**KURUKSHETRA UNIVERSITY, KURUKSHETRA**



**SCHEME & SYLLABUS**

**FOR**

**BACHELOR OF TECHNOLOGY (CHEMICAL ENGINEERING)**

**FINAL YEAR (SEMESTER-VII & VIII)**

**(w.e.f. session 2018-2019)**

**BACHELOR OF TECHNOLOGY (CHEMICAL ENGINEERING)**

**KURUKSHETRA UNIVERSITY, KURUKSHETRA**



*SCHEME OF STUDIES/EXAMINATION*

**SEMESTER-VII (w.e.f. session 2018-2019)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S. No** | **Course No.** | **Course Title** | **Teaching Schedule** | **Allotment of Marks** | **Dur of Exam (Hrs.)** |
| **L** | **T** | **P** | **Hrs/Wk** | **Theory** | **Sessional** | **Practical** | **Total** |
| 1 | CHE-401N | Process Equipment Design | 4 | 1 | 0 | 5 | 75 | 25 | 0 | 100 | 3 |
| 2 | CHE-403N | Transport Phenomenon | 4 | 1 | 0 | 5 | 75 | 25 | 0 | 100 | 3 |
| 3 | CHE-405N | Petroleum Processing Engineering | 4 | 0 | 0 | 4 | 75 | 25 | 0 | 100 | 3 |
| 4 | CHE-407N | Environmental Engineering | 4 | 0 | 0 | 4 | 75 | 25 | 0 | 100 | 3 |
| 5 | CHE- | Elective-I | 4 | 0 | 0 | 4 | 75 | 25 | 0 | 100 | 3 |
| 6 | CHE-409N | Process Plant Utilities | 4 | 1 | 0 | 5 | 75 | 25 | 0 | 100 | 3 |
| 7 | CHE-411N | Environmental Engineering (Lab) | 0 | 0 | 3 | 3 | 0 | 40 | 60 | 100 | 3 |
| 8 | CHE-413N | Project (Minor) | 0 | 0 | 3 | 3 | 0 | 50 | 50 | 100 | 3 |
| 9 | CHE-415N | Seminar | 0 | 0 | 2 | 2 | 0 | 50 |  | 50 | 3 |
| 10 | CHE-417N | Industrial Training Viva | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 100 | 3 |
|  |  | **Total** | **24** | **3** | **8** | **35** | **450** | **290** | **210** | **950** |  |

|  |
| --- |
| **Elective-I** |
| **S. No.** | **Course No.** | **Course Title** | **L** | **T** | **P** | **Hrs/Wk** | **Theory** | **Sessional** | **Practical** | **Total** | **Dur of Exam (Hrs.)** |
| 1 | CHE-419N | Fluidization Engineering | 4 | 0 | 0 | 4 | 75 | 25 | 0 | 100 | 3 |
| 2 | CHE-421N | Non Conventional Energy Systems | 4 | 0 | 0 | 4 | 75 | 25 | 0 | 100 | 3 |
| 3 | CHE-423N | Fertilizer Technology  | 4 | 0 | 0 | 4 | 75 | 25 | 0 | 100 | 3 |
| 4 | CHE-425N | Food Technology | 4 | 0 | 0 | 4 | 75 | 25 | 0 | 100 | 3 |

**Note:**

1. Industrial Training which was undergone by the students after VI sem is to be evaluated during VII sem as **(CHE-417N)** through submission of certified computerized report to the Head of the Department followed by viva-voce, seminar/presentation
2. Students will be allowed to use scientific calculator, however, sharing of calculator will not be permitted.

