NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

NEW SYLLABI FOR THE CURRICULAM OF UG COURSE

(BACHELOR OF TECHNOLOGY)

COMMON FIRST YEAR COURSES –(2018 -19 ONWARDS)

FIRST SEMESTER

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
MAC 01	MATHEMATICS - I	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
Basic concepts of function, limit, differentiation and integration.		CT+EA					
Course Outcomes	• CO1: Fundamentals of Differential Calculus • CO2: Fundamentals of Integral Calculus • CO3: Fundamentals of Vector Calculus • CO4: Basic Concepts of Convergence						
Topics Covered	**Functions of Single Variable:** Rolle's Theorem and Lagrange's Mean Value Theorem (MVT), Cauchy's MVT, Taylor's and Maclaurin's series, Asymptotes & Curvature (Cartesian, Polar form). (8) **Functions of several variables:** Function of two variables, Limit, Continuity and Differentiability, Partial derivatives, Partial derivatives of implicit function, Homogeneous function, Euler's theorem and its converse, Exact differential, Jacobian, Taylor's & Maclaurin's series, Maxima and Minima, Necessary and sufficient condition for maxima and minima (no proof), Stationary points, Lagrange's method of multipliers. (10) **Sequences and Series:** Sequences, Limit of a Sequence and its properties, Series of positive terms, Necessary condition for convergence, Comparison test, D Alembert's ratio test, Cauchy's root test, Alternating series, Leibnitz's rule, Absolute and conditional convergence. (6) **Integral Calculus:** Mean value theorems of integral calculus, Improper integral and it classifications, Beta and Gamma functions, Area and length in Cartesian and polar co-ordinates, Volume and surface area of solids of revolution in Cartesian and polar forms, (12) **Multiple Integrals:** Double integrals, Evaluation of double integrals, Evaluation of triple integrals, Change of order of integration, Change of variables, Area and volume by double integration, Volume as a triple integral. (10) **Vector Calculus:** Vector valued functions and its differentiability, Line integral, Surface integral, Volume integral, Gradient, Curl, Divergence, Green's						

	theorem in the plane (including vector form), Stokes' theorem, Gauss's divergence theorem and their applications. (10)
Text Books, and/or reference material	**Text Books:** 1. E. Kreyszig, Advanced Engineering Mathematics: 10 th edition, Wiley India Edition. 2. Daniel A. Murray, Differential and Integral Calculus, Fb & c Limited, 2018. 3. Marsden, J. E; Tromba, A. J.; Weinstein: Basic Multivariable Calculus, Springer, 2013. **Reference Books:** 1. Tom Apostal, Calculus-Vol-I & II, Wiley Student Edition, 2011. 2. Thomas and Finny: Calculus and Analytic Geometry, 11 th Edition, Addison Wesley.

Course Code	**Title of the course**	**Program Core (PCR) / Electives (PEL)**	**Total Number of contact hours**				Credit
			Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Total Hours**	
PHC01	**PHYSICS**	**PCR**	**2**	**1**	**0**	**3**	**3**
Pre-requisites:		Course Assessment methods: (Continuous (CT), MID term and End Term Assessment (EA))					
NIL		CT+EA					
Course Outcomes	CO1: To realize and apply the fundamental concepts of physics such as superposition principle, simple harmonic motion to real world problems. CO2: Learn about the quantum phenomenon of subatomic particles and its applications to the practical field. CO3: Gain an integrative overview and applications of fundamental optical phenomena such as interference, diffraction and polarization. CO4: Acquire basic knowledge related to the working mechanism of lasers and signal propagation through optical fibers.						
Topics Covered	**Harmonic Oscillations** - Linear superposition principle, Superposition of two perpendicular oscillations having same and different frequencies and phases, Free, Damped and forced vibrations, Equation of motion, Amplitude resonance, Velocity resonance, Quality factor, sharpness of resonance, etc. [8] **Wave Motion** - Wave equation, Longitudinal waves, Transverse waves, Electro-magnetic waves. [3] **Introductory Quantum Mechanics** - Inadequacy of classical mechanics, Blackbody radiation, Planck's quantum hypothesis, de Broglie's hypothesis, Heisenberg's uncertainty principle and applications, Schrodinger's wave equation and applications to simple problems: Particle in a one-dimensional box, Simple harmonic oscillator, Tunnelling effect. [8] **Interference & Diffraction** - Huygens' principle, Young's experiment, Superposition of waves, Conditions of sustained Interference, Concepts of coherent sources, Interference by division of wavefront, Interference by division of amplitude with examples, The Michelson interferometer and some problems; Fraunhofer diffraction, Single slit, Multiple slits, Resolving power of grating. [13] **Polarisation** - Polarisation, Qualitative discussion on Plane, Circularly and elliptically polarized light, Malus law, Brewster's law, Double refraction (birefringence) - Ordinary and extra-ordinary rays, Optic axis etc.; Polaroid, Nicol prism, Retardation plates and analysis of polarized lights. [5]						

	Laser and Optical Fiber - Spontaneous and stimulated emission of radiation, Population inversion, Einstein's A & B co-efficient, Optical resonator and pumping methods, He-Ne laser. Optical Fibre– Core and cladding, Total internal reflection, Calculation of numerical aperture and acceptance angle, Applications. [5]
Text Books, and/or reference material	**TEXT BOOKS**: 1. The Physics of Vibrations and Waves, H. John Pain, Willy and Sons 2. Vibrations and Waves in Physics, Iain G. Main, Cambridge University Press 3. Engineering Physics, H. K. Malik and A. K. Singh, McGraw-Hill. **REFERENCE BOOKS**: 1. Quantum Physics, R. Eisberg and R. Resnick, John Wiley and Sons 2. Fundamental of Optics, Jankins and White, McGraw-Hill 3. Optics, A. K. Ghatak, Tata McGraw-Hill 4. Waves and Oscillations, N. K. Bajaj, Tata McGraw-Hill 5. Lasers and Non-linear Optics, B. B. Laud , New Age International Pvt Lt

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYC 01	Engineering Chemistry	PCR	2	1	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
None		CT+EA					

Course Outcomes	• CO1: Introduced to chemical thermodynamics, kinetics, electrochemistry, absorption and catalytic processes for engineering applications • CO2: To learn fundamentals of polymer chemistry and petroleum engineering. • CO3: Introduced to basic spectroscopic techniques for structure determination and characterization. • CO4: To study few inorganic and bioinorganic compounds of industrial importance.
Topics Covered	**ORGANIC CHEMISTRY** i. Fundamentals of organic reaction mechanisms; Few important reactions and their mechanism along with their applications; Robinson annulation, Hydroboration reaction, Organometallic reagents (Gilman reagents), Metathesis using Grubb's catalyst and Wittig reaction. (3) ii. Fundamental concept on stereochemistry and application: Conformation and configuration of organic compounds, Diastereo-selective, enantio-selective, regio-selective, stereo-specific and stereo-selective reactions. (3) iii. Polymer chemistry and polymer engineering: Fundamental concept on polymer chemistry; synthesis and application of important polymers, Rubber and plastic materials. Conducting polymer. (2) iv. Petroleum Engineering and oil refinery: origin of mineral oils, separation principle and techniques of distillation of crude oil, Uses of different fractions, octane number, cetane number, Knocking, anti-knock compounds, and Bio-Fuel. (2) v. Structure elucidation of organic compounds by modern spectroscopic methods; Application of UV-Visible and FT-IR spectroscopy. (3)

	INORGANIC CHEMISTRY i. **Coordination Chemistry:** Crystal Field Theory of octahedral and tetrahedral complexes, colour and magnetic properties, Jahn-Teller distortion, pseudo Jahn-Teller distortion, Isomerism and stereochemistry.(5) ii. **Bioinorganic Chemistry:** Heme and non-heme O_2 transport protein (Haemoglobin, Myoglobin), Chlorophyll and photosynthesis. (3) iii. **Inorganic Materials:** Introduction towards industrially important inorganic materials like cementing material, refractory material, fertiliser, inorganic polymer. (2) iv. **Organometallic Chemistry:** π-acid ligands, stabilization of metal low oxidation state and 18 electron rules, metal carbonyls and nitrosyls, metal-alkene complexes. (4) **PHYSICAL CHEMISTRY** i. **Thermodynamics:** 2nd law of thermodynamics, entropy, free energy, Gibbs Helmholtz equation, change of phase. Cryogenics: joule Thomson experiment. (4) ii. **Chemical Kinetics:** 2nd and 3rd order rate expression, Reversible reaction, Chain reaction, Consecutive reaction, Temp effect on reaction rate. (4) iii. **Electrochemistry:** Electrochemical cell, Effect of pH, precipitation and complex formation on EMF of oxidation/reduction processes. (2) iv. **Absorption:** Physical and Chemical absorption, Absorption isotherms. (1) v. **Catalysis:** Types of catalysis, Rate expression for Catalysed reaction, Acid-base and Enzyme catalysis. (2)
Text Books, and/or reference material	Suggested Text Books: (i) Physical Chemistry by P. Atkins, Oxford (ii) A guidebook to mechanism in Organic chemistry: Peter Sykes; Pearson Edu. (iii) Inorganic Chemistry Part-I & II, R. L. Dutta, The new book stall Suggested Reference Books: **Organic Chemistry**: (i) Basic stereochemistry of organic molecules: S. Sengupta; Oxford University press (ii) Engineering Chemistry: Wiley (iii) Elementary Organic Spectroscopy: William Kemp, ELBS with Macmillan **Inorganic Chemistry:** (i) Inorganic Chemistry: Principle structure and reactivity, J. E. Huheey, E. A. Keiter and R. L. Keiter, Pearson Education (ii) Bioinorganic Chemistry -- Inorganic Elements in the Chemistry of Life: An Introductionand Guide, 2nd Edition, Wolfgang Kaim, Brigitte Schwederski, Axel Klein. (iii) Inorganic Chemistry Fourth Edition, Shriver & Atkins, Oxford **Physical Chemistry:** (i) Physical Chemistry by G.W Castellan (ii) Physical Chemistry by P. C. Rakshit

<table>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)#</td><td>Total Hours</td></tr>
<tr><td>XEC01</td><td>ENGINEERING MECHANICS</td><td>PCR</td><td>2</td><td>1</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous (CT) and end assessment (EA))</td></tr>
<tr><td colspan="2"></td><td colspan="6">CT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• CO1: Improves the knowledge of mechanics and ability to draw free body diagrams.
• CO2: Imparts knowledge on application of mechanics for special problems like truss and frame analysis.
• CO3: Builds up ability to calculate centroid and moments of inertia for various shapes and its application thereof.
• CO4: Enhances the idea on dynamics with different engineering applications using momentum and energy principles.
• CO5: Introduces with Virtual Work Principle and its simple application.
• CO6: Prepares the prerequisites for studying the subject Strength of Materials / Solid Mechanics.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Engineering Mechanics; measurement and SI units. [1]

Vectors and force as a vector; Resultant of a system of forces on a particle; free body diagram and conditions of equilibrium of a particle; problems on particles; equilibrium of particles in space. [2]

Resultant of a system of forces and couples on a rigid body; conditions of equilibrium of a rigid body; free body diagrams of rigid bodies subjected to different types of constraints; simple space problems of rigid bodies. [4]

Coefficients of static and kinetic friction; problems involving friction; theories of friction on square threaded power screw and flat belt. [5]

Simple trusses; analysis of trusses by method of joints and method of sections. [5]

Centre of gravity and centre of mass; centroids of lines, curves and areas; first moment of area; second moment of area; polar moment of inertia; radius of gyration of an area; parallel axis theorem; mass moment of inertia. [4]

Path, velocity, acceleration; rectilinear and curvilinear motion; motion of system of particles; introduction to the concept of plane kinematics of rigid bodies. [6]

Newton's second law of motion; dynamic equilibrium and D'Alembert's principle; linear momentum; angular momentum; rectilinear and curvilinear motion; principles of work–energy and impulse–momentum; impact of system of particles; introduction to the concept of plane kinetics of rigid bodies. [12]

Principle of Virtual Work, Solution of Problems on Mechanics using Principle of</td></tr>
</table>

	Virtual Work [3]
Text Books, and/or reference material	1) S P Timoshenko and D H Young, Engineering Mechanics, 5th Edition 2) J L Meriam and L G Kraige, Engineering Mechanics, 5th Edition, Wiley India 3) F P Beer and E R Johnston, Vector Mechanics for Engineers 4) I H Shames, Engineering Mechanics

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)#	Total Hours	
ESC01	**Environmental Science**	PCR	2	0	0	2	2
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
		CT+EA					
Course Outcomes	• Understand the importance of environment and ecosystem. • Understand the fundamental aspect of pollutant tracking and its implementation in natural and anthropogenic pollution of air and water system. • Understand the scientific basis of local and as well as global issues. • Apply of knowledge to develop sustainable solution.						
Topics Covered	**Introduction:** Multidisciplinary nature of Environmental Studies; Basic issues in Environmental Studies. [2] Human population and the Environment. [1] Social issues and the Environment. [1] **Constituents of our Environment & the Natural Resources:** Atmosphere– its layers, their characters; Global warming, Ozone depletion, Acid rain, etc. [5] Hydrosphere - Its constituents, Oceans, Groundwater, Surface waters; Hydrological cycle. [4] Lithosphere - constituents of lithosphere; Rock and Mineral resources; Plate Tectonic Concept and its importance. [5] Biosphere – its components; Ecosystems and Ecology; Biodiversity; Biomes. [5] Natural disaster and their management – Earthquakes, Floods, Landslides, Cyclones. [3] **Pollution:** Pollutants and their role in air and water pollution. [2]						
Text Books, and/or reference material	1. Environmental Studies – Benny Joseph – Tata McgrawHill-2005 2.Environmental Studies – Dr. D.L. Manjunath, Pearson Education-2006. 3.Principles of Environmental Science and Engineering – P. Venugoplan Rao, Prentice Hall of India. 4.Environmental Science and Engineering – Meenakshi, Prentice Hall India. 5.Environmental studies – R. Rajagopalan – Oxford Publication - 2005. 6.Text book of Environmental Science & Technology – M. Anji Reddy – BS Publication..						

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			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
XES51	**ENGINEERING GRAPHICS**	PCR	1	0	3	4	2.5
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					
Course Outcomes	• To develop the ability of mental visualization of different objects • To impart knowledge regarding standard conventions on lettering, dimensioning, symbols etc • To introduce with the theory of orthographic projection to solve problems on one/two/three dimensional objects • To prepare for the higher semester departmental drawings • To give exposure to read/interpret industrial drawing and to communicate with relevant people						
Topics Covered	Graphics as language of communication; technical drawing tools and their up-keep; types of lines; construction of geometrical figures; lettering and dimensioning. [6] Construction and use of scales; construction of curves of engineering importance such as curves of conic section; spirals, cycloids, involutes and different loci of points; use of equations for drawing some curves. [9] Descriptive geometry: necessity and importance of orthographic projection; horizontal and vertical reference planes; coordinate of points; orthographic projection of points and lines situated in different quadrants, viz. 1^{st}, 2^{nd}, 3^{rd} and 4^{th} quadrants; traces of lines. First angle and third angle projection of lines and planes; views from top, front and left (or right); true length and true inclination of lines with planes of projections; primary auxiliary projection of points, lines and planes; auxiliary plan and auxiliary elevation. [9] Projection of simple regular solids, viz. prisms, cubes, cylinders, pyramids, cones, tetrahedrons, spheres, hemi-spheres etc. [6] Section of solids; section by perpendicular planes; sectional views; true shapes of sections. [6] Dimensional techniques; international and national standards (ISO and BIS). [3] Freehand graphics. [3]						
Text Books, and/or reference material	1)… Engineering Drawing and Graphics – K Venugopal 2)… Engineering Drawing – N D Bhat 3)… Practical Geometry and Engineering Graphics – W Abbott						

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			Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Total Hours**	

HSS51	Professional Communication Lab	PCR	1	0	2	3	2

Pre-requisites	Course Assessment methods (Continuous Test (CT) and/or End Assessment (EA))
None	CT

Course Outcomes	• CO1: Improvement in linguistic proficiency of the learners • CO2: Improvement in communicative ability of the learners
Topics Covered	1. Professional Communication: Introduction (1) 2. Technical Writing: Basic Concepts (2) 3. Style in Technical Writing (3) 4. Technical Report (2) 5. Recommendation Report (2) 6. Progress Report (1) 7. Technical Proposal (3) 8. Business Letters (3) 9. Letters of Job Application (2) 10. Writing Scientific and Engineering Papers (3) 11. Effective Use of Graphic Aids (2) 12. Presentation Techniques (6) 13. Group Discussion (6) 14. Interview Techniques (6)
Text Books, and/or reference material	**Text Book:** 1. English for Engineers –Sudharshana & Savitha (Cambridge UP) **Reference Books:** 1. Technical Communication—Raman & Sharma (Oxford UP) 2. Effective Technical Communication—M A Rizvi (McGraw Hill Education)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)#	Total Hours	
PHS51	**PHYSICS LABORATORY**	PCR	**0**	**0**	**2**	**2**	**1**

Pre-requisites	Course Assessment methods: (Continuous evaluation (CE) and end assessment (EA))
NIL	CE+EA

Course Outcomes	• CO1: To realize and apply different techniques for measuring refractive indices of different materials. • CO2: To realize different types of waveforms in electrical signals using CRO. • CO3: To understand charging and discharging mechanism of a capacitor. • CO4: To understand interference, diffraction and polarization related optical phenomena. • CO5: To acquire basic knowledge of light propagation through fibers.
Topics Covered	1. Find the refractive index of a liquid by a travelling microscope.

	2. Determine the refractive index of the material of prism using spectrometer. 3. Determination of amplitude and frequency of electrical signals by oscilloscope. 4. To study the characteristics of RC circuits. 5. To study Brewster's law/Malus' law using laser light. 6. To study the diffraction of light by a grating. 7. To study the interference of light by Newton's ring apparatus. 8. To determine numerical aperture of optical fiber. 9. Determination of Planck constant.
Text Books, and/or reference material	**SUGGESTED BOOKS**: 1) A Text Book on Practical Physics – K. G. Majumdar. 2) Practical Physics – Worsnop and Flint **REFERENCE**: 1) Instruction sheets

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			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYS51	**CHEMISTRY LABORATORY**	PCR	0	0	2	2	1
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
None		CT+EA					
Course Outcomes	• CO1: To learn basic analytical techniques useful for engineering applications. • CO2: Synthesis and characterization methods of few organic, inorganic and polymer compounds of industrial importance. • CO3: Learn chromatographic separation methods. • CO4: Applications of spectroscopic measurements.						
Topics Covered	i. Experiments based on pH metry: Determination of dissociation constant of weak acids by pH meter. ii. Experiments based on conductivity measurement: Determination of amour of HCl by conductometric titration with NaOH. iii. Estimation of metal ion: Estimation of Fe^{2+} by permangnomentry iv. Estimation of metal ion: Determination of total hardness of water by EDTA titration. v. Synthesis and characterization of inorganic complexes: e. g. $Mn(acac)_3$, $Fe(acac)_3$, cis-bis(glycinato)copper(II) monohydrate and their characterization by m. p. , FTIR etc. vi. Synthesis and characterization of organic compounds: e.g. Dibenzylideneacetone. vii. Synthesis of polymer: polymethylmethacrylate viii. Verification of Beer-Lamberts law and determination of amount of iron present in a supplied solution.						

	ix. Chromatography: Separation of two amino acids by paper chromatograph x. Determination of saponification value of fat/ vegetable oil
Text Books, and/or reference material	Suggested Text Books: 1. Vogel's Quantitative Chemical Analysis (6th Edition) Prentice Hall 2. Advanced Physical Chemistry Experiments: By Gurtu & Gurtu 3. Comprehensive Practical Organic Chemistry: Qualitative Analysis By V. K. Ahluwalia and S. Dhingra Suggested Reference Books: 1. Practical Chemistry By R.C. Bhattacharya 2. Selected experiments in Physical Chemistry By N. G. Mukherjee

Course Code	**Title of the course**	Program Core (PCR) / Electives (PEL)	**Total Number of contact hours**				**Credit**
			Lecture (L)	**Tutorial (T)**	**Practical (P)#**	**Total Hours**	
WSS51	**WORKSHOP PRACTICE**	PCR	**0**	**0**	**3**	**3**	**1.5**
Pre-requisites		Course Assessment methods: (Continuous evaluation (CE) and end assessment (EA))					
NIL		CE+EA					

Course Outcomes	• CO1: Study and practice on machine tools and their operations • CO2: Practice on manufacturing of components using workshop trades including fitting, carpentry, foundry and welding • CO3: Identify and apply suitable tools for machining processes including turning, facing, thread cutting and tapping • CO4: Develop basic electrical engineering knowledge for house wiring practice
Topics Covered	**M/c shop & Carpentry shop -- 3X3= 9hrs.** • Introduction on machining process. • Introduction to machine tools- Lathe, Shaper, Milling and Drill machine. • Introduction to woods- Types, structure, disease and defect of wood. • Introduction to wood working machines and tools. • Making of dovetail joint and bridle joint. **Welding Shop & Sheet metal -- 3X3= 9hrs.** • Introduction to welding.Safety and precautions in welding. • Formation of weld bead by SMAW on mild steel flat. • Formation of weld bead by oxy-fuel welding on mild steel flat. • Introduction to sheet Metal works. • Tools and Machines used in sheet metal works. • Concept of development, marking out of metal sheets. • Cutting and joining of metal sheets.

	• Safety precautions, General warning needed in the shop floor. **Black smithy & Foundry -- 3X3= 9hrs.** • Introduction Smithing and Forging- Tools, Machines, Furnaces and its accessories, fuels. • Safety and precautions in blacksmithy. • Making of bars of different cross-sections. • Making of hexagonal headed bolts. • Forge welding. • Introduction to Foundry Technology. • Preparation of sand mould using Solid/Split Pattern. **Fitting & Electrical shop -- 3X3= 9hrs.** • Introduction to hand metal cutting tools with specifications, nomenclature and their use. • Marking tools, measuring tools and their use. • Fitting of joints of mild steel flats. • Introduction to electrical hazards and safety precaution. • Wire jointing and soldering. • PVC Conduit Wiring controlled by separate single way switches. • PVC Cashing Capping Wiring for two way switches. • Conduit wiring for the connection of a Calling Bell with In & Out Indicators. • Batten Wiring and Cleat Wiring. • Tube Light Connection. • Insulation Resistance Testing of 1ph / 3ph Motor and House Wiring. • Earth Resistance Testing. • DOL Starter Connection. **Viva voce -- 1X3= 3hrs.**
Text Books, and/or reference material	1. Workshop Technology Part I and Part II by W. A. J. Chapman 2. Elements of Workshop Technology S. K. Hazra Chowdhury, A. K. Hazra Chowdhury and Nirjhar Roy 3. Mechanical Workshop Practice by K. C. John

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			Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Total Hours**	

XXS-51	**Co-curricular Activities**	PCR	**0**	**0**	**2**	**2**	**1**
Pre-requisites	Course assessment methods: Continuous evaluation (CE) and end assessment (EA)						
NIL	CE + EA						
Course Outcomes	• CO1: Social Interaction: Through the medium of sports • CO2: Ethics: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them • CO3: Self-directed and Life-long Learning: Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes. • CO4: Personality development through community engagement • CO5: Exposure to social service						
Topics Covered	**YOGA** • Introduction of Yoga. • Sitting Posture/Asanas- Padmasana, Vajrasana, Ardha kurmasana, Ustrasana, Bakrasana, Sasankasana, Janusirshasana, Suryanamaskar. • Mudra- Gyana mudra, Chin mudra, Shuni mudra, Prana mudra, Adi mudra, Anjali mudra. • Laying Posture/Asanas- Pavana Muktasana, Uttana Padasana, Sarpasana, Bhujangasana (Cobra Pose), Eka Pada Śalabhāsana, Dhanurasana, Chakrasana, Viparitkarani. • Meditation- Yog nidra, Om chant, Pray chant. • Standing Posture/Asanas- Tadasana (Mountain Pose), Vrikshasana (Tree Pose), Ardha chandrasana, Trikonasana, Utkatasana, Padahastasana. • Pranayama- Deep breathing, Anulom Vilom, Suryabhedi, Chandrabhedi. • Kriya- Kapalbhati, Trataka. **ATHLETICS** • Introduction of Athletic. • Starting Technique for Track events- Standing start, Crouch start & Block start. • Finishing Techniques. • Relay Race- 4×100m, 4×400m & Baton Exchange Technique & Rules. • Track Marking with Fundamentals- 200m, 400m and Diagonal Distance Radius, Straight Distance, Staggers of Different Lanes & Curve Distance. **BASKETBALL** • Introduction and Players stance and ball handling.						

	• Passing- Two hand chest pass, Two hand bounce pass, One hand baseball pass, Side arm pass, Over head pass, Hook pass. • Receiving- Two hand receiving, One hand receiving, Receiving in stationary position, Receiving while jumping and Receiving while running. • Dribbling- Dribble, High dribble, Low dribble, Reverse dribble, Rolling dribble. • Rules of Basketball. • Basketball game. **VOLLEYBALL** • Introduction of Volleyball • Service- Underarm service, Sidearm service, Tennis service, Floating service, Jump service. • Pass: Underarm pass- Ready position, Teaching stage of underarm pass and Upper hand pass- Volley pass, Back pass, Short set, Jump set & Underarm set. • Rules and their interpretation. **FOOTBALL** • Introduction of Football • Push pass- Instep inside, Instep outer side. • Kicking- Spot kick, Instep kick, Lofted kick. • Dribbling- One leg, Both legs, Instep. • Trapping- Rolling ball sole trapping, High ball sole trapping, High ball chest trapping, High ball thigh trapping. • Throwing- Standing throw, Running throw, Seating throw. • Goal Keeping- Griping the ball, Full volley, Half volley, Drop Kick. • Rules and their interpretation. **CRICKET** • Introduction of Cricket • Batting gripping & Stance, Bowling gripping technique. • Batting front foot defense & Drive. • Batting Back foot defense & Drive. • Batting Square cut. • Bowling medium pace, Bowling off break. • Fielding drill, Catching (Short & High). • Rules & Regulation. **BADMINTON** • Basic introduction about Badminton and Badminton court. • Racket parts, Racket Grip, Shuttle Grip.

