**KURUKSHETRA UNIVERSITY, KURUKSHETRA (K.U.K) – 136119, HARYANA, INDIA**

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| **Bachelor of Technology (Chemical Engineering)** |
| **Credit-Based Scheme of Studies/Examination(Modified)** |
| **Semester III(w.e.f. session 2019-2020)** |
| **S. No.** | **Course Code** | **Subject** | **L:T:P** | **Hours/Week** | **Credits** | **Examination Schedule (Marks)** | **Duration of Exam (Hrs.)** |
|
| **Major Test** | **Minor Test** | **Practical** | **Total** |
| 1. | ES-CHE-201A | Chemical Engineering Thermodynamics-I | 3:1:0 | 4 | 3 | 75 | 25 | 0 | 100 | 3 |
| 2. | BS-CH-203A | Chemistry-II | 3:0:0 | 3 | 3 | 75 | 25 | 0 | 100 | 3 |
| 3. | PC-CHE-203A | Chemical Engineering Process Calculations | 3:1:0 | 4 | 4 | 75 | 25 | 0 | 100 | 3 |
| 4. | PC-CHE-205A | Fluid Flow | 3:0:0 | 3 | 3 | 75 | 25 | 0 | 100 | 3 |
| 5. | BS-209A | Advance Mathematics | 3:1:0 | 4 | 3 | 75 | 25 | 0 | 100 | 3 |
| 6. | PC-CHE-207A | Unit Processes |  3:0:0 | 3 | 3 | 75 | 25 | 0 | 100 | 3 |
| 7. | BS-CH-209LA | Chemistry-II (Lab) |  0:0:3 | 3 | 1.5 | 0 | 40 | 60 | 100 | 3 |
| 8. | PC-CHE-211LA | Fluid Flow Lab |  0:0:3 | 3 | 1.5 | 0 | 40 | 60 | 100 | 3 |
| **Total** |  | **27** | **22** | **450** | **230** | **120** | **800** |  |
| 9. | \*MC-902A | Constitution of India | 3:0:0 | 3 | - | 75 | 25 | 0 | 100 | 3 |
| 10. | SIM-201A\* | Seminar on Summer Internship | 2:0:0 | 2 | 0 | 0 | 50 | 0 | 50 |  |

**\*Note: 1.** \*MC-902A is a mandatory credit-less course in which the students will be required to get passing grade.

2. SIM-201A\* is a mandatory credit-less course in which the students will be evaluated for the Summer Internship (training)undergone after 2nd semester and students will be required to get passing marks to qualify.

3. The students will be allowed to use non-programmable scientific calculator. However, sharing/exchange of calculator is prohibited in the examination.

4. Electronics gadgets including Cellular phones are not allowed in the examination.

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| **Bachelor of Technology (Chemical Engineering)** |
| **Credit-Based Scheme of Studies/Examination(Modified)** |
| **Semester IV(w.e.f. session 2019-2020 )** |
| **S. No.** | **Course Code** | **Subject** | **L:T:P** | **Hours/Week** | **Credits** | **Examination Schedule (Marks)** | **Duration of Exam (Hrs)** |
|
| **Major Test** | **Minor Test** | **Practical** | **Total** |
| 1 | HM-902A | Fundamentals of Management | 3:0:0 | 3 | 3 | 75 | 25 | 0 | 100 | 3 |
| 2 | PC-CHE-204A | Heat Transfer | 3:1:0 | 4 | 4 | 75 | 25 | 0 | 100 | 3 |
| 3 | PC-CHE-206A | Mechanical Operations | 3:0:0 | 3 | 3 | 75 | 25 | 0 | 100 | 3 |
| 4 | PC-CHE-208A | Numerical Methods in Chemical Engineering | 3:1:0 | 4 | 3 | 75 | 25 | 0 | 100 | 3 |
| 5 | ES-CHE-212A | Material Technology | 3:0:0 | 3 | 3 | 75 | 25 | 0 | 100 | 3 |
| 6 | PC-CHE-214LA | Heat Transfer (Lab) | 0:0:3 | 3 | 1.5 | 0 | 40 | 60 | 100 | 3 |
| 7 | PC-CHE-216LA | Mechanical Operations (Lab) | 0:0:3 | 3 | 1.5 | 0 | 40 | 60 | 100 | 3 |
| **Total** |  | **23** | **19** | **375** | **205** | **120** | **700** |  |
| 8 | MC-901A | Environmental Sciences | 3:0:0 | 3 | 0 | 75 | 25 | 0 | 100 | 3 |

**Note:**

1. Students be encouraged to go to 6-8 weeks summer internships mandatory during the summer break after the completion of fourth semester exams.
2. MC-901A is a mandatory credit-less course in which the students will be required to get passing marks to qualify.`
3. The students will be allowed to use non-programmable scientific calculator. However, sharing/exchange of calculator is prohibited in the examination.
4. Electronics gadgets including Cellular phones are not allowed in the examination.

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| **ES-CHE-201A** | **CHEMICAL ENGINEERING THERMODYNAMICS-I** |
| **Lecture** | **Tutorial** | **Practical** | **Theory** | **Sessional** | **Total** | **Credits** | **Time** |
| **3** | **1** | **-** | **75** | **25** | **100** | **3** | **3** |
| **Purpose** | To understand the basics of thermodynamics and P-V-T behavior, Laws of Thermodynamics, Thermodynamics relations, concept of Power and Refrigeration cycle. |
|  **Course Outcomes** |
| **CO1** | To Introduce with the basics of thermodynamics and P-V-T behavior. |
| **CO2** | To familiarize with the Laws of Thermodynamics. |
| **CO3** | To familiarize with the concept of Thermodynamics relations. |
| **CO4** | To familiarize with the concept of Power and Refrigeration cycle. |

**Unit I**

**Introduction and P-V-T behavior:** Concept of Work and heat, Cp, CV, open system and closed system, extensive and intensive properties, Internal Energy, enthalpy, entropy, P-V-T behavior of Pure Fluids- Virial equations, cubic equations, generalized correlations, Throttling process, Joules Thompson coefficient.