**BACHELOR OF TECHNOLOGY (CHEMICAL ENGINEERING)**

**KURUKSHETRA UNIVERSITY, KURUKSHETRA**



*SCHEME OF STUDIES/EXAMINATIONS*

**SEMESTER-VIII (w.e.f. session 2018-2019)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S. No** | **Course No.** | **Course Title** | **Teaching Schedule** | **Allotment of Marks** | **Dur of Exam (Hrs.)** |
| **L** | **T** | **P** | **Hrs/Wk** | **Theory** | **Sessional** | **Practical** | **Total** |
| 1 | CHE-402N | Process Engineering Economics | 4 | 2 | 0 | 6 | 75 | 25 | 0 | 100 | 3 |
| 2 | CHE-404N | Energy Technology | 4 | 1 | 0 | 5 | 75 | 25 | 0 | 100 | 3 |
| 3 | CHE-406N | Industrial Hazards and Safety | 4 | 1 | 0 | 5 | 75 | 25 | 0 | 100 | 3 |
| 4 | CHE- | Elective-II | 4 | 1 | 0 | 5 | 75 | 25 | 0 | 100 | 3 |
| 5 | CHE- | Elective-III | 4 | 1 | 0 | 5 | 75 | 25 | 0 | 100 | 3 |
| 6 | CHE-408N | Energy Technology (Lab) | 0 | 0 | 3 | 3 | 0 | 40 | 60 | 100 | 3 |
| 7 | CHE-410N | Project (Major) |  |  | 6 | 6 |  | 100 | 100 | 200 | 3 |
| 8 | CHE-412N | Comprehensive Viva | 0 | 0 | 0 | 0 | 0 | 0 | 75 | 75 | 3 |
| 9 | CHE-414N | General Fitness and Aptitude Test | 0 | 0 | 0 | 0 | 0 | 0 | 75 | 75 | 3 |
|  |  | **Total** | **20** | **6** | **9** | **35** | **375** | **265** | **310** | **950** |  |

|  |
| --- |
| **Elective-II** |
| **S. No.** | **Course No.** | **Course Title** | **L** | **T** | **P** | **Hrs/Wk** | **Theory** | **Sessional** | **Practical** | **Total** | **Dur of Exam (Hrs.)** |
| 1 | CHE-416N | Pulp and Paper Technology | 4 | 1 | 0 | 5 | 75 | 25 | 0 | 100 | 3 |
| 2 | CHE-418N | Catalytic Processes | 4 | 1 | 0 | 5 | 75 | 25 | 0 | 100 | 3 |
| 3 | CHE-420N | Novel Separation Techniques | 4 | 1 | 0 | 5 | 75 | 25 | 0 | 100 | 3 |
| **Elective-III** |
| 1 | CHE-422N | Mixing Theory and Practice | 4 | 1 | 0 | 5 | 75 | 25 | 0 | 100 | 3 |
| 2 | CHE-424N | Optimization Techniques in Chemical Engineering  | 4 | 1 | 0 | 5 | 75 | 25 | 0 | 100 | 3 |
| 3 | CHE-426N | Fermentation Technology | 4 | 1 | 0 | 5 | 75 | 25 | 0 | 100 | 3 |

**Note:** Students will be allowed to use scientific calculator, however, sharing of calculator will not be permitted.

**PROCESS EQUIPMENT DESIGN**

**CHE-401N**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **L** | **T** | **P** | **Theory:** | **75 Marks** |
| **4** | **1** | **-** | **Sessional:** | **25 Marks** |
|  |  |  | **Total:** | **100 Marks** |
|  |  |  | **Duration of Exam:** | **3 Hour** |

**UNIT-I**

Basic considerations in equipment design, general design procedures, material of construction, corrosion, protective coating, corrosion prevention, choice of materials, stress strain, biaxial stress and triaxial stress. Stress strain relationship for elastic bodies. Theories of failure. Process flow diagrams.

**UNIT-II**

Design of piping and piping networks. Selection, specification requirement of process pumps, fans and blowers.

**UNIT-III**

Introduction to codes for pressure vessel design, classification of pressure vessels, Design of cylindrical and spherical shells under internal and external pressure. Selection and design of closures selection and design of flanges. Design of leg support and saddle support including bearing plates and anchor bolt.

**UNIT-IV**

Process design and specifications of shell and tube heat exchangers and condensers.

**BOOKS RECOMMENDED:**

1. Chemical Engineering Vol-6: J.M.Coulson and J.F.Richardson- Pergamon Press.
2. Process Equipment Design: M.V.Joshi and V.V.Mahajani- MacMillan India Ltd.
3. Introduction to Chemical Equipment Design, Bhattacharya B.C.

**REFERENCE BOOKS:**

* 1. Process Heat Transfer: D.Q.Kem- McGraw Hill.
	2. Plant Design and Economics for Chemical Engineers.
	3. Process Equipment Design, M.V.Joshi.

**TRANSPORT PHENOMENON**

**CHE-403N**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **L** | **T** | **P** | **Theory:** | **75 Marks** |
| **4** | **1** | **-** | **Sessional:** | **25 Marks** |
|  |  |  | **Total:** | **100 Marks** |
|  |  |  | **Duration of Exam:** | **3 Hour** |

**UNIT-I**

Transport of momentum, Heat and Mass transfer by molecular motion- Newton’s law of viscosity, Fourier’s law of heat conduction, Fick’s law of diffusivity.

**UNIT-II**

Emphasis on the analogy between Momentum, Heat and Mass transfer with respect to transport mechanism and governing equations.