	• Basic stance, Basic Footwork, Shadow practice (Full court movement). • Strokes services: Forehand- Overhead & Underarm, Backhand- Overhead & Underarm. • Match practice (Single & Double). • Rules & Regulation. **TABLE TENNIS** • Introduction of Table Tennis. • Basic Stance and Grip (Shake hand & Pen hold). • Service Basic. • Stroke: Backhand- Push, Deep Push, Chop, Rally, Drive, Drop Shot, Flick, Block, Smash. • Stroke: Forehand- Push, Deep Push, Chop, Rally, Drive, Drop Shot, Flick, Block, Smash. • Rules and their interpretations. • Table Tennis Match (Singles & Doubles). **NCC** • FD-1 General Introduction and words of command. • FD-2 Attention, Stand at ease and Stand easy, Turning and inclining at the halt. • FD-3 Sizing, Forming up in three Ranks Numbering, Open and Close order March and Dressing. • FD-4 Saluting at the halt, Getting on parade, Dismissing and falling out. • FD-5 Marching, Length of pace and Time of Marching in quick time and Halt, Slow March and Halt. • FD-7 Turning on the March and Wheeling. • FD-12 Parade practice. **TAEKWONDO** • Introduction about Taekwondo- Meaning of Taekwondo, Korean language of dress, Fighting area, Punch, Block, Kicks etc. • Stance- Ready stance, Walking stance, Fighting stance, Front stance, Back stance, Cat stance etc. • Punch Technique- Front fist punch, Rear fist punch, Double fist punch, With stance etc. Blocks- Upper blocks, Middle block, Side block, Suto etc. • Foot Technique (Balgisul)- Standing kick (Saseochagi), Front kick (Abchagi), Doliyo (Chagi), Abdal chagi (Butterfly kick), Back kick etc. **NSS** • Swachha Bharat Mission • Free Medical Camp • Sanitation drive in and around the campus.

	• Unnat Bharat Abhiyaan • Matribhasha Saptah celebration

SECOND SEMESTER

<table>
<tr><td colspan="8">Department of Mathematics</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td>Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td><td></td></tr>
<tr><td>MAC 02</td><td>MATHEMATICS - II</td><td>PCR</td><td>3</td><td>1</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Basic concepts of set theory, differential equations and probability.</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• CO1: Develop the concept of basic linear algebra and matrix equations so as to apply mathematical methods involving arithmetic, algebra, geometry to solve problems.
• CO2: To acquire the basic concepts required to understand, construct, solve and interpret differential equations.
• CO3: Develop the concepts of Laplace transformation & Fourier transformation with its property to solve ordinary differential equations with given boundary conditions which are helpful in all engineering & research work.
• CO4: To grasp the basic concepts of probability theory</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Elementary algebraic structures: Group, subgroup, ring, subring, integral domain, and field. (5)
Linear Algebra: Vector space, Subspaces, Linear dependence and independence of vectors, Linear span, Basis and dimension of a vector space. Rank of a matrix, Elementary transformations, Matrix inversion, Solution of system of Linear equations, Eigen values and Eigen vectors, Cayley-Hamilton Theorem, Diagonalization of matrices. (15)
Ordinary Differential Equations: Existence and uniqueness of solutions of ODE (Statement Only), Equations of first order but higher degree, Clairaut's equation, Second order differential equations, Linear dependence of solutions, Wronskian determinant, Method of variation of parameters, Solution of simultaneous equations. (12)
Fourier series: Basic properties, Dirichlet conditions, Sine series, Cosine series, Convergence. (4)
Laplace and Fourier Transforms: Laplace transforms, Inverse Laplace transforms, Convolution theorem, Applications to Ordinary differential equations. Fourier transforms, Inverse Fourier transform, Fourier sine and cosine transforms and their inversion, Properties of Fourier transforms, Convolution. (10)
Probability: Historical development of the subject and basic concepts, Axiomatic definition of probability, Examples to calculate probability, Stochastic simulation, Random numbers. Random variables and probability distributions, Binomial distribution, Normal distribution. (10)</td></tr>
</table>

Text Books, and/or reference material	**Text Books:** 1. E. Kreyszig, Advanced Engineering Mathematics: 9th edition, Wiley India Edition. 2. Gilbert Strang, Linear algebra and its applications (4th Edition), Thomson (2006). 3. Shepley L. Ross, Differential Equations, 3rd Edition, Wiley Student Edition. **Reference Books:** 1. S. Kumaresan, Linear algebra - A Geometric approach, Prentice Hall of India (2000). 2. C. Grinstead, J. L. Snell, Introduction to Probability, American Mathematical Society

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSC01	**INTRODUCTION TO COMPUTING**	PCR	2	1	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
Basic knowledge of computer. CSC01 assumes no prior knowledge of programming.		CT+EA					
Course Outcomes	CO1: Recognize the changes in hardware and software technologies with respect to the evolution of computers and describe the function of system software's (operating Systems) and application software's, languages, number system, logic gates. CO2: Illustrate the flowchart and inscribe an algorithm for a given problem Inscribe C programs using operators. CO3: Develop conditional and iterative statements to write C programs. CO4: Exercise user defined functions to solve real time problems CO5: Inscribe C programs that use Pointers to access arrays, strings and functions. CO6: Exercise user defined data types including structures and unions to solve problems..						
Topics Covered	Fundamentals of Computer: History of Computer, Generation of Computer, Classification of Computers 2L Basic Anatomy of Computer System, Primary & Secondary Memory, Processing Unit, Input & Output devices [2] Languages: Assembly language, high level language, compiler and assembler (basic concepts) [1] Binary & Allied number systems representation of signed and unsigned numbers. BCD, ASII. Binary Arithmetic & logic gates [2] Basic concepts of operating systems like MS DOS, MS WINDOW, UNIX, Algorithm & flow chart [1]						

	C Fundamentals: The C character set identifiers and keywords, data type & sizes, variable names, declaration, statements [2] Operators & Expressions: Arithmetic operators, relational and logical operators, type, conversion, increment and decrement operators, bit wise operators, assignment operators and expressions, precedence and order of evaluation. Input and Output: Standard input and output, formatted output -- printf, formatted input scanf. [8] Flow of Control: Statement and blocks, if - else, switch, loops - while, for do while, break and continue, go to and labels [5] Fundamentals and Program Structures: Basic of functions, function types, functions returning values, functions not returning values, auto, external, static and register Variables, scope rules, recursion, function prototypes, C pre-processor, command line arguments. [5] Arrays and Pointers: One dimensional, two dimensional arrays, pointers and functions, multi-dimensional arrays. [10] Structures Union and File: Structure, union , structures and functions, arrays of structures, file read, file write [5]
Text Books, and/or reference material	Text Books: 1. Let us C by Kanetkar 2. C Programming by Gottfried 3. Introduction to Computing by Balaguruswamy 4. The C-programming language by Dennis Ritchie Reference Books: 1. Computer fundamental and programming in C by P Dey and M. Ghosh 2. Computer fundamental and programming in C by Reema Thareja 3. programming with C by Schaum Series

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECC01	**Basic electronics**	PCR	2	1	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					
Course Outcomes		• CO1: Acquire idea about basic electronic circuit, construction, operation. • CO2: Learn to use these Circuit elements for different applications.. • CO3: Learn to analyze the circuits and to find out relation between input and output.					
Topics Covered		Semiconductors and its properties. (3) PN Junction formation and construction of Diode. (5) Diode circuits as rectifiers, Diode based waveform shaping circuits. (4) Bipolar Junction Transistor, construction and operation. (4) BJT Biasing circuits, different types. (3) Amplifier, Single stage, CE,CB, CC, operation and uses. (4) Feedback amplifier, advantages & disadvantages, basic closed loop analysis (3) Other Semiconductor Devices : Operation and use of LED, JFET, DIAC,					

	MOSFET(2) Opamp: Characteristics of ideal operational amplifier Pin Configuration of IC 741, Analysis of simple operational amplifier circuits: concept of virtual ground; non-inverting amplifier and inverting amplifier Applications: voltage follower, summer, differentiator, integrator(6) Oscillator: Positive feedback and condition of oscillation R-C phase-shift oscillator, Wien bridge oscillator(3) Boolean Algebra : Boolean algebra, De Morgan's theorem, simplification of Boolean expression, Number system, range extension of numbers, Different codes: Gray code, ASCII code and different BCD codes and their uses(4) Logic Gates : NOT, OR, AND, NOR, NAND, EX-OR, EX-NOR gates Simplification of logic functions, Realizations of logic expressions using logic gates(4)
Text Books, and/or reference material	Text Books: 1. Introduction Electronic Devices & Circuit Theory,11/e, 2012, Pearson: Boylestad & Nashelsky 2. Integrated Electronics: Millman & Halkias Reference Books: 1. The Art of Electronics 3e, by Paul Horowitz, Winfield Hill 2. Electronics - Circuits and Systems, Fourth Edition by Owen Bishop 3. Electronics Fundamentals: Circuits, Devices & Applications (8e) by Thomas L. Floyd & David M. Buchla. 4. Electronic Principles, by Albert Paul Malvino Dr. and David J. Bates 5. Experiments Manual for use with Electronic Principles (Engineering Technologies & the Trades) by Albert Paul Malvino Dr., David J. Bates, et al.

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEC01	**ELECTRICAL TECHNOLOGY**	PCR	2	1	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					
Course Outcomes	• CO1: To learn the fundamentals of Electric Circuits and Network theorems. • CO2: To develop an idea on Magnetic circuits, Electromagnetism • CO3: To learn about single phase and polyphase AC circuits. • CO4: Introduction to single phase transformer. • CO5: Introduction to the transient analysis of RLC circuits with DC excitation.						
Topics Covered	Fundamentals of Electric Circuits: Ohm's laws, Kirchhoff's laws, Independent and Dependent sources, Analysis of simple circuits. (3) Network theorems. (4) Magnetic field, Concept of magnetic circuits, Magnetomotive Force, Reluctance, Ampere's circuital law and Biot-Savart law, Determination of B/H curve, Comparison of electric and magnetic circuit, Electromagnetic induction, Faraday's laws of electromagnetic induction, Direction and Magnitude of induced E.M.F. (7) Self and mutual Inductance, Inductances in series and parallel, Energy stored in inductor, Capacitance, Capacitance in series and parallel, Relationship between charge, voltage and current, Energy stored in capacitor (5)						

	Transients with D.C. excitation. (5) Generation of alternating voltage and current, E.M.F. equation, Average and R.M.S. value, Phase and phase difference, Phasor representation of alternating quantity, Behaviour of A.C. circuits, Resonance in series and parallel R-L-C circuits (7) Single-Phase Transformer , equivalent circuits, open circuit and short circuit tests (6) Polyphase system, Advantages of 3-phase system, Generation of 3-phase voltages, Voltage, current and power in a star and delta connected systems, 3-phase balanced and unbalanced circuits, Power measurement in 3-phase circuits. (5)
Text Books, and/or reference material	Text Books: 1. Electrical & Electronic Technology by Hughes, Pearson Education India Reference Books: 1. Advanced Electrical Technology by H. Cotton, Reem Publication Pvt. Ltd 2. Electrical Engineering fundamentals by Vincent Deltoro, Pearson Education India

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
BTC01	LIFE SCIENCE	PCR	2	0	0	2	2
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
		CT+EA					
Course Outcomes	CO1: To be familiarized with the basic cellular organization of organisms and cellular communications. CO2: To impart an understanding about the basic structure and functions of the macromolecules and their biosynthesis and catabolism. CO3: To give an understanding of the key features of the structure, growth, physiology and behavior of bacteria, viruses, fungi and protozoa CO4: To introduce molecular biology to understand biological processes in various applications. CO5: To provide a foundation in immunological processes and an overview of the interaction between the immune system and pathogens. CO6: To provide knowledge about biological and biochemical processes that require engineering expertise to solve them						

Topics Covered	**1. Cell Biology (4)** a) Introduction to life science: prokaryotes & eukaryotes Definition; Difference b) Introduction to cells Define cell, different types of cell c) Cellular organelles All organelles and functions in brief d) Cellular communications Introduction to basic signaling; endocrine, paracrine signaling; concepts of receptor, ligand, on-off switch by phosphorylation/dephosphorylation **2. Biochemistry (4)** a) Biological function of carbohydrate and lipid Introduction, structure and function b) Biological function of nucleic acids and protein Introduction, structure and function c) Catabolic pathways of Macromolecules Introduction to catabolism, hydrolysis and condensation reactions; Catabolism of glucose- Glycolysis, TCA; overall degradation of proteins and lipids d) Biosynthesis of Macromolecules Generation of ATP (ETS), Generation of Glucose (Photosynthesis) **3. Microbiology (5)** a) Types of microorganisms and their general features Bacteria, Yeast, Fungi, Virus, Protozoa- general introduction with practical significance and diseases b) Microbial cell organization Internal and External features of cell- bacterial cell wall, viral capsule, pilus etc, c) Microbial nutritional requirements and growth Different Sources of energy; growth curve d) Basic microbial metabolism Fermentation, Respiration, Sulfur, N_2 cycle **4. Immunology (5)** a) Basic concept of innate and adaptive immunity Immunity-innate and adaptive, differences, components of the immune system b) Antigen and antibody interaction Antigen and antibody, immunogen, factors affecting immunogenicity, basic antigen-antibody mediated assays, introduction to monoclonal antibody c) Functions of B cell B cell, antibody production, memory generation and principle of

	vaccination d) Role of T cell in cell-mediated immunity Th and Tc, functions of the T cell with respect to different pathogen and cancer cell **5. Molecular Biology (5)** a) Prokaryotic Genomes (Genome organization & structure) Nucleoid, circular or linear b) Eukaryotic Genomes (Genome organization & structure) Intron, exon, packaging, chromatin c) Central Dogma (Replication, Transcription and Translation) d) Applications of Molecular Biology (Diagnostics, DNA-fingerprinting, Recombinant products etc.) Introduction to Recombinant DNA, fingerprinting, cloning **6. Bioprocess Development (5)** a) Microbial growth kinetics Batch, fed-batch and continuous systems, Monod Equation b) Enzyme kinetics, including kinetics of enzyme inhibition and deactivation Definition of enzymes, activation energy, Concepts of Km, Vmax, Ki c) Microbial sterilization techniques and kinetics Introduction to sterilization, dry and moist sterilization d) Thermodynamics of biological system Concepts of Enthalpy, Entropy, favorable reactions, exergonic and endergonic reactions e) Material and energy balance for biological reactions Stoichiometry
Text Books, and/or reference material	1. Biotechnology 01 Edition, authored by U. Satyanarayana, Publisher: BOOKS & ALLIED (P) LTD.-KOLKATA 2. Biochemistry by Lehninger. McMillan publishers 3. Microbiology by Pelczar, Chan and Krieg, Tata McGraw Hill 4. Brown, T.A., Genetics a Molecular Approach, 4th Ed. Chapman and Hall, 1992 5. Kuby J, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002. 6. Bioprocess Engineering: Basic Concepts (2nd Edition), Shuler and Kargi, Prentice Hall International.

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
XES52	**GRAPHICAL ANALYSIS USING CAD**	PCR	0	0	2	2	1
Pre-requisites		Course Assessment methods (Continuous (CT) and end					

	assessment (EA))
NIL	CT+EA
Course Outcomes	• Introduction to graphical solution of mechanics problems • Graphical solution of problems related to resultant/equilibrium in coplanar force system (Imparting knowledge on polar diagram, funicular polygon) • Introducing Maxwell diagram and solution of plane trusses by graphical method • Determination of centroid of plane figures by graphical method • Exposure to AutoCAD software for computer aided graphical solution
Topics Covered	• Graphical analysis of problems on statics. [14] • Graphical solution of engineering problems using CAD (with the help of "AutoCAD") [14]
Text Books, and/or reference material	1)… Engineering Drawing and Graphics – K Venugopal 2)… AutoCAD — George Omura 3)… Practical Geometry and Engineering Graphics – W Abbott

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSS51	**COMPUTING LABORATORY**	PCR	0	0	2	2	1
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					
Course Outcomes	• CO1: To understand the principle of operators. • CO2: To understand the principle of loops, branching statements • CO3: To understand the working principle of function, recursion • CO5: To understand arrays , pointer, parameter passing techniques • CO6: To detail out the operations of strings • CO7: To understand structure, union • CO7: Application of C-programming to solve various real time problems						
Topics Covered	**List of Experiments:** 1. Assignments on expression evaluation 2. Assignments on conditional branching, iterations, pattern matching 3. Assignments on function, recursion 4. Assignments on arrays, pointers, parameter passing 5. Assignments on string using array and pointers 6. Assignments on structures, union						
Text Books, and/or reference material	**Text Books:** 1. Let us C by Kanetkar 2. C Programming by Gottfried 3. Introduction to Computing by Balaguruswamy 4. The C-programming language by Dennis Ritchie **Reference Books:** 1. Computer fundamental and programming in C by P Dey and M. Ghosh 2. Computer fundamental and programming in C by Reema Thareja 3. programming with C by Schaum Series						

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<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>ECS 51</td><td>Basic electronics Lab</td><td>PCR</td><td>0</td><td>0</td><td>2</td><td>2</td><td>1</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT) and end assessment (EA))</td></tr>
<tr><td colspan="3">NIL</td><td colspan="5">CT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• CO1: Acquire idea about basic electronic components, identification and behavior.
• CO2: To determine IV characteristics of these Circuit elements for different applications.
• CO3: Learn to analyze the circuits and observe and relate input and output signals.</td></tr>
<tr><td>Labs Conducted.</td><td colspan="7">1. To know your laboratory : To identify and understand the use of different electronic and electrical instruments.
2. To identify and understand name and related terms of various electronics components used in electronic circuits.: Identify different terminals of components, fid their values and observe numbering associate with it.
3. Use of oscilloscope and function generator: Use of oscilloscope to measure voltage, frequency/time and Lissajous figures of displayed waveforms.
4. Study of half wave and Full-wave (Bridge) rectifier with and without capacitor filter circuit.:
5. Realization of basic logic gates: Truth table verification of OR, AND, NOT, NOT and NAND logic gates from TTL ICs
6. Regulated power supply: To study LM78XX and LM79XX voltage regulator ICs
7. Transistor as a Switch: To study and perform transistor as a switch through NOT gate
8. Zenner diode as voltage regulator
9. To study clipping and Clamping circuits
10. To study different biasing cirtis.
11. Study of CE amplifier and observe its frequency response.</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7"><u>Text Books</u>:
1. Experiments Manual for use with Electronic Principles (Engineering Technologies & the Trades) by Albert Paul Malvino Dr., David J. Bates, et al.
<u>Reference Books</u>:
1. The Art of Electronics 3e, by Paul Horowitz, Winfield Hill
2. Electronic Principles, by Albert Paul Malvino Dr. and David J. Bates</td></tr>
</table>

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EES51	**ELECTRICAL TECHNOLOGY LABORATORY**	PCR	0	0	2	2	1
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					
Course Outcomes	• CO1: To understand the principle of superposition. • CO2: To understand the principle of maximum power transfer • CO3: To understand the characteristics of CFL, incandescent Lamp, carbon lamp. • CO4: To understand the calibration of energy meter. • CO5: To understand open circuit and short circuit test of single phase transformer. • CO6: To analyse RLC series and parallel circuits • CO7: To understand three phase connections						
Topics Covered	**List of Experiments:** 1.To verify Superposition and Thevenin theorem 2. To verify Norton and Maximum power transfer theorem 3. Characteristics of fluorescent and compact fluorescent lamp 4. Calibration on energy meter 5. To perform the open circuit and short circuit test on single phase transformer 6. To study the balanced three phase system for star and delta connected load 7. Characteristics of different types of Incandescent lamps 8. Study of Series and parallel R-L-C circuit						
Text Books, and/or reference material	Text Books: 1. Suggested Text Books: 1. Handbook of Laboratory Experiments in Electronics and Electrical Engineering by A M Zungeru (Author), J M Chuma (Author), H U Ezea (Author)						

Course Code	**Title of the course**	Program Core (PCR) / Electives (PEL)	**Total Number of contact hours**				**Credit**
			Lecture (L)	**Tutorial (T)**	**Practical (P)#**	**Total Hours**	
XXS-52	**Co-curricular Activities**	PCR	**0**	**0**	**2**	**2**	**1**
Pre-requisites	Course assessment methods: (Continuous evaluation((CE) and end assessment (EA)						
NIL	CE + EA						
Course Outcomes	• CO1: Social Interaction: Through the medium of sports • CO2: Ethics: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept						

	responsibility for them • CO3: Self-directed and Life-long Learning: Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes. • CO4: Personality development through community engagement • CO5: Exposure to social service
Topics Covered	**YOGA** • Sitting Posture/Asanas- Gomukhasana, Swastikasana, Siddhasana, Ustrasana, Janusirsasana, Ardha Matsyendrasana (Half-Spinal Twist Pose), Paschimottanasana, Shashankasana, Bhadrasana. • Mudra- Vayu, Shunya, Prithvi, Varuna, Apana, Hridaya, Bhairav mudra. • Laying Posture/Asanas- Shalabhasana (Locust Posture), Dhanurasana (Bow Posture), Ardha Halasana (Half Plough Pose), Sarvangasana (Shoulder Stand), Halasana (Plough Pose), Matsyasana, Supta Vajrasana, Chakrasana (Wheel Posture), Naukasana (Boat Posture), Shavasana (Relaxing Pose), Makaraasana. • Meditation- 'Om'meditation, Kundalini Or Chakra Meditation, Mantrameditation. • Standing Posture/Asanas- Ardha Chakrsana (Half Wheel Posture), Trikonasana (Triangle Posture), Parshwa Konasana (Side Angle Posture), Padahastasana, Vrikshasana (Tree Pose), Garudasana (Eagle Pose). • Pranayama- Nadi sodha, Shitali, Ujjayi, Bhastrika, Bhramari. • Bandha- Uddiyana Bandha, Mula Bandha, Jalandhara Bandha, Maha Bandha. • Kriya- Kapalabhati, Trataka, Nauli. **ATHLETICS** • Long Jump- Hitch kick, Paddling, Approach run, Take off, Velocity, Techniques, Flight & Landing • Discus throw, Javelin throw and Shot-put- Basic skill & Technique, Grip, Stance, Release & Follow through. • Field events marking. • General Rules of Track & Field Events. **BASKETBALL** • Shooting- Layup shot, Set shot, Hook shot, Jump shot. Free throw. • Rebounding- Defensive rebound, Offensive rebound. • Individual Defensive- Guarding the man without ball and with ball. • Pivoting. • Rules of Basketball. • Basketball game.

	VOLLEYBALL • Spike- Straight spike, Body turn spike, Tip spike, Back attack, Slide spike, Wipe out spike. • Block- Single block, Double block, Triple block, Group block. • Field Defense- Dig pass, Double pass, Roll pass. • Rules and their interpretation. **FOOTBALL** • Dribbling- Square pass, Parallel pass, Forward pass. • Heading (Standing & Running)- Fore head, Side fore head, Drop heading, Body covering during heading. • Kicking- Full volley, Half volley, Drop kick, Back volley, Side volley, Chiping (lobe). • Tackling: Covering the angle, Chessing time sliding chese, Heading time shoulder tackle etc. • Feinting- Body movement to misbalance the opponent and find space to go with ball. • Rules of Football. **CRICKET** • Batting straight drive. • Batting pull shot. • Batting hook shot. • Bowling good length, In swing. • Bowling out swing, Leg break, Goggle. • Fielding drill. • Catching (Long & Slip). • Wicket keeping technique. • Rules & Regulation. **BADMINTON** • Net play- Tumbling net shot, Net Kill, and Net Lift. • Smashing. • Defensive high clear/Lob. • Half court toss practice, Cross court toss drop practice, Full court Game practice. • Player Positioning, Placements. • Rules & Regulation. • Doubles & Mixed doubles match practice. **TABLE TENNIS** • Stroke: Backhand- Topspin against push ball, Topspin against deep ball, Topspin against rally ball, Topspin against topspin.