**Unit II**

**Laws of thermodynamics:** Laws of thermodynamics Energy equations for close system and steady flow processes, Limitations of first law, carnot cycles, concept of available energy and dead state availability and irreversibility.

**Unit III**

**Thermodynamics relations:** Maxwell relations, Helmholtz and Gibbs function, Tds equations, clausiusclapeyron equation.

**Unit IV**

**Power and Refrigeration cycle:** Rankine cycle, Air standard cycles, vapour compression cycle, otto cycle, Brayton cycle, refrigerant and their properties, Liquifaction of gases, generation of power from heat.

**Books Recommended:**

1. Y.V.C. Rao, Chemical Engineering Thermodynamics, University Press.
2. Smith & van Ness, Introduction to Chemical Engineering Thermodynamics, McGraw Hill.
3. B. Bhattacharyya and S. C. Bera, Engineering Thermodynamics and Fluid Mechanics, New Age International Publishers.
4. Radha Krishnan, Fundamentals of Engineering Thermodynamics, PHI Publishers.
5. P.K. Nag, Engineering Thermodynamics, Tata McGrew Hill.

 **Note: The Examiner will be given the question paper template to set the question paper.**

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| **BS-CH-203A** | **CHEMISTRY – II** |
| **Lecture** | **Tutorial** | **Practical** | **Theory** | **Sessional** | **Total** | **Credits** | **Time** |
| **3** | **-** | **-** | **75** | **25** | **100** | **3** | **3** |
| **Purpose** | To familiarize with the basic knowledge of Organic reactions and mechanism Chemistry of Hydrocarbons, Chromatographic analysis methods, Kinetic of a chemical reaction and chemical Equilibrium of the processes. |
|  |  |  | **Course Outcomes** |  |  |
| **CO1** | To understand the basic knowledge of organic reactions and mechanism, substitution and addition of electrophilic, nucleophillic, free radical and chemistry of hydrocarbons. |
| **CO2** | To familiarize with the various Chromatographic analysis methods. |
| **CO3** | To introduce the Kinetic of a chemical reaction. |
| **CO4** | To give in-depth knowledge of chemical Equilibrium of the processes. |

**UNIT I**

**Classification of Organic Reactions**: Types of mechanism, types of reactions, Reaction intermediates, the mechanism ofthe following type of reactions. substitution - Electrophiilic, nucleophiilic, fee radical, Addition- Electrophilic, nucleophillic, free radical Elimination-Elimination ( E1 and E2 type) Rearrangement, Migration with electron (electrophillic).

**Chemistry of Hydrocarbons:** Sources, preparation and uses of alkanes, alkenes, alkynes, cracking & reforming aromatic hydrocarbons, concept of aromaticity (Huckel rule, 4n+2) rule) and directive effect.

**UNIT II**

**Chromatography:** Introduction, classification, solid, Liquid chromatography (LSC, TLC, Liquid - Liquid Chromatography(LLC), Column, GPC, HPLC, Gas-Liquid Chromatography (GLC).

**UNIT III**

**Chemical Kinetics:** Rate expression of reactions of various orders, rate mechanism, kinetics of complex reactions,molecularity, order of reaction, concept of energy barrier and activation energy theories of reaction rates, Arhenius equation.

**UNITIV**

**Chemical Equilibrium:** Equilibrium constant, Factors affecting, Ka, Kp, Standard free energy and equilibrium constant, homogeneous and heterogeneous chemical equilibria, Le Chtelier's principle and its applications' Relation between Kp and Kc.

**Books Recommended:**

1. Advanced organic chemistry (Reaction Mechanism and structure) by JerryMarch (Willey Eastern 3rd edition)
2. Text Book of Organic Chemistry by R'K' Bansal' (T'M'H')
3. Organic Chemistry by Morrison, Bayd (P'H'L')
4. Chromatography by B'K' Sharma (Goel Publishing' Merrut')
5. Organic Chemistry Vol' I By l'L' Finar (ELBS)'
6. Schaum's solved Problems series,Organic Chemistry(T'M'H')
7. Organic Reaction Mechanism, 3rdedition(T.M.H')by R.K.Bansal.

 **Note: The Examiner will be given the question paper template to set the question paper.**

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| **PC-CHE-203A** |  | **CHEMICAL ENGINEERING PROCESS CALCULATIONS** |  |
| **Lecture** | **Tutorial** | **Practical** | **Theory** | **Sessional** |  | **Total** | **Credits** | **Time** |
| **3** | **1** | **-** | **75** | **25** |  | **100** | **4** | **3** |
| **Purpose** | To familiarize with the concept of units, their dimensions and conversions, stoichiometric and composition relations, various Gas laws, Material balance and Energy balance. |
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|  |  |  | **Course Outcomes** |  |  |  |
| **CO1** | To introduce the basic concept of units, their dimensions and conversions, stoichiometric and composition relations. |
|  |
| **CO2** | To understand the various Gas laws and Henry’s Law, Humidity and use of humidity charts for engineering calculations. |
|  |
| **CO3** | To familiarize with the concept of Material balances for systems with and without chemical reactions, species and elemental balance. |
|  |
| **CO4** | To familiarize with the concept of Steady state energy balance for systems with and without chemical reactions, Enthalpy-concentration charts; Degrees of freedom in steady state processes, Unsteady state material and energy balance. |
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**Unit I**

**Units and Dimensions:** Introduction-Units, their dimensions and conversions, Dimensional consistency of equations, Dimensional and dimensionless constants, Mass and volume relations, Stoichiometric and composition relations, Excess reactants, Degree of completion, Conversion, Selectivity and Yield.

**Unit II**

**Gas Law and Humidity:** Gas laws-Ideal gas law, Dalton’s Law, Amagat’s Law, and Average molecular weight of gaseousmixtures. Vapour pressure-Effect of temperature on vapour pressure, Vapour pressure plot (Cox chart), Vapour pressures of miscible and immiscible liquids and solutions, Raoult’s Law and Henry’s Law. Relative Humidity and percent saturation; Dew point, Dry and Wet bulb temperatures; Use of humidity charts for engineering calculations

**Unit III**

**Material Balance:** Material balances for systems with and without chemical reactions, species and elemental balance.Analysis of systems with by-pass, recycle and purge. Heat capacity of gases, liquids and solutions, Heat of fusion and vaporization.

