC PROJECTIONS

Introduction to Engineering Drawing covering, Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular

Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute; Scales – Plain, Diagonal and Vernier Scales; Orthographic Projections Orthographic Projections covering Principles of Orthographic Projections- Conventions Projections of Points and lines inclined to both planes; Projections of planes inclined Planes - Auxiliary Plane. **[6]**

UNIT-II: Projection of Regular Solids

Projections of Regular Solids covering, those inclined to both the Planes- Auxiliary Views

UNIT-III: Sections and Sectional Views of Right Angular Solids

Sections and Sectional Views of Right Angular Solids covering, Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone **[6]**

UNIT-IV ISOMETRIC PROJECTIONS

Isometric Projections covering, Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions. Overview of computer graphics, demonstrating knowledge of the theory of CAD software. **[6]**

Reference Books

1. Engineering Drawing-Bhat, N.D.& M. Panchal, Charotar Publishing House, 2008
2. Engineering Drawing and Computer Graphics- Shah, M.B. & B.C. Rana, Pearson Education, 2008
3. A Text Book of Engineering Drawing-Dhawan, R.K., S. Chand Publications,2007
4. Text book on Engineering Drawing-Narayana, K.L. & P Kannaiah, Scitech Publishers, 2008

BSM-195: ENVIRONMENTAL ENGINEERING SCIENCE

Course category	Basic Sciences & Maths (BSM)
Pre-requisite Subject	NIL
Contact hours/week	Lecture : 2, Tutorial : 0, Practical: 0
Number of Credits	2
Course Assessment methods	Continuous assessment through tutorials, attendance, home assignments, quizzes, Minor and Major Theory Examination.
Course Objectives:	This course provides the knowledge and understanding of a. Basic chemistry of water and nature b. Knowledge of ecosystem c. Concepts of environmental and atmospheric chemistry
Course Outcomes:	d. Laws of central pollution control board

The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course.

1. Acquire basic knowledge about Environment, which allows students to gain qualitative and quantitative skills.
2. Aware of environmental pollution and control methods along with quality standards of air, water etc along with waste management.
3. Understanding of natural resources their use and environmental problems due to overexploitation.
4. Gain basic knowledge about the chemical reactions taking place in the environment.
5. Gain knowledge of environmental chemistry
6. Norms of pollution control bodies

UNIT-I

The Chemistry of Natural Waters , Oxidation-Reduction Chemistry in Natural Waters, Ion Concentrations in Natural Waters and Drinking Water, Water Pollution and Purification of Water, Water Disinfection , Desalination of Salty Water, Groundwater: Its Supply, Chemical Contamination, and Remediation The Chemical Contamination and Treatment of Wastewater and Sewage .Management of water resources. **[6]**

UNIT-II

Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystem: (a) Forest ecosystem (b) Grassland Ecosystem (c) Aquatic ecosystems (ponds, rivers, oceans). Introduction- Definition : genetic, species and ecosystem diversity, Biogeographical classification of India, Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, National and local levels, India as a mega-diversity nation, Hot-spots of biodiversity **[6]**

UNIT-III

Basic concept of Environmental chemistry, Introduction to atmospheric chemistry, Layers of the atmosphere and their chemical composition, chemistry of gaseous and particulate pollutants, , Stratospheric ozone depletion, Ozone Holes , stratospheric ozone chemistry , Fossil fuel burning, CO_2 emissions, Greenhouse Effect Tropospheric air pollution, concept of fog and smog, Consequences of air pollution. The Human Health Effects of Outdoor Air Pollutants **[6]**

UNIT-IV

Central Pollution Control Board (CPCB), and International standards of water, air, and soil pollution. Environmental modeling: Air and Waste water treatment. **[6]**

Books & References

1. Environmental Chemistry - Colin Baird and Michael Cann, W. H. Freeman
2. Environmental Chemistry - Stanley E. Manahan, CRC Press; 9th edition.
3. Sonja Krause, Herbert M. Clark, James P. Ferris, Robert L. Strong Chemistry of the Environment, Elsevier Science & Technology Books.
4. Eugene R. Weiner Applications of Environmental Chemistry, CRC Press, LLC.
5. By Clair N. Sawyer, Perry L. McCarty, Gene F. Parkin Chemistry for environmental engineering and science (5th edition), McGraw-Hill Professional.