	• Stroke: Forehand- Topspin against push ball, Topspin against deep ball, Topspin against rally ball, Topspin against topspin. • Stroke- Backhand lob with rally, Backhand lob with sidespin, Forehand lob with rally, Forehand lob with sidespin. • Service: Backhand/Forehand- Push service, Deep push service, Rally service. • Service: Backhand sidespin (Left to right & Right to left). • Service: Forehand- High toss backspin service, High toss sidespin service, High toss reverse spin service. • Rules and their interpretations. • Table Tennis Match (Singles & Doubles). **NCC** • FD-6 Side pace, Pace Forward and to the Rear. • FD-7 Turning on the March and Wheeling. • FD-8 Saluting on the March. • FD-9 Marking time, Forward March and Halt in Quick Time. • FD-10 Changing step. • FD-11 Formation of Squad and Squad Drill. • FD-12 Parade practice. **TAEKWONDO** • Poomsae (Forms)- Jang, Yi Jang. • Self Defense Technique- Self defense from arms, Fist and Punch. • Sparring (Kyorugi)- One step sparring, Two step sparring, Fight (Free sparring). • Combination Technique- Combined kick and punch. • Board Breaking (Kyokpa)- Sheet breaking. • Interpretation Rules above Technique of Taekwondo. **NSS** • No Smoking Campaign • Anti- Terrorism Day Celebration • Any other observation/celebration proposed by Ministry/institute • Public Speaking • Discussion on Current Affairs • Viva voce

Semester -III

<table>
<tr><td colspan="7">Department of Mathematics</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MAC331</td><td>MATHEMATICS-III</td><td>PCR</td><td>3</td><td>1</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="5">Basic knowledge of topics included in MAC01 & MAC02</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">• CO1: Acquire the idea about mathematical formulations of phenomena in physics and engineering.
• CO2: To understand the common numerical methods to obtain the approximate solutions for the intractable mathematical problems.
• CO3: To understand the basics of complex analysis and its role in modern mathematics and applied contexts.
• CO4: To understand the optimization methods and algorithms developed for solving various types of optimization problems.</td></tr>
<tr><td>Topics Covered</td><td colspan="6"><u>Partial Differential Equations (PDE):</u> Formation of PDEs; Lagrange method for solution of first order quasilinear PDE; Charpit method for first order nonlinear PDE; Homogenous and Nonhomogeneous linear PDE with constant coefficients: Complimentary Function, Particular integral; Classification of second order linear PDE and canonical forms; Initial & Boundary Value Problems involving one dimensional wave equation, one dimensional heat equation and two dimensional Laplace equation. [14]
<u>Numerical Methods:</u> Significant digits, Errors; Difference operators; Newton's Forward, Backward and Lagrange's interpolation formulae; Numerical solutions of nonlinear algebraic/transcendental equations by Bisection and Newton-Raphson methods; Trapezoidal and Simpson's 1/3 rule for numerical integration; Euler's method and modified Eular's methods for solving first order differential equations. [14]

<u>Complex Analysis:</u> Functions of complex variable, Limit, Continuity and Derivative; Analytic function; Harmonic function; Conformal transformation and Bilinear transformation; Complex integration; Cauchy's integral theorem; Cauchy's integral formula; Taylor's theorem, Laurent's theorem (Statement only); Singular points and residues; Cauchy's residue theorem. [17]

<u>Optimization:</u>
Mathematical Preliminaries: Hyperplanes and Linear Varieties; Convex Sets, Polytopes and Polyhedra. [2]
Linear Programming Problem (LPP): Introduction; Formulation of linear programming problem (LPP); Graphical method for its solution; Standard form of LPP; Basic feasible solutions; Simplex Method for solving LPP. [9]</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="6">Text Books:
1. An Elementary Course in Partial Differential Equations-T. Amarnath
2. Numerical Methods for scientific & Engineering Computation- M.K.Jain, S.R.K. Iyengar & R.K.Jain.
3. Foundations of Complex Analysis- S. Ponnuswami
4. Operations Research Principles and Practices- Ravindran, Phillips, Solberg
5. Advanced Engineering Mathematics- E. Kreyszig
Reference Books:
1. Complex Analysis-L. V. Ahfors
2. Elements of partial differential equations- I. N. Sneddon
3. Operations Research- H. A. Taha</td></tr>
</table>

<table>
<tr><th colspan="8">Department of Chemical Engineering</th></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>CHC302</td><td>Process Calculations</td><td>PCR</td><td>3</td><td>1</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous (CT) and end assessment (EA))</td></tr>
<tr><td colspan="2">Nil</td><td colspan="6">CT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• CO1:Learn fundamentals of units and dimension, dimensionless groups and their implications [PO a, c, e, k]
• CO2:Graphical interpretation of experimental data, use of log-log and semi log plotsfor non-linear equations [PO a, c, e, k]
• CO3:Understanding of mass and energy balance for various chemical processes [PO a, c, e]
• CO4:understanding the Ideal gas equation, Raoult’s law, Henry’s law, and psychrometric property [PO a, c, e, k]</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Module - I
• Units and dimension, Dimensionless groups and their significance, Dimensional homogeneity and analysis: Buckingham’s pi theorem and its application, repeating variables, Rayleigh methods, Stepwise methodology (3)
• Adiabatic Flame Temperature and its importance, Energy balance in thermal reactor, Computation of AFT, effect of temperature and pressure (3)
• Basic understanding of application of semi-log and log-log graph, Unit operation and experimental data fittings in log-log and semi-log graph paper, Problem-solving techniques (3)
Module - II
• Energy conservation laws, Energy balance, Laws of thermodynamics with examples, Enthalpy calculation for systems without Chemical Reaction, Estimation of Heat Capacities of solids,Estimation of Heat Capacities: liquids and gases. Heat of fusion and vaporization(4)
• Enthalpy calculation for systems with Chemical Reaction, Calculations of heat of reaction, heat of combustions, heat of formation and heat of neutralization, Kopps rule (3)
• Effect of Temperature and Pressure on Heat of Reaction, Hess’s Law, Application of Material and Energy balance to problems of various chemical processes (7)
Module - III
• Atmospheric air and its composition, the property of moist air and ideal gas law, Humidity and its significance, various humidity/saturation terms like molar, absolute, relative & percentage saturation (4)
• Fundamental concept of dry-bulb, wet-bulb, adiabatic saturation temperatures, and dew point. Psychometric/humidity chart and its application (4)
• Humid volume, enthalpy and specific heat of moist air, humidification and de-humidification operation and material balance. Theoretical analysis and Energy balance during adiabatic saturation and wet bulb temperature (3)
Module - IV
• Ideal gas laws and its significance, Molar concept, Concept of partial pressure & partial volume, Dalton’s law and Amagat’s law and Numerical problems on their applications[4]
• Fundamental concept of vapor pressure & boiling point, Clausius-Clapeyron equation, Antoine equation and numerical problems on their applications, Numerical problems on Duhring& Cox plots. Ideal& non-ideal solutions, Raoult’s law, Henry’s law and their applications in numerical problems. [4]

Tutorial on above topics and class tests (14)</td></tr>
</table>

Text Books, and/or reference material	**Text Books:** 1. Basic Principles and Calculations in Chemical Engineering – David Himmelblau, PHI 2. Chemical Process Principles – Hougen and Watson, Part-I, CRC Press, CBS. 3. Stoichiometry-4thedn, Bhatt and Vora, Tata Mc-Graw Hill

Department of Chemical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CHC302	**Chemical Engineering Thermodynamics**	**PCR**	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
Nil		CT+EA					
Course Outcomes	CO1: Apply the laws of thermodynamics to chemical engineering processes and conversion devices [PO a, c, e, k] CO2: Calculate thermodynamic properties using equations of state, charts and tables [PO a, c, e] CO3: Apply the concept of phase equilibrium to multi-phase systems [PO a, c, e, k] CO4: Solve problems of single and multi-phase chemically reactive systems using the concept of chemical reaction equilibrium [PO a, c, e, k]						
Topics Covered	**Module - I** • Scope of thermodynamics and fundamental concepts. Microscopic and microscopic view (1 hr) • First law of thermodynamics: Applications to batch and flow systems (2 hr) • Second and third law of thermodynamics: Reversibility and irreversibility, Carnot cycle, entropy, free energies, exergy (2 hr) **Module - II** • Real gases: Equations of state, compressibility charts, departure functions (3 hr) • Thermodynamics of flow processes: Single and multi-stage compression, expansion through nozzles (2 hr) • Refrigeration and liquefaction of gases: Vapour compression, cascade, absorption and gas refrigeration cycles, Choice of refrigerants, Linde and Claude processes of liquefaction of gases (4 hr) **Module - III** • Thermodynamic property relations: Maxwell's relations and thermodynamic functions of pure substances. Residual properties, fugacity (7 hr) **Module - IV** • Solution thermodynamics and phase equilibrium: Multi-component gaseous systems and solution. Partial molal properties and thermodynamic potential, criteria for equilibrium, thermodynamic properties of solutions, Gibbs-Duhem equation and consistency of thermodynamic data. Activity and activity coefficient, estimation of activity coefficient- Margules and Van laar equations, ASOG and UNIFAC methods. Generation of VLE data. Calculation of bubble and dew points of ideal and non-ideal solutions. Azeotropes. systems. Phase equilibrium at elevated pressure (12 hr) **Module - V** • Chemical reaction equilibrium: Estimation of equilibrium constant. Homogeneous reactions. Heterogeneous reactions (9 hr)						

	Tutorial on above topics and class tests (14 hr)
Text Books, and/or reference material	Text Books: 4. Chemical Engineering Thermodynamics – J. M. Smith & H. C. Van Ness and M. M. Abbott (Tata McGraw Hill) 5. Chemical & Engineering Thermodynamics – S. I. Sandler (Wiley) 6. Chemical Engineering Thermodynamics – G. N. Halder (Prentice Hall of India)

Department of Chemical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CHC303	**Fluid Mechanics**	**PCR**	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods [Continuous (CT) and end assessment (EA)]					
Nil		CT+EA					
Course Outcomes	CO1: Create a fundamental understanding of fluid statics, kinematics and kinetics [PO a, c] CO2: Apply mass, momentum and energy balance to hydrostatic and fluid flow problems [PO a, c, e, k] CO3: Analyze flow of Newtonian and non-Newtonian fluids through closed pipelines and piping network [PO a, c, e, k] CO4: Acquire knowledge of Fluid machineries and flow measuring devices [PO a, c, e, k]						
Topics Covered	**Module - I** • Fluids and fluid properties, continuum concept (1 hr) • Fluid statics: Pressure and pressure measuring devices (2 hr) • Fluid kinematics, different flow regimes, equation of continuity. Boundary layer (2 hr) • Skin and form friction (1 hr) **Module - II** • Bernoulli's equation, Hagen-Poiseuille equation, Fanning's equation and their applications (5 hr) • Pipes, fittings and valves. Pressure losses due to sudden expansion, contraction and fittings (5 hr) • Navier-Stoke's equation and total energy balance equation (4 hr) • Turbulent flow, Reynold's stress, universal velocity profile (2 hr) **Module - III** • Flow past solid surface, drag, flow through packed bed, fluidization, pneumatic conveying (3 hr) • Flow of compressible fluids, flow through convergent-divergent nozzles (2 hr) • Non-Newtonian fluids: Their characteristics and calculation of pressure drop due to their flow through pipes (2 hr) • Flow measuring devices: Orificemeter, venturimeter, rotameter, weirs, anemometer, pitot tubes, etc. (3 hr) **Module - IV** • Fluid machineries: Pumps, blowers and compressors (10 hr)						

	Tutorial on above topics and class tests (14 hr)
Text Books, and/or reference material	Text Books: 1. Unit Operations – McCabe W L and Smith J L (McGraw Hill) 2. Transport Processes and Unit Operations – GeankoplisJ G, Allen A H, Lepek D H (Prentice Hall) 3. Principle of Unit Operations – Foust A S, Wenzel L A, Curtis W, Maus L, Anderson L B (Wiley)

Department of Chemistry							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYC 331	**CHEMISTRY-II**	PCR	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
Engineering Chemistry CYC01		CT+EA					

Course Outcomes	• CO1: To learn advanced analytical techniques useful for chemical engineering. • CO2: To learn the few catalytic process commonly used in industrial applications. • CO3: To learn thermodynamics of solutions and understanding of phase diagrams of single and multicomponent systems. • CO4: To learn fundamentals of fats, oils and carbohydrate chemistry together with basics of large scale organic synthesis.
Topics Covered	**ORGANIC CHEMISTRY** i. Organic C-C bond formation: application of Grignard reagents, ethyl acetoacetate and malonic esters. (3 hr) ii. Principles of large scale organic synthesis having industrial importance. (1 hr) iii. Carbohydrate chemistry: Classification, structure elucidation. Reactions of glucose and fructose; mutarotation, inversion of cane sugar. (5 hr) iv. Fats and oils, soaps and detergents. (3 hr) **INORGANIC CHEMISTRY** i. Application of coordination compound in analytical chemistry: complexometric titration, biological application. (3 hr) ii. Analytical methods used to metal ions estimation: Gravimetric, UV-Vis spectrophotometric, atomic absorption spectrometric, solvent extraction etc. (4 hr) iii. Catalyst: General principles, homogeneous catalysts: hydrogenation of alkenes, hydroformylation, methanol carbonylation, Wacker oxidation of alkenes etc. Heterogeneous catalyst: hydrogenation catalysts, ammonia synthesis, alkene polymerisation (Zigler Natta catalyst). (6 hr) **PHYSICAL CHEMISTRY** i. Thermodynamic condition of chemical equilibrium, Chemical potential, Activity, Fugacity, Gibbs-Duhem equation, Duhem-Margulesequatuion. 1st and 2nd order transition. (2 hr) ii. Transition state theory towards rate of elementary chemical reaction, salt effect on rate of a chemical reaction. Photochemical and photophysical

	processes, Jablonsky diagram. (3 hr) iii. Phase rule and its derivation, phase diagram of CO_2, H_2O and Sulphur system, two component system, solid-liquid and binary liquid mixture, fractional distillation, steam distillation, azotrope, ideal and nonideal solution, Routs law and Henrys law, Colligative properties. (6 hr) iv. Conductance and transport number, Buffer solution, Debye-Huckel limiting law, Salt effect and common ion effect on solubility of weak electrolytes. Ion-solvent and ion-ion interaction. Electrochemical cell with transference: liquid junction potential. (6 hr)
Text Books, and/or reference material	<u>Suggested Text Books:</u> (i) Organic Chemistry: R.T. Morrison and R.N Boyd, Prentice Hall of India Pvt.Ltd. (ii) Physical Chemistry by P. C. Rakshit (iii) Inorganic Chemistry Fourth Edition, Shriver & Atkins, Oxford <u>Suggested Reference Books:</u> **Organic Chemistry**: (i) Organic Chemistry by Volhardt. **Inorganic Chemistry:** (i) Inorganic Chemistry Part-I & II, R. L. Dutta (ii) Fundamentals of Analytical Chemistry By Skoog, West, Holler and Crouch **Physical Chemistry:** (i) Physical Chemistry by P. Atkins, Oxford (ii) Physical Chemistry by G.W Castellan

Department of Chemistry							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYS381	**CHEMISTRY II LABORATORY**	PCR	0	0	3	3	1.5
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
None		CT+EA					
Course Outcomes	• CO1: To learn advanced chemical analysis useful for chemical engineering. • CO2: Estimation of metal ion concentration using advanced spectroscopic techniques. • CO3: Advanced synthesis and characterization methods for few compounds of industrial importance.						
Topics Covered	i. Determination of CMC of a surfactant: conductometrically and surface tension measurement. ii. Potentiometric titration: estimation of Fe^{2+} in Mohr's salt. iii. Determination of solubility product of lead iodide. iv. Kinetics of ester hydrolysis. v. Spectroscopic Estimation of metal ion: Estimation of Cu^{2+}/ Cr^3 vi. Estimation of metal ion: Estimation of Na^+, K^+, Ca^{2+} by Flame photometry vii. Estimation of base content of commercially available antacid and acid content of vitamin C.						

	viii. Synthesis of Mohr's salt. ix. Synthesis of paracetamol. x. Analysis of pyrolusite ore. (36 hr)
Text Books, and/or reference material	Suggested Text Books: 1. Vogel's Quantitative Chemical Analysis (6th Edition) Prentice Hall 2. Advanced Physical Chemistry Experiments: By Gurtu&Gurtu 3. Comprehensive Practical Organic Chemistry: Qualitative Analysis By V. K. Ahluwalia and S. Dhingra Suggested Reference Books: 1. Practical Chemistry By R.C. Bhattacharya 2. Selected experiments in Physical Chemistry By N. G. Mukherjee

Department of Chemical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)#	Total Hours	
CHS 351	**CHEMICAL ENGINEERING COMPUTING LABORATORY 1**	PCR	0	0	3	3	1.5
Pre-requisites							
Process calculations, Fluid mechanics, Thermodynamics		Viva-Voce					
Course Outcomes	• CO1: To solve chemical engg problems using computers (a,d,e,k) • CO2: To use mathematical methods to solving chemical engineering problem (a,d,e,k)						
Topics Covered	1. Module I 9 hr 1. Familiarization of programming environment and execution of sample programs 2. Expression evaluation 3. Conditionals and branching 4. Iteration 5. Functions 6. Arrays Module II 9 hr Solution of liner and non-liner algebraic equations System of linear and non-liner algebraic equations Module III 9 hr Initial value ODES using Euler explicit and implicit technique. Non-linear ODEs System of Linear ODEs System of non-liner and Stiff ODEs. Module IV 9 hr The problems related to chemical engineering are given as laboratory assignments. Most of the problems deals with the various numerical methods taught in the Mathematics course. The problems on Phase Equilibrium, Equation of State, Determination of Bubble point and Dew Point calculation.						

Text Books, and/or reference material	Suggested Text Books: 1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India. 2. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill. 3. John H. Mathews, Numerical Methods Using FORTRAN. Prentice-Hall India 4. R. White and V. R. Subramanian, Computational Methods in Chemical Engineering.PHI.

Semester-IV

Department of Chemical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)#	Total Hours	
CHC401	**HEAT TRANSFER**	**PCR**	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
CHC301, CHC303		CT+EA					
Course Outcomes	• CO1:Illustrate principles of heat transfer of different heat exchanging phenomena [PO a, e] • CO2:Apply laws of heat transfer for energy balance ofchemical processes [PO a, c, e, k] • CO3**:** Solve heat transfer problems of different difficulty levels [PO a, c, e, k] • CO4**:**Design and analyze heat transfer equipment[PO a, c, e, k]						

Topics Covered	**Module - I** • Mechanism of heat transmission: Conduction, Convection and Radiation. Conduction: Fourier's law; Steady-state heat transfer through plane wall and composite slabs, cylinders and spheres; Thermal contact resistance, Critical thickness of insulation, Optimum thickness of insulation; Unsteady-state heat transfer - use of Gurnie-Lurie chart, one and two-dimensional conduction in different geometry. (10 hrs.) **Module - II** • Convection: Forced convection; Heat transfer coefficients; Overall Heat Transfer Coefficients; Log-mean temperature difference; Dimensional analysis of heat transfer; Equivalent diameter; General equation for forced convection; Thermal boundary layer; Analogy between heat and momentum transfer. (10 hrs) **Module - III** • Natural convection: Empirical equations; Condensation: Film Condensation, Derivation of heat transfer coefficient, Empirical equations; Boiling of liquids: Concept of excess temperature, Pool boiling, Forced convection boiling; Radiation: Black body and Gray body; Laws of radiation; View factor; Radiant heat exchange between surfaces (12hrs) **Module - IV** • Heat exchangers: Type of different heat exchangers and their design - Double pipe, Shell and tube, Finned tube and Compact heat exchangers; Condensers and reboilers. (5 Hrs.) • Evaporation: Type of evaporators with accessories; Capacity and Steam economy; Boiling point rise/elevation; Multiple effect evaporators; Design of single and multiple effect evaporators. (5 Hrs.) **Tutorial on above topics and class Tests (14 hrs)**
Text Books, and/or reference material	Text Books: 1. Process Heat Transfer: D. Q. Kern, MGH 2. Heat Transfer Principles and Application, B. K. Dutta, PHI. Reference Books: 1. Heat Transfer: An Engineering Approach: Cengel and Boles, Tata Mc-Graw Hill

Department of Chemical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)#	Total Hours	
CHC402	**MECHANICAL OPERATIONS**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous evaluation (CE) and end assessment (EA))					
Fluid Mechanics		CE+EA					
Course Outcomes	• Identify principles of separation of liquid-solid, gas-solid, and solid-solid [b, c] • Design and analyze mechanical operation equipments [b,c]						

	• Compare performances and select type of size separation, solid-liquid separation and size reduction equipment [e, h, k] • Learn industrial applications of size separation, solid-liquid separation, size reduction equipments [k]
Topics Covered	• Particle size and shape, particle size distribution:Determination of mean particle size, Sieve analysis, Industrial screens, Effectiveness of screens [5] Size reduction and classification of solid particles:Principles of crushing and grinding, Equipment – selection, Operating principles ofCoarse crushing equipment, Intermediate & Grinding equipment, Laws of crushing and grinding – limitation and applicability [11] • Size enlargement: Granulation and other size enlargement operations. [2] • Fluid – particles separation: Terminal settling velocity, free and hindered settling, equal settling velocity and sedimentation; Classifications and clarifications; Settling chambers, thickening, tabling, jigging, floatation, centrifugal separators, centrifuge, cyclone separators, electro-static precipitator, magnetic separator, etc. [16] • Filtration: Introduction; Types of filtration; Filtration equations; batch and continuous filtration equipment – Bed, Plate and Frame, Leaf and Rotary Drum Vacuum Filters; Filter Aid and Filter Medium; Washing [12] • Agitation and mixing: Types of equipment and power requirement, Mixing Index. [5] Conveying of solids: Bins, silo and hoppers, Conveyors and elevators, Hydraulic and pneumatic transport [5]
Text Books, and/or reference material	Suggested Text Books: 1. G. G. Brown, *Unit Operations*, CBS Publishers & Distributors, 2005 2. W. McCabe. J. Smith, P .Harriott ,*Unit Operations of Chemical Engineering*, McGraw Hill Education, 2017 Suggested Reference Books: 1. W.L. Badger and J. T. Banchero,*Introduction to Chemical Engineering*, McGraw-Hill book company, 1955 2. C.J.Geankoplis,*Transport Processes and Separation Process Principles (Includes Unit Operations)*, Prentice Hall India Learning Private Limited, 2004 3. Richardson, *Coulson and Richardson's Chemical Engineering, Volume 2, 5th*

	Edition: Particle Technology And Separation Processes, Elsevier,2006

Department of Chemical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)#	Total Hours	
CHC403	Mass Transfer - I	**PCR**	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
CHC301, CHC303		CT+EA					

Course Outcomes	• CO1: Illustrate principles of mass transfer of chemical processes [PO a, e] • CO2:Apply laws of mass transfer for mass balance of chemical processes [PO a, c, e, k] • CO3**:** Solve mass transfer problems of different difficulty levels [PO a, c, e, k] • CO4**:**Design and analyze mass transfer equipment [PO a, c, e, k]
Topics Covered	**Module - I** Mass transfer operation and principles. General principles of diffusion process, Molecular and eddy diffusion in fluids, Diffusion in solids and measurement of diffusivity, Multi-component diffusion, Diffusion through a variable area, Knudsen diffusion, surface diffusion and self-diffusion (09 hrs) **Module - II** Convective mass transfer and mass transfer coefficients: Introduction. Dimensionless groups in mass transfer and correlations for the convective mass transfer coefficient. Theories of mass transfer, Analogy between Momentum, Heat and Mass Transfer, Inter-phase mass transfer and Basic laws, Two-film theory, overall mass transfer coefficient, Material balance in contacting equipment – the operating line and Mass transfer in stage-wise contact of two phases (10 hrs) **Module III** Gas absorption and stripping: Introduction. Design of a packed tower: Design method based on individual mass transfer coefficients. Design method based on the overall mass transfer coefficient. Determination of the number of stages in a tray tower, HETP, Tray efficiency, Gas-liquid contacting equipment, tray or plate column, operational features of tray column: Hydraulic gradient and multi-pass trays, weeping and dumping, entrainment, flooding, turndown ratio and estimation of diameter of tray. (12 hrs) **Module IV** Elementary idea about multi-component absorption and adsorption with chemical reactions. Extraction: Liquid-liquid extraction, Equilibrium data, Use of triangular diagrams, selectivity and choice of solvent, Single and multi stage calculation in liquid-liquid extraction. Extraction efficiency, Principles of leaching and stage calculation methods. (11 hrs) **Tutorial on above topics and class Tests (14 hrs)**

Text Books, and/or reference material	Text Books: 1. Mass Transfer Operations: R.E. Treybal 2. Principles of Mass Transfer & Separation Processes: B. K. Dutta Reference Books: 1. A. P. Sinha and P. De, Mass Transfer Principles and Operations, PHI 3. Unit Operations of Chemical Engineering: W.L. McCabe & J.C. Smith 2. Chemical Engineering: 5th Ed., Coulson & Richardson 3. Principles of Unit Operation: C. J. Geankoplis

Department of Mechanical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
MEC 432	Mechanical Design of Equipment and Components	PEL	**3**	**0**	**0**	**3**	**3**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
		CT+EA					
Course Outcomes	CO1 System to control volume formulation CO2 Mathematical formulation of laws of thermodynamics CO3 Properties of pure substances CO4 Knowledge of stress and strain CO5 Principles of machine design						
Topics Covered	• Relation between system and control volume approaches. 2 hr • Equation of states. 2 hr • Zeroth, first and second law of thermodynamics. 2 hr • Gouy-Stodola theorem. (1) Applications of SFEE. 2 hr • Carnot cycle, reversed Carnot cycle, Heat engine, heat pump and refrigerators. 2hr • First and second law based performances. 2 hr • Properties of pure substances, Vapour power cycle—Rankine cycle. 3 hr • Air standard cycles—Otto, Diesel, dual and Joule-Brayton cycles. 3 hr • Review of stress, strain and deformation. 2 hr • Engineering materials and their properties. 2 hr • General principle of machine design. 2 hr • Factor of safety. 2 hr • Use of data book in mechanical design. 2 hr • Design of shaft and key. 2 hr • Mechanical drives: Introduction to simple gear drive and belt drive. 3 hr • Types of pressure vessels: Thin cylinder and thick cylinder. 3 hr						
Text Books, and/or reference material	**Text Books:** 1. P. K. Nag, Engineering Thermodynamics, McGraw-Hill. 2. E. Fermi, Thermodynamics, Dover. 3. V B Vhandari, Design of Machine elements [3rd edition]						
	Reference Books: 1.M. Planck. Treatise on thermodynamics. Dover.						

	2. E. P. Gyftopoulos, G. P. Beretta, Thermodynamics: Foundations and applications, Dover.

Department of Chemical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)#	Total Hours	
CHS451	Fluid Mechanics Laboratory	PCR	0	0	3	3	1.5
Pre-requisites		Course Assessment methods (Continuous evaluation (CE) and end assessment (EA))					
CHC 303 [Fluid Mechanics]		CE+EA					
Course Outcomes	I. To prove experimentally laws/equations like Bernoulli's equation, Fanning's equation, etc. [PO: a,b,d,e,g,k] II. To determine discharge coefficients of flow meters like orifice and venture meter, and velocity profiles using pitot tube [PO: a,b,d,e,g,k] III. To determine K factor of pipe fittings and valves [PO: a,b,d,e,g,k] IV. To draw characteristic curves of pumps [PO: a,b,d,e,g,k] V. To create an experimental understanding of laminar and turbulent flow regimes [PO: a,b,d,e,g,k]						
Topics Covered	**List of Experiments** 1. To study different types of flow using Reynold's apparatus. 2. To verify Bernoulli's equation experimentally. 3. To determine point velocity by using Pitot tube. 4. To determine flow velocity by using Venturi meter and Orifice meter. 5. To study the flow characteristic in packed bed. 6. To study the flow characteristic in a helical coil. 7. To study the reciprocating pump characteristics. 8. To determine the losses due to friction in pipes and fittings. 36 hr						
Text Books, and/or reference material	Suggested Text Books: 1) Transport Processes and Unit Operations - C. J. Geankoplis						

Department of Chemical Engineering						
Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
		Lecture (L)	Tutorial (T)	Practical (P)#	Total Hours	

PROCESS EQUIPMENT DESIGN-1 (CHS 452)	PCR	0	0	3	3	1.5
Pre-requisites						
	Report submission and Viva-Voce					
Course Outcomes	• **CO1:** Knowledge of basics of process equipment design and important parameters of equipment design (a,b,c) • **CO2**: Ability to choose material for equipment design (a, b) • **CO3**: Ability to design pressurize vessels and various parts of vessels (a,k) • CO4: Knowledge of equipment fabrication and testing methods (h)					
Topics Covered	• Introduction to the basic principles and criteria of pressure vessel design. (3 hrs) • Unfired pressure vessels with internal and external and external pressure. (3 hrs) • Introduction to standards, codes and regulations. (3 hrs) • Selection of material and design of various parts of vessel (3 hrs) • Design of storage vessels and their design. (6 hrs) • Design of supports for vertical and horizontal towers. (6 hrs) • Pipe joints and fittings, gaskets. (3 hrs) • Sketching and drawing of vessel (3 hrs) • Numerical solutions for vessel design (6 hrs)					
Text Books, and/or reference material	Suggested Text Books: • Process Equipment Design by Lloyd E. Brownell & Edwin H. Young • Process Equipment Design by M. V. Joshi Suggested Reference Books: • Introduction to Chemical Equipment Design: Mechanical Aspects by B. C. Bhattacharya • Plant Design and Economics for Chemical Engineers by M.S. Peters and K.D. Timmerhaus • Chemical Process Equipment: Selection and Design by James R. Couper					

WSS481- Workshop Practice II (for Chemical Engineering)

Contact hour: 0 + 0 + 3= 3 **Credit= 1.5**

Total contact hour= 39 **Type: Engineering core**

M/c shop -- 3X6=18hrs.

- Mechanism and function of different parts of machine tool.
- Machining operations:

1) Machining of shaft and knurling by lathe.
2) Thread cutting by lathe.

3) Taper turning by lathe.
4) Machining of gear blank by lathe.
5) Making of Square Bar by shaper.
6) Machining of surface by shaper.
7) Spur gear cutting by milling.

- Introduction of two and three axis CNC m/cs.
- Explanation of 'G' and 'M' Codes.