**Unit IV**

**Energy Balance:** Steady state energy balance for systems with and without chemical reactions; Calculations and application of heat of reaction, combustion, formation, neutralisation and solution; Enthalpy-concentration charts; Degrees of freedom in steady state processes, solution of simultaneous material and energy balance problems using flow sheeting codes; Unsteady state material and energy balance.

**Books Recommended:**

1. D.M. Himmelblau, Basic Principles and calculations in Chemical Engineering, Printice-Hall.
2. O.A. Hougen, K.M.Watson & R.A.Ragatz, Chemical process principles, John Willey & sons.
3. D. P. Tiwari, Chemical Calculation,Vrinda Publications (Zalgaon).
4. S. N. Saha, Chemical Engineering process calculation, Dhanpat Rai publication.
5. Bhatt and Vora, Stoichiometry, Nirali Publications.

 **Note: The Examiner will be given the question paper template to set the question paper.**

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| **PC-CHE-205A** |  |  |  | **FLUID FLOW** |  |  |  |
| **Lecture** | **Tutorial** | **Practical** | **Theory** | **Sessional** | **Credits** | **Total** |  | **Time** |
| **3** | **-** | **-** | **75** | **25** | **3** | **100** |  | **3** |
| **Purpose** | Application of fluid, fluid forces, pressure measurement in fluid, energy.To understand the concept and losses, friction factor and various flow measuring devices. |
|  |  |  | **Course Outcomes** |  |  |  |
| **CO1** | To understand the fundamental concepts of fluids, Classification of fluid-forces, Pressure measurement by manometers, Types of flow, velocity distribution for laminar flow in conduits, Reynold's number and its significance. |
| **CO2** | To understand the concept of Conservation of mass, momentum and energy, Euler's equation. Energy losses. |
| **CO3** | To familiarize with the basic equations of fluid flow and flow measuring devices. |
| **CO4** | To familiarize with the flow of incompressible fluids in conduits. |  |  |
| **CO5** | To familiarize the concept of hydrodynamic boundary layer and dimensional analysis by Rayleigh’s and Buckingham’s method. |
| **CO6** | To familiarize with the flow past immersed bodies and transportation of fluids. |

**UNIT I**

**Introduction:** Fluid, Properties of fluid, Classification of fluids, Newton’s law of viscosity, Rheological classification of fluids, Pressure and temperature dependence, Types of flow, Lines to describe the flow, Application of fluid flow in Chemical Engineering.

**Fluid Statistics and Its Applications:** Hydrostatic equilibrium, parametric equation, Hydrostatic equilibrium in centrifugal field; Concept of atmospheric, gauge and absolute pressure, manometers, pressure measurement by simple and differential manometer.

**UNIT II**

**Basic Equations of Fluid Flow and Flow Measuring Devices:** Basic equations of fluid flow: Continuity equation, equation of motion, Flow measurement using Venturimeter, Orificemeter, Rotameter & Pitot Tube.

**Flow of Incompressible Fluids in Conduits:** Shear stress distribution, Relation between skin friction and wall shear, The friction factor; Laminar flow through circular pipe, on inclined plane, through annular space; Relation between average and maximum velocity, Major and Minor Loses, Darcy Weisbach equation, Friction factor chart.

**UNIT III**

**Boundary Layer and Dimensional Analysis:** Concept of hydrodynamic boundary layer, Growth over a flat plate, Different thickness of boundary layer, Fundamental dimensions of quantities, Dimensional homogeneity, Dimensional analysis by Rayleigh’s method and Buckingham’s method, Dimensionless numbers.

**UNIT IV**

**Flow Past Immersed Bodies And Transportation Of Fluids:** Drag and drag coefficient, Flow through beds of solids, Motion of particles through fluids, Introduction to fluidization, Pipes and tubing’s, Joints and fitting Major and minor losses, Different types of valves, Pumps: Centrifugal pump, Performance of centrifugal pumps.

**Books Recommended:**

1. J.M. Coulson and J.F. Richardson, Chemical Engineering, Vol-1, Pergamon.
2. W.L. McCabe and J.C. Smith, Unit Operations of Chemical Engineering, McGraw Hill.
3. A.K. Jain, Fluid Mechanics, Khanna publishers, New Delhi.
4. Jagdish Lal, Hydraulics & Fluid Mechanics, Metro-polliton Books Co. Pvt. Ltd. Delhi
5. D. S. Kumar, Fluid Mechanics, S. K. Kataria& Sons.

 **Note: The Examiner will be given the question paper template to set the question paper.**

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| **BS-209A** | **Advance Mathematics** |
| **Lecture** | **Tutorial** | **Practical** | **Theory** | **Sessional** | **Total** | **Credits** | **Time** |
| **3** | **1** | **-** | **75** | **25** | **100** | **3** | **3** |
| **Purpose** | **To provide the conceptual knowledge of Engineering mathematics** |
|  **Course Outcomes** |
| **CO1** | To study various fundamental concepts of Fourier series and Fourier Transformation. |
| **CO2** | To study and understand the functions of a complex variables. |
| **CO3** | To study the Probability Distributions. |
| **CO4** | To study the linear programming problem formulation. |

**UNIT – I**

**Fourier Series:** Euler’s Formulae, Conditions for Fourier expansions, Fourier expansion of functions having points of discontinuity, change of interval, Odd & even functions, Half-range series.

Fourier Transforms: Fourier integrals, Fourier transforms, Fourier cosine and sine transforms.

Properties of Fourier transforms, Convolution theorem, Perseval’s identity, Relation between Fourier and Laplace transforms, Fourier transforms of the derivatives of a function, Application to boundary value problems.