BCH-121: PROCESS PLANT SAFETY

Course Category	: Departmental Core (DC)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 1, Tutorial: 0, Practical: 2
No of Credits	: 2
Course Assessment Methods	: Continuous assessment through attendance, home assignments, quizzes and one minor test, one major theory and practical test.
Course Objectives	This course provides the knowledge and understanding of a. Industrial safety procedures b. Plant safety and color codes c. Indian codes of safety and hazards d. Use of personal protectives devices
Course Outcome	Students are expected to understand: 1. Importance of industrial safety 2. Hazards in chemical process industries 3. Safety aspects in industries layout 4. Personal Protective Devices 5. Classification of hazardous chemicals 6. Handling of hazardous chemicals

Unit I: Safety Procedures

Importance of Industrial Safety. Types of hazard: Chemical hazard, Thermal hazard, Electrical hazard, Mechanical hazard, Vibrational hazard, Biological hazard, Radioactive hazard **[4]**

Unit II: Safety aspects in plant layout

Safety aspects in plant layout, Ventilation and lighting, Color codes and symbols for safety in chemical plants, Classification of Color codes and symbols, Color codes for gas cylinders, Color codes for pipelines **[4]**

Unit III: Classify Personal Protective Devices

Personal Protective Devices (PPDs), Non respiratory, Respiratory, Indian Standards & codes for safety & health **[4]**

Unit III: Characteristics of hazardous chemicals

hazardous chemicals like, Chlorine, Nitric Acid, Ammonia, Carbon Monoxide, Caustic Soda, Phosphoric Acid, Sulfuric Acid, HCl, Storage, Handling & Transportation of hazardous chemicals, Fire hazards & their causes **[4]**

References

1. Willard, H. H; Merritt, L. L; Dean, J. A; Instrumental Methods of analysis, CBS Publishers and Distributors, Shahdara, Delhi, 6th dition, 1986.
2. Margaret-Ann Armour, Hazardous Laboratory Chemicals Disposal Guide, 2 nd Edition, 1996
3. Hein, M; Peisen, J.P, Miner, R. L, Foundations of College Chemistry in the Laboratory, John Wiley and Sons, 2011
4. D.Venkateswarlu, K.R.Upadrashta, K.D. Chandrasekaran, Manual of Chemical Technology, Chemtech-I, Chemical Engineering Education Development Centre, IIT, Madras, 1975
5. L M Deshmukh, Industrial safety management Tata McGraw Hill, New Delhi, 2006
6. Sunil S. R.K. Rao, Industrial Safety, Health & Environment management, Khanna Publishers, Jain New Delhi, 2006

List of Practical

1. Prepare a chart of Indian safety standards
2. Identify different hazards in a given chemical plant
3. Identify different chemical hazards in a given chemical plant
4. Identify colour codes for pipelines
5. Identify colour codes for gas cylinders
6. Identify different safety symbols for chemical industry
7. Demonstrate Personal Protective Devices
8. Prepare a handouts of safe handling practices for hazardous chemicals

BME 151: TECHNICAL ARTS

Course Category: Engineering Fundamentals (EF)
Pre-requisite Subject: Nil
Contact hours/week: Lecture: 0, Tutorial:0, Practical: 4
No of Credits: 2
Course Objectives: This course provides the knowledge and understanding of

a. Different shops in workshop
b. Tool making processes
c. Application conventional and non-conventional knowledge for tool making
d. Process for development of various products

Course Assessment Methods: Continuous assessment through practical test

Course Outcomes: After completion of this course the students are expected to be able to demonstrate following knowledge, skills, and attitudes

1. Understand the importance, materials, applications, and safety in different shops for the development of a product/ component.
2. The knowledge of tools and processes used in carpentry and foundry shops
3. The knowledge of products development through casting process and study of different casting defects.
4. The knowledge of forming process
5. Able to develop different tools and processes in black smithy, welding, and sheet metal shops.
6. The knowledge of conventional and non-conventional machining will develop ability of producing various products.

Topics Covered (Make at least one job in each shop):

Introduction:
· Need for and importance of Technical Arts.
· Shop Layout: Concept and Importance.
· Mechanical properties of metals& non-metals.
· Ferrous Metals and alloys- composition and applications. · Non-Ferrous Metals and alloys-composition and applications. · Safety precautions at shop floor.
Carpentry Shop:
· Draw layout of carpentry shop
· Study of tools & operations and carpentry joints.
· Preparation of half-lap corner joint, mortise &Tennon joint
· Simple exercise on woodworking lathe
Fitting Shop:
· Layout of fitting shop
· Study of tools & operations
· Simple exercises involving fitting work
· Simple exercises involving drilling/tapping/die
Black Smithy Shop:
· Layout of Smithy Shop
· Study of tools & operations
· Hot and cold working
· Simple exercises based on black smithy operations such as upsetting, drawing down, punching, bending, fullering & swaging.
Welding Shop:
· Layout of welding shop
· Study of equipment of gas welding & arc welding
· Preparation of simple butt and lap welded joints.
· Oxy-acetylene flame cutting
· Study of welding defects.