Pattern shop -- 3X3=9hrs

- Description of wooden pattern.
- Types of pattern, pattern allowance.
- Layout and design of pattern making.
- Making of V-block.

Foundry shop -- 3X3= 9hrs

- Preparation of sand mould using Solid/Split Pattern.
- Aluminium casting using the prepared mould.
- Determination of properties of Green Moulding Sand using Sand Testing Equipments.
- Foundry Tooling Design.

Viva voce -- 1X3= 3hrs.

Semester -V

Department of Chemical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CHC501	Chemical Reaction Engineering	**PCR**	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
Nil		CT+EA					
Course Outcomes	CO1: Understand the fundamentals of chemical kinetics and identify reaction mechanisms [PO a, c, e] CO2: Design, analyze and compare ideal and non-ideal chemical reactors and bioreactors [PO a, c, e, k] CO3: Understand the fundamentals of heterogeneous reactions; fluid solid catalytic & noncatalytic, and fluid-fluid reactions [PO a, c, e] CO4: Design& analyze fluid-solid non-catalytic and catalytic reactors [PO a, c, e, k]						

Topics Covered	**Module - I** • Review of elements of reaction kinetics: The rate expression, mechanism of reactions, Arrhenius' equation (2) • Interpretation of rate data: Constant volume and variable volume batch reactors (4) **Module - II** • Single homogeneous reaction: Design of isothermal and adiabatic batch, plug flow and back mix reactors (8) • Multiple reactions: Independent, parallel and series reactions, autocatalytic reactions. Choice of reactors for single and multiple reactions and multiple reactor systems (4) **Module - III** • Biochemical reactions: Enzyme-catalyzed and biomass growth reaction kinetics, design of bioreactors (3) • Non-ideal flow in reactors:, residence time distribution of fluid in vessels, RTD in ideal and non-ideal reactors, modeling of non-ideal reactors (5) **Module - IV** • Solid-fluid catalyzed reactions: Catalysis, porous catalyst, steps in catalytic reactions, surface kinetics, pore diffusion resistance, performance equations, interaction of physical and chemical rate processes, effectiveness factor, selectivity, product distribution in multiple reactions, effect of pore distribution, experimental methods. Catalytic reactors (6) • Fluid-fluid reactions: Overall rate equations, application to reactor design (3) **Module - IV** • Solid-fluid noncatalytic reactions: Shrinking core model, determination of rate-controlling steps and application to design of reactors (7) Tutorial on above topics and class tests (14)
Text Books, and/or reference material	1. H. S. Fogler, Elements of Chemical Reaction Engineering, Prentice Hall India 2. O. Levenspiel, Chemical Reaction Engineering, Wiley.

Department of Chemical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)#	Total Hours	
CHC 502	MASS TRANSFER-2	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous evaluation (CE) and end assessment (EA))					
CHC 403, CHC301		CE+EA					
Course Outcomes	• CO1: Understanding fundamentals of some major Mass transfer operations [PO a, c, e] • CO2: Application of design principles for mass transfer devices [PO a, c, e, k]						

	• CO3: Learning operations of various mass transfer systems [PO a, c, e] • CO4: Building foundation for process intensification [PO a, c, e, k] • CO5:Motivation towards innovations for novel systems of mass transfer [PO a, c, e]
Topics Covered	**Module-I** Humidification & Dehumidification Operations: Principles of Humidification & Dehumidification Wet & dry bulb thermometry, Construction and use of humidity charts, characteristics of saturated and unsaturated vapor- gas mixtures, design & operation of cooling tower, Design problems (10 hrs) **Module-II** Drying: Theory and mechanism of drying, steady and unsteady state drying, classification and selection of industrial dryers, estimation of drying rates, drying characteristics of materials, performance and design of batch and continuous dryers (11 hrs) **Module-III** • Distillation processes: Vapor- liquid equilibrium, relative volatility, azeotropism, Equilibrium and flash distillation, types of distillation columns and construction, Rectification of binary systems, enthalpy-composition diagram and construction (6 hrs) **Module-IV** • Rectification column design methods: Lewis-Sorel &Ponchon–Savarit, McCabe-Thiele method, Design problems (6 hrs) **Module-V** • Special distillation processes: Membrane, molecular, extractive, catalytic Distillation, multi-component Distillation & introduction to ASPEN PLUS (3hrs) **Module-VI** • Theory of crystallization, Nucleation and crystal growth, Batch and continuous crystallizers, Design calculations for crystallizers (3 hrs) **Module- VII** Membrane separation basics, classification, transport & exclusion mechanisms, Membrane modules and design problems on micro, ultra, nano& reverse osmosis (3hrs) **Tutorial on above topics and class Tests (14 hrs)**
Text Books, and/or reference material	Suggested Text Books: • Unit Operations of Chemical Engineering: W.L. McCabe & J.C. Smith • Mass Transfer Operations: R.E. Treybal Suggested Reference Books: • Principles of Mass Transfer & Separation Processes: B. K. Dutta • Introduction to chemical engineering: W.L.Badger&J.T.Banchero • Membrane Science & Technology, Osada& Nakagawa • Industrial Water Treatment Process Technology, P. Pal, Elsevier Science • Chemical Engineering: Coulson & Richardson • Principles of Unit Operation: C. J. Geankoplis

<table>
<tr><td colspan="8">Department of Chemical Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)#</td><td>Total Hours</td></tr>
<tr><td>CHC503</td><td>CHEMICAL PROCESS TECHNOLOGY</td><td>PCR</td><td>3</td><td>1</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous evaluation (CE) and end assessment (EA))</td></tr>
<tr><td colspan="3">Knowledge of Unit operations and Unit processes</td><td colspan="5">CE+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">CO1:Ability to understand the manufacturing of various inorganic and organic chemicals [c, e]
CO2: Ability to understand the process flow diagram and various process parameters [b]
CO3:Ability to identify and solve engineering problems during production [e]
Knows current scenario of chemical & allied process industries. [j, k]</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Module I:
Basic philosophy of a process flow diagram (PFD). Elements of a PFD. General discussion on Influence of various parameters on deciding process for a product and method of drawing PFD., Water-sources and it’s economic use. Water conditioning processes, Industrial waste water treatment - different processes [5 hrs]
Industrial production of oxygen and nitrogen, cryogenic and non-cryogenic processes. Hydrogen manufacture from different source-steam reforming and partial oxidation processes. [5 hrs]
Cement, glass, ceramic industries: Raw materials, principles of manufacture, flow-sheet (10 hrs)
Module II:
Chlor-alkali industries: Production and consumption pattern, manufacture ofChlorine-caustic soda: Raw materials, principles of manufacture, Mercury-cathode & Membrane process: flow-sheet and sequence of operation, other processes, advancement of process technology and major engineering problems, uses.
Soda-ash:Production and consumption pattern, Raw materials, Solvey process Physico-chemical principles of manufacture, carbonation and ammonia recovery step, flow-sheet and sequence ofoperation, other processes, advancement of process technology and modified Solvey process, major engineering problems, uses. (12 hrs)

Module III:
Industrial Acids:
Hydrochloric Acid: Raw materials, principles of manufacture, flow-sheet and sequence ofoperation, Sulfuric acid: sulfuric acid production process, Contact process, Physico-chemical principles and general theory of contact reaction with thermodynamic and reaction engineering aspects, different types of catalyst, DCDA process, uses. Nitric Acid: Raw materials,Ostwald Process –physico-</td></tr>
</table>

	chemical principles, catalyst, process flow sheet, Phosphoric Acid: Raw materials, manufacturing process with process flow sheet (5 hrs) **Module IV:** Fertilizer Industries: Nitrogenous fertilizers: Synthesis of ammonia- physico chemical principles, catalyst for synthesis of ammonia, process flow sheet, Urea - Raw materials, manufacturing process with flow sheet, sequence of operation, Ammonium sulphate:Rawmaterials, manufacturing process with flow sheet, Phosphatic fertilizers: Manufacturing process of super phosphate of lime ,triple super phosphate and ammonium phosphate, Mixed fertilizers: NPK – manufacturing process, details of major equipments. (7 hrs) **Module V:** Organic chemical industries: Oils & Fats: Methods of extracting vegetable oils, Hydrogenation of oils, major engineering problems and improved technology, Soaps, Detergents &Glycerin: Classification of cleaning compounds, uses, Methods of soap production, Methods of detergent manufacture, Methods of production of Glycerin. Process description& flow sheet of each process Sugar and starch industries: Manufacturing process with flow diagram, Sugar refining, manufacturing process of starch and their different by-products; Glucose, Sorbitol &Polyols, Pulp and paper Industries, technology and manufacturing methods, world market (12 hrs)
Text Books, and/or reference material	<u>Suggested Text Books:</u> • Dryden, C. E., and Rao, M.G. (Ed.), Outlines of Chemical Technology Affiliated East West Press. • Austins, G.T., Sherve's Chemical Process Industries, MGH 5thEdn. Suggested Reference Books: • Venkateswarlu, S. (Ed.) Chemtech (II) Chemical Engineering Development Centre, IIT, Madras. • S. K. Ghoshal, S. K. Sanyal and S. Datta, Introduction to Chemical Engineering, Tata McGraw Hill, New Delhi. • Kirk &Othmer (Ed.), Encyclopedia of Chemical Technology

Department of Chemical Engineering

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)#	Total Hours	
CHC504	Process Control and Instrumentation	PCR	3	1	0	4	4

Pre-requisites Knowledge of applied mathematics, Unit operations	Course Assessment methods (Continuous evaluation (CE) and end assessment (EA))
NIL	CE+EA

Course Outcomes	• Understanding the working principle of various measuring instruments like, level, temperature, pressure, flow, concentration and pH etc. (a, b, c) • Process modeling fundamentals: Differential equation models, Laplace transforms, linearization, idealized dynamic behavior, transfer functions, block diagram, and process optimization. [b, c, e] • Evaluate stability, frequency response, and other characteristics relevant to process control. [k]
Topics Covered	Module I: Introduction to Instrumentation 15hrs Measurement of High temperature, Measurement of Moderate to Low Temperature, Measurement of High Pressure, Measurement of Moderate to Low Pressure, Measurement of gas and liquid flow, Measurement of multiphase flow, Measurement of liquid level Module II: Process Dynamics & Transfer function 10 hrs Process Dynamics & Model: I/O model-first-order and second-order process, Linearization and concept of deviation variable, Laplace Transform, Block Diagram, Different forcing function: step, pulse, impulse, ramp, and sinusoid. Lumped and distributed parameter system Transfer function: SISO & MIMO systems, Transient response of first, second and higher order systems, Transportation lag; Pade, approximation, Control valve: Characteristics curves and transfer function. Open loop transfer Module III: Closed loop systems and Stability 10 hrs Closed loop systems and its components: Measuring device, Controller, Final Control Element (FCE), transmission line; Block diagram, Servo and Regulator control, closed loop response, Different type of analog controller: P, PI, PD, PID, On-Off. Concept of Stability: BIBO, characteristics equation, Routh– Hurwitz method, root locus method. Frequency Response Analysis and Controller Tuning:Amplitude Ratio and Phase Lag calculation for: General, first, second and higher order systems, Dead time, P, PI, PD, PID controllers and their respective Bode plot &Nyquist plot; Bode &Nyquist stability criteria; Module IV: Controller design7hrs Empirical tuning criteria: one quarter decay ratio, ISE, IAE, ITAE. Controller tuning: Cohen-Coon, Zeigler-Nichols method; Elementary idea of feed forward, cascade, ratio, adaptive and digital computer control. Model-based control –Internal model controller

Text Books, and/or reference material	**Text Book/ References:** 1. Process Systems Analysis and Control, Donald Coughanowr McGraw-Hill Science/Engineering/Math; 2 edition (March 1, 1991) 2. Chemical Process control, G. Stephanopoulos, PHI, 2008 3. Essentials of Process Control, Luyben et al. McGraw-Hill Companies (August 1, 1996) 4. Process control, Thomas Marlin, McGraw-Hill Education; 2nd International edition (July 1, 2000)

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Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CHS 551	Heat Transfer Laboratory	PCR	0	0	3	3	1.5
Pre-requisites							
		Viva-Voce					
Course Outcomes	I. Apply the knowledge of fundamentals of heat transfer equipment on laboratory (a,c) II. Experimentation and data analysis (a,c) III. Handling various instruments and solve various difficulty levels (c,e) IV. Learn industrial applications of heat transfer equipment (c, e) V. Complete process design through assignment / group task (k)						
Topics Covered	• Determination of overall heat transfer coefficient using plate type heat exchanger • Determination of overall heat transfer coefficient for drop wise & film wise condensation • Determination of overall heat transfer coefficient using counter flow/parallel flow concentric pipe heat exchanger. • Determination of boiling point elevation of aqueous salt solutions. • Determination of thermal conductivity of metal rod. • Determination of emissivity for black body and test plate. • Determination of overall heat transfer coefficient using shell and tube heat exchanger. 36 hr						

Text Books, and/or reference material	Text Books: • Laboratory manual Reference Books: • Process Heat Transfer: D Q Kern • Heat Transfer: Principles and Applications: B. K Dutta

Department of Chemical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CHS552	Mechanical Operation Laboratory	PCR	0	0	3	3	1.5
Pre-requisites							
		Viva-Voce					
Course Outcomes	I. Understand of the fundamental principles underlying mechanical operation through practical experimentation. (a, b) II. Know the principles of different mechanical operation equipment. (a,b) III. Design and analyse mechanical operation equipment. (c,e) IV. Compare performances and select type of mechanical operation equipment. (c,e) V. Learn industrial applications of size reduction equipment (k)						
Topics Covered	1. To verify Rittinger's Law in a Jaw Crusher 2. To Study comminution through a Ball Mill and calculate its theoretical Efficiency 3. Studies on the performance of the Cyclone Separator-(I. To study the characteristics of a cyclone separator. II. To measure the fractional collection efficiency of different particle size ratio) 4. To determine overall effectiveness of a vibrating screen for a given solid sample of unknown size 5. To determine the mixing index of flour and pulses in kneader mixer 6. To determine the power consumption in a propeller mixer and compare it with the actual power requirements in agitated vessel 7. To run the operation of Plate and Frame Filter Press For filtration of calcium carbonate slurry. (I. To determine the lost quantity of calcium carbonate after filtration process.) 8. To study the influence of different flow rates of water on separation efficiency of an Elutriator 9. To determine average size of a group of particles in a mixture based on volume and surface and graphical representation of screen analysis data for size distribution of the mixture. 10. To study the working of continuous type thickener 36 hr						

Text Books, and/or reference material	Text Books: Lab Manual 1. Unit Operations- G. G Brown (CBS Publishers & Distribution) 2. Introduction to Chemical Engineering-Badger and Banchero (McGraw-Hill) 3. Transport Processes and Unit Operation-C. J. Geankoplis (Prentice-Hall India) Reference Books: 4. Mechanical Operations for Chemical Engineers-C.M. Narayanan, B.C. Bhattacharyya (Khanna Publishers) 5. Unit Operations Of Chemical Engineering-Mc. Cabe Smith &Harriot (TMH) 6. Unit Operation-C.J. King 7. Coulson & Richardson's Chemical Engineering Volume.2

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Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CHS553	Process Equipment Designs 2	PCR	0	0	3	3	3
Pre-requisites							
		Viva-Voce					
Course Outcomes	CO1: Ability to design Evaporator and techno-economic evaluation [a,b, c] CO2: Ability to design Shell and Tube Heat Exchanger and selection of materials [a,b,c]						
Topics Covered	• Design of Multiple Effects Evaporator and techno-economic evaluation. 18 hrs • Selection of material Design of Shell and tube heat exchanger 18 hrs						

Text Books, and/or reference material	Text Books: • Process Heat Transfer by Kern • Coulson & Richardson's Chemical Engineering Design (Vol 6) • Process Equipment Design by Lloyd E. Brownell & Edwin H. Young • Process Equipment Design by M. V. Joshi Reference Books: • Introduction to Chemical Equipment Design: Mechanical Aspects by B. C. Bhattacharya • Plant Design and Economics for Chemical Engineers by M.S. Peters and K.D. Timmerhaus • Chemical Process Equipment: Selection and Design by James R. Couper.

Semester VI

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
XEC 631	Economics and Management Accounting	PCR	3	0	0	3	3
Pre-requisites- NIL		Course Assessment methods (Continuous (CT) and end assessment (EA))					
		CT+EA					
Course Outcomes	• CO1:To make budding engineers aware of various aspects of micro economic theories which will help engineers to take decision in the organization • CO2:To impart knowledge on various tools and techniques applied in economics by the executives of an organization • CO3:To make potential engineers aware of macro economics variables affecting business • CO4:To impart knowledge on basics of accounting procedure and functional knowledge required in the area of accounting decision making						
Topics Covered	**Group A: Microeconomics** **Unit 1:** ***Economics: Basic Concepts (2)*** (a) Introduction to study of Economics and Microeconomics for Engineers (b) Markets and Prices: definition, extent (c) Demand and Supply – market mechanism – market equilibrium – elasticity of demand and supply – market equilibrium – short run versus long run (d) Understanding the effects of changing market conditions (e) Effects of government intervention in market – price control **(2)** **Unit 2:** ***Theory of Consumer Behaviour*** (a) Utility – ordinal utility – cardinal utility – constructing a utility function – some examples of utility function – Marginal Utility (MU) (b) Consumer preferences – assumptions about preferences – indifference curves – perfect substitutes, perfect compliments – the marginal rate of substitution (MRS)						

(c) The budget constraint – properties of budget set – change of budget line – taxes, subsidies and rationing
(d) Optimal choice – consumer demand – price changes and income changes – normal versus inferior goods – Engel curves – income effect and substitution effect and Giffen good
(e) Price Consumption Curve and the demand curve – Slutsky decomposition – ordinary versus compensated demand curve
(f) Elasticity of demand – direct effect, cross effect, substitutes and compliments
(g) Consumer surplus – compensating variation and equivalent variation

(3)

Unit 3: ***Theory of Production, Cost and Firms***
(a) Technology of production – production function
(b) Properties of production function with one variable input – average product and marginal product
(c) Law of Diminishing Marginal Returns
(d) Iso-quants, input flexibility, diminishing rate of factor substitution
(e) Iso-cost curves
(f) Optimizing behaviour of the firm
(g) Long-run and the short-run – returns to scale
(h) Cobb-Douglas Production, CES Production Function
(i) Measuring cost: Economic cost versus accounting cost, opportunity cost, sunk cost, fixed cost, variable cost
(j) Long-run versus short-run costs
(k) Economies of scale – short run and long run

(3)

Unit 4: ***Analyses of Market Structures: Perfect Competition***
(a) Perfect Competition – assumptions – price taking behaviour (Demand curve of an individual firm)
(b) Supply schedule – very short period, short period and long period
(c) Equilibrium of an individual firm
(d) Long run industry supply curves – constant, increasing and decreasing cost industry
(e) Efficiency of competitive market – consumer and producer surplus effects of tax and subsidy, price control

(3)

Unit 5: ***Monopoly Market***
(a) Average Revenue and Marginal Revenue
(b) Monopolist's output decision
(c) The effect of tax on monopoly output and price
(d) Multiplant Monopolist
(e) Price discrimination – First and Second Degree - Two part tariff - Third Degree
(f) Monopoly Power – Mark-up Pricing
(g) Social cost of monopoly
(h) Dead-weight loss
(i) Natural Monopoly

(2)

Unit 6: ***General Equilibrium and Welfare Economics***
(a) Interdependence in the economy
(b) 2 persons 2 goods Pure Exchange Model – Edgeworth Box Diagram
(c) Contract Curve
(d) Existence of Equilibrium – offer curve
(e) Walras' Law
(f) General Equilibrium with production – 2 good 2 factor case
(g) Contract curve
(h) Production Possibility Frontier
(i) Pareto optimality
(j) Externalities in consumption and production – market failure

Group B: Macroeconomics

Unit 1: ***Introduction to Macroeconomic Theory (2)***
(a) Introduction to study of Economics and Macroeconomics for Engineers
(b) Economy as a circular flow between firm sector and household sector – Firm, Household and Government
(c) Basic Macroeconomic Variables - Configurations of Aggregate Output, Employment, Interest and Price Level
(d) Fundamental Macroeconomic Problems – unemployment, inflation
(e) Fluctuation of output – rate of growth – high unemployment, hyper -inflation, depression and stagflation

Unit 2: ***National Income Accounting (3)***
(a) Gross National Product (GNP)
(b) Gross Domestic Product (GDP)
(c) Net National Product (NNP)
(d) Personal Income (PI)
(e) Relation between GNP, GDP, NNP and PI
(f) Nominal and Real GNP
(g) GNP Deflator
(h) Methods of Measurement of GNP – Measuring Gross Value of GNP – Factor Share Method, Expenditure Method, Value Addition Method

(i) Foreign or External Sector

Unit 3: ***Determination of Equilibrium Level of Income(3)***

(a) Aggregate Demand – Components – Consumption, Investment, Government Expenditure and Net Exports
(b) Consumption Function – Consumption and Savings
(c) Investment Function
(c) Aggregate Demand
(d) Equilibrium Output – Keynesian Cross Diagram
(e) Multiplier
(f) Stability of Equilibrium Output
(g) Paradox of Thrift
(h) Government Sector – Government Budget – the Balanced Budget Multiplier
(i) Taxes as a function of income
(j) Multiplier and changes in tax rate
(k) The Goods Market – Consumption Demand – Investment Demand
(l) Planned Investment and Interest Rate
(m) Goods' Market Equilibrium – IS Curve Derivation

Unit 4: ***Money, Interest and Income(4)***

(g) Money: Definition and Components of Money Demand and Money Supply.
(h) Money Market Equilibrium – LM Curve
(i) Equilibrium in goods and money market
(j) Dynamic Equilibrium Condition: Changes in Equilibrium levels of income and interest rate
(l) Monetary Policy – Transmission Mechanism
(m)Liquidity Trap – Interest inelasticity
(n) Fiscal Policy and Crowding Out
(o) Effectiveness of Fiscal and Monetary Policy in terms of IS-LM Model
(p) Derivation of Aggregate Demand Function (C-M Curve)

Unit 5: ***Inflation and Unemployment (2)***

(a) Inflation – Measures, types and effects
(b) Classical Theory of Inflation – Quantity Theory of Money and Inflation
(c) Keynesian Theory of Inflation
(d) Concept of Inflationary Gap
(e) Unemployment and Inflation – Stagflation
(f) Demand pull and Cost push inflation – interaction between demand pull and cost push inflation
(g) Measures of controlling inflation
(h) Unemployment – Natural Rate of Unemployment
(i) Philips Curve and NAIRU
(j) Short and Long Run Philips Curve

Unit 6: ***Output, Price and Employment(2)***

(a) Supply of Output – Aggregate Production Function
(b) Aggregate Demand for and Supply of Labour
(c) Aggregate Supply Function – Relation between Aggregate Supply and Price
(e) Shifts in Aggregate Demand and Supply Curve
(g) Determination of Aggregate Output, Employment, Rate of Interest and Pr ice
(h) Comparison of Keynesian and Classical Position – Aggregate Supply and Demand in Classical Theory
(i) Neutrality of Money – Classical Dichotomy – Effects of Monetary and Fiscal
Policy in Classical Framework

Part 2: Management Accountancy

Unit 1: INTRODUCTION TO ACCOUNTING (2)

Definition of Accountancy; Accounting vs. Book Keeping, Attributes of Accounting, Objectives of Accounting; Branches of Accounting, Users of Accounting Statements, Generally Accepted Accounting Principles (GAAP)

Unit 2: Preparation of Trial Balance and Final accounts(8)

PRIMARY BOOKSOF ACCOUNTS (JOURNAL)

Meaning of Journal, Format of Journals, Rules of Debit and Credit, Opening Entry, Simple and Compound entries, Numerical Problems

SECONDARY BOOSOF ACCOUNTS (LEDGER)

Meaning of Ledger, Formats of Ledgers, Ledger Posting, Numerical Problems

Cash Book

Nature of Cash Book, Different Types of Cash Books - Single Column, Double Column and Triple Column, Petty Cash Book

Concept, Preparation of Trial Balance, Numerical Problems, Advantages and Limitations of Trial Balance

Concepts, Procedure for the Preparation of Trading A/c, Profit and Loss A/c and Balance Sheet and different types of adjustments.

	Unit 3: Cost volume and profit analysis (4)
Text Books, and/or reference material	Text Books: 1. Pindyck, R.S. & Rubenfeld, D. L.: Microeconomics, Pearson Education, Chapters 1, 2. 2.Varian, H. R.: Intermediate Microeconomics, EWP, Chapter 1. 3. N. G. Mankiw: Macroeconomics, Worth Publishers, Chapters 4, 6, 10 4. W. H. Branson: Macroeconomics – Theory and Policy (2nd ed), AITBS 5.Gupta, RL and Radhaswamy, M : Financial Accounting ; Sultan Chand and Sons 6.Ashoke Banerjee: Financial Accounting, Excel Books 7.Maheshwari:Introduction to Accounting,Vikas Publishing 8.Shukla, MC, Grewal TS, and Gupta, SC : Advanced Accounts; S. Chand & Co

Department of Chemical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CHC601	Transport Phenomena	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
		CT+EA					
Course Outcomes	• CO1: To create an understanding on universal approach of transport phenomena and fundamental transport processes like mass, momentum and energy. (PO:a, c, e) • CO2: To give an understanding on shell balance technique, setting of boundary conditions etc. for different geometry of a system (PO:a, c, e, k) • CO3:To develop NSE, equation of continuity, equation of energy etc. from the fundamental concept of conservation (PO:a, c, e, k) • CO4: To solve problems on mass, momentum and energy transport using shell balance techniques and basic transport equations (PO:a, c, e, k) •						
Topics Covered	<u>Module: I</u> •Transport Phenomena: Basic concepts, fundamental transport Processes and their relation, transport properties, measurement of properties, boundary conditions etc. 6 hrs. <u>Module II</u> •Momentum transport phenomena: Shell balance technique, Derivations of momentum, velocity, shear force etc. in rectangular, cylindrical and spherical coordinate systems by using shell balance, Equation of continuity and change (mass, momentum & energy), Navier stokes equation (NSE), Euler equation, application of NSE in rectangular, cylindrical and spherical coordinate systems. 10 hrs. <u>Module-III</u> •Flow of fluids in thin films, parallel plates, circular tubes and annulus, adjacent flow of two immiscible fluids, couette flow, rotating surface flow and radial flow, flow near a wall suddenly set in motion.						