**UNIT-III**

Development of mathematical models of transfer processes through shell momentum balance, shell energy balance and shell mass balance for solving in laminar specific problem of transport of momentum, heat and mass in laminar flow in solids in one dimension.

**UNIT-IV**

Development of general differential equations of Fluid flow, Heat Transfer and Mass Transfer and their application in solving one dimensional steady state and unsteady state problem of momentum, heat and mass transfer.

TEXT BOOKS:

1. “Transport Phenomenon”, B.S. Bird, W.E. Stewart and E.N. Lightfoot, John Wiley & Sons.
2. “Transport Processes and Unit Operations”, C.J. Geankopils- Prentice Hall of India

REFERANCE BOOKS:

1. “Transport Phenomenon-A unified approach”, R. S. Brodkey & H.C. Hershey, McGraw Hill.
2. “Unit Operation of Chemical Engineering”, W.L. McCabe & J.C. Smith, McGraw Hill.

**PETROLEUM PROCESSING ENGINEERING**

**CHE-405N**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **L** | **T** | **P** | **Theory:** | **75 Marks** |
| **4** | **-** | **-** | **Sessional:** | **25 Marks** |
|  |  |  | **Total:** | **100 Marks** |
|  |  |  | **Duration of Exam:** | **3 Hour** |

**UNIT-I**

Introduction to petroleum industry, world petroleum resources, petroleum industry in India: origin. Exploration, drilling and production of petroleum crudes, transportation of crudes and products, crude pretreatment composition and classification of crudes.

**UNIT-II**

Methods of evaluation: ASTM, TBP and EFV distillation. Petroleum products such as LPG gasoline, naphtha, kerosene diesel oils, lubricating oils, waxes and rube still

**UNIT-III**

Separation Process: Operation of topping and vacuum distillation units, tube still furnaces, solvent extraction process, solvent dewaxing.

**UNIT-IV**

Conversion Process: Thermal cracking visbreaking and cooking process catalytic cracking

**TEXT BOOKS**

1. Petroleum Refinery Engineering, W. L. Nelson McGraw Hill.

2. Modern Petroleum Technology by G.D. Pohl Hoston, halsled press, Division of Wiley

Eastem.

**REFERENCE BOOKS**

l.Petroleum products by V.B. Guthrie. Handbook McGraw Hill.

2.“Advances in petroleum chemistry" and Refining by K.A. Kobeand J.J. MC Ketta Interscience.

**ENVIRONMENTAL ENGINEERING**

**CHE-407N**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **L** | **T** | **P** | **Theory:** | **75 Marks** |
| **4** | **-** | **-** | **Sessional:** | **25 Marks** |
|  |  |  | **Total:** | **100 Marks** |
|  |  |  | **Duration of Exam:** | **3 Hour** |

**UNIT-I**

Industrial pollution and its importance in environment, industrial waste regulatory legislations, Preventions of environmental pollution through conservation, recycle and reuse of wastes, recovery of by-products from industrial effluents. Economics considerations of waste disposal, raw material substitution, process and equipment modifications.

**UNIT - II**

Air Pollution: Principle air pollutants, and their sources, effect of air pollutants on human health, animals and vegetation, atmospheric dispersion of air pollutants, temperature inversion, air pollution control techniques - process and equipments used for control of gaseous pollutants.

**UNTT - III**

Water Pollution: Types of water pollutants, their sources and ill effects, BOD and COD characteristics of water (physical, chemical and biological) waste water treatment techniques, primary treatment involving removal of suspended particles through flocculation, settling, skimming and friction. Secondary treatment: biological treatment, aerobic and anaerobic digestion, activated sludge processes, trickling filters and oxidation periods.

**UNIT.IV**

Solid wastes: Hazardous and non-hazardous wastes, methods of treatment and disposal, land filling, incineration of solid wastes, Biodegradation.

**REFERENCE BOOKS:**

1. Environmental Pollution Control Engineering, by C.S.Rao, WireyEastern,New Delhi.
2. Waste water system Engineering : HW. parker prentice Hail of rndia.
3. Waste water Engineering, by Metcarf and Eddy rnc., Tata McGraw Hiil, Derhi.
4. Air pollution : M.N. Raoand H.y.N. Rao- Tata McGraw Hill
5. Environmental Engineering: G.N. panday and G.c. Gamey - Tata McGrawHiil.
6. Environmental Engineering: Peavy H.s. And Rowe D.R. - McGraw Hill

**PROCESS PLANT UTILITIES**

**CHE-409N**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **L** | **T** | **P** | **Theory:** | **75 Marks** |
| **4** | **1** | **-** | **Sessional:** | **25 Marks** |
|  |  |  | **Total:** | **100 Marks** |
|  |  |  | **Duration of Exam:** | **3 Hour** |

**UNIT-I**

**Water:** Water resources, storage and characterization of water, conditioning for process industries e.g. boiler feed cooling etc. Recycling aspects of water.