Sheet-metal Shop:
· Layout of Sheet metal shop
· Metals used in sheet metal work such as Galvanized iron, Copper sheet, Aluminum sheet
· Study of tools & operations
· Fabrication of Funnel, toolbox, tray, electric panel box etc.
Machine Shop:
· Layout of Machine shop
· Study of Lathe, Drilling, Shaper, Planer and Milling Machines and commonly done operations on these machines
· Single point and Multi-point Cutting tools
· Making a job on lathe involving plane turning step turning, taper turning, and threading operations
Foundry Shop:
· Layout of foundry shop
· Study of tools & operations
· Study on pattern allowances
· To prepare a Mould with the use of a core and cast it
· Study of casting defects
Advanced Machining Lab:
· Layout of the Advanced Machining Lab.
· Study about Computerized Numerically Controlled and Non- conventional machining processes.
· Study of Flexible Manufacturing System.
· Simple experiments on CNC turning and milling.
Project:
· Each group will fabricate a simple utility project using above different shops.

Books and References:

1. Fundamental of Modern Manufacturing: Materials, Processes and Systems: M. P. Groover (John Wiley)
2. Fundamental of Manufacturing Processes: G. K. Lal and S. K. Choudhary (Narosa).
3. Manufacturing technology – Machine Tools: P. N. Rao (TMH)
4. Manufacturing technology – Foundry, Forming and Welding: P. N. Rao (TMH).
5. Manufacturing Engineering & Technology: Kalpakjian (Pearson)
6. Advanced Machining Processes: V. K. Jain (Allied Publishers)
7. Manufacturing Science: A. Ghosh and A.K. Mallik (East- West Press).
8. Workshop Technology Vol-I: B. S. Raghuvanshi (DhanpatRai and Sons)
9. Workshop Technology Vol-II: B. S. Raghubanshi (DhanpatRai and Sons)

BHM-101/151 PROFESSIONAL COMMUNICATION (L-T-P: 2-0-0)

Course Category: Humanities & Social Science (HSS)
Pre-requisite Subject: None
Contact hours/week: 2 Credit
No of Credits: Lecture: 2, Tutorial:0, Practical: 0(Total Credit: 02)
Course Assessment Methods: Continuous assessment through tutorials, Attendance, home assignments, quizzes, TwoTest and one Major Theory Exam.

Course Objective:Thecourse aims:

1) To sensitize the students to understand the role& importance of communication for personal & professional success.
2) To enable learners to exhibit knowledge, skills, and judgment in and around human communication that facilitates their ability to work collaboratively with others in an interpersonal environment.
3) To develop awareness and understanding of applying appropriate communication strategies resulting into the enhancement of learners' employability skills.

Course Outcomes: The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course.

1) Use of various facets of communication skills, such as, Reading, Writing, Listening and speaking skills.
2) To identify, formulate and solve the real life problems with positive attitude.
3) To inculcate the habit of learning and developing the communication and soft skills by practice.
4) To enhance effortless speaking and writing skills with the help of rich word power.
5) To develop personality by introducing and inculcating effective presentation strategies.
6) To focus on audio, visual aids for effective oral communication skills

UNIT – I VERBAL COMMUNICATION: 6 Hours

Received Pronunciation; how to activate passive vocabulary; Technical/non-technical and Business Presentations; questioning and answer skills; soft skills for professionals; role of body postures, movements, gestures, facial expressions, dress in effective communication; Information/ Desk/ Front Office/ Telephone conversation; how to face an interview/press conference; Group discussions, debates, elocution.

UNIT – II: READING COMPREHENSION 6 Hours

Skimming and Scanning; factual and inferential comprehension; prediction; guessing meaning of words from context; word reference; use and interpretation of visuals and graphics in technical writing.

UNIT – III: WRITTEN COMMUNICATION: 6 Hours

Note Making and Note Taking; summarizing; invitation, advertisement, agenda, notice and memos; official and commercial letters; job application; resume and curriculum vitae; utility, technical, project and enquiry reports; paragraph writing: General – Specific, Problem – Solution, Process – Description, Data – Comment.

UNIT – IV: SHORT ESSAYS: 6 Hours

Description and Argument; comparison and contrast; illustration; using graphics in writing: tables and charts, diagrams and flow charts, maps and plans, graphs; how to write research paper; skills of editing and revising; skills of referencing; what is a bibliography and how to prepare it.