	10 hrs. Module-IV •Energy transport: Basic energy transport equations, derivation using elementary volume concept and conservation theorems in different coordinate system, analysis of energy transport using shell balance techniques and basic transport equations. 8 hrs. Module-V •Conduction with energy sources in fixed bed catalytic reactors and in cooling fins, forced convection in circular tubes, natural convection from a heated plate and unsteady state conduction of finite slab. 10 hrs. Module-VI •Mass transport : Types of fluxes and their relation, continuity equation for a binary mixture, boundary conditions , analysis of mass transport using shell balance techniques and equation of continuity for different coordinate systems, steady and unsteady state systems, diffusion in porous catalyst with and without chemical reaction, diffusion in falling liquid film, turbulent mass flux, interphase mass transport 12 hrs.
Text Books, and/or reference material	Text Books: 1. Transport Phenomena by Bird, Stewart & Lightfoot, Wiley, 2nd Edition, 2010. 2. Introduction to Transport Phenomena: Momentum, Heat And Mass by Bodh Raj, PHI Learning, 2012 Reference Books: 1.Transport Phenomena: A Unified Approach by Brodkey& Hershey, McGraw-Hill Chemical Engineering Series, Brodkey Publishing, 2003

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Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CHC 602	**PETROLEUM REFINING & PETROCHEMICALS**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
CHC 602, CHC 403		CT+EA					
Course Outcomes	• CO1: Understanding the role of petroleum as energy source amidst world energy scenario (a,c) • CO2: Learning design and operation of petro refineries and petrochemical complexes (a,c)						

	• CO3: Learning safe practices in operations of refineries and petrochemical complexes (a,c) • CO4: Identifying challenges, energy security issues and environmental issues and process intensification (h) • CO5 :Techno-economic analysis & trouble shooting (m)
Topics Covered	**Module-I** Petroleum - Origin and Occurrence, Exploration, Estimation and recovery, Evaluation of crude, Properties, Problems, Prospects &Challenges of petroleum refining in India, testing and specifications of petroleum products (10 hrs) **Module-II** Processing of Crude Petroleum - Atmospheric and Vacuum distillation, column control schemes, Cracking, Reforming, Visbreaking, Delayed Coking, Alkylation, Isomerization (12 hrs) **Module-III** Production of finished petroleum goods like, LPG, Kerosene, Petrol, Diesel, Lubricating Oil, Bitumen, Hydro processing (12 hrs) **Module-IV** Petrochemicals- feedstock, classification of petrochemicals, Cracking of raw feed stock for intermediate feed stock production, manufacture of PVC, PE, POLY STYRENE, BTX. etc. (14 hrs) Quiz, Exam, Assignment (8 hr)
Text Books, and/or reference material	Text Books: • Petroleum Refining Engineering: W.L. Nelson • Petrochemicals Technology: B.K.B. Rao Reference Books: 1. Advanced Petroleum Refining: G.M. Sarkar 2. Environmental Control in Petroleum Refining: J.C. Reis 3. Petroleum Refining Technology & Economics: J.H. Gary & G.E. Handwerk

Department of Chemical Engineering						
Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
		Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
PROCESS MODELLING AND SIMULATION CHC 603	PEL	3	0	0	3	3
Pre-requisites: Process calculation, Engg. Math I-III		Course Assessment methods (Continuous (CT), Midterm (MT) and end assessment (EA))				
		CT+MT+EA				
Course Outcomes	• CO1: Understanding the principle ofmass, energy and momentum conservation					

	equations. (a, e, k) • CO2: Concept of steady state and unsteady state model equations (a, e) • CO3: Numerical techniques to solve Algebraic, ODE and PDE (a,c,e) • CO4: Solution of various model equationsand graphical presentation (a,c,e, m)
Topics Covered	Module – 1 • Introduction to Mathematical Model and its Necessity: Empirical relationship, experimentation, data interpretation, correlation and mathematical modelling using example 2 h • Model Development Principles and Classification of Models: Dimensional Analysis, Synthesis of sub-models, Experimental facts, Hypothesis, Scale up concept, Steady state, unsteady state model, dynamic response, Constitutive relationships, Deterministic and Stochastic – Macroscopic diffusion equation, Lumped and Distributed Parameter - Stirred tank and plug flow models, Linear and non-linear models 4h • Conservation principles of mass and energy and momentum balance equations and Modelling of few simple systems**,** Gravity flow tank, Flash drum, Distillation column, Double pipe heat exchanger, Gas-liquid absorption column, CSTR, Batch reactor, Plug flow reactor. 12h Module – 2 • Development of dynamic model Input output model vs. state model, system parameters, numerical integration, Linear models and deviation variables, linearization of non-linear models, System with one state variables, one input. State space model,Heated mixing tank, Isothermal CSTR, Non-isothermal CSTR with 2^{nd} order chemical reaction, linearized model for the system and state space representation, Stability analysis and Eigen values. 7 h • Model development of Pyrolysis, Combustion, Gasification process of coal and biomass and comprehensive modelling in TGDA, Isothermal mass loss Apparatus. 5 h Module – 3 Specialized Modeling for distributed parameter system: Distributed parameter system and model equations,the general conservation equation and interpretation of individual terms, the, Detail derivation of Finite Volume Method (FVM) and its application to steady state diffusive, convective and convective-diffusive problem. Extensions of the same for unsteady state operation, Presence of non-linear reaction terms, radiation term and linearization technique. Solution ofmodel equations. 14h Tutorial and class test 14 h

Text Books, and/or reference material	Text Books: 1.*Lyuben*, W.L, *Process Modelling*, Simulation and Control, McGraw-Hill, N.Y. 1990. 2. Patankar, S. V., 'Numerical fluid flow and heat transfer', 1980, Hemisph

Department of Chemical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CHS 651	**FUEL LABORATORY**	PCR	0	0	3	3	1.5
Pre-requisites							
		Viva-Voce					

Course Outcomes	I. Demonstrate and understand the principles of fuel properties testing instrument. (a,b) II. Conduct the experiments for determination of properties of different fuels.(a,b) III. Analyze the performance of equipment through group tasks. (a,b,d)
Topics Covered	1. Proximate Analysis of Coal determines the moisture ash, volatile matter and fixed carbon of coal in terms of weight percentage. 2. Shattering Index of Coke 3. Caking Index 4. Swelling Index 5. Viscosity of Fuel Oils 6. Determination of Flash point and Fire point of an oil by closed cup Pensky Martin Apparatus 7. Determination of moisture content of fuel oil by Dean and Stark Apparatus 8. Aniline point determination by thin film 9. Determination of vapour pressure of petroleum products using Reid Apparatus. 10. To perform atmospheric distillation of petroleum product and to find out percent recovery, percent total recovery, percent loss, percent residue. 11. Determination of calorific value of solid fuel by Bomb Calorimeter 12. Determination of carbon residue of fuel by Conradson Method 36 hr

Text Books, and/or reference material	Text Books: 1. Modern Petroleum Refining: B. K. B. Rao 2. Fuels & Combustion: Samir Sarkar Reference Books: 1. Petroleum Refining Engineering: W. L. Nelson 2. Petroleum Refining Technology & Economics: J.H. Gary & G.E. Handwerk .

Department of Chemical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CHS652	**REACTION ENGINEERING LABORATORY**	PCR	0	0	3	3	1.5
Pre-requisites							
		Viva-Voce					
Course Outcomes	I. Understand the fundamental principles of reaction kinetics in different reactor through practical experimentation (a,b, l) II. Study the non-catalytic homogeneous saponification reaction in CSTR. (a, b, i, k) III. Study the residence time distribution in a CSTR. (a, b, i, k) IV. Study the non-catalytic homogeneous saponification reaction in plug flow reactor. (a, b, i, k) V. Study the non-catalytic homogeneous saponification reaction in isothermal batch reactor. (a, b, i, k)						
Topics Covered	• Study of Non-catalytic homogeneous reaction in an Isothermal Batch Reactor. • Study of non-catalytic homogeneous saponification reaction in a tubular flow reactor and to interpret the kinetic data of the given reaction in the form of a rate equation. • Residence distribution (RTD) Studies in CSTR. • Study of non-catalytic homogeneous saponification reaction in a continuous stirred tank reactor and to interpret the kinetic data of the given reaction in the form of a rate equation. • Removal of dye using Fenton oxidation process and evaluation of its Kinetic data. 36 hr						

Text Books, and/or reference material	Text Books: Laboratory Manual

Department of Chemical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CHS653	**MASS TRANSFER LABORATORY**	PCR	0	0	3	3	1.5
Pre-requisites							
		Viva-Voce					

Course Outcomes	• CO1: To demonstrate an understanding of mass transfer modes and models (a,b) • CO2: To formulate the idea of the different types of interface reactions (a,b) • CO3:To apply principles of mass transfer phenomena to chemical process industries (a,b) • CO4: To enable solving the problems on process and materials related combined heat and mass transfer phenomena. (c,e, f)
Topics Covered	1. Study the characteristics of simple batch distillation. 2. Determination of diffusivity of a hydrocarbon liquid through air. 3. Study performance of drying in atmospheric tray drier. 4. Find out the heat transfer co-efficient for drop wise & film wise condensation. 5. Study the characteristics of a bubble cap column and to find the overall efficiency and murphree efficiency. 6. Determination of overall heat transfer coefficient of an open pan evaporator. 7. Calculate hold up in a rotary drier. 8. Study flooding and loading phenomenon in packed absorption tower. 36 hr
Text Books, and/or reference material	Text Books: • Mass Transfer: R.E.Treybal • Unit operations of chemical engineering: W.L. McCabe &J.C.Smith • Laboratory manual Reference Books: • Principles of Mass Transfer & Separation Processes: B. K. Dutta

Semester VII

<table>
<tr><td colspan="8">DEPARTMENT OF MANAGEMENT STUDIES</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MSC-731</td><td>PRINCIPLES OF MANAGEMENT</td><td>PCR</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites- NIL</td><td colspan="6">Course Assessment methods (Continuous (CT) and end assessment (EA))</td></tr>
<tr><td colspan="2"></td><td colspan="6">CT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• CO1:To make budding engineers aware of various management functions required for any organization
• CO2:To impart knowledge on various tools and techniques applied by the executives of an organization
• CO3:To make potential engineers aware of managerial function so that it would help for their professional career
• CO4:To impart knowledge on organizational activities operational and strategic both in nature
• C05: To impart knowledge on each functional area of management like Marketing, Finance, Behavioral Science and Quantitative Techniques and decision science</td></tr>
<tr><td>Topics Covered</td><td colspan="7">UNIT I: Management Functions and Business Environment: Business environment-macro, Business environment -micro; Porter’s five forces, Management functions – overview, Different levels and roles of management, Planning- Steps, Planning and environmental analysis with SWOT, Application of BCG matrix in organization (8)
UNIT II: Quantitative tools and techniques used in management: Forecasting techniques, Decision analysis, PERT & CPM as controlling technique (7)
UNIT III: Creating and delivering superior customer value: Basic understanding of marketing, Consumer behavior-fundamentals, Segmentation, Targeting & Positioning, Product Life cycle. (8)
UNIT IV: Behavioral management of individual: Motivation, Leadership, Perception, Learning. (8)
UNIT V: Finance and Accounting: Basics of Financial management of an organization, Preparation of Financial accounting, Analysis of Financial statements, CVP Analysis, An overview of financial market with special reference to India .(12)</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">Text Books:
1. Financial Management, 11th Edition, I M Pandey, Vikas Publishing House.
2. Marketing Management 15th Edition, Philip Kotler and Kelvin Keller, Pearson India
3. Management Principles, Processes and practice, first edition, Anil Bhat and Arya Kumar, Oxford Higher education
4. Organizational Behavior,13 th edition, Stephen P Robbins, Pearson Prentice hall India
5. Operations Management, 7th edition (Quality control, Forecasting), Buffa & Sarin, Willey</td></tr>
</table>

Departmental Elective -1CHE 710-719)

Departmental Elective -2CHE 710-719)

Departmental Elective -3 CHE 710-719)

<table>
<tr><td colspan="7">Department of Chemical Engineering</td></tr>
<tr><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>Process Control And Instrumentation Laboratory (CHS 751)</td><td>PCR</td><td>0</td><td>0</td><td>3</td><td>3</td><td>1.5</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="5"></td></tr>
<tr><td colspan="2"></td><td colspan="5">Viva-Voce</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">I. Understand the fundamental principles underlying process control through practical experimentation (a,b,l)
II. Learn the inherent characteristics of control valve. (ac,h)
III. Experimentation and data analysis. (b,c,d)
IV. Handling various instruments and solve various difficulty levels. (c,e,f,k)</td></tr>
<tr><td>Topics Covered</td><td colspan="6">1. Study the control valve flow coefficient (C_v) and its inherent characteristics.
2. Study the temperature control trainer and to find out steady state process gain.
3. Compare the observed transient response with the theoretical transient response for the interacting – non-interacting system.
4. Study the step response of mercury manometer and water manometer.
5. Plot Bode diagram of manometer systems and design the controller using Z-N tuning method.
6. Study the root locus of a manometer and hence to determine the region of stability.
36 hr</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="6">Text Books: Lab Manual</td></tr>
</table>

Department of Chemical Engineering						
Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
		Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CHEMICAL ENGINEERING COMPUTING LABORATORY- 2 (CHS 752)	PCR	0	0	3	3	1.5
Pre-requisites						
	Viva-Voce					
Course Outcomes	• CO1: To measure the steady state response and dynamic response of a process system (a,b) • CO2: To compare the responses with those obtained from the mathematical model (a,c) • CO3: To validate the methods for closed-loop stability analysis in context to a practical controller (a,b) • CO4: To validate the controller tuning methods in context to a practical controller (a,c)					
Topics Covered	1. Determination of Time constant of temperature sensor 2. Determination of Time constant of pressure sensor 3. Determination of Damping coefficient of a Manometer 4. Determination of Control valve characteristics 5. Response of interacting and non-interacting system 6. Online tuning of Level controller (H/W) and trainer (S/W) 7. Temperature controller 8. DCS trainer 36 hr					
Text Books, and/or reference material	Text Books: Lab Manual					

Department of Chemical Engineering						
Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
		Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
Computer Aided Process Equipment	PCR	0	0	3	3	1.5

Design (CHS 753)						

Pre-requisites	
	Viva-Voce
Course Outcomes	• CO1: Students are groomed to become confident design engineers / process simulators. They are also made conversant with all aspects of chemical engineering science, since development of CAD packages demands proficiency in all unit operations and unit processes. (a, b, c, f)
Topics Covered	• Introduction to the basic principles distillation process and its applications • Design of distillation column with its process design and mechanical design and various parts of column and drawing of internals of distillation column • Computer Aided process design of distillation column by ASPEN Plus
Text Books, and/or reference material	Text Books: 1. L. E. Brownell, E. H. Youg, "Process Equipment Design" John Wiley & Sons Publications, 2004. 2. J.M. Coulson and J. Richardson, "Chemical Engineering", Vol. 6, Asian Books Printers Ltd. 3. Indian Standard Specifications IS-803, 1962; IS-4072, 1967; IS-2825, 1969. Indian Standards Institution, New Delhi. Reference Books: 1. R.H. Perry, "Chemical Engineers' Handbook", McGraw-Hill. 2. W.L. McCabe, J.C. Smith and P. Harriot, "Unit Operation of Chemical Engineering", McGraw-Hill, 2001. 3. Aspen plus manuals

CHS754	**Vocational Training / Summer Internship & Seminar**	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
Pre-requisites	Viva-Voce		0	0	2	2	1
Course Outcomes		CO1: Ability to understand all the Unit Operations and Unit Processes in real-life problem. (h,k) CO2: Knowledge sharing (h)					
Topics Covered		Industrial Training, Internship etc. 4 -8 weeks					
Text Books, and/or reference material	NA						

CHS 755 (3 1.5 3) Project-1

Semester VIII

1. Departmental Elective-4
2. Departmental Elective-5

CHS 851 (15 5 15) Project-2
CHS 852 (1) Project-Seminar

List of Departmental Electives (CHE710-719)

<table>
<tr><td colspan="8">Department of Chemical Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>CHE 710</td><td>ENERGY SOURCES AND UTILISATION</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous (CT) and end assessment (EA))</td></tr>
<tr><td colspan="2"></td><td colspan="6">CT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• CO1: Learn different sources of energy and basic terminology (a,b)
• CO2: Identify characteristic properties of fuels and analyze fuel processing equipment (a, e)
• CO3: Compare performances and select type of fuel processing equipment (k)</td></tr>
<tr><td>Topics Covered</td><td colspan="7">• Introduction: Survey of different sources of energy and their utilization. (2 hrs)
• Fossil fuels: Coal, Petroleum and gaseous fuels. (1 hr)
• Coal: Origin and formation of coal . Petrographic constituents of coal, Properties and testing. Classifition of coal, Coal preparation- washing and blending, Metallurgical and other uses. Carbonisation of coal, coke ovens and recovery of by-products. (12 hrs)
• Petroleum : Constitution of petroleum, Origin and Occurrence of crude, Evaluation of crude, Properties, testing and specifications of petroleum products- Octane no.; Reid vapor pressure; Flash point; Fire point; Smoke point; Pour point; Cloud point; Aniline point and Diesel index; Cetane no. , Processing of Crude Petroleum (12 hrs)
• Gaseous fuels: Classification. Manufacture of producer and water gas. (5 hrs)
• Combustion and furnace: Combustion characteristics, Combustion appliances--furnaces, waste heat recovery system, burners. (6 hrs)
• Non-conventional energy sources: Solar energy Nuclear Energy from biomass, Geothermal, Wind, Tidal (4 hrs)
Quiz, assignment, group task: (14 hrs)</td></tr>
</table>

Text Books, and/or reference material	Text Books: 1. Modern Petroleum Refining: B. K. B. Rao 2. Fuels & Combustion: Samir Sarkar Reference Books: 1. Petroleum Refining Engineering: W. L. Nelson 2. Petroleum Refining Technology & Economics: J.H. Gary & G.E. Handwerk 3. The elements of fuel technology: G. W. Himus

Department of Chemical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CHE711	**Non-Conventional Energy Engineering**	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
CHC401		CT+EA					
Course Outcomes	• CO1: Learn about energy technology of different conventional and non-conventional energy resource and Recent worldwide energy market scenario • CO2: Design & analyze of different renewable energy collectors and renewable energy thermal power plants • CO3: Learn industrial and domestic applications of different renewable energy sources • CO4: Solve energy technology problems of different difficulty levels through tutorials						
Topics Covered	<u>Module 1</u> Wind Energy: Sources and potentials, Wind energy conversion, General formula - Lift and Drag- Basis of wind energy conversion – Effect of density, frequency variances, angle of attack, and wind speed. Windmill rotors Horizontal axis and vertical axis rotors. Determination of torque coefficient,.horizontal and vertical axis windmills, performance characteristics, Betz criteria, Design and analysis of wind turbines. geographical aspects. (10 hrs) <u>Module 2</u> Solar Energy-Energy available form Sun, Solar radiation data, Solar energyconversioninto heat, Flat plate and Concentrating collectors, Construction and performance analysis of solar flat plate collectors, Mathematical analysis of Flat plate collectors and collector efficiency, collector efficiency factor, tilt factors, collector heat removal factor, Hottel-Willier-Bliss equation. Principle of Natural and Forced convection,						

	Salt gradient solar ponds: construction, operation, technical problems, Solar drying and dehumidification: Solar cabinet dryers, convective dryers Solar engines- Stirling, Brayton engines, Photovoltaic, p-n junction, solar cells, PV systems, Stand-alone, Grid connected solar power satellite. . (10 hrs) Module 3 Nuclear Energy: Nuclear fission principles, types of nuclear reactors (BWR, PWR, PHWR, LMCR, GCR, FFR). Nuclear reactor analysis: four factor formula, resonance absorption, reactor buckling, multiplication factor, thermal utilisation coefficient, reflector saving, fast fission factor, optimum moderator to fuel ratio. Radioactive waste disposal Energy from Ocean: Wave, Tidal and OTEC energy- Difference between tidal and wave power generation, Principles of tidal and wave power generation, OTEC power plants (closed cycle, open cycle, hybrid cycle), operation and technical problems, environmental impact, Tidal power, salinity power plants, Geothermal systems: Resources, types of wells, methods of harnessing the energy, Hot water and dry steam systems, energy extraction principles. (10 hrs) Module 4 Energy from biomass: Biomass utilization: pyrolysis, gasification, anaerobic digestion(biogas production). Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, Biodiesels: Manufacture and characteristics. Gasohol: Characteristics and manufacture, use of pervaporation technology. Synthetic liquid fuels from coal: F – T Process, Coal hydrogenation, MTOG process. (10 hrs)
Text Books, and/or reference material	**Text Books:** • Ashok V Desai, Non-Conventional Energy, Wiley Eastern Ltd, New Delhi, 2003 • K M, Non-Conventional Energy Systems, Wheeler Publishing Co. Ltd, New Delhi, 2003. **Reference Books**: • Ramesh R & Kumar K U, Renewable Energy Technologies, Narosa Publishing House, New Delhi, 2004 • Wakil MM, Power Plant Technology, McGraw Hill Book Co, New Delhi, 2004. • Non – Conventional Energy Sources. Rai. • Solar Energy. S P Sukhatme and J K Nayak, 2017

Department of Chemical Engineering

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CHE	**PROCESS ENGINEERING**	PEL	3	0	0	3	3

712							

Pre-requisites Unit operations and Chemical reactor, Chemical Process Technology, Optimal design methods	Course Assessment methods (Continuous (CT) and end assessment (EA))
	CT+EA
Course Outcomes	• CO1: Understanding process design concepts (a, d,e,k) • CO2: To troubleshoot real-time chemical processes (PO-a,c,k) • CO3: To do optimal plant operation (PO-a,e.k,m)
Topics Covered	Section I: Introduction (5hrs) Course objectives and course outcomes- Definition of process engineering– responsibilities of Process Engineers. Structure of Processes and Process Engineering Section II: Process Design and Flow sheeting (12hrs) Process design principles; process selection; Degree of freedom; selection of design variable; mass balance and energy balance; process flow sheeting; sizing of equipment Section III: Process dynamics and dynamic optimization (12hrs) Process response and retrofitting; Dynamic models; Optimization models for process synthesis and design; dynamic optimization; real-time optimization; Section IV: Process Synthesis (10hrs) Basic concepts in process synthesis; flowsheet optimization and economic analysis; process trouble shooting; case studies
Text Books, and/or reference material	Text Books: 1. Rudd DF, Watson, CC. Strategies of process engineering, John Wiley, 1968 2. Seader WD, Seader, JD, Lewin, DR. Product & process design principles, John Wiley, 2004 3. Arthur W. Westerberg, I.E. Grossmann, and Lorenz T. Biegler, Systematic Methods of Chemical Process Design. Prentice Hall

Cou rse Cod	Title of the course	Program Core (PCR) /	Total Number of contact hours				Cre dit
			Lecture (L)	Tutoria l (T)	Practic al (P)	Tot al	

e		Electives (PEL)				Hours	
CHE 713	**Boiling Heat Transfer**	PEL	3	0	0	3	3
Pre-requisites: Mathematical methods, Transport Phenomena, Heat transfer		Course Assessment methods (Continuous (CT) and end assessment (EA))					
		CT+EA					
Course Outcomes	• CO1: Concept of a vapor bubbles (PO-a,d) • CO2: Understanding micro-convection of heat (PO-a, b, d) • CO3: Computing boiling regimes and heat transfer coefficients (PO-a,b,e) • CO4: Modeling boiling flow and instabilities (PO-a,e)						
Topics Covered	Module I: Concept of a vapor bubbles (10hrs) Boiling; Bubbles; growth mechanisms; modeling issues for pool boiling and flow boiling Module II: Boiling regimes and heat transfer coefficients (10hrs) Various boiling regimes; determination of heat transfer coefficients; subcooled boiling; saturated/bulk boiling; Module III: Interfacial Instabilities and Flow Instabilities in Boiling (10hrs) Types of interfacial instabilities and flow instabilities; their mechanisms; consequences Module IV: Condensation (10hrs) Collapse of vapor bubbles; their mechanism; condensation heat transfer coefficients **Course Assessment Method:** The theory performance of students are evaluated **Text Book** 1. John G. Collier, John R. Thome, Convective Boiling and Condensation, Clarendon Press, 1994 2. L S Tong , Y S Tang, Boiling Heat Transfer And Two-Phase Flow, CRC Press, 1997 3. R.T. Lahey, Boiling Heat Transfer, ELSEVIER, 1992						

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
	CHEMICAL PLANT DESIGN AND	PEL	3	0	0	3	3

	ECONOMICS						
Pre-requisites: Unit operations and Chemical reactor, Chemical Process Technology, Optimal design methods		Course Assessment methods (Continuous (CT) and end assessment (EA))					
		CT+EA					
Course Outcomes	• CO1: Managing various process design projects (PO-a,d,k,l) • CO2: Understanding process design concept based on mass-energy balance and optimization (PO-a,e.k,m) • CO3: Determining design-project feasibility and implementation time (PO-a,d,e,k,m)						
Topics Covered	**Module I: Plant Design life cycle (10hrs)** Various stages of a plant design project – managing the various stages of plant design project – various approaches. Various scheduling methods for plant design **Module II: Plant Design Projects (12hrs)** Process design principles; process selection-DOF-design variable; -mass balance and energy balance; flowsheeting; sizing of equipment; P&ID-basic engineering package (BEP); Principles of equipment layout in and site selection for chemical plants; Types and selection of materials of construction for process equipments **Module III: Feasibility of Plant Design (10hrs)** Estimation of cost and profit - taxes & depreciation-rate of return (ROI)-case studies; Screening of Process Alternatives; Concepts of investment, interest and time value of money; Profitability analysis. Analysis of alternative investments and replacements. **Module IV: Case studies (13 hrs)** Design of Reactors; Design of Separation Processes; Energy Integration and Design of Heat Exchanger Network (Pinch Technology);						

Text Books, and/or reference material	Text Books: 1. Peters, M S, Timmerhaus, KD, Plant Design and Economics, McGraw Hill, 1991 2. Towler G, Sinnott, Ray, Chemical Engineering Design, Elsevier, 2008 3. Rudd DF, Watson, CC. Strategies of process engineering, John Wiley, 1968 4. Seader WD, Seader, JD, Lewin, DR. Product & process design principles, John Wiley, 2004. Reference Books:

Department of Chemical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CHE 715	**PROCESS SAFETY IN CHEMICAL INDUSTRIES**	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
		CT+EA					
Course Outcomes		• understand the key principles of process safety and its management and consequences of poor process safety (human, environmental and business consequences) [a, c] • understand the hazards associated with process plant and how the risks can be controlled [f, h] • understand the key process safety requirements at each stage in the life cycle of process plant from conceptual design through to operation, maintenance and modification [b, c] • understand the interdependence and the need for overall organization process safety management capability [h, j, k]					
Topics Covered		Review of Industry Accidents 4 hrs Basic Laboratory Safety 2 hrs To study the importance of personal protective equipments such as Gumboot, Helmet, Gloves, Aprons, Ear plugs, nose mask etc. in chemical plant 3 hrs Toxic Substance and Confined Spaces 5 hrs Fire and Explosion 4hrs Chemical Process Safety 6hrs Hazard Identification & Risk Assessment 5hrs Hazard Evaluation 2hrs Hazard and Operability Studies (HAZOP) 4hrs Accidents					

	Industrial accidents – accident costs – identification of accident spots; remedial measures; identification and analysis of causes of injury to men and machines – accident prevention – accident proneness – vocational guidance, fault free analysis, fire prevention and fire protection. 7 hrs
Text Books, and/or reference material	Text Books: 1. Chemical Process Safety: Daniel Crowl and Joseph F. Louvar, 3rd ed., PHI Chemical Engg. Series 2. Chemical Process Safety: Fundamentals with Applications: Daniel Crowl and Joseph F. Louvar, 3rd ed., Pearson New International Edition.