**UNIT-II**

**Steam:** Steam generation: Boilers, boiler accessories, Steam distribution. Steam Traps, insulation, condensate utilization.

**UNIT-III**

**Compressed Air and Vacuum:** Reciprocating air compressors, vacuum pumps. Air receivers, piping systems, different type of ejectors and barometric condensers.

**UNIT-IV**

Air Conditioning, Refrigeration and Power Generation: Review of refrigeration cycles. Cooling load calculations, refrigeration piping and layout, dehumidification. Internal combustion engine, gas turbines steam power plants, dual power system and cogeneration.

**BOOKS RECOMMENDED:**

* 1. Wenghen, D.A. Theory and Practice of Heat Engines, ELBS Camridge University Press.
	2. Arora, C.P. Refrigeration and Air conditioning, Tata McGraw Hill, Delhi.
	3. Checketekem, High Temperature Heat Carriers, 1963, A.V. Pergamon Press.

**REFERENCE BOOKS:**

* 1. Ballaney, P.L.Refrigeration and Air Conditioning.
	2. Kurl, W.F.J.M. Reuse of Water in Industry, Butterworth.
	3. Goodall, P.M. Efficient use of steam (1980).

**ENVIRONMENTAL ENGINEERING (LAB)**

**CHE-411N**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **L** | **T** | **P** | **Sessional:** | **40 Marks** |
| **-** | **-** | **3** | **Practical:** | **60 Marks** |
|  |  |  | **Total:** | **100 Marks** |
|  |  |  | **Duration of Exam:** | **3 Hour** |

**LIST OF EXPERIMENTS**

1. Determination of COD in water sample.
2. To find total dissolved solids (TDS), volatile and non-volatile components.
3. To find total suspended solids (TSS), volatile and non- volatile components
4. Determination of BOD in water sample
5. Determination of dissolved oxygen (DO) in water sample
6. Determine the acid value of water sample.
7. Determine pH of acid base sample after calibration of pH meter

**Note:**  At least six experiments are to be performed

**FLUIDIZATION ENGINEERING**

**CHE-419N**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **L** | **T** | **P** | **Theory:** | **75 Marks** |
| **4** | **-** | **-** | **Sessional:** | **25 Marks** |
|  |  |  | **Total:** | **100 Marks** |
|  |  |  | **Duration of Exam:** | **3 Hour** |

**UNIT-I**

Importance of fluidization in process industry, comparison of fluidized bed with other models of contacting, advantages and disadvantages.

Fixed bed of particles of one and mixed size, fluidization with and without carryover of particles, minimum fluidization velocity of particles, pneumatic transport of solids, mapping of regimes.

**UNIT-II**

Bubble behavior and bed properties: Single rising bubble models, wake region and solids within bubbles, interaction and coalescence of bubbles, bubble formation, slug flow.

Bubbling fluidized beds: Emulsion phase, gas flow, bubble properties, Physical and flow models.

**UNIT-III**

Entrainment and Elutriation from fluidized beds: Free board behavior, gas outlet location, entrainment from tall and short vessels.

High velocity fluidization: Turbulent fluidization beds, fast fluidization, pressure drop in Turbulent and fast fluidization.

**UNIT-IV**

Spouted Bed: Hydrodynamics and processing in spouted beds.

Calculation Systems: Circuits for the circulation on solids, pressure balance, flow of gar solid mixtures in down comers, flow in pneumatic transport lines.

**BOOKS RECOMMENDED:**

Fluidization Engineering by D. Kunii and O.Levenspiel, IInd ed. Butterworth-Heinemann, (1991)

**NON CONVENTIONAL ENERGY SYSTEMS**

**CHE-421N**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **L** | **T** | **P** | **Theory:** | **75 Marks** |
| **4** | **-** | **-** | **Sessional:** | **25 Marks** |
|  |  |  | **Total:** | **100 Marks** |
|  |  |  | **Duration of Exam:** | **3 Hour** |

**UNIT-I**

**SOLAR ENERGY:** Solar radiation and its measurement, Limitations in the application of solar energy, solar collectors-types and constructional details. Solar water heating, applications of solar energy for air heating, crop drying, space cooling, water desalination, solar concentrator, photovoltaic power generation using silicon cells.