**UNIT-II**

**Functions of a Complex Variables:** Functions of a complex variable, Exponential function, Trigonometric, Hyperbolic and Logarithmic functions, limit and continuity of a function, Differentiability and analyticity. Cauchy-Riemann equations, Necessary and sufficient conditions for a function to be analytic, Polar form of the Cauchy-Riemann equations, Harmonic functions, Application to flow problems, Conformal transformation, Standard transformations (Translation, Magnification &rotation, inversion & reflection, Bilinear).

**UNIT-III**

**Probability Distributions:** Probability, Baye’s theorem, Discrete & Continuous probability distributions, Moment generating function, Probability generating function, Properties and applications of Binomial, Poisson and normal distributions.

**UNIT-IV**

**Linear Programming:** Linear programming problems formulation, Solution of Linear Programming Problem using Graphical method, Simplex Method, Dual-Simplex Method.

**Text Book**

1. Higher Engg. Mathematics : B.S. Grewal
2. Advanced Engg. Mathematics : E. Kreyzig

**Reference Book**

1. Complex variables and Applications : R.V. Churchil; Mc. Graw Hill
2. Engg. Mathematics Vol. II: S.S. Sastry; Prentice Hall of India.
3. Operation Research : H.A. Taha.
4. Probability and Statistics for Engineer : Johnson. PHI.

 **Note: The Examiner will be given the question paper template to set the question paper.**

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| **PC-CHE-207A** |  |  |  |  | **UNIT PROCESS** |  |  |
| **Lecture** | **Tutorial** | **Practical** |  | **Theory** | **Sessional** |  | **Total** | **Credits** | **Time** |
| **3** | **-** | **-** |  | **75** | **25** |  | **100** | **3** | **3** |
| **Purpose** | To make student able to understand about various unit operations. |  |  |
|  |  |  |  | **Course Outcomes** |  |  |
| **CO1** | To familiarize with the Alkylation process.  |  |  |  |
| **CO2** | To understand the concept of hydrogenation. |  |  |  |
| **CO3** | To familiarize with the Sulfonation. |  |  |  |  |
| **CO4** | To familiarize with the halogenations and nitration. |  |  |

**UNIT-I**

**ALKYLATION:** Products derived from alkylation, types of alkylation, factors controlling alkylation, flow street for alkylaryl sulfonates, sulfuric acid alkylation for petroleum industry equipment for alkylation-kellogg cascade alkylater.

**UNIT - II**

**HYDROGENATION:** Products derived from hydrogenation, types of hydrogenation, factors controlling hydrogenation, equipment for hydrogenation, apparatus and rnaterial of construction, high pressure autoclave, shaking autoclave, flow sheet for synthesis of methanol from carbon rnonoxide and hydrogen, Hydrogenation of oil.

**UNIT - III**

**SULFONATION:**Sulfonation and sulfonating agents, physical and chemical factors in sulfonation, mechanism of desulfonation, Industrial equipment and techniques, batch surfonation kettle, ball mill sulfonator, flowsheet for manufacture of anthraquinone sulphonate ethanol from methylene.

**UNIT-IV**

**HALOGENATION:** Products derived by halogenation, types of halogenation, mechanism of dehalogenation, Design and construction of equipment for halogenations, flow sheets for manufacture of chroroacetic acid, monochroroacetic acid & chloral.

**NITRATION:** Products derived from nitration, types of nitration, process equipment for nitration, batch nitration, continuous nitration, schmidt nitration of propane.

**BOOKS RECOMMENDED:**

1. Unit Processes in Organic synthesis by P.H. Groggins (MGH)
2. Chemical Technology by Merk and Hahn (MGH)
3. Chemical Egg. Dev., NT, Madras (Organic)-ll Centre.

 **Note: The Examiner will be given the question paper template to set the question paper.**

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| **BS-CH-209LA** | **CHEMISTRY- II LAB** |
| **Lecture** | **Tutorial** | **Practical** | **Practical** |  | **Sessional** |  | **Total** | **Credits** | **Time** |
| **-** | **-** | **3** | **60** |  | **40** |  | **100** | **1.5** | **3** |
| **Purpose** | To make student able to identify and quantify organic compounds. |
|  |  |  | **Course Outcomes** |  |  |  |
| **CO1** | Students will be able to perform preliminary tests to identify organic compounds. |
| **CO2** | Students will be able to analyze functional groups of organic compounds and prepare derivatives. |
| **CO3** | Students will be able to determine kinetics of reaction by method of half- life period. |
| **CO4** | Students will be able to determine the activation energy for reaction by integral and differential method. |

**ldentification of organic compounds :**

1. Preliminary tests (elemental analysis, lgnition, colour, odour and determination of physical constants)
2. Functional group analysis.
3. Preparation of derivatives, Organic Acids, Aldehydes, Ketones, Amides, .Phenols, amines, Carbohydrates, Hydrocarbons.
4. Preparation of aspirin, 2,4, 6- tribromo aniline, picric acid from phenol, iodoform, S benzyl isothiourounim chloride.

**Quantitative organic analysis**:

1. Estimation of phenol, aniline, formaldehyde.

2. To determine kinetics of reaction between ethyl acetate and sodium hydroxide at room temp. by method of half-life period.

1. To determine the activation energy for reaction between ethyl acetate and sodium hydroxide by integral and differential method.

**Books Recommended:**

1. A. I. Vogel, Qualitative Organic analysis (ELBS) Longman.
2. Satish Aggarwal& R.C. Aggarwal, Advanced organic analysis, Pargati Prakashan.
3. G. Mann, Practical Organic Chemistry, Longman

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| **PC-CHE-211LA** | **FLUID FLOW LAB** |
| **Lecture** | **Tutorial** | **Practical** | **Practical** |  | **Sessional** |  | **Total** | **Credits** | **Time** |
| **-** | **-** | **3** | **60** |  | **40** |  | **100** | **1.5** | **3** |
| **Purpose** | To provide practical knowledge for the application of flow measurement devices, calibration of flow measurement device, pressure drop in pipe flow, determination of equivalent length of various fittings in pipe line. |
|  |  |  | **Course Outcomes** |  |  |  |
| **CO1** | Students will be able to use various flow measurement devices to measure flow rates. |
| **CO2** | Students will be able to calibrate flow measurement device. |
| **CO3** | Students will be able to determine pressure drops in pipe flow. |
| **CO4** | Students will be able to determine equivalent length of various fittings in pipe line. |

**List of Experiments**:

1. Flow measurement by Venturimeter.
2. Flow measurement by Orifice meter.
3. Calibration of Rotameter.
4. Flow measurement by V-notch.
5. Pressure drop in pipe flow.
6. Verification of Bernoulli's Theorem.
7. Determine friction factor in pipes of different material.
8. Flow measurement by Pitot tube.
9. To obtain the equivalent length of various fittings.