Department of Chemical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CHE 716	**Membrane Separation Process**	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
		CT+EA					
Course Outcomes	• CO1: Learn fundamentals of membrane separation processes and current market scenario (a • CO2: Classify and characterize membrane separation processes (a, c) • CO3: Principles and methodologies of separation and transport of molecules through membrane and latest development (a, c) • CO4: Complete process design of separation and exercise problems through tutorials/ assignment / group task ((b, h, k)						
Topics Covered	• Membrane Separation Processes: Types of membranes and membrane characterization, Membrane modules and motion of molecules through membrane, Classification & characterization of Membrane Separation Processes (6 hrs) • Reserve Osmosis (RO): Fundamentals, Osmotic Pressure, Models of Solvent and solute Transport through membrane – Fluxes, Rejection and Separation factor, Mechanism of salt rejection by CA membrane, Concentration Polarization, applications (6 hrs) • Nano-filtration (NF): Fundamentals of NF, Models and Types of transport mechanism in NF membranes, Applications of NF (3 hrs) • Ultra-filtration (UF): Models and Types of transport in UF membranes, Membranes for UF – Fouling and concentration Polarization in UF, Separation schemes using UF, Dia-filtration – process design – batch, continuous, multistage (7 hrs) • Micro-filtration (MF): Membranes for MF – transport mechanism						

	(3 hrs) • Dialysis: Solute transport in dialyzer – analysis of dialysis operation, Mode of dialysis, Hemo-dialysis – dialysis equipment – applications (3 hrs) • Electro –dialysis (ED): Types of ED – ion transport fundamentals, Resistances and voltages in ED cells – power requirement, ED membranes and cells, Problems of ED operation, Plant design and process cost (4 hrs) • Liquid membrane: Nature and types of available liquid membranes, Liquid membranes on solid membranes (facilitated transport) (2 hrs) • Pervaporation (PV): Theory of PV – parameter study, Classification of PV – air heated PV, Osmotic distillation, thermo-pervaporation, Advantages and disadvantages of PV, Application of PV (4 hrs) • Gas Separation: Membrane gas separation, Industrial applications (2 hrs) • Membrane distillation, membrane contactor (2 hrs)
Text Books, and/or reference material	Text Books: • Separation Processes – C. J. King • Synthetic membranes – P. M. Bungay, H. K. Lonsdale, M. N. de Pinho Reference Books: • Membrane Separation Processes – KaushikNath • Membrane Hand Book – W. Ho and K. K. Sirkar • Industrial Processing with membranes – R. E. Lacey & S Loeb • Reverse Osmosis – S. Sourirajan • Ultrafiltration Handbook – M. Cheryan • Principles of Mass Transfer and Separation Processes – B. K. Dutta • Membrane Technology in Environmental Pollution Control, P.Pal • Industrial Water Treatment Process Technology, P.Pal, Elsevier Science • Membrane Technology in Environmental Pollution Control. P.Pal

Department of Chemical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CHE 717	**Process Intensification**	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
		CT+EA					
Course Outcomes	CO1: Understanding the concept, need and benefits of process intensification amidst stringent environmental regulations, concerns for energy security and sustainable development CO2: Learn different approaches of achieving process intensification						

	CO3: Learning the principles of green chemistry and green processing CO4: Learning design, operation, analysis and application of selected process intensification technologies
Topics Covered	Module 1: Basics of Process Intensification, definitions, routes, benefits, need for process intensification, sustainable development issues 4 Hrs Module 2: Twelve principles of green chemistry. Matrices for chemistry: Effective mass yield, carbon efficiency, atom economy, reaction mass efficiency, Environmental factor (E) 4 Hrs Module 2: Process Intensification by Multifunctional equipment, Principles, design, operation and case studies 4 Hrs Module 3: Process Intensification by reactive distillation: Principles, design, control, feasibility, technical evaluation, case studies 4 Hrs Module 4: Process Intensification by catalytic distillation: Principles, design, operation, application, economics 4 Hrs Module 5: Process Intensification by Membrane application: principles, modular design issues, energy saving prospects, space-saving prospects, green processing prospects, case studies 4 Hrs Module 6: Case studies of process intensification in lactic acid manufacture, glutamic acid manufacture, industrial wastewater treatment and reuse, recovery of valuables 6 Hrs Module 7: Process Intensification through cavitation reactors, oscillatory baffled reactors, sono-chemical, hydrodynamic cavitation reactors, case studies 4 Hrs • Module 8: Process Intensification through monolith reactors: Hydrodynamics, design, advantages, applications 4 hrs
Text Books, and/or reference material	References: 1. Intensification of bio-based processes, A. Gorak, Andrzej Stankiewicz edited. RSC publication 2. A.Stankiewicz, J.A. Moulijin, Re-engineering the Chemical Processing Plant, Process intensification, Marcel Dekker, New York (2004) 3. Membrane based technologies for environmental pollution control, P.Pal, Elsevier Sci.

<table>
<tr><th colspan="8">Department of Chemical Engineering</th></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>CHE 718</td><td>COLLOIDS AND INTERFACE ENGINEERING</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous (CT) and end assessment (EA))</td></tr>
<tr><td colspan="2">NIL</td><td colspan="6">CT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• CO1: Acquire an idea about the application of colloidal chemistry, fluid-fluid and solid-fluid interface engineering in different industrial fields.
• CO2: To learn the fundamental knowledge of intermolecular forces involved in colloids and interfaces
• CO3: Introduction to surface active agent and learn about the application of surface active agents to enhance the efficiency in the process.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Module: 1
Importance and scope of the subject. Overview of colloidal systems, interfaces and surface. Properties and application of the colloids. Colloidal stability factor. Kinetic theory of colloidal systems: sedimentation, centrifugation, diffusion, Domestic and industrial application of colloidal solution.
Adsorption at fluid-fluid and fluid-solid interface, Thermodynamics of interfaces, Interfacial rheology and transport process.
(10 hours)
Module: 2
Surface active agent: Surfactant, Surface and interfacial tension, surface free energy. Surface tension for curved interfaces, Surface excess and Gibbs equation.
Theory of surface tension, contact angle, and wetting. Thermodynamics of micelle and mixed micellar formation. Adsorption of single and mixed surfactants at interfaces, Mixed micellar properties, Rheology of surfactant systems.
Preparation, mechanistic details of stabilization and relationship between HLB and solubility parameter, characterization and Application
(10 hours)
Module: 3
Intermolecular forces relevant to colloidal systems: Electrostatic and van der Waals forces. DLVO theory.
Measurement techniques of surface tension, contact angle, zeta potential, particle size.
(10 hours)
Module: 4
Overview of industrial applications of various interfacial phenomena in the industries [Mattress industry (Foam: preparation, characterization, stability), petroleum industry, Mineral processing industry Pesticides, firefighting, personal care formulations], Super hydrophobic surface and self-cleaning surfaces. Case studies related interfacial science.
Application of interfacial engineering concept through the surface modification for the synthesis of nanostructured material by using surface active agent.
(12 hours)</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">Text Books:
1. P. C. Hiemenz, and R. Rajagopalan, Principle of colloid and surface chemistry, 3rd edition, Mercel Dekher, N. Y. 1997.
2. Pallab Ghosh, Colloid and Interface Science, 1st Edition, PHI Learning, 2009.
3. M. J. Rosen, Surfactants and Interfacial Phenomena, Wiley-Interscience Publication, New York, 2004.
Reference Books:</td></tr>
</table>

	4. Drew Myers, Surfaces, Interfaces and Colloids, 3rd Edition, Wiley, 2006. 5. Tharwat F. Tadros, Applied Surfactants Principles and Applications, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, 2005. 6. J. Israelachvili, Intermolecular and Surface Forces, Academic Press, New York, 1992.

Departmental Elective (CHE 810-818)

<table>
<tr><td colspan="8">Department of Mechanical Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>CH-810</td><td>Multiphase flow</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT) and end assessment (EA))</td></tr>
<tr><td colspan="3">CHC-303 (Fluid Mechanics)</td><td colspan="5">CT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">CO 1: To learn fundamental of multiphase flow, different flow patterns and flow pattern maps. [PO: a,e,h,j,k]

CO 2: To learn transport mechanism of multiphase flow and industrial application of multiphase flow along with different measurement techniques for multiphase flow [PO: a,e,j,k]

CO 3: To learn different flow models in multiphase flow. [PO: a,c,e,h,k]

CO 4: Design & stability analysis of different types of multiphase flow and solving multiphase flow problems of different difficulty level. [PO: a,c,e,h,j,k]</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Module I: Introduction to multiphase flow (7L)
Two phase flow: Gas/Liquid and Liquid/liquid systems: Flow patterns in pipes, analysis of two phase flow situations, Prediction of holdup and pressure drop or volume fraction, Bubble size in pipe flow, Lockchart-Martinelli parameters, Bubble column and its design aspects, Minimum carryover velocity. holdup ratios, pressure drop and transport velocities and their prediction.
Module II: Flow Models (10L)
Flow patterns - identification and classification - flow pattern maps and transition - momentum and energy balance - homogeneous and separated flow models - correlations for use with homogeneous and separated flow models - void fraction and slip ratio correlations - influence of pressure gradient - empirical treatment of two phase flow - drift flux model - correlations for bubble, slug and annular flows Introduction to three phase flow,
Module III: Design and Stability of multiphase system (10L)
Dynamics of gas-solid liquid contactors (agitated vessels, packed bed, fluidized bed, pneumatic conveying, bubble column, trickle beds), Flow regimes, pressure drop, holdup, distributions, mass and heat transfer, reactions, Applications of these contactors
Module IV: Measurement techniques for multiphase flow (10L)
Measurement techniques in multiphase flow: Conventional and novel measurement techniques for multiphase systems (Laser Doppler anemometry, Particle Image</td></tr>
</table>

	Velocimetry) **Module V: Hydrodynamics of three phase systems (5L)** An introduction of three phase flow; liquid – solid flow, gas-solid flow; liquid-liquid-gas flow; gas-liquid-solid flow; principle of hydraulic and pneumatic transportation; flow regime identification; related measurement techniques.
Text Books, and/or reference material	1. Clift, R., Weber, M.E. and Grace, J.R., Bubbles, Drops, and Particles, Academic Press, New York, 1978. 2. Y. T. Shah, Gas-Liquid-Solid reactors design, McGraw Hill Inc, 1979 3. Fan, L. S. and Zhu, C., Principles of Gas-solid Flows, Cambridge University Press, 1998 4. Govier, G. W. and Aziz. K., "The Flow of Complex Mixture in Pipes", Van Nostrand Reinhold, New York, 1972. 5. Wallis, G.B., "One Dimensional Two Phase Flow", McGraw Hill Book Co., New York, 1969. 6. Crowe, C. T., Sommerfeld, M. and Tsuji, Y., Multiphase Flows with Droplets and Particles, CRC Press, 1998 7. Kleinstreuer, C., Two-phase Flow: Theory and Applications, Taylor & Francis, 2003 Rhodes, M., Introduction to Particle Technology, John Wiley & Sons, New York. 1998.

Department of Chemical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CHE811	**Chemical Reactor Analysis**	**PEL**	**3**	**0**	**0**	**3**	**3**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
CHC501		CT+EA					
Course Outcomes	CO1: Design&analyzefluid-solidnon-catalyticandcatalyticreactors [a, c, e, k] CO2: Design&analyzemultiphasereactors [a, c, e, k] CO3: Design bioreactors and analyzenon-ideal reactors [a, c, e, k] CO4: Analyze thermal instability of reactors [a, c, e]						
Topics Covered	**Module I:** • Design and analysis of non-catalytic solid-fluid reactors(4) **Module II:** • Analysis of catalytic reactors: Packed, moving-bed and fluidized-bed reactors (8) **Module II:** • Multiphase reactors: slurry and trickle bed reactors (9) **Module IV:** • Multiple steady states and thermal instability of reactors; Dynamic analysis of CSTR; Sustained oscillation and limit cycle (5) **Module V:** • Design of bioreactors (5) **Module VI:** • Modelling of non-ideal reactors (5)						

	Text Books 1. Chemical Reaction Engineering – Octave Levenspiel (Wiley) 2. Elements of Chemical Reaction Engineering – H. Scott Fogler (Prentice hall) Tutorial on above topics and class tests (6)
Text Books, and/or reference material	Text books: 1. H. S. Fogler, Elements of Chemical Reaction Engineering, Prentice Hall India 2. O. Levenspiel, Chemical Reaction Engineering, Wiley. Reference book: 1. Chemical Reactor Analysis and Design - G F Froment& K B Bischoff (Wiley)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CHE 812	**Bioprocess & Bioreactor Engineering**	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
CHC 301, CHC 403, CHC501		CT+EA					
Course Outcomes	• CO1: Apply kinetics of biochemical reactions for design of bioreactor [PO a, c, e, k] • CO2: Analyze performance of ideal and non ideal bioreactors [PO a, c, e, k] • CO3: Integrate different type of reactor and reactor assembly [PO a, c, e, k]						
Topics Covered	**Module I:** Introduction to the kinetics of Bioprocess; Enzyme kinetics; Cell growth kinetics; Kinetics of metabolic product synthesis by cells; Introduction of segregated and non-segregated models; Kinetics of immobilized enzymes and cells. (15 hrs) **Module II:** Background of bioreactors, Type of bioreactors – Airlift bioreactors, Airlift pressure cycle bioreactors, Loop bioreactor, Stirred tank bioreactors, Fluidized bed bioreactors, Trickle bed bioreactor, Bubble column fermenter, Design equations for CSTR fermenter, Two stage reactors, Reactors with non ideal mixing, Parametric sensitivity, Multiplicity in Biosystems, Global and local stability analyses of Bioreactors. (10 hrs) **Module III:** Bioreactor controlling probes, Characteristics of bioreactor sensors, Temperature measurement and control, DO measurement and control, pH/redox measurement and control, Detection and prevention of the foam, Biosensors. (5 hrs) **Module IV:**						

	Downstream processing in bioprocesses; Industrial application of bioprocesses. Bioprocess considerations in using animal cell cultures and plant cell cultures. (5 hrs) **Tutorial on above topics and class tests (7)**
Text Books, and/or reference material	Text Books: 1. J. E. Bailey, D. F. Ollis, Biochemical Engineering Fundamentals, Second Edition, Mc. Graw Hill Inc., Singapore, 1986. 2. H. W. Blanch, D. S. Clark, Biochemical Engineering, Special Indian Edition, Marcel Dekker Inc. New York, 2007. 3. M. L. Shuler, F. Kargi, Bioprocess Engineering - Basic Concepts, Second Edition, Prentice Hall of India Private Ltd., New Delhi, 2002. Reference Books: 4. P. M. Doran, Bioprocess Engineering Principles, Academic Press, California, 2009. 5. J. Nielsen, J. Villadsen, G. Liden, Bioreaction Engineering, Second Edition, Springer, 2007. 6. N. C. Price and L. Stevens, Fundamentals of Enzymology: The cell and Molecular Biology of Catalytic Proteins, Third Edition, Oxford University Press, Oxford, 2006. 7. D. G. Rao, Introduction to Biochemical Engineering, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2008.

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CHE 813	**INDUSTRIAL POLLUTION CONTROL AND TREATMENT**	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
Knowledge of all Unit Operations and Unit processes		CT+EA					
Course Outcomes		• The fundamental concepts in environmental engineering dealing with water, air, and land pollution. [PO k] • Graduates will learn a solid foundation in mathematics, sciences, and technical skills needed to analyze and design environmental engineering systems. [PO a,b,c,e] • Graduates will be familiar with current and emerging environmental engineering and global issues, and have an understanding of ethical and societal responsibilities. [PO h] • The necessary qualifications for employment in environmental engineering and related professions, for entry into advanced studies, and for assuming eventual leadership roles in their profession.[PO d]					

Topics Covered	Module -1: Introduction to Water Treatment: National & International Scenario; World-wide Water resources Management; Water quality standards – Drinking water standards; Industrial effluent standards **3 hr** Module-2: Physico-Chemical Treatment Technology : Aeration, Ion exchange, Ozone treatment, adsorption. Chemical coagulation-precipitation, settling, flocculation theorems, Chlorination, advanced scheme for municipal water treatment**.** **6 hr** Module-3: Biological Treatment: Basics of biological water treatment, relevant kinetics, biological reactor configurations, Activated sludge process, trickling filtration, lagoon treatment, submerged aerators, upward flow sludge blanket reactor, rotating disc biological contactors, advances in biological treatment. **7 hr** Module-4: Membrane Treatment: Different membranes and modules in water treatment; Transport mechanisms in membrane separation; Principles of Forward and Reverse osmosis; Membrane distillation, Micro and ultrafiltration; Nanofiltration and hybrid processes in water treatment processes. **7 hr** Module-5: Industry-specific advanced water treatment schemes: Petroleum refinery waste treatment, coke-oven waste treatment, pharmaceutical waste treatment, tannery wastewater treatment. **5 hr** <u>Module-6AIR POLLUTION</u> ▪ Environmental threats ▪ Role of Atmosphere in dispersion , Plume behavior ▪ Dispersion problems and Stack Design(Tutorial): ▪ Control devices –Cyclone Separators, ESP, Venturi scrubber, gravity separator, filters ▪ Design Problems (Tutorial) ▪ Abatement of gaseous pollutants & VOCs **10 hr** <u>Module-7</u> Solid and hazardous Waste management **4 hrs**
Text Books, and/or reference material	Text Books: 1. Industrial water treatment Process Technology, P. Pal, Elsevier Science 2. Membrane Technology in Environmental Pollution Control, P.Pal 3. Environmental Pollution Control Engineering – C.S. Rao Reference Books: 1. Groundwater Arsenic remediation: Treatment Technology and Scale up, P. Pal, Elsevier Science 2. Handbook of Chlorination and Alternative disinfection, Geo. Clifford White, Wiley 3. Water Treatment Plant Design, Stephen J. Randtke, Michael B. Horsley(EDs.), ASCE

	4.Water Technology, N.F. Gray, Elsevier Science

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Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				
		Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	Credit
COMBUSTION ENGINEERING (CHE 814)	PEL	3	0	0	3	3

Pre-requisites: Process calculation, Material and energy balance, Engg. Mathematics, ODE, PDE, Numerical techniques, modelling simulation with computing skill using c and Matlab.	Course Assessment methods (Continuous (CT), Midterm (MT) and end assessment (EA))
	CT+MT+EA

Course Outcomes	• CO1: Mass and energy balance during combustion of solid, liquid and gaseous fuel. • CO2: Reaction kinetics and mechanism of Pyrolysis, Combustion and gasification. • CO3: Burner design for different industrial application. • CO4: Clean coal technologies, coal bed methane blending of biomass with coal.
Topics Covered	Module – 1 • Properties of solid liquid and gaseous fuels Classification, Composition, Calorific Values, Lower and higher heating values, ASTM test techniques of solid, liquid and gaseous fuels. 3 h • Gasification of coal – Coal gasification technologies, chemical reactions, process conditions, design of gasification equipment. Underground coal gasification technology, process route. 3 h • Clean coal Technologies: What is clean coal technology? Principle and objectives. Oxyfuel combustion, Biochar, Carbon capture and storage, Carbon sequestration, Kyoto Protocol, Mitigation of global warming, Refined coal, Coal bed methane deposits, CBM recovery through microporous network, Primary method-Dewatering process, Secondary method (Carbon dioxide injection technique). 6 h Module – 2 • Stoichiometry of combustion - Chemical equations, Mass and energy balance of solid liquid and gaseous fuel combustion, concept of mixture fraction and equivalence ratio, problems on Fuel efficiency, excess air ratio and draft.Gas analyzers- Orsat and modern gas analyzers 7h Module – 3 • Combustion of liquid and gaseous fuels Theory of diffusion flame, development diffusion flame equations and its solution technique, length of diffusion flame, chemical properties of diffusion flame & Premixed flame and its nature. Burner design for liquid and gaseous fuel, Types of Burners, design parameters and problems.7 h

	Module – 4 • Combustion of solid fuels Stages of combustion- drying, devolatilization, volatile combustion, combustion of residual char.Pulverized coal combustion, Combustion in fluidized bed system, burning rate in fluidized bed, factors affecting combustion efficiency. • Combustion in bubbling fluidized bed boilers Combustion mechanism dense phase and lean phase concept and mass and energy balance, Recirculation of fly ash, effect of design parameters on combustion efficiency. • Single particle combustion modelling- Single particle combustion modelling using volume reaction model, reaction mechanism and role of pore surface area. Heat and species transport equation in porous medium.Excremental technique in TG/DTA and drop tube furnace. 12 h • Tutorial and class test 5h
Text Books, and/or reference material	Text Books: 1. **Combustion and Fuel Technology, A.K. Shaha** **2. Combustion and gasification in Fluidized bed, PrabirBasu, Taylor & Francis** Reference Books:

Subject Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CHE 815	**Process Analysis and Optimization**	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
MAC01, MAC02, CHS351		CT+EA					
Course Outcomes	• CO1: Conceptualization of a chemical process and its needs • CO2: Solving material and heat balance for a large-scale process • CO3: Understanding process synthesis • CO4: Solving optimal design and control problems simultaneously						

	• CO5: Real time optimization techniques and their implementations
Topics Covered	Module - I Cramer's rule, Inverse of matrix, Gauss elimination, Gauss Jordan method, LU decomposition, Gauss Seidel method, error analysis, Linear regression 9 hrs. Module - II Bisection method, successive substitution method, Newton-Raphson method, Secant method, Eigen values, Eigen vectors and its application in solving differential equations 10 hrs Module - III Multi-variable optimization algorithms: Unidirectional search, Direct search methods, Gradient based methods, Constrained optimization algorithms: Kuhn-Tucker conditions, Transformation methods. 8 hrs Module - IV Sensitivity analysis, Direct search for constrained minimization, Linearized search techniques, Feasible direction method, Generalized reduced gradient method, Gradient projection method. 6hrs Module-V ODE- Initial Value Problem, Boundary Value Problem, Specialized algorithms: Integer programming, Geometric programming, Nontraditional optimization algorithms: Genetic algorithms, Simulated annealing, Global optimization. 5 hrs
Text Books, and/or reference material	Text Books: 1. S. K. Gupta, "Numerical Techniques for Engineers", New Age International Publishers, 3rd edition, 2015 2. Deb K., Optimization for engineering design, Algorithms and examples, Prentice Hall of India, New Delhi, 2005. 3. Mathematical Methods in Chemical & Environmental Engineering: Ajay K. Ray, Thomson Learning, 2000. Reference Books: 1. S. Dutta, "Optimization in Chemical Engineering", Cambridge University Press, 2017

Department of Chemical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CHE816	CFD Applications in Chemical Engineering	PCR	3	0	0	3	3
Pre-requisites							
Course Outcomes	• CO1: To learn basics of continuum based modelling and simulation; Its area of applications and limitations [PO: a,e,h,j,k] • CO2: To learn different discretization methods of continuum based governing equations [PO: a,b,e,k] • CO3: To learn different steps of CFD simulations [PO: a,b,e,j,k] • CO4: To learn the use of CFD techniques in realistic problems [PO: a,b,e,h,j,k]						

Topics Covered	Module I: **Introduction** Introduction to Computational Fluid Dynamics (2) Conservation Equations (2) Discretization. Different Numerical methods and their comparison; Finite Difference Method, Finite Volume Method, Finite Element Method, etc. (5) Source terms and their linearization (1) Solution of discretized equations (2) Module II: **Solution of mass and energy equations** Solution of diffusive problems: Steady 1D, Steady 2D and Steady 3D problems. Unsteady 1D, 2D unsteady and 3D unsteady problems (9) Solution of convective-diffusion problems: Steady and unsteady problems; Different schemes (9) Module III:**Solution of momentum equations** SIMPLE, SIMPLER, SIMPLEC algorithms (10)
Text Books, and/or reference material	Text Books: 1.Numerical heat transfer and fluid flow by S.V. Patankar, Hemisphere Publishing Corporation, 1980. 2.Introduction to Computational Fluid Dynamics by Anil W. Date, Cambridge University Press, 1st Edition, 2005.