**UNIT-II**

**BIOFUELS:** Importance, combustion, pyrolysis and other thermo chemical processes for biomass utilization. Alcoholic fermentation, anaerobic digestion for biogas production.

**UNIT-III**

**WIND POWER:** Principle of energy from wind, windmill construction and operation details, electricity generation and mechanical power generation.

**UNIT-IV**

**TIDAL POWER:** Its meaning, causes of tidal and their energy potential, enhancement of tides, power generation from tides, principles of ocean thermal energy conversion (OTEC).

**GEOTHERMAL ENERGY:** Geotechnical wells and other resources, dry rock and hot aquifer analysis, harnessing geothermal energy resources.

**BOOKS ROCOMMENDED:**

1. Renewable Energy Resources by J.Twiddel and T. Weir, E & F N Spon (1986).
2. Principles of Solar Energy by F. Kreith and J.F. Kreith, McGraw Hill (1978).
3. Energy Technology- Non conventional, Renewable and conventional by S. Rao, B.B Parulekar, Khanna Publisher.

**FERTILIZER TECHNOLOGY**

**CHE-423N**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **L** | **T** | **P** | **Theory:** | **75 Marks** |
| **4** | **-** | **-** | **Sessional:** | **25 Marks** |
|  |  |  | **Total:** | **100 Marks** |
|  |  |  | **Duration of Exam:** | **3 Hour** |

**UNIT-I**

Micro and macro nutrients fertilizer grades, different types of fertilizer, fertilizer storage and handling. Nitrogenous fertilizers. Synthesis gas: various feed stocks, merits/demerits. Synthesis gas production by stem reforming and partial oxidation, purification methods, shift convertors, carbon dioxide removal systems, final gas purification.

**UNIT-II**

Ammonia synthesis: Different types of reactors, their design considerations and operations.

Urea: Physiochemical consideration. Various processes. Calcium ammonium nitrate ammonium sulphate, methods of production.

**UNIT-III**

Phosphatic fertilizer: Raw materials, triple super phosphate, phosphoric acid, processes of manufacture and their limitations.

**UNIT-IV**

Potash fertilizer: Methods of production of potassium chloride and potassium sulphate. Complex NPK fertilizer: mono and di ammonium phosphates, urea ammonium phosphate, mixed fertilizer, granulation techniques.

**TEXT BOOKS:**

1. Chemistry and Technology of fertilizer by A.V. Slack, Interscience Publishers (1966)

2. Shreve’s Chemical Process industries by G.T. Austin, McGraw Hill.

3. Outlines of Chemical Technology by M.G. Rao and M. Dryden, 1985 Affiliated East west Process, New Delhi

**FOOD TECHNOLOGY**

**CHE-425N**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **L** | **T** | **P** | **Theory:** | **75 Marks** |
| **4** | **-** | **-** | **Sessional:** | **25 Marks** |
|  |  |  | **Total:** | **100 Marks** |
|  |  |  | **Duration of Exam:** | **3 Hour** |

**UNIT-I**

Classification of foods, nutritional aspects of foods, causes of food spoilage, Food poison: bacterial toxins, food borne illnesses. Principles of food preservations.

**High and low temperature preservation of food:** Thermal death of bacteria, Thermal process evaluation, Batch and continuous sterilization. Pasteurization, blanching, canning metabolism as a function of temperature, refrigeration, storage of foods, freezing methods and equipment

**UNIT-II**

**Drying and dehydration of foods:** Principles of drying and dehydration of foods: drying methods and equipment, sun drying, freeze drying. Diffusion-pervapouration.

**Food preservation by chemical:** Food additives, auto oxidants, surface-active agents, stabilizers, bleaching and maturing agents, Pickling and fermentation of foods.

**UNIT-III**

**Radiation preservation of foods:** Various types of radiations and their classifications, physical and chemical reactions induced by radiation, interaction of radiation with living micro-organisms, food irradiation and microwave heating.

**UNIT-IV**

Preservation and processing of food: Preservation and processing of food material such as fruits, vegetables, bread, dairy products, fish, meat, alcoholic and soft drinks.

Techniques for packaging and storage of food materials.

**BOOKS RECOMMENDED:**

1. Fundamentals of Food Engineering by S. C. Charm, AVI Publishing Co. (1971).
2. Principles of Dairy Processing by J.N. Warner, Wiley Eastern (1976).