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| **MC-902A** | **Constitution of India** |
| **Lecture** | **Tutorial** | **Practical** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **-** | **-** | **75** | **25** | **100** | **3 Hrs.** |
| **Purpose** | **To know the basic features of Constitution of India** |
| **Course Outcomes** |
| **CO1** | **The students will be able to know about salient features of the Constitution of India.** |
| **CO2** | **To know about fundamental duties and federal structure of Constitution of India.**  |
| **CO3** | **To know about emergency provisions in Constitution of India.** |
| **CO4** | **To know about fundamental rights under constitution of India.** |

 **UNIT-I**

1. Meaning of the constitution law and constitutionalism, Historical perspective of the Constitution of India. Salient features and characteristics of the Constitution of India.
2. Scheme of the fundamental rights

**UNIT - II**

1. The scheme of the Fundamental Duties and its legal status. The Directive Principles of State Policy – Its importance and implementation. Federal structure and distribution of legislative and financial powers between the Union and the States.
2. Parliamentary Form of Government in India – The constitution powers and status of the President of India

**UNIT - III**

1. Amendment of the Constitutional Powers and Procedure. The historical perspectives of the constitutional amendments in India.
2. Emergency Provisions: National Emergency, President Rule, Financial Emergency. Local Self Government – Constitutional Scheme in India.

**UNIT-IV**

7. Scheme of the Fundamental Right to Equality. Scheme of the Fundamental Right to certain Freedom under Article 19.

8. Scope of the Right to Life and Personal Liberty under Article 21.

**Text Books**

1. Constitution of India. Prof.Narender Kumar (2008) 8th edition. Allahabad Law Agency**.**

**Reference Books:**

1. The constitution of India. P.M. Bakshi (2016) 15th edition. Universal law Publishing.

 **Note: The Examiner will be given the question paper template to set the question paper.**

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| **HM - 902A** | **Fundamentals of Management**  |
| **L** | **T** | **P** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **0** | **3** | **75** | **25** | **100** | **3 Hour** |
| **Purpose** | **To enhance the knowledge about the basic management concepts so that engineers can apply their managerial skills.** |
|  | **Course outcomes** |
| **CO1** | An overview about Business Environment and its Components. |
| **CO2** | Understand the concept of Financial Management and its importance. |
| **CO3** | Enabling the students to know about the hiring and guiding the work force by the understanding of Human Resource Management. |
| **CO4** | To understand the concept of economical production aspects of Management. |

**UNIT 1**

**Business Environment:** Concept, nature and objectives of business, social responsibility of business, Constituent of Business Environment; Economic, Social, Political, Legal and technological. Definition, Nature and Significance of Management, Henry Fayol’s Principles of Management, Functions of Management.

**UNIT 2**

**Financial Management:** Introduction of Financial Management, Objectives of Financial Decisions, Financial Planning-Tools of financial planning, Management of working capital, factors affecting requirements of working capital. Capital Structure decisions. Features of appropriate capital structure. Sources of finance.

**UNIT 3**

**Personnel Management:** Personnel Management-Meaning, Nature and importance, Functions of Personnel Management (a) Managerial Functions and (b) Operative functions. Job Analysis; Meaning and importance; Process of Job Analysis, Job Description and Job Specification. Human Resource Development-Meaning and Concept.

**UNIT 4**

**Production Management:** Production Management: Definition and objectives. Plant Location: Ideal plant location, Factors affecting plant location. Plant Layout: Ideal plant layout, Factors affecting Plant layout. Work Measurement: Meaning Objectives and Essentials of work measurement. Production Control: meaning and Importance of production control and steps involved in production control, Nature, scope and importance of Marketing Management, Modern Marketing concepts. Role of marketing in economics development. Marketing Mix. Marketing Information System. Meaning, nature and scope of International Marketing.

**Suggested Books:**

* Charunilam , “Business Environment” , Himalaya Publishing House
* Harold, Koontz & Cyriol ,”Mangement” , MGH
* Principles of Personnel Management-Edwin B.PhilpoMGH
* Cundiff &Stiff , “Basic Marketing” PHI

**Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.**

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| **PC-CHE-204A** | **HEAT TRANSFER** |
| **Lecture** | **Tutorial** | **Practical** | **Theory** | **Sessional** |  | **Total** | **Credits** | **Time** |
| **4** | **1** | **-** | **75** | **25** |  | **100** | **4** | **3** |
| **Purpose** | To understand the basic concept and applications of various modes of heat transfer, boiling & condensation, Evaporation and types of Heat exchangers. |
|  |  |  | **Course Outcomes** |  |  |  |
| **CO1** | To understand the concept of basic equations of steady state condition in slab, cylinder and sphere, Critical thickness of insulation, Use of transient temperature charts and lumped system analysis. |
| **CO2** | To understand the basic concept of convection, boiling & condensation |  |
| **CO3** | To familiarize with the concept of various types of Heat exchangers. |  |
| **CO4** | To familiarize with the concept of Radiation and Evaporations. |  |  |  |

**UNIT I**

**Introduction:** Basis equation - one dimensional, two dimensional and three dimensional, Steady state condition in slab, cylinder and sphere, Critical thickness of insulation. Finned surfaces, Transient conduction Analytical solution for slabes, Use of transient temperature charts for slabs, cylinders and sphere and lumped system analysis.

**UNIT II**

**Convection:** Concept of free and forced convection. Dimensional Analysis.Empirical correlations for free and forcedconvection for various shapes.