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Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CHE 817	NANOTECHNOLOGY	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					
Course Outcomes	• CO1: Acquire the concept of nanotechnology at the basic level to apply for different application. • CO2: Acquire the concept of synthesis and characterization of nanomaterials. • CO3: Acquire the idea how to apply nanotechnology in different fields (catalysis, energy and environment) for better efficiency.						
Topics Covered	Module: 1 Introduction to the physics of solid state. Structure and bonding elements of nanoscience & nanotechnology. (8 hours) Module: 2 Synthesis of nanomaterials: General Top Down and Bottom up approaches. Physical Methods, Chemical Methods & Biological Methods. Mechanical, Structural, Thermal, Electrical & Optical properties. (10 hours) Module: 3 Characterization techniques of nanomaterials: Spectroscopy, XRD, BET, TGA, SEM and TEM. Some special nanomaterials: Carbon nanotubes, Porous silicon, Zeolites, Aerogels, Core-shell, Hollow and Yolk-shell nanoparticle. (12 hours) Module: 4						

	Application of the nanomaterials in different fields. Nanolithography, Nanocomposites. Nanoparticles as catalyst Nanoparticles in energy and environment application. Nanoparticles in biomedical application. (12 hours)
Text Books, and/or reference material	**Text Books:** 1. T. Pradeep, Nano: The Essentials, Understanding Nanoscience and Nano Technology, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2007. 2. Nanotechnology: Principles & Practices; Sulabh K. Kulkarni, Capital Publishing Company, Kolkata **Reference Books:** 3. Principles of nanotechnology: N. Phani kumar; Scitech, Kolkata 4. Introduction to nanotechnology: Charles P. Poole & Frank Li Owens, Wiley India (p) Ltd, New Delhi

Department of Chemical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CHE 818	PINCH TECHNOLOGY	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
Heat Transfer ()		CT+EA					
Course Outcomes	• CO1: Acquire an idea to optimize the process heat recovery and reducing the external utility loads. • CO2: To achieve financial saving by constructing the best process heat integration.						
Topics Covered	Module: 1 Introduction to process Intensification and Process Integration (PI). Areas of application and techniques available for PI, onion diagram. Overview of Pinch Technology: Introduction, Basic concepts, How it is different from energy auditing, Roles of thermodynamic laws, problems addressed by Pinch Technology. Key steps of Pinch Technology: Concept of ΔT_{min} , Data Extraction, Targeting, Designing, Optimization-Supertargeting Basic Elements of Pinch Technology: Grid Diagram, Composite curve, Problem Table Algorithm, Grand Composite Curve. Targeting of Heat Exchanger Network: Energy Targeting, Area Targeting, Number of units targeting, Shell Targeting and Cost targeting. (12 hours) Module: 2 Designing of HEN: Pinch Design Methods, Heuristic rules, stream splitting, and design of maximum energy recovery (MER). Use of multiple utilities and concept of utility pinches, Design for multiple utilities pinches, Concept of threshold problems and design strategy. Network evolution and evaluation-identification of loops and paths, loop breaking and path relaxation. (10 hours) Module: 3 Design tools to achieve targets, Driving force plot, remaining problem analysis, diverse pinch concepts, MCp ratio heuristics. Targeting and designing of HENs with different ΔT_{min} values, Variation of cost of utility,						

	fixed cost, TAC, number of shells and total area with ΔTmin Capital-Energy trade-offs. Process modifications-Plus/Minus principles, Heat Engines and appropriate placement of heat engines relative to pinch. Heat pumps, Appropriate placement of heat pumps relative to pinch. Steam Rankin Cycle design, Gas turbine cycle design, Integration of Steam and Gas turbine with process. Refrigeration systems, Stand alone and integrated evaporators. Heat integrations and proper placement of Reactors for batch Processes as well as continuous processes. (15 hours) Module: 4 Case studies on heat integration by pinch technology (5 hours)
Text Books, and/or reference material	**Text Books:** 1. Shenoy U. V.; "Heat Exchanger Network Synthesis", Gulf Publishing Co. 2. Smith R.; "Chemical Process Design", McGraw-Hill. 3. Linnhoff B., Townsend D. W., Boland D, Hewitt G. F., Thomas B. E. A., Guy A. R., and Marsland R. H.; "A User Guide on Process Integration for the Efficient Uses of Energy", Inst. Of Chemical Engineers. **Reference study:** Research article

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

NEW SYLLABI FOR THE CURRICULAM OF UG COURSE

(BACHELOR OF TECHNOLOGY)

COMMON FIRST YEAR COURSES –(2018 -19 ONWARDS)

FIRST SEMESTER

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
MAC 01	MATHEMATICS - I	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
Basic concepts of function, limit, differentiation and integration.		CT+EA					
Course Outcomes	• CO1: Fundamentals of Differential Calculus • CO2: Fundamentals of Integral Calculus • CO3: Fundamentals of Vector Calculus • CO4: Basic Concepts of Convergence						
Topics Covered	**Functions of Single Variable:** Rolle's Theorem and Lagrange's Mean Value Theorem (MVT), Cauchy's MVT, Taylor's and Maclaurin's series, Asymptotes & Curvature (Cartesian, Polar form). (8) **Functions of several variables:** Function of two variables, Limit, Continuity and Differentiability, Partial derivatives, Partial derivatives of implicit function, Homogeneous function, Euler's theorem and its converse, Exact differential, Jacobian, Taylor's & Maclaurin's series, Maxima and Minima, Necessary and sufficient condition for maxima and minima (no proof), Stationary points, Lagrange's method of multipliers. (10) **Sequences and Series:** Sequences, Limit of a Sequence and its properties, Series of positive terms, Necessary condition for convergence, Comparison test, D Alembert's ratio test, Cauchy's root test, Alternating series, Leibnitz's rule, Absolute and conditional convergence. (6) **Integral Calculus:** Mean value theorems of integral calculus, Improper integral and it classifications, Beta and Gamma functions, Area and length in Cartesian and polar co-ordinates, Volume and surface area of solids of revolution in Cartesian and polar forms, (12) **Multiple Integrals:** Double integrals, Evaluation of double integrals, Evaluation of triple integrals, Change of order of integration, Change of variables, Area and volume by double integration, Volume as a triple integral. (10) **Vector Calculus:** Vector valued functions and its differentiability, Line integral, Surface integral, Volume integral, Gradient, Curl, Divergence, Green's						

	theorem in the plane (including vector form), Stokes' theorem, Gauss's divergence theorem and their applications. (10)
Text Books, and/or reference material	**Text Books:** 1. E. Kreyszig, Advanced Engineering Mathematics: 10 th edition, Wiley India Edition. 2. Daniel A. Murray, Differential and Integral Calculus, Fb & c Limited, 2018. 3. Marsden, J. E; Tromba, A. J.; Weinstein: Basic Multivariable Calculus, Springer, 2013. **Reference Books:** 1. Tom Apostal, Calculus-Vol-I & II, Wiley Student Edition, 2011. 2. Thomas and Finny: Calculus and Analytic Geometry, 11 th Edition, Addison Wesley.

Course Code	**Title of the course**	**Program Core (PCR) / Electives (PEL)**	**Total Number of contact hours**				Credit
			Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Total Hours**	
PHC01	**PHYSICS**	**PCR**	**2**	**1**	**0**	**3**	**3**
Pre-requisites:		Course Assessment methods: (Continuous (CT), MID term and End Term Assessment (EA))					
NIL		CT+EA					
Course Outcomes	CO1: To realize and apply the fundamental concepts of physics such as superposition principle, simple harmonic motion to real world problems. CO2: Learn about the quantum phenomenon of subatomic particles and its applications to the practical field. CO3: Gain an integrative overview and applications of fundamental optical phenomena such as interference, diffraction and polarization. CO4: Acquire basic knowledge related to the working mechanism of lasers and signal propagation through optical fibers.						
Topics Covered	**Harmonic Oscillations** - Linear superposition principle, Superposition of two perpendicular oscillations having same and different frequencies and phases, Free, Damped and forced vibrations, Equation of motion, Amplitude resonance, Velocity resonance, Quality factor, sharpness of resonance, etc. [8] **Wave Motion** - Wave equation, Longitudinal waves, Transverse waves, Electro-magnetic waves. [3] **Introductory Quantum Mechanics** - Inadequacy of classical mechanics, Blackbody radiation, Planck's quantum hypothesis, de Broglie's hypothesis, Heisenberg's uncertainty principle and applications, Schrodinger's wave equation and applications to simple problems: Particle in a one-dimensional box, Simple harmonic oscillator, Tunnelling effect. [8] **Interference & Diffraction** - Huygens' principle, Young's experiment, Superposition of waves, Conditions of sustained Interference, Concepts of coherent sources, Interference by division of wavefront, Interference by division of amplitude with examples, The Michelson interferometer and some problems; Fraunhofer diffraction, Single slit, Multiple slits, Resolving power of grating. [13] **Polarisation** - Polarisation, Qualitative discussion on Plane, Circularly and elliptically polarized light, Malus law, Brewster's law, Double refraction (birefringence) - Ordinary and extra-ordinary rays, Optic axis etc.; Polaroid, Nicol prism, Retardation plates and analysis of polarized lights. [5]						

	Laser and Optical Fiber - Spontaneous and stimulated emission of radiation, Population inversion, Einstein's A & B co-efficient, Optical resonator and pumping methods, He-Ne laser. Optical Fibre– Core and cladding, Total internal reflection, Calculation of numerical aperture and acceptance angle, Applications. [5]
Text Books, and/or reference material	**TEXT BOOKS**: 1. The Physics of Vibrations and Waves, H. John Pain, Willy and Sons 2. Vibrations and Waves in Physics, Iain G. Main, Cambridge University Press 3. Engineering Physics, H. K. Malik and A. K. Singh, McGraw-Hill. **REFERENCE BOOKS**: 1. Quantum Physics, R. Eisberg and R. Resnick, John Wiley and Sons 2. Fundamental of Optics, Jankins and White, McGraw-Hill 3. Optics, A. K. Ghatak, Tata McGraw-Hill 4. Waves and Oscillations, N. K. Bajaj, Tata McGraw-Hill 5. Lasers and Non-linear Optics, B. B. Laud , New Age International Pvt Lt

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYC 01	Engineering Chemistry	PCR	2	1	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
None		CT+EA					

Course Outcomes	• CO1: Introduced to chemical thermodynamics, kinetics, electrochemistry, absorption and catalytic processes for engineering applications • CO2: To learn fundamentals of polymer chemistry and petroleum engineering. • CO3: Introduced to basic spectroscopic techniques for structure determination and characterization. • CO4: To study few inorganic and bioinorganic compounds of industrial importance.
Topics Covered	**ORGANIC CHEMISTRY** i. Fundamentals of organic reaction mechanisms; Few important reactions and their mechanism along with their applications; Robinson annulation, Hydroboration reaction, Organometallic reagents (Gilman reagents), Metathesis using Grubb's catalyst and Wittig reaction. (3) ii. Fundamental concept on stereochemistry and application: Conformation and configuration of organic compounds, Diastereo-selective, enantio-selective, regio-selective, stereo-specific and stereo-selective reactions. (3) iii. Polymer chemistry and polymer engineering: Fundamental concept on polymer chemistry; synthesis and application of important polymers, Rubber and plastic materials. Conducting polymer. (2) iv. Petroleum Engineering and oil refinery: origin of mineral oils, separation principle and techniques of distillation of crude oil, Uses of different fractions, octane number, cetane number, Knocking, anti-knock compounds, and Bio-Fuel. (2) v. Structure elucidation of organic compounds by modern spectroscopic methods; Application of UV-Visible and FT-IR spectroscopy. (3)

	INORGANIC CHEMISTRY i. **Coordination Chemistry:** Crystal Field Theory of octahedral and tetrahedral complexes, colour and magnetic properties, Jahn-Teller distortion, pseudo Jahn-Teller distortion, Isomerism and stereochemistry.(5) ii. **Bioinorganic Chemistry:** Heme and non-heme O_2 transport protein (Haemoglobin, Myoglobin), Chlorophyll and photosynthesis. (3) iii. **Inorganic Materials:** Introduction towards industrially important inorganic materials like cementing material, refractory material, fertiliser, inorganic polymer. (2) iv. **Organometallic Chemistry:** π-acid ligands, stabilization of metal low oxidation state and 18 electron rules, metal carbonyls and nitrosyls, metal-alkene complexes. (4) **PHYSICAL CHEMISTRY** i. **Thermodynamics:** 2nd law of thermodynamics, entropy, free energy, Gibbs Helmholtz equation, change of phase. Cryogenics: joule Thomson experiment. (4) ii. **Chemical Kinetics:** 2nd and 3rd order rate expression, Reversible reaction, Chain reaction, Consecutive reaction, Temp effect on reaction rate. (4) iii. **Electrochemistry:** Electrochemical cell, Effect of pH, precipitation and complex formation on EMF of oxidation/reduction processes. (2) iv. **Absorption:** Physical and Chemical absorption, Absorption isotherms. (1) v. **Catalysis:** Types of catalysis, Rate expression for Catalysed reaction, Acid-base and Enzyme catalysis. (2)
Text Books, and/or reference material	Suggested Text Books: (i) Physical Chemistry by P. Atkins, Oxford (ii) A guidebook to mechanism in Organic chemistry: Peter Sykes; Pearson Edu. (iii) Inorganic Chemistry Part-I & II, R. L. Dutta, The new book stall Suggested Reference Books: **Organic Chemistry**: (i) Basic stereochemistry of organic molecules: S. Sengupta; Oxford University press (ii) Engineering Chemistry: Wiley (iii) Elementary Organic Spectroscopy: William Kemp, ELBS with Macmillan **Inorganic Chemistry:** (i) Inorganic Chemistry: Principle structure and reactivity, J. E. Huheey, E. A. Keiter and R. L. Keiter, Pearson Education (ii) Bioinorganic Chemistry -- Inorganic Elements in the Chemistry of Life: An Introductionand Guide, 2nd Edition, Wolfgang Kaim, Brigitte Schwederski, Axel Klein. (iii) Inorganic Chemistry Fourth Edition, Shriver & Atkins, Oxford **Physical Chemistry:** (i) Physical Chemistry by G.W Castellan (ii) Physical Chemistry by P. C. Rakshit

<table>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)#</td><td>Total Hours</td></tr>
<tr><td>XEC01</td><td>ENGINEERING MECHANICS</td><td>PCR</td><td>2</td><td>1</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous (CT) and end assessment (EA))</td></tr>
<tr><td colspan="2"></td><td colspan="6">CT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• CO1: Improves the knowledge of mechanics and ability to draw free body diagrams.
• CO2: Imparts knowledge on application of mechanics for special problems like truss and frame analysis.
• CO3: Builds up ability to calculate centroid and moments of inertia for various shapes and its application thereof.
• CO4: Enhances the idea on dynamics with different engineering applications using momentum and energy principles.
• CO5: Introduces with Virtual Work Principle and its simple application.
• CO6: Prepares the prerequisites for studying the subject Strength of Materials / Solid Mechanics.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Engineering Mechanics; measurement and SI units. [1]

Vectors and force as a vector; Resultant of a system of forces on a particle; free body diagram and conditions of equilibrium of a particle; problems on particles; equilibrium of particles in space. [2]

Resultant of a system of forces and couples on a rigid body; conditions of equilibrium of a rigid body; free body diagrams of rigid bodies subjected to different types of constraints; simple space problems of rigid bodies. [4]

Coefficients of static and kinetic friction; problems involving friction; theories of friction on square threaded power screw and flat belt. [5]

Simple trusses; analysis of trusses by method of joints and method of sections. [5]

Centre of gravity and centre of mass; centroids of lines, curves and areas; first moment of area; second moment of area; polar moment of inertia; radius of gyration of an area; parallel axis theorem; mass moment of inertia. [4]

Path, velocity, acceleration; rectilinear and curvilinear motion; motion of system of particles; introduction to the concept of plane kinematics of rigid bodies. [6]

Newton's second law of motion; dynamic equilibrium and D'Alembert's principle; linear momentum; angular momentum; rectilinear and curvilinear motion; principles of work–energy and impulse–momentum; impact of system of particles; introduction to the concept of plane kinetics of rigid bodies. [12]

Principle of Virtual Work, Solution of Problems on Mechanics using Principle of</td></tr>
</table>

	Virtual Work [3]
Text Books, and/or reference material	1) S P Timoshenko and D H Young, Engineering Mechanics, 5th Edition 2) J L Meriam and L G Kraige, Engineering Mechanics, 5th Edition, Wiley India 3) F P Beer and E R Johnston, Vector Mechanics for Engineers 4) I H Shames, Engineering Mechanics

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)#	Total Hours	
ESC01	**Environmental Science**	PCR	2	0	0	2	2
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
		CT+EA					
Course Outcomes	• Understand the importance of environment and ecosystem. • Understand the fundamental aspect of pollutant tracking and its implementation in natural and anthropogenic pollution of air and water system. • Understand the scientific basis of local and as well as global issues. • Apply of knowledge to develop sustainable solution.						
Topics Covered	**Introduction:** Multidisciplinary nature of Environmental Studies; Basic issues in Environmental Studies. [2] Human population and the Environment. [1] Social issues and the Environment. [1] **Constituents of our Environment & the Natural Resources:** Atmosphere– its layers, their characters; Global warming, Ozone depletion, Acid rain, etc. [5] Hydrosphere - Its constituents, Oceans, Groundwater, Surface waters; Hydrological cycle. [4] Lithosphere - constituents of lithosphere; Rock and Mineral resources; Plate Tectonic Concept and its importance. [5] Biosphere – its components; Ecosystems and Ecology; Biodiversity; Biomes. [5] Natural disaster and their management – Earthquakes, Floods, Landslides, Cyclones. [3] **Pollution:** Pollutants and their role in air and water pollution. [2]						
Text Books, and/or reference material	1. Environmental Studies – Benny Joseph – Tata McgrawHill-2005 2.Environmental Studies – Dr. D.L. Manjunath, Pearson Education-2006. 3.Principles of Environmental Science and Engineering – P. Venugoplan Rao, Prentice Hall of India. 4.Environmental Science and Engineering – Meenakshi, Prentice Hall India. 5.Environmental studies – R. Rajagopalan – Oxford Publication - 2005. 6.Text book of Environmental Science & Technology – M. Anji Reddy – BS Publication..						

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
XES51	**ENGINEERING GRAPHICS**	PCR	1	0	3	4	2.5
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					
Course Outcomes	• To develop the ability of mental visualization of different objects • To impart knowledge regarding standard conventions on lettering, dimensioning, symbols etc • To introduce with the theory of orthographic projection to solve problems on one/two/three dimensional objects • To prepare for the higher semester departmental drawings • To give exposure to read/interpret industrial drawing and to communicate with relevant people						
Topics Covered	Graphics as language of communication; technical drawing tools and their up-keep; types of lines; construction of geometrical figures; lettering and dimensioning. [6] Construction and use of scales; construction of curves of engineering importance such as curves of conic section; spirals, cycloids, involutes and different loci of points; use of equations for drawing some curves. [9] Descriptive geometry: necessity and importance of orthographic projection; horizontal and vertical reference planes; coordinate of points; orthographic projection of points and lines situated in different quadrants, viz. 1^{st}, 2^{nd}, 3^{rd} and 4^{th} quadrants; traces of lines. First angle and third angle projection of lines and planes; views from top, front and left (or right); true length and true inclination of lines with planes of projections; primary auxiliary projection of points, lines and planes; auxiliary plan and auxiliary elevation. [9] Projection of simple regular solids, viz. prisms, cubes, cylinders, pyramids, cones, tetrahedrons, spheres, hemi-spheres etc. [6] Section of solids; section by perpendicular planes; sectional views; true shapes of sections. [6] Dimensional techniques; international and national standards (ISO and BIS). [3] Freehand graphics. [3]						
Text Books, and/or reference material	1)… Engineering Drawing and Graphics – K Venugopal 2)… Engineering Drawing – N D Bhat 3)… Practical Geometry and Engineering Graphics – W Abbott						

Course Code	**Title of the course**	**Program Core (PCR) / Electives (PEL)**	**Total Number of contact hours**				**Credit**
			Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Total Hours**	

HSS51	Professional Communication Lab	PCR	1	0	2	3	2

Pre-requisites	Course Assessment methods (Continuous Test (CT) and/or End Assessment (EA))
None	CT

Course Outcomes	• CO1: Improvement in linguistic proficiency of the learners • CO2: Improvement in communicative ability of the learners
Topics Covered	1. Professional Communication: Introduction (1) 2. Technical Writing: Basic Concepts (2) 3. Style in Technical Writing (3) 4. Technical Report (2) 5. Recommendation Report (2) 6. Progress Report (1) 7. Technical Proposal (3) 8. Business Letters (3) 9. Letters of Job Application (2) 10. Writing Scientific and Engineering Papers (3) 11. Effective Use of Graphic Aids (2) 12. Presentation Techniques (6) 13. Group Discussion (6) 14. Interview Techniques (6)
Text Books, and/or reference material	**Text Book:** 1. English for Engineers –Sudharshana & Savitha (Cambridge UP) **Reference Books:** 1. Technical Communication—Raman & Sharma (Oxford UP) 2. Effective Technical Communication—M A Rizvi (McGraw Hill Education)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)#	Total Hours	
PHS51	**PHYSICS LABORATORY**	PCR	**0**	**0**	**2**	**2**	**1**

Pre-requisites	Course Assessment methods: (Continuous evaluation (CE) and end assessment (EA))
NIL	CE+EA

Course Outcomes	• CO1: To realize and apply different techniques for measuring refractive indices of different materials. • CO2: To realize different types of waveforms in electrical signals using CRO. • CO3: To understand charging and discharging mechanism of a capacitor. • CO4: To understand interference, diffraction and polarization related optical phenomena. • CO5: To acquire basic knowledge of light propagation through fibers.
Topics Covered	1. Find the refractive index of a liquid by a travelling microscope.

	2. Determine the refractive index of the material of prism using spectrometer. 3. Determination of amplitude and frequency of electrical signals by oscilloscope. 4. To study the characteristics of RC circuits. 5. To study Brewster's law/Malus' law using laser light. 6. To study the diffraction of light by a grating. 7. To study the interference of light by Newton's ring apparatus. 8. To determine numerical aperture of optical fiber. 9. Determination of Planck constant.
Text Books, and/or reference material	**SUGGESTED BOOKS**: 1) A Text Book on Practical Physics – K. G. Majumdar. 2) Practical Physics – Worsnop and Flint **REFERENCE**: 1) Instruction sheets

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYS51	**CHEMISTRY LABORATORY**	PCR	0	0	2	2	1
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
None		CT+EA					
Course Outcomes	• CO1: To learn basic analytical techniques useful for engineering applications. • CO2: Synthesis and characterization methods of few organic, inorganic and polymer compounds of industrial importance. • CO3: Learn chromatographic separation methods. • CO4: Applications of spectroscopic measurements.						
Topics Covered	i. Experiments based on pH metry: Determination of dissociation constant of weak acids by pH meter. ii. Experiments based on conductivity measurement: Determination of amour of HCl by conductometric titration with NaOH. iii. Estimation of metal ion: Estimation of Fe^{2+} by permangnomentry iv. Estimation of metal ion: Determination of total hardness of water by EDTA titration. v. Synthesis and characterization of inorganic complexes: e. g. $Mn(acac)_3$, $Fe(acac)_3$, cis-bis(glycinato)copper(II) monohydrate and their characterization by m. p. , FTIR etc. vi. Synthesis and characterization of organic compounds: e.g. Dibenzylideneacetone. vii. Synthesis of polymer: polymethylmethacrylate viii. Verification of Beer-Lamberts law and determination of amount of iron present in a supplied solution.						

	ix. Chromatography: Separation of two amino acids by paper chromatograph x. Determination of saponification value of fat/ vegetable oil
Text Books, and/or reference material	Suggested Text Books: 1. Vogel's Quantitative Chemical Analysis (6th Edition) Prentice Hall 2. Advanced Physical Chemistry Experiments: By Gurtu & Gurtu 3. Comprehensive Practical Organic Chemistry: Qualitative Analysis By V. K. Ahluwalia and S. Dhingra Suggested Reference Books: 1. Practical Chemistry By R.C. Bhattacharya 2. Selected experiments in Physical Chemistry By N. G. Mukherjee

Course Code	**Title of the course**	Program Core (PCR) / Electives (PEL)	**Total Number of contact hours**				**Credit**
			Lecture (L)	**Tutorial (T)**	**Practical (P)#**	**Total Hours**	
WSS51	**WORKSHOP PRACTICE**	PCR	**0**	**0**	**3**	**3**	**1.5**
Pre-requisites		Course Assessment methods: (Continuous evaluation (CE) and end assessment (EA))					
NIL		CE+EA					

Course Outcomes	• CO1: Study and practice on machine tools and their operations • CO2: Practice on manufacturing of components using workshop trades including fitting, carpentry, foundry and welding • CO3: Identify and apply suitable tools for machining processes including turning, facing, thread cutting and tapping • CO4: Develop basic electrical engineering knowledge for house wiring practice
Topics Covered	**M/c shop & Carpentry shop -- 3X3= 9hrs.** • Introduction on machining process. • Introduction to machine tools- Lathe, Shaper, Milling and Drill machine. • Introduction to woods- Types, structure, disease and defect of wood. • Introduction to wood working machines and tools. • Making of dovetail joint and bridle joint. **Welding Shop & Sheet metal -- 3X3= 9hrs.** • Introduction to welding.Safety and precautions in welding. • Formation of weld bead by SMAW on mild steel flat. • Formation of weld bead by oxy-fuel welding on mild steel flat. • Introduction to sheet Metal works. • Tools and Machines used in sheet metal works. • Concept of development, marking out of metal sheets. • Cutting and joining of metal sheets.

	• Safety precautions, General warning needed in the shop floor. **Black smithy & Foundry -- 3X3= 9hrs.** • Introduction Smithing and Forging- Tools, Machines, Furnaces and its accessories, fuels. • Safety and precautions in blacksmithy. • Making of bars of different cross-sections. • Making of hexagonal headed bolts. • Forge welding. • Introduction to Foundry Technology. • Preparation of sand mould using Solid/Split Pattern. **Fitting & Electrical shop -- 3X3= 9hrs.** • Introduction to hand metal cutting tools with specifications, nomenclature and their use. • Marking tools, measuring tools and their use. • Fitting of joints of mild steel flats. • Introduction to electrical hazards and safety precaution. • Wire jointing and soldering. • PVC Conduit Wiring controlled by separate single way switches. • PVC Cashing Capping Wiring for two way switches. • Conduit wiring for the connection of a Calling Bell with In & Out Indicators. • Batten Wiring and Cleat Wiring. • Tube Light Connection. • Insulation Resistance Testing of 1ph / 3ph Motor and House Wiring. • Earth Resistance Testing. • DOL Starter Connection. **Viva voce -- 1X3= 3hrs.**
Text Books, and/or reference material	1. Workshop Technology Part I and Part II by W. A. J. Chapman 2. Elements of Workshop Technology S. K. Hazra Chowdhury, A. K. Hazra Chowdhury and Nirjhar Roy 3. Mechanical Workshop Practice by K. C. John

Course Code	**Title of the course**	Program Core (PCR) / Electives (PEL)	**Total Number of contact hours**				**Credit**
			Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Total Hours**	

XXS-51	**Co-curricular Activities**	PCR	**0**	**0**	**2**	**2**	**1**
Pre-requisites	Course assessment methods: Continuous evaluation (CE) and end assessment (EA)						
NIL	CE + EA						
Course Outcomes	• CO1: Social Interaction: Through the medium of sports • CO2: Ethics: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them • CO3: Self-directed and Life-long Learning: Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes. • CO4: Personality development through community engagement • CO5: Exposure to social service						
Topics Covered	**YOGA** • Introduction of Yoga. • Sitting Posture/Asanas- Padmasana, Vajrasana, Ardha kurmasana, Ustrasana, Bakrasana, Sasankasana, Janusirshasana, Suryanamaskar. • Mudra- Gyana mudra, Chin mudra, Shuni mudra, Prana mudra, Adi mudra, Anjali mudra. • Laying Posture/Asanas- Pavana Muktasana, Uttana Padasana, Sarpasana, Bhujangasana (Cobra Pose), Eka Pada Śalabhāsana, Dhanurasana, Chakrasana, Viparitkarani. • Meditation- Yog nidra, Om chant, Pray chant. • Standing Posture/Asanas- Tadasana (Mountain Pose), Vrikshasana (Tree Pose), Ardha chandrasana, Trikonasana, Utkatasana, Padahastasana. • Pranayama- Deep breathing, Anulom Vilom, Suryabhedi, Chandrabhedi. • Kriya- Kapalbhati, Trataka. **ATHLETICS** • Introduction of Athletic. • Starting Technique for Track events- Standing start, Crouch start & Block start. • Finishing Techniques. • Relay Race- 4×100m, 4×400m & Baton Exchange Technique & Rules. • Track Marking with Fundamentals- 200m, 400m and Diagonal Distance Radius, Straight Distance, Staggers of Different Lanes & Curve Distance. **BASKETBALL** • Introduction and Players stance and ball handling.						