**PROCESS ENGINEERING ECONOMICS**

**CHE-402N**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **L** | **T** | **P** | **Theory:** | **75 Marks** |
| **4** | **2** | **-** | **Sessional:** | **25 Marks** |
|  |  |  | **Total:** | **100 Marks** |
|  |  |  | **Duration of Exam:** | **3 Hour** |

**UNIT-I**

**Cost Estimation:**

Factors affecting investment and production costs, capital investment-fixed investments and working capital. Cost indices. Estimating equipment costs by scaling 6/10 factor rule. Methods for estimating capital investment. Estimations of total product cost. Different cost involved in the total product for a typical chemical process plant.

**UNIT-II**

**lnterest and lnstrument costs:**

Simple and compound interest. Nominal and effective rates of interest. continuous interest. ordinary annuity. Perpetuities and capitalized costs.

**UNIT-III**

**Taxes and lnsurance**:

Type of taxes and tax returns, type of insurance and returns, types of insurance of legal responsibility.

**Depreciation :**

Types of depreciation, service life, salvage value, present value and methods of determining depreciation single unit and group depreciation, single unit and group depreciation.

**UNIT-IV**

**Profitability Alternative lnvestment and Replacements:**

Methods for profitability evaluation, cash flow diagram. Determination of acceptable investment. Alternatives when an investment must be made and analysis with a small increment investment, replacement, break even analysis.. Balance sheet and income statement.

**Optimum design:**

Procedure with one variable optimum reflex ratio in distillation and other examples.

**BOOKS RECOMMENDED:**

1. Peters, M.S. Timmerhaus, K.D. Plant Design and Economics of Chemical Engineers.
2. Ulrich G.D. A Guide to chemical Engineering process Design and Economics, Than Wiley (1984).
3. Guthrie, K.M. Craftsman Solano Beach Calif (1974)

**ENERGY TECHNOLOGY**

**CHE-404N**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **L** | **T** | **P** | **Theory:** | **75 Marks** |
| **4** | **1** | **-** | **Sessional:** | **25 Marks** |
|  |  |  | **Total:** | **100 Marks** |
|  |  |  | **Duration of Exam:** | **3 Hour** |

**UNIT-I**

**Introduction:** Classification of energy source and resources, present and future energy demands.

Solid Fuels: Principal solid fuels, Classification of Indian coals, coal preparation, storage of coal, low and high temperature carbonization, briquetting.

**UNIT–II**

**Liquid fuels:** crude petroleum, Physical processing of crude petroleum- distillation, purification of petroleum products, properties of petroleum products , liquid fuels from coal by hydrogenation or liquification, storage and handling of liquid fuels.

**UNIT-III**

**Gaseous Fuels:** Natural gas, LPG, Producer gas Water gas and carburetted water gas, storage and distribution of gaseous fuels.

**UNIT-IV**

**Principles of combustion:** Combustion of fuels (solid, liquid and gaseous), Combustion equipment, Incomplete combustion, efficiency and heat recovery, calorific value, gas analysis, Fluidized bed combustion.

**BOOKS RECOMMENDED:**

1. Elements of Fuel, Furnaces and Refractories by O.P. Gupta, Khanna Publisher, Delhi.
2. Energy Technology, Non conventional, Renewable and conventional by S.Rao & B.B. Parulekar, Khanna Publisher, Delhi

**REFERENCES BOOKS:**

1. Fuels - solid, liquid and gaseous by J.S. Brame and J.C. King, MGH.

**INDUSTRIAL HAZARDS AND SAFETY**

**CHE-406N**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **L** | **T** | **P** | **Theory:** | **75 Marks** |
| **4** | **1** | **-** | **Sessional:** | **25 Marks** |
|  |  |  | **Total:** | **100 Marks** |
|  |  |  | **Duration of Exam:** | **3 Hour** |

**UNIT-I**

Definition, ldentification, classification and assessment of various types of industrial hazards. General principles of industrial safety, importance of safety in chemical industrial. Protective and preventive measures in hazard control.

**UNIT-II**

Standard safety procedures for disaster control, lndian legislation on safety and prevention of hazards and safety code. Environmental Protection Act (1986).

**UNIT-III**

Toxic chemicals, Maximum allowable concentration and other standards biological threshold limit values, toxicity and radioactivity. Regulations for storage and handling of hazardous substances and labelling.

**UNIT-IV**

Hazards, hazards classification, hazard due to the explosion' Dow's fire and explosion index, HMOP, guide words and their meaning, application of guide words to hazardous operation- deviation, possible causes, Consequences and actions required, event trees and fault trees.