**Boiling & Condensation:** Film wise and drop wise condensation, Laminar film condensation on a vertical plate, Film condensation on tubes, Boiling regimes, Bubble growth and nucleate boiling.

**UNIT III**

**Heat Exchangers:** Basic types of heat exchanges, Overall heat transfer coefficient, log mean temperature difference, Effectiveness and NTU methods for heat exchanger analysis.

**UNIT IV**

**Radiation:** Black body radiation, radiation properties, concept of shape factor, Radiation exchange in enclosure with black surface.

**Evaporators:** Types of evaporators, Single & Multiple effect evaporators, calculations for surface area requirement. Methods of feeding.

**Books Recommended:**

1. W. L. McCabe & J. C. Smith, Unit operations of chemical engineering, McGraw Hill Book Company, New Delhi
2. J. P. Holman, Heat Transfer, McGraw Hill Book Company, New Delhi.
3. M. L. Oziski, Heat Transfer, McGraw Hill lnternational Editions.
4. A. J. Chapman, Heat, Macmillan lndian, Delhi.
5. D. S. Kumar, Heat and Mass Transfer, S.K. Kataria and Sons, Delhi. .
6. Kirk, D. Hegen, Heat Transfer with Applications, Prentice Hall lnternational. Inc., New Jercy.

 **Note: The Examiner will be given the question paper template to set the question paper.**

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| **PC-CHE-206A** | **MECHANICAL OPERATIONS** |
| **Lecture** | **Tutorial** | **Practical** | **Theory** | **Sessional** | **Total** | **Credits** | **Time** |
| **3** | **-** | **-** | **75** | **25** | **100** | **3** | **3** |
| **Purpose** | To understand the concept of unit operation and their role in chemical engineering industries, Types of mechanical operations, various size reduction techniques. |
|  |  | **Course Outcomes** |  |  |  |
| **CO1** | To Introduce the concept of unit operation and their role in chemical engineering industries, Types of mechanical operations, Particle size and shape, Measurement and analysis, various size reduction techniques. |
| **CO2** | To familiarize with the concept of various methods of mixing of solids, Size enlargement: scope and applications and techniques, Filtration. |
| **CO3** | To understand the concept of Drag force, Settling velocity of a particle in a fluid, Stoke's law, Elutriation, Classifiers, Thickeners, Gravity separation, concept of relative velocity. |
| **CO4** | To familiarize with the concept of Storage of Solids, Flow of solids by gravity, Transport of solids, particle collection systems. |

**UNIT I**

**Introduction to Unit operations:** Introduction to unit operation and their role in chemical engineering industries, Types of mechanical operation, Particle size and shape, Particulate mass, Size and shape distributions, Measurement and analysis, Concept of average diameter, Screening, types of screens, effectiveness of screens, particle separation efficiency. Mixing of solids, blending, kneading, etc., Filtration: classification of filters, theory of filtration, cake resistance.

**UNITII**

**Size Reduction and Size Enlargement of Solids:** Size reduction, Crushing, Grinding and ultrafine grinding and selection of equipment, Laws of grinding. Construction and working principle of mostly used equipments, viz., Jaw crushers, gyratory crushers, hammer mill, crushing rolls, ball mills, and fluid energy mills. Size enlargement: scope and applications, size enlargement techniques, Agglomeration and compaction.

**UNITIII**

**Drag force and Separation of solid particles:** Flow around' single particle, Drag force & drag coefficient, Settling velocity of a particle in a fluid, Stoke's law, Elutriation, Classifiers, Hindered & free settling of particles, Thickeners, Gravity separation, concept of relative velocity.

**UNIT IV**

**Storage, Handling & Transport of Solids:** Storage of Solids, Flow of solids by gravity, Transport of solids by screw/ belt conveyors, pneumatic conveyors, cyclones, Bag filters, Electrostatic precipitators; particle collection systems.

**Books Recommended:**

1. J. M. Coulson & J. F. Richardson, Chemical Engineering, Vol. II, Pergamon press.
2. G. G. Brown, Unit Operations, Asia publishing House.
3. A. S. Foustetal, Principle of Unit Operations, John Wiley.
4. W. L. McCabe & J. C. Smith, Unit Operations of Chemical Engineering,McGraw Hill.
5. B. C. Bhattacharya & C. M. Narayanan, Mechanical Operations for Chemical Engineers,Khanna publishers.

 **Note: The Examiner will be given the question paper template to set the question paper.**

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| **PC-CHE-208A** | **Numerical Methods in Chemical Engineering** |
| **Lecture** | **Tutorial** | **Practical** | **Theory** | **Sessional** | **Total** | **Credits** | **Time** |
| **4** | **1** | **-** | **75** | **25** | **100** | **3** | **3** |
| **Purpose** | To understand the concept of types of errors, Eigen values and Eigen vectors of matrices, Non-linear algebraic equations, Function evaluation, Ordinary differential equations |
|  **Course Outcomes** |
| **CO1** | To Introduce the concept of error, linear algebraic equations |
| **CO2** | To familiarize with the Eigen values and Eigen vectors of matrices, non-linear algebraic equations |
| **CO3** | To understand the Linear Regression, Interpolation and Extrapolation Technique |
| **CO4** | To familiarize with the Ordinary Differential Equations |

**UNIT-I**

**Errors:** Classification, significant digits and numerical stability.

**Linear algebraic equations:** Cramer's rule, Gauss Elimination and LU Decomposition Gauss-Jordan elimination,

Gauss-Seidel and Relaxation Methods.

**UNIT-II**

**Eigen values and eigenvectors of matrices**: Faddeev Leverrier's Method, Power Method

**Non linear algebraic equations**: Single variable successive substitutions (Fixed Point Method), Multivariable successive substitutions, single variable Newton-Raphson Technique, Multivariable Newton-Raphson Technique.