	• Passing- Two hand chest pass, Two hand bounce pass, One hand baseball pass, Side arm pass, Over head pass, Hook pass. • Receiving- Two hand receiving, One hand receiving, Receiving in stationary position, Receiving while jumping and Receiving while running. • Dribbling- Dribble, High dribble, Low dribble, Reverse dribble, Rolling dribble. • Rules of Basketball. • Basketball game. **VOLLEYBALL** • Introduction of Volleyball • Service- Underarm service, Sidearm service, Tennis service, Floating service, Jump service. • Pass: Underarm pass- Ready position, Teaching stage of underarm pass and Upper hand pass- Volley pass, Back pass, Short set, Jump set & Underarm set. • Rules and their interpretation. **FOOTBALL** • Introduction of Football • Push pass- Instep inside, Instep outer side. • Kicking- Spot kick, Instep kick, Lofted kick. • Dribbling- One leg, Both legs, Instep. • Trapping- Rolling ball sole trapping, High ball sole trapping, High ball chest trapping, High ball thigh trapping. • Throwing- Standing throw, Running throw, Seating throw. • Goal Keeping- Griping the ball, Full volley, Half volley, Drop Kick. • Rules and their interpretation. **CRICKET** • Introduction of Cricket • Batting gripping & Stance, Bowling gripping technique. • Batting front foot defense & Drive. • Batting Back foot defense & Drive. • Batting Square cut. • Bowling medium pace, Bowling off break. • Fielding drill, Catching (Short & High). • Rules & Regulation. **BADMINTON** • Basic introduction about Badminton and Badminton court. • Racket parts, Racket Grip, Shuttle Grip.

	• Basic stance, Basic Footwork, Shadow practice (Full court movement). • Strokes services: Forehand- Overhead & Underarm, Backhand- Overhead & Underarm. • Match practice (Single & Double). • Rules & Regulation. **TABLE TENNIS** • Introduction of Table Tennis. • Basic Stance and Grip (Shake hand & Pen hold). • Service Basic. • Stroke: Backhand- Push, Deep Push, Chop, Rally, Drive, Drop Shot, Flick, Block, Smash. • Stroke: Forehand- Push, Deep Push, Chop, Rally, Drive, Drop Shot, Flick, Block, Smash. • Rules and their interpretations. • Table Tennis Match (Singles & Doubles). **NCC** • FD-1 General Introduction and words of command. • FD-2 Attention, Stand at ease and Stand easy, Turning and inclining at the halt. • FD-3 Sizing, Forming up in three Ranks Numbering, Open and Close order March and Dressing. • FD-4 Saluting at the halt, Getting on parade, Dismissing and falling out. • FD-5 Marching, Length of pace and Time of Marching in quick time and Halt, Slow March and Halt. • FD-7 Turning on the March and Wheeling. • FD-12 Parade practice. **TAEKWONDO** • Introduction about Taekwondo- Meaning of Taekwondo, Korean language of dress, Fighting area, Punch, Block, Kicks etc. • Stance- Ready stance, Walking stance, Fighting stance, Front stance, Back stance, Cat stance etc. • Punch Technique- Front fist punch, Rear fist punch, Double fist punch, With stance etc. Blocks- Upper blocks, Middle block, Side block, Suto etc. • Foot Technique (Balgisul)- Standing kick (Saseochagi), Front kick (Abchagi), Doliyo (Chagi), Abdal chagi (Butterfly kick), Back kick etc. **NSS** • Swachha Bharat Mission • Free Medical Camp • Sanitation drive in and around the campus.

	• Unnat Bharat Abhiyaan • Matribhasha Saptah celebration

SECOND SEMESTER

<table>
<tr><td colspan="8">Department of Mathematics</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td>Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td><td></td></tr>
<tr><td>MAC 02</td><td>MATHEMATICS - II</td><td>PCR</td><td>3</td><td>1</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Basic concepts of set theory, differential equations and probability.</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• CO1: Develop the concept of basic linear algebra and matrix equations so as to apply mathematical methods involving arithmetic, algebra, geometry to solve problems.
• CO2: To acquire the basic concepts required to understand, construct, solve and interpret differential equations.
• CO3: Develop the concepts of Laplace transformation & Fourier transformation with its property to solve ordinary differential equations with given boundary conditions which are helpful in all engineering & research work.
• CO4: To grasp the basic concepts of probability theory</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Elementary algebraic structures: Group, subgroup, ring, subring, integral domain, and field. (5)
Linear Algebra: Vector space, Subspaces, Linear dependence and independence of vectors, Linear span, Basis and dimension of a vector space. Rank of a matrix, Elementary transformations, Matrix inversion, Solution of system of Linear equations, Eigen values and Eigen vectors, Cayley-Hamilton Theorem, Diagonalization of matrices. (15)
Ordinary Differential Equations: Existence and uniqueness of solutions of ODE (Statement Only), Equations of first order but higher degree, Clairaut's equation, Second order differential equations, Linear dependence of solutions, Wronskian determinant, Method of variation of parameters, Solution of simultaneous equations. (12)
Fourier series: Basic properties, Dirichlet conditions, Sine series, Cosine series, Convergence. (4)
Laplace and Fourier Transforms: Laplace transforms, Inverse Laplace transforms, Convolution theorem, Applications to Ordinary differential equations. Fourier transforms, Inverse Fourier transform, Fourier sine and cosine transforms and their inversion, Properties of Fourier transforms, Convolution. (10)
Probability: Historical development of the subject and basic concepts, Axiomatic definition of probability, Examples to calculate probability, Stochastic simulation, Random numbers. Random variables and probability distributions, Binomial distribution, Normal distribution. (10)</td></tr>
</table>

Text Books, and/or reference material	**Text Books:** 1. E. Kreyszig, Advanced Engineering Mathematics: 9th edition, Wiley India Edition. 2. Gilbert Strang, Linear algebra and its applications (4th Edition), Thomson (2006). 3. Shepley L. Ross, Differential Equations, 3rd Edition, Wiley Student Edition. **Reference Books:** 1. S. Kumaresan, Linear algebra - A Geometric approach, Prentice Hall of India (2000). 2. C. Grinstead, J. L. Snell, Introduction to Probability, American Mathematical Society

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSC01	**INTRODUCTION TO COMPUTING**	PCR	2	1	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
Basic knowledge of computer. CSC01 assumes no prior knowledge of programming.		CT+EA					
Course Outcomes	CO1: Recognize the changes in hardware and software technologies with respect to the evolution of computers and describe the function of system software's (operating Systems) and application software's, languages, number system, logic gates. CO2: Illustrate the flowchart and inscribe an algorithm for a given problem Inscribe C programs using operators. CO3: Develop conditional and iterative statements to write C programs. CO4: Exercise user defined functions to solve real time problems CO5: Inscribe C programs that use Pointers to access arrays, strings and functions. CO6: Exercise user defined data types including structures and unions to solve problems..						
Topics Covered	Fundamentals of Computer: History of Computer, Generation of Computer, Classification of Computers 2L Basic Anatomy of Computer System, Primary & Secondary Memory, Processing Unit, Input & Output devices [2] Languages: Assembly language, high level language, compiler and assembler (basic concepts) [1] Binary & Allied number systems representation of signed and unsigned numbers. BCD, ASII. Binary Arithmetic & logic gates [2] Basic concepts of operating systems like MS DOS, MS WINDOW, UNIX, Algorithm & flow chart [1]						

	C Fundamentals: The C character set identifiers and keywords, data type & sizes, variable names, declaration, statements [2] Operators & Expressions: Arithmetic operators, relational and logical operators, type, conversion, increment and decrement operators, bit wise operators, assignment operators and expressions, precedence and order of evaluation. Input and Output: Standard input and output, formatted output -- printf, formatted input scanf. [8] Flow of Control: Statement and blocks, if - else, switch, loops - while, for do while, break and continue, go to and labels [5] Fundamentals and Program Structures: Basic of functions, function types, functions returning values, functions not returning values, auto, external, static and register Variables, scope rules, recursion, function prototypes, C pre-processor, command line arguments. [5] Arrays and Pointers: One dimensional, two dimensional arrays, pointers and functions, multi-dimensional arrays. [10] Structures Union and File: Structure, union , structures and functions, arrays of structures, file read, file write [5]
Text Books, and/or reference material	Text Books: 1. Let us C by Kanetkar 2. C Programming by Gottfried 3. Introduction to Computing by Balaguruswamy 4. The C-programming language by Dennis Ritchie Reference Books: 1. Computer fundamental and programming in C by P Dey and M. Ghosh 2. Computer fundamental and programming in C by Reema Thareja 3. programming with C by Schaum Series

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECC01	**Basic electronics**	PCR	2	1	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					
Course Outcomes		• CO1: Acquire idea about basic electronic circuit, construction, operation. • CO2: Learn to use these Circuit elements for different applications.. • CO3: Learn to analyze the circuits and to find out relation between input and output.					
Topics Covered		Semiconductors and its properties. (3) PN Junction formation and construction of Diode. (5) Diode circuits as rectifiers, Diode based waveform shaping circuits. (4) Bipolar Junction Transistor, construction and operation. (4) BJT Biasing circuits, different types. (3) Amplifier, Single stage, CE,CB, CC, operation and uses. (4) Feedback amplifier, advantages & disadvantages, basic closed loop analysis (3) Other Semiconductor Devices : Operation and use of LED, JFET, DIAC,					

	MOSFET(2) Opamp: Characteristics of ideal operational amplifier Pin Configuration of IC 741, Analysis of simple operational amplifier circuits: concept of virtual ground; non-inverting amplifier and inverting amplifier Applications: voltage follower, summer, differentiator, integrator(6) Oscillator: Positive feedback and condition of oscillation R-C phase-shift oscillator, Wien bridge oscillator(3) Boolean Algebra : Boolean algebra, De Morgan's theorem, simplification of Boolean expression, Number system, range extension of numbers, Different codes: Gray code, ASCII code and different BCD codes and their uses(4) Logic Gates : NOT, OR, AND, NOR, NAND, EX-OR, EX-NOR gates Simplification of logic functions, Realizations of logic expressions using logic gates(4)
Text Books, and/or reference material	Text Books: 1. Introduction Electronic Devices & Circuit Theory,11/e, 2012, Pearson: Boylestad & Nashelsky 2. Integrated Electronics: Millman & Halkias Reference Books: 1. The Art of Electronics 3e, by Paul Horowitz, Winfield Hill 2. Electronics - Circuits and Systems, Fourth Edition by Owen Bishop 3. Electronics Fundamentals: Circuits, Devices & Applications (8e) by Thomas L. Floyd & David M. Buchla. 4. Electronic Principles, by Albert Paul Malvino Dr. and David J. Bates 5. Experiments Manual for use with Electronic Principles (Engineering Technologies & the Trades) by Albert Paul Malvino Dr., David J. Bates, et al.

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEC01	**ELECTRICAL TECHNOLOGY**	PCR	2	1	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					
Course Outcomes	• CO1: To learn the fundamentals of Electric Circuits and Network theorems. • CO2: To develop an idea on Magnetic circuits, Electromagnetism • CO3: To learn about single phase and polyphase AC circuits. • CO4: Introduction to single phase transformer. • CO5: Introduction to the transient analysis of RLC circuits with DC excitation.						
Topics Covered	Fundamentals of Electric Circuits: Ohm's laws, Kirchhoff's laws, Independent and Dependent sources, Analysis of simple circuits. (3) Network theorems. (4) Magnetic field, Concept of magnetic circuits, Magnetomotive Force, Reluctance, Ampere's circuital law and Biot-Savart law, Determination of B/H curve, Comparison of electric and magnetic circuit, Electromagnetic induction, Faraday's laws of electromagnetic induction, Direction and Magnitude of induced E.M.F. (7) Self and mutual Inductance, Inductances in series and parallel, Energy stored in inductor, Capacitance, Capacitance in series and parallel, Relationship between charge, voltage and current, Energy stored in capacitor (5)						

	Transients with D.C. excitation. (5) Generation of alternating voltage and current, E.M.F. equation, Average and R.M.S. value, Phase and phase difference, Phasor representation of alternating quantity, Behaviour of A.C. circuits, Resonance in series and parallel R-L-C circuits (7) Single-Phase Transformer , equivalent circuits, open circuit and short circuit tests (6) Polyphase system, Advantages of 3-phase system, Generation of 3-phase voltages, Voltage, current and power in a star and delta connected systems, 3-phase balanced and unbalanced circuits, Power measurement in 3-phase circuits. (5)
Text Books, and/or reference material	Text Books: 1. Electrical & Electronic Technology by Hughes, Pearson Education India Reference Books: 1. Advanced Electrical Technology by H. Cotton, Reem Publication Pvt. Ltd 2. Electrical Engineering fundamentals by Vincent Deltoro, Pearson Education India

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
BTC01	LIFE SCIENCE	PCR	2	0	0	2	2
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
		CT+EA					
Course Outcomes	CO1: To be familiarized with the basic cellular organization of organisms and cellular communications. CO2: To impart an understanding about the basic structure and functions of the macromolecules and their biosynthesis and catabolism. CO3: To give an understanding of the key features of the structure, growth, physiology and behavior of bacteria, viruses, fungi and protozoa CO4: To introduce molecular biology to understand biological processes in various applications. CO5: To provide a foundation in immunological processes and an overview of the interaction between the immune system and pathogens. CO6: To provide knowledge about biological and biochemical processes that require engineering expertise to solve them						

Topics Covered	**1. Cell Biology (4)** a) Introduction to life science: prokaryotes & eukaryotes Definition; Difference b) Introduction to cells Define cell, different types of cell c) Cellular organelles All organelles and functions in brief d) Cellular communications Introduction to basic signaling; endocrine, paracrine signaling; concepts of receptor, ligand, on-off switch by phosphorylation/dephosphorylation **2. Biochemistry (4)** a) Biological function of carbohydrate and lipid Introduction, structure and function b) Biological function of nucleic acids and protein Introduction, structure and function c) Catabolic pathways of Macromolecules Introduction to catabolism, hydrolysis and condensation reactions; Catabolism of glucose- Glycolysis, TCA; overall degradation of proteins and lipids d) Biosynthesis of Macromolecules Generation of ATP (ETS), Generation of Glucose (Photosynthesis) **3. Microbiology (5)** a) Types of microorganisms and their general features Bacteria, Yeast, Fungi, Virus, Protozoa- general introduction with practical significance and diseases b) Microbial cell organization Internal and External features of cell- bacterial cell wall, viral capsule, pilus etc, c) Microbial nutritional requirements and growth Different Sources of energy; growth curve d) Basic microbial metabolism Fermentation, Respiration, Sulfur, N_2 cycle **4. Immunology (5)** a) Basic concept of innate and adaptive immunity Immunity-innate and adaptive, differences, components of the immune system b) Antigen and antibody interaction Antigen and antibody, immunogen, factors affecting immunogenicity, basic antigen-antibody mediated assays, introduction to monoclonal antibody c) Functions of B cell B cell, antibody production, memory generation and principle of

	vaccination d) Role of T cell in cell-mediated immunity Th and Tc, functions of the T cell with respect to different pathogen and cancer cell **5. Molecular Biology (5)** a) Prokaryotic Genomes (Genome organization & structure) Nucleoid, circular or linear b) Eukaryotic Genomes (Genome organization & structure) Intron, exon, packaging, chromatin c) Central Dogma (Replication, Transcription and Translation) d) Applications of Molecular Biology (Diagnostics, DNA-fingerprinting, Recombinant products etc.) Introduction to Recombinant DNA, fingerprinting, cloning **6. Bioprocess Development (5)** a) Microbial growth kinetics Batch, fed-batch and continuous systems, Monod Equation b) Enzyme kinetics, including kinetics of enzyme inhibition and deactivation Definition of enzymes, activation energy, Concepts of Km, Vmax, Ki c) Microbial sterilization techniques and kinetics Introduction to sterilization, dry and moist sterilization d) Thermodynamics of biological system Concepts of Enthalpy, Entropy, favorable reactions, exergonic and endergonic reactions e) Material and energy balance for biological reactions Stoichiometry
Text Books, and/or reference material	1. Biotechnology 01 Edition, authored by U. Satyanarayana, Publisher: BOOKS & ALLIED (P) LTD.-KOLKATA 2. Biochemistry by Lehninger. McMillan publishers 3. Microbiology by Pelczar, Chan and Krieg, Tata McGraw Hill 4. Brown, T.A., Genetics a Molecular Approach, 4th Ed. Chapman and Hall, 1992 5. Kuby J, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002. 6. Bioprocess Engineering: Basic Concepts (2nd Edition), Shuler and Kargi, Prentice Hall International.

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
XES52	**GRAPHICAL ANALYSIS USING CAD**	PCR	0	0	2	2	1
Pre-requisites		Course Assessment methods (Continuous (CT) and end					

	assessment (EA))
NIL	CT+EA
Course Outcomes	• Introduction to graphical solution of mechanics problems • Graphical solution of problems related to resultant/equilibrium in coplanar force system (Imparting knowledge on polar diagram, funicular polygon) • Introducing Maxwell diagram and solution of plane trusses by graphical method • Determination of centroid of plane figures by graphical method • Exposure to AutoCAD software for computer aided graphical solution
Topics Covered	• Graphical analysis of problems on statics. [14] • Graphical solution of engineering problems using CAD (with the help of "AutoCAD") [14]
Text Books, and/or reference material	1)… Engineering Drawing and Graphics – K Venugopal 2)… AutoCAD — George Omura 3)… Practical Geometry and Engineering Graphics – W Abbott

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSS51	**COMPUTING LABORATORY**	PCR	0	0	2	2	1
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					
Course Outcomes	• CO1: To understand the principle of operators. • CO2: To understand the principle of loops, branching statements • CO3: To understand the working principle of function, recursion • CO5: To understand arrays , pointer, parameter passing techniques • CO6: To detail out the operations of strings • CO7: To understand structure, union • CO7: Application of C-programming to solve various real time problems						
Topics Covered	**List of Experiments:** 1. Assignments on expression evaluation 2. Assignments on conditional branching, iterations, pattern matching 3. Assignments on function, recursion 4. Assignments on arrays, pointers, parameter passing 5. Assignments on string using array and pointers 6. Assignments on structures, union						
Text Books, and/or reference material	**Text Books:** 1. Let us C by Kanetkar 2. C Programming by Gottfried 3. Introduction to Computing by Balaguruswamy 4. The C-programming language by Dennis Ritchie **Reference Books:** 1. Computer fundamental and programming in C by P Dey and M. Ghosh 2. Computer fundamental and programming in C by Reema Thareja 3. programming with C by Schaum Series						

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<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>ECS 51</td><td>Basic electronics Lab</td><td>PCR</td><td>0</td><td>0</td><td>2</td><td>2</td><td>1</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT) and end assessment (EA))</td></tr>
<tr><td colspan="3">NIL</td><td colspan="5">CT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• CO1: Acquire idea about basic electronic components, identification and behavior.
• CO2: To determine IV characteristics of these Circuit elements for different applications.
• CO3: Learn to analyze the circuits and observe and relate input and output signals.</td></tr>
<tr><td>Labs Conducted.</td><td colspan="7">1. To know your laboratory : To identify and understand the use of different electronic and electrical instruments.
2. To identify and understand name and related terms of various electronics components used in electronic circuits.: Identify different terminals of components, fid their values and observe numbering associate with it.
3. Use of oscilloscope and function generator: Use of oscilloscope to measure voltage, frequency/time and Lissajous figures of displayed waveforms.
4. Study of half wave and Full-wave (Bridge) rectifier with and without capacitor filter circuit.:
5. Realization of basic logic gates: Truth table verification of OR, AND, NOT, NOT and NAND logic gates from TTL ICs
6. Regulated power supply: To study LM78XX and LM79XX voltage regulator ICs
7. Transistor as a Switch: To study and perform transistor as a switch through NOT gate
8. Zenner diode as voltage regulator
9. To study clipping and Clamping circuits
10. To study different biasing cirtis.
11. Study of CE amplifier and observe its frequency response.</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7"><u>Text Books</u>:
1. Experiments Manual for use with Electronic Principles (Engineering Technologies & the Trades) by Albert Paul Malvino Dr., David J. Bates, et al.
<u>Reference Books</u>:
1. The Art of Electronics 3e, by Paul Horowitz, Winfield Hill
2. Electronic Principles, by Albert Paul Malvino Dr. and David J. Bates</td></tr>
</table>

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EES51	**ELECTRICAL TECHNOLOGY LABORATORY**	PCR	0	0	2	2	1
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					
Course Outcomes	• CO1: To understand the principle of superposition. • CO2: To understand the principle of maximum power transfer • CO3: To understand the characteristics of CFL, incandescent Lamp, carbon lamp. • CO4: To understand the calibration of energy meter. • CO5: To understand open circuit and short circuit test of single phase transformer. • CO6: To analyse RLC series and parallel circuits • CO7: To understand three phase connections						
Topics Covered	**List of Experiments:** 1.To verify Superposition and Thevenin theorem 2. To verify Norton and Maximum power transfer theorem 3. Characteristics of fluorescent and compact fluorescent lamp 4. Calibration on energy meter 5. To perform the open circuit and short circuit test on single phase transformer 6. To study the balanced three phase system for star and delta connected load 7. Characteristics of different types of Incandescent lamps 8. Study of Series and parallel R-L-C circuit						
Text Books, and/or reference material	Text Books: 1. Suggested Text Books: 1. Handbook of Laboratory Experiments in Electronics and Electrical Engineering by A M Zungeru (Author), J M Chuma (Author), H U Ezea (Author)						

Course Code	**Title of the course**	Program Core (PCR) / Electives (PEL)	**Total Number of contact hours**				**Credit**
			Lecture (L)	**Tutorial (T)**	**Practical (P)#**	**Total Hours**	
XXS-52	**Co-curricular Activities**	PCR	**0**	**0**	**2**	**2**	**1**
Pre-requisites	Course assessment methods: (Continuous evaluation((CE) and end assessment (EA)						
NIL	CE + EA						
Course Outcomes	• CO1: Social Interaction: Through the medium of sports • CO2: Ethics: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept						

	responsibility for them • CO3: Self-directed and Life-long Learning: Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes. • CO4: Personality development through community engagement • CO5: Exposure to social service
Topics Covered	**YOGA** • Sitting Posture/Asanas- Gomukhasana, Swastikasana, Siddhasana, Ustrasana, Janusirsasana, Ardha Matsyendrasana (Half-Spinal Twist Pose), Paschimottanasana, Shashankasana, Bhadrasana. • Mudra- Vayu, Shunya, Prithvi, Varuna, Apana, Hridaya, Bhairav mudra. • Laying Posture/Asanas- Shalabhasana (Locust Posture), Dhanurasana (Bow Posture), Ardha Halasana (Half Plough Pose), Sarvangasana (Shoulder Stand), Halasana (Plough Pose), Matsyasana, Supta Vajrasana, Chakrasana (Wheel Posture), Naukasana (Boat Posture), Shavasana (Relaxing Pose), Makaraasana. • Meditation- 'Om'meditation, Kundalini Or Chakra Meditation, Mantrameditation. • Standing Posture/Asanas- Ardha Chakrsana (Half Wheel Posture), Trikonasana (Triangle Posture), Parshwa Konasana (Side Angle Posture), Padahastasana, Vrikshasana (Tree Pose), Garudasana (Eagle Pose). • Pranayama- Nadi sodha, Shitali, Ujjayi, Bhastrika, Bhramari. • Bandha- Uddiyana Bandha, Mula Bandha, Jalandhara Bandha, Maha Bandha. • Kriya- Kapalabhati, Trataka, Nauli. **ATHLETICS** • Long Jump- Hitch kick, Paddling, Approach run, Take off, Velocity, Techniques, Flight & Landing • Discus throw, Javelin throw and Shot-put- Basic skill & Technique, Grip, Stance, Release & Follow through. • Field events marking. • General Rules of Track & Field Events. **BASKETBALL** • Shooting- Layup shot, Set shot, Hook shot, Jump shot. Free throw. • Rebounding- Defensive rebound, Offensive rebound. • Individual Defensive- Guarding the man without ball and with ball. • Pivoting. • Rules of Basketball. • Basketball game.

	VOLLEYBALL • Spike- Straight spike, Body turn spike, Tip spike, Back attack, Slide spike, Wipe out spike. • Block- Single block, Double block, Triple block, Group block. • Field Defense- Dig pass, Double pass, Roll pass. • Rules and their interpretation. **FOOTBALL** • Dribbling- Square pass, Parallel pass, Forward pass. • Heading (Standing & Running)- Fore head, Side fore head, Drop heading, Body covering during heading. • Kicking- Full volley, Half volley, Drop kick, Back volley, Side volley, Chiping (lobe). • Tackling: Covering the angle, Chessing time sliding chese, Heading time shoulder tackle etc. • Feinting- Body movement to misbalance the opponent and find space to go with ball. • Rules of Football. **CRICKET** • Batting straight drive. • Batting pull shot. • Batting hook shot. • Bowling good length, In swing. • Bowling out swing, Leg break, Goggle. • Fielding drill. • Catching (Long & Slip). • Wicket keeping technique. • Rules & Regulation. **BADMINTON** • Net play- Tumbling net shot, Net Kill, and Net Lift. • Smashing. • Defensive high clear/Lob. • Half court toss practice, Cross court toss drop practice, Full court Game practice. • Player Positioning, Placements. • Rules & Regulation. • Doubles & Mixed doubles match practice. **TABLE TENNIS** • Stroke: Backhand- Topspin against push ball, Topspin against deep ball, Topspin against rally ball, Topspin against topspin.

	• Stroke: Forehand- Topspin against push ball, Topspin against deep ball, Topspin against rally ball, Topspin against topspin. • Stroke- Backhand lob with rally, Backhand lob with sidespin, Forehand lob with rally, Forehand lob with sidespin. • Service: Backhand/Forehand- Push service, Deep push service, Rally service. • Service: Backhand sidespin (Left to right & Right to left). • Service: Forehand- High toss backspin service, High toss sidespin service, High toss reverse spin service. • Rules and their interpretations. • Table Tennis Match (Singles & Doubles). **NCC** • FD-6 Side pace, Pace Forward and to the Rear. • FD-7 Turning on the March and Wheeling. • FD-8 Saluting on the March. • FD-9 Marking time, Forward March and Halt in Quick Time. • FD-10 Changing step. • FD-11 Formation of Squad and Squad Drill. • FD-12 Parade practice. **TAEKWONDO** • Poomsae (Forms)- Jang, Yi Jang. • Self Defense Technique- Self defense from arms, Fist and Punch. • Sparring (Kyorugi)- One step sparring, Two step sparring, Fight (Free sparring). • Combination Technique- Combined kick and punch. • Board Breaking (Kyokpa)- Sheet breaking. • Interpretation Rules above Technique of Taekwondo. **NSS** • No Smoking Campaign • Anti- Terrorism Day Celebration • Any other observation/celebration proposed by Ministry/institute • Public Speaking • Discussion on Current Affairs • Viva voce