**BOOKS RECOMMENDED:**

1. Chemical process safety fundamentals with applications by crowl, D'A' and Louvar, J.F. Prentice Hall, Delhi.
2. Safety in process plant design by Wells, G'L'
3. Industrial hazards and safety handbook'

**ENERGY TECHNOLOGY (LAB)**

**CHE-408N**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **L** | **T** | **P** | **Sessional:** | **40 Marks** |
| **-** | **-** | **3** | **Practical:** | **60 Marks** |
|  |  |  | **Total:** | **100 Marks** |
|  |  |  | **Duration of Exam:** | **3 Hour** |

**LIST OF EXPERIMENTS:**

1. To find out flash point and fire point.
2. To find the pour point and cloud point.
3. To find the aniline point of fuel.
4. To find the viscosity of liquid fuel using Redwood viscometer.
5. To study the ASTM distillation unit.
6. Proximate analysis and ultimate analysis of coal.
7. Bomb Calorimeter.
8. Junckers Gas Colorimeter.

**PULP AND PAPER TECHNOLOGY**

**CHE-416N**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **L** | **T** | **P** | **Theory:** | **75 Marks** |
| **4** | **1** | **-** | **Sessional:** | **25 Marks** |
|  |  |  | **Total:** | **100 Marks** |
|  |  |  | **Duration of Exam:** | **3 Hour** |

**UNIT-I**

Present status of pulp and paper manufacture.

**Raw Material Preparation:** Fibrous raw materials. Debarking, chipping, chip screening, storage.

**Pulping:** Chemical and mechanical pulping processes.

**UNIT-II**

**Bleaching:** Objective of bleaching, bleachability requirement, bleaching chemicals and their production, single and multi-stage bleaching process.

Pulp Processing: Deknotting, defibering, brown stock washing, Screening, Cleaning, thickening, blending.

**UNIT-III**

**Paper manufacture:** Approach flow system, wire part, sheet forming process. Sheet transfer mechanism, press part, theory of pressing, dryer part, paper drying process, calendaring, cylinder mould machine, finishing, fiber recovery systems, recent developments in paper making, coating and lamination.

**UNIT-IV**

**Paper properties:** Physical (optical, strength and resistance), chemical and electrical properties. Paper defects.

**Paper grades:** Types, composition, manufacturing techniques, properties and uses, environmental pollution control in papermaking.

**BOOK RECOMMENDED:**

1. Pulp and Paper Chemistry and Chemical Technology by J.P. Casey. Vol. 1,3rd ed., Wiley Interscience Publication.
2. Pulping Processes by S. A. Rydholm, Wiley Interscience Publication.
3. Pulp and Paper Science and Technology by C. E. Libby, Vol-1, MeGraw Hill.

**CATALYTIC PROCESSES**

**CHE-418N**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **L** | **T** | **P** | **Theory:** | **75 Marks** |
| **4** | **1** | **-** | **Sessional:** | **25 Marks** |
|  |  |  | **Total:** | **100 Marks** |
|  |  |  | **Duration of Exam:** | **3 Hour** |

**UNIT-I**

Classification of catalytic reactors. Physical properties of catalyst. Classification and preparation of catalyst.

**UNIT-II**

Dynamics of selective and polyfunctional catalysis, rate of fluid solid catalytic reactions, analysis of external transport processes in heterogeneous reactions in fixed bed, fluidized bed and slurry reactors.

**UNIT-III**

Intrapettet mass transfer, heat transfer, mass transfer with reactions and simultaneous heat and mass transfer with reactions, catalyst selectivity and poisoning.

**UNIT-IV**

Design calculations for ideal catalytic reactors operating at isothermal adiabatic and non-adiabatic conditions. Deviations from ideal reactor performance. Design of industrial fixed bed, fluidized bed and slurry reactors.

**BOOK RECOMMENDED:**

1. Chemical Engineering Kinetics by J.M Smith, McGraw Hill, 3rd ed. (1981).
2. Mass Transfer in Heterogeneous Catalysis by C. N. Satterfield, MIT Press, Cambridge.

**NOVEL SEPARATION TECHNIQUES**

**CHE-420N**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **L** | **T** | **P** | **Theory:** | **75 Marks** |
| **4** | **1** | **-** | **Sessional:** | **25 Marks** |
|  |  |  | **Total:** | **100 Marks** |
|  |  |  | **Duration of Exam:** | **3 Hour** |

**UNIT-I**

Separation processes in chemical and biochemical industries, categorization of separation processes, equilibrium and rate governed processes.

Nature of bubbles and foams, stability of foams fraction techniques, batch, continuous, single stage and multistage columns.

**UNIT-II**

Physical factors in membranes, osmotic pressure, partition coefficient and permeability, concentration polarization, electrolyte diffusion facilitated transport.