**UNIT-III**

**Function evaluation**: Least squares curve-fit (Linear Regression), Newton's interpolation formulae (equal intervals), Newton's Divided Difference Interpolation Polynomial, Lagrangian Interpolation Unequal intervals), differentiation formulae, Integration formulae or Quadratures (Trapezoidal, Simpson's 1/3 and 3/8 rules), Extrapolation Technique of Richardson and Gaunt

**UNIT-IV**

**Ordinary differential equations:** Initial value problems; ode-ivps The Finite difference Technique

**TEXT BOOKS**

1. Numerical methods with programming in ‘C’, T. Veerarajan, and T. Ramachandran, TMGH(2007).

2. Numerical Methods for Scientists and Engineers ,SankaraRao K, 3rd edition PHI, New Delhi, (2007).

**REFERENCE BOOKS:**

1. Numerical Methods for Engineers, S.C. Chapra and R.P. Canale, 5th Edition, TMGH, New Delhi, 2007.

2. Numerical Methods in Engineering and Science, B.S. Grewal, and,J.S. Grewal, 6th Ed,Khanna Pub.2004.

 **Note: The Examiner will be given the question paper template to set the question paper.**

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| **ES-CHE-212A** |  |  |  | **MATERIAL TECHNOLOGY** |  |
| **Lecture** |  | **Tutorial** | **Practical** | **Theory** | **Sessional** | **Total** | **Credits** | **Time** |
| **3** | **0** | **-** | **75** | **25** | **100** | **3** | **3** |
| **Purpose** | To understand the concept and applications of material science, Crystal Geometry, Isothermal transformations, Heat Treatment, Corrosion and its Prevention, various polymers |
|  |  |  |  | **Course Outcomes** |  |  |  |
| **CO1** |  | To Introduce the material science, classification of engineering materials. |
| **CO2** |  | To understand the concept of Isothermal transformations (TTT Curves); Heat Treatment methods. |
| **CO3** |  | To familiarize with the Corrosion and its Prevention. |  |  |
| **CO4** |  | To familiarize with the typical engineering materials. |  |  |

**Unit I**

**Introduction:** Introduction to material science, classification of engineering materials, Crystal Geometry And StructureDetermination, Crystal Imperfections: Point imperfections, Line imperfections-edge and screw dislocations, Surface imperfections.

**Unit II**

**Isothermal transformations (TTT Curves); Heat Treatment methods:** Isothermal transformations (TTT Curves); Heat Treatment: Annealing Normalizing, Hardening, Martempering, Austempering, Hardenability, Quenching, Tempering, Carburising, Cyaniding, Nitriding, Flame hardening.

**Unit III**

**Corrosion and its Prevention:** Corrosion and its Prevention: Direct corrosion, Electro-chemical corrosion, Galvanic cells,High temperature corrosion, Passivity, Factor influencing corrosion rate, Control and prevention of corrosion-modification of corrosive environment, Inhibitors, Cathodic protection, Protective coatings, glass lining, lead lining, FRP lining.

**Unit IV**

**Engineering Materials:** Typical Engineering Materials: Ferrous metals, Non ferrous metals and alloys – Aluminum and its alloys, Copper and its alloys, Alloy steels Alloys for high temperature service, Ceramic materials – Structure of ceramics, Polymorphism, Speciality glasses and refractories, properties and applications. Polymers: Classifications, comparison and properties, of various polymers and their relationship with chain structure. Grey and white cast iron- properties, applications,Uses.

**Books Recommended:**

1. V. Raghawan, Material Science & Engineering, Prentice Hall.
2. O.P. Khanna, Material Science,DhanpatRai Publications, New Delhi.
3. S. K. HajraChoudhury, Material Science and Processes**,** 2nd Edition, Indian BookDistributing Co.,1982.
4. R. L. Timings, Kemal Ahmet, EngineeringMaterial,Vol. I&II., Longman Publisher.
5. V.L. Van Vlack, Material of Engineering: Concepts and Application,Addison Wesley.

 **Note: The Examiner will be given the question paper template to set the question paper.**

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| **PC-CHE-214LA** | **HEAT TRANSFER LAB** |
| **Lecture** | **Tutorial** | **Practical** | **Practical** | **Sessional** | **Total** | **Credits** | **Time** |
| **-** | **-** | **3** | **60** |  | **40** | **100** | **1.5** | **3** |
| **Purpose** | To providepractical knowledgeof the application of different modes of heat transfer theory, heat transfer through composite walls, pipe and rod |
|  |  |  | **Course Outcomes** |  |  |
| **CO1** | Student will be able to determine heat transfer coefficient. |  |
| **CO2** | Student will be able to determine Filmwise and Dropwise condensation. |
| **CO3** | Student will be able to determine LMTD, Thermal conductivity, Emissivity. |
| **CO4** | Student will be able to determine Stefan Boltzman constant. |  |

**LIST OF EXPERIMENTS:**

1. To determine total thermal resistance and total thermal conductivity of composite wall.
2. To determine the thermal conductivity of insulating powder.
3. To find out heat transfer coefficient of vertical cylinder in natural convection.
4. (a) To study the unsteady state heat transfer and compare theoretical vs. practical value of response

(b) To determine the convective heat transfer coefficient.

1. (a) To determine the heat flow rate through the lagged pipe for known value of thermalconductivity of lagging material.

(b) To plot the temperature distribution across the lagging material.

1. To calculate LMTD for parallel and counter flow in double pipe heat exchanger.
2. To find average heat transfer coefficient for dropwiseand filmwise condensation and findthe overall heat transfer.
3. To study the temperature distribution along the length of a pin fin under natural convection heat transfer.
4. To study the temperature distribution along the length of a pin fin under forced convection heat transfer.
5. To find the emissivity of the test plate surface at various temperature and compare with the actual reported value.
6. To determine the thermal conductivity of metal rod.
7. (i) To demonstrate super thermal conductivity heat pipe and to compare its working with that of best conductor
8. (ii) To plot temperature vs. time response of three pipes

(iii) Temperature distribution along length of three members at different time intervals can be plotted and nearly isothermal temperature distribution in case of heat pipe.

1. To find out the Stefan Boltzmann constant.
2. To find heat transfer coefficient for heated pipe and air is forced to flow through it for different air flow.