Text & Books:

1) Bansal, R.K. & Harrison J.B., (1972)*Spoken English*, Orient Longman, India.
2) Chauhan, Narender Kr. & Singh, Sudhir N., (2013) *Formal Letters*, Pankaj Publication International, New Delhi.
3) Chhabra T.N., (2019) *Business Communication*, Sun India Publication, New Delhi.
4) Dixon Robert J., (1986)*Complete Course in English*, Prentice Hall of India, New Delhi.
5) Jones, Daniel.(2012) *Cambridge English Pronouncing Dictionary*, 18thEdition, Paperback, CUP, India.
6) Lewis, Norman, (2015) *Word Power Made Easy*, Penguin India.
7) Sethi J. & Jindal, (1993)*Handbook of Pronunciation of English Words* - D.V.A, Prentice Hall of India, New Delhi.
8) Sharma R.C. & Mohan Krishna, (2017)*Business Correspondence and Report Writing*, Tata McGraw Hill.
9) Thomson, A. J. & and Martinet A. V., (1997)*A Practical English Grammar*,Paperback,Ed. IVth, Oxford.

BCH-122: FLUID FLOW OPERATION

Course Category	: Program link basic science and engineering courses (PLBSE)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 2
No of Credits	: 5
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes and one minor test, one major theory and practical test.
Course Objectives	This course provides the knowledge and understanding of a. Basic concepts of fluid flow operations b. Types of flows c. Application different flow measuring devices d. Basic concept and selection of pumping devices for fluid
Course Outcome	Students are expected to: 1. Apply basics equation to fluid flow operations 2. Apply knowledge of macroscopic balances 3. Understand compressible, incompressible fluids and liquid mixing 4. Understand fluid flow measurement device and calculations of pressure drop in pipelines 5. Understand concept of hydrodynamic boundary layer 6. Select device for pumping of fluids

Syllabus

UNIT 1: Fluid Flow Basics

Fluid flow phenomena, Types of fluids, Basic equations of fluid flow: Macroscopic momentum balance, Macroscopic balance in potential flow: Bernoulli theorem and its application. **[9]**

UNIT 2: Compressible and Incompressible Fluids

Flow of incompressible fluids in pipes and closed channels, Process of compressible fluids, Liquid Mixing: Types of mixing patterns, mixing mechanism, and mixing equipments. **[9]**

UNIT 3: Fluid Flow Measurements

Devices for measurement of Pressure, Fluid flow measuring devices. Calculation of Pressure Drop in a Pipe, Minor Losses in Fittings. Concept of hydrodynamic boundary layer, growth over a flat plate, different thickness of boundary layer. **[9]**

UNIT 4: Pumping of Fluids

Hydraulic pumps: Positive Displacement Pumps, Reciprocating Pumps, Rotary Pumps and Screw Pumps. Centrifugal Pumps, Characteristic Curves of Centrifugal Pumps, NPSH. Centrifugal pumps verses Reciprocating pumps pump losses and Efficiencies, Multistage pumps, Work and power Input. **[9]**

Books

1. McCabe W., Smith J., "Unit Operations of Chemical Engineering", 7th Edition, McGraw Hill Education (2017).
2. Gupta V., Gupta S. K., "Fluid Mechanics and its Applications", Wiley Eastern, New Delhi (1984).
3. Shames I. H., "Mechanics of Fluids", 4th Edition, McGraw-Hill, Inc (2002)
4. Coulson J. M., Richardson J. F., "Chemical Engineering: Volume-I", 4th Edition, Pergamon Press (1990).
5. Jain A. K., "Fluid Mechanics including Hydraulic Machines", Khanna Publishers, Delhi (2007).
6. Geankoplis C. J., "Transport Processes and Unit Operations", 4th Edition, Prentice-Hall Inc (2004).

CHEMICAL ENGINEERING FLUID MECHANICS LAB

1. To find the flow rate using a V notch.
2. To find the friction losses in a Straight and bend pipe.
3. Study of Pipe fittings and Valves.
4. To study the Reynolds apparatus and verify experimentally.
5. To study the working principle of a reciprocating pump and to determine the percentage of slip.
6. To study the working principle of a centrifugal pump and determine its efficiency experimentally.
7. To find out the flow profile of water from hook's gauge and determination of coefficient of velocity, coefficient of discharge, coefficient of resistance, coefficient of contraction.
8. To determine the pressure drop in a packed bed by Leva's and Ergun's equation and verify experimentally.
9. To determine the minimum fluidization velocity in a fluidized/tapered fluidized bed and verify experimentally.
10. Determination of discharge coefficient with Reynolds Number in case of an orifice meter and a venturi meter.
11. Study and verification of the flow pattern in a Bernoulli's apparatus.
12. Determination of the mixing, fluidization and segregation index of the given sample of bed materials in a fluidized bed.