**UNIT-III**

Ultra filtration, reverse osmosis and electro dialysis, membrane structure and production.

**UNIT-IV**

Theory and application of pervapouration, permeation, critical extraction and freez-drying.

**BOOKS RECOMMENDED:**

1. Separation Processes by C. J. King, Tata McGraw Hill.
2. New Separation Techniques by J.D. Henry & N.N. Li, AICHE Today Series, AICHE (1975).
3. Hand Book of Separation Techniques for Chemical Engineers by Philip A. Schweitzer, McGraw Hill Book Company.

**MIXING THEORY AND PRACTICE**

**CHE-422N**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **L** | **T** | **P** | **Theory:** | **75 Marks** |
| **4** | **1** | **-** | **Sessional:** | **25 Marks** |
|  |  |  | **Total:** | **100 Marks** |
|  |  |  | **Duration of Exam:** | **3 Hour** |

**UNIT-I**

Impeller types, tank geometry and impeller placement. Power comsumption and head, effect of tank baffles, effect of impeller location, motor and impeller loading.

**UNIT-II**

Settling velocity, process design consideration, selection of mixers, and power consumption in slurries. Liquid-liquid emulsion and their correlation parameters. Uniform dispersion criteria, gas-liquid dispersion criteria.

**UNIT-III**

**Chemical Reaction:** Macro nixing, influence of flow pattern on chemical reaction. Micro mixing, influence of diffusion on chemical reaction.

**UNIT-IV**

**Liquid-solid mass transfer:** Principle method of correlation, Gas-liquid-solid processes.

**Liquid-liquid mass transfer:** Batch mass transfer relationship, counter-current, multistage operation, mixer settlers.

**Gas-liquid mass transfer:** Effect of gas rate and power on gas-liquid mas transfer.

BOOKS RECOMMENDED:

1. Mixing principles and Application by S. Nagata, John Wiley, 1975.
2. Fluid mixing Technology by J. Y. Oldshue, McGraw Hill, !983.

**OPTIMIZATION TECHNIQUES IN CHEMICAL ENGINEERING**

**CHE-424N**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **L** | **T** | **P** | **Theory:** | **75 Marks** |
| **4** | **1** | **-** | **Sessional:** | **25 Marks** |
|  |  |  | **Total:** | **100 Marks** |
|  |  |  | **Duration of Exam:** | **3 Hour** |

**UNIT-I**

Introduction to system analysis and modeling with reference to chemical engineering problems. Different methods for solving one and two variable problems, with and without constrints- case studies, application of langrangian multiplier method.

**UNIT-II**

Liner programming-modeling, graphical method, single phase simplex method, two phase complex method, duality, sensitivity analysis.

**UNIT-III**

Geometric Programming-Problems with degree of difficulty equal to zero and one, with and without constraints.

**UNIT-IV**

Search Methods-sequential search method, golden section method, and dichotomous search method.

Introduction to dynamic programming as applied to discrete multistage problems.

Computer programming techniques applied to optimization.

**BOOKS RECOMMENDED:**

1. Optimization Theory and Practice by Baveridege and Schecheter.
2. Linear programming by Hadley
3. Non-linear programming by Hadley

**FERMENTATION TECHNOLOGY**

**CHE-426N**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **L** | **T** | **P** | **Theory:** | **75 Marks** |
| **4** | **1** | **-** | **Sessional:** | **25 Marks** |
|  |  |  | **Total:** | **100 Marks** |
|  |  |  | **Duration of Exam:** | **3 Hour** |

**UNIT-I**

Introduction to fermentation processes, microbial culture, microbial growth kinetics, multistage systems, feedback systems, feed batch cultures. Application of batch, continuous, and feed batch cultures.

**UNIT-II**

Isolation, preservation and improvement of industrial micro-organisms, isolation methods, selection and characterization of microorganisms, various methods of preservation of microorganism mutagens.

**UNIT-III**

Air and media sterilization techniques, sterilization of equipment and fermenters, instrumentation and classification of fermenters, their design, sampling and monitoring of various parameters, foam control.

**UNIT-IV**

Development of inocula for bacterial and fungal processes, effect of inocula on morphology of fungi in submerged culture. Asceptic inoculation to plant fermenters. Recovery and purification of fermentation products, separation of biomass, various methods of product separation and purification, filtration, precipitation, centrifugation and ion exchange.

**BOOKS RECOMMENDED:**

1. Principle of Fermentation Technology by P.F. Stanbury and Whitaker, Pergemon Press, (1984)