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| **PC-CHE-216LA** | **MECHANICAL OPERATIONS LAB** |
| **Lecture** | **Tutorial** | **Practical** | **Theory** | **Sessional** | **Total** | **Credits** | **Time** |
| **-** | **-** | **3** | **60** | **40** | **100** | **1.5** | **3** |
| **Purpose** | To provide the practical knowledge for the application of theories of Drag coefficient, Sedimentation, size reduction, grinding, screen analysis, separation of particles from air, filtration of slurry, Elutriation and the pressure drop in packed bed. |
|  **Course Outcomes** |
| **CO1** | Students will be able to know the concept of Drag coefficient, Sedimentation, Size reduction. |
| **CO2** | Students will be able to know the principle and working of grinding in a ball mill, separation of dust particles from air and filtration of slurry. |
| **CO3** | Students will be able to know the solid separation techniques and size distribution of particles |
| **CO4** | Students will be able to determine the pressure drop in a packed bed. |

**LIST OF EXPERIMENTS:**

1. Drag coefficient: Determination of drag coefficient from the plot of drag coefficient Vs modified Reynolds No. and verify Stroke’s law.
2. To carry out Batch Sedimentation.
3. Size reduction: To determine the efficiency of the roll crusher for crushing a material of known working index.
4. Grinding in a Ball Mill:
	1. To determine the critical speed, work index, Bond’s law,Rittenger’s law, Kick’s law.
	2. To determine the surface area generation for the given amount of feed.
5. Screen Analysis: To analyze sample for size distribution using sieve shaker.
6. Separation of dust particles from air:
	1. To study the performance of given cylinder (efficiency vs. dp).
	2. To study the effect of inlet gas velocity on overall efficiency.
	3. To study the effect of solid concentration or dp or Drop.
7. Packed bed: Determination of pressure drop packed bed
8. Filtration of slurry: To calculation specific cake resistance and medium resistance in plate and frame filter press.
9. Elutriation: To analyze given sample of sand using Elutriator.

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| **MC-901A** | **Environmental Sciences** |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **0** | **0** | **75** | **25** | **100** | **3 Hrs.** |
| **Purpose** | To learn the multidisciplinary nature, scope and importance of Environmental sciences. |
| **Course Outcomes (CO)** |
| **CO1** | The students will be able to learn the importance of natural resources. |
| **CO2** | To learn the theoretical and practical aspects of eco system. |
| **CO3** | Will be able to learn the basic concepts of conservation of biodiversity. |
| **CO4** | The students will be able to understand the basic concept of sustainable development. |

**UNIT 1**

The multidisciplinary nature of environmental studies, Definition, Scope and Importance, Need for public awareness, Natural Resources: Renewable and Non-Renewable Resources: Natural resources and associated problems.

1. Forest Resources: Use and over-exploitation, deforestation, case studies. Timber eztraction, mining, dams and their effects on forests and tribal people.
2. Water Resources: Use & over-utilization of surface & ground water, floods, drought, conflicts over water, dams-benefits and problems.
3. Mineral Resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
4. Food Resources: World Food Problems, changes caused by agriculture and overgazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.
5. Energy Resources: Growing energy needs, renewable & non-renewable energy sources, use of alternate energy sources. Case studies.
6. Land Resources: Land as a resource, land, degradation, man induced landslides, soil erosion and desertification.

Role of an individual in conservation of natural resources, Equitable use of resources for sustainable lifestyle.

**UNIT II**

**Ecosystem-Concept of an ecosystem**. Sturcture and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological Succession, Food Chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystem: (a) Forest Ecosystem, (b) Grassland Ecosystem, (c) Desert Ecosystem and (d) Aquatic Ecosystems (ponds, streams, lakes, rivers, oceans, esturaries

Field Work: Visit to a local area to document Environment assets-river/forest/grassland/hill/mountain, Visit to a local polluted site-Urban /Rural Industrial/Agricultural, Study of common plants, insects and birds, Study of simple ecosystems-pond, river, hill, slopes etc. (Field work equal to 5 lecture hours).

**UNIT III**

**Biodiversity and its conservation:** Introduction, Definition: genetic, species and ecosystem diversity. Biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity of global, National and local levels. India as a mega-diversity nation Hot spots of Biodiversity, Threats to biodiversity: Habitat loss, poaching of wild life, man-wildlife conflicts, Endangered and endemic species of India, Conservation of Biodiversity- In situ and Ex-Situ conservation of biodiversity.

**Environmental Pollution Definition:** Cause, effects and control measures of (a) Air Pollution (b) Water Pollution (c) Soil Pollution (d) Marine Pollution (e) Noise Pollution (f) Thermal Pollution (g) Nuclear Hazards

Solid waste management- cause, effects and control measures of urban and industrial wastes, Role of an individual in prevention of pollution, Pollution case studies, Disaster management: floods, earthquake, cyclone and landslides

**UNIT IV**

**Social Issues and the Environment**. From unsustainable to sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management. Resettlement and rehabilitation of people: Its problems and concerns, Case Studies: Environmental ethics-issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies: Wasteland Reclamation, Consumerism and waste products, Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and Control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation, Public Awareness, Human population and the Environment, Population growth, variation among nations, Population explosion-Family Welfare Programme, Environment and human health. Human rights, Value Education, HIV/AIDS, Women and Child Welfare, Role of Information Technology in Environment and Human Health, Case Studies, Drugs and their effects; Useful and harmful drugs, Use and abuse of drugs, Stimulant and depressan drugs, Concept of drug de-addiction, Legal position on drugs and laws related to drugs.

**Suggested Books**

* + - * Environmental Studies- Deswal and Deswal. Dhanpat Rai and Co.
			* Environmental Science and Engineering Anandan, P. and Kumaravelan, R. 2009. Scitech Publications (India) Pvt. Ltd., India.
			* Environmental Studies. Daniels Ranjit R. J. and Krishnaswamy. 2013. Wiley India.
			* Environmental Science- Botkin and Keller. 2012. Wiley , India

**Note: The Examiner will be given the question paper template to set the question paper.**