

M.Sc. Process Engineering Courses

FIRST SEMESTER					
SR.No	CODE	COURSE TITLE	CREDIT HOURS	STATUS	PREREQUISITE
1	*NE-101	Fundamentals of Nuclear Engineering	3	C	Nil
2	*NE-103	Numerical Computing	3	C	Nil
3	*NE-105	Thermal Engineering Principles	2	C	Nil
4	*NE-106	Applied Mathematics – I	2	C	Nil
5	CME-411	Applied Mineralogy	2	O	Nil
6	CME-511	Mathematical Modelling of Physical Systems	2	O	Nil
7	CME-412	Environmental Engineering – I	2	O	Nil
8	CME-413	Fundamentals of Radiation Protection	3	C	Nil
SECOND SEMESTER					
9	CME-512	Process Heat Transfer	3	C	*NE-105
10	CME-513	Transport Phenomena – I	3	C	*NE-105, *NE-106
11	CME-514	Mineral Processing	3	O	CME-411
12	CME-414	Process Engineering Laboratory – I	3	C	Nil
13	CME-515	Environmental Pollution Assessment & Control	3	O	CME-412
14	CME-516	Process Mass and Momentum Transfer	3	C	*NE-105
15	CME-517	Applied Mathematics – II	3	O	*NE-106
THIRD SEMESTER					
16	*NE-307	Numerical Methods in Engineering	3	C	*NE-103, *NE-106
17	CME-611	Nuclear Chemical Engineering	3	O	CME-512, CME-516
18	CME-612	Transport Phenomena – II	3	O	CME-513, *NE-312
19	CME-518	Process Dynamics and Control	3	O	*NE-106, *NE-312
20	CME-613	Combustion Emission & Control	3	O	CME-512
21	CME-519	Extractive Metallurgy	3	O	CME-514
22	CME-531	Process Engineering Laboratory –II	3	C	Nil
23	CME-532	Instrumental Analysis	3	O	Nil
FOURTH SEMESTER					
24	*NE-427	Project Management	3	C	Nil
25	CME-699	Seminar Project	3	C	Nil
26	CME-614	Computational Fluid Dynamics	3	C	CME-612, *NE-307
27	CME-615	Advanced topics in Mineral Processing	3	O	CME-514, CME-516
28	CME-616	Advanced topics in Environmental Engineering	3	O	CME-515
29	CME-617	Advanced Process Control	3	O	CME-518
30	CME-618	Turbulence Modelling and Grid Generation	3	O	CME-612, *NE-307
31	CME-533	Explosives and Propellants	3	O	Nil
32	CME-534	Water Treatment Technology	3	O	CME-412
33	CME-619	Meteorology & Atmospheric Dispersion	3	O	CME-412, CME-513
34	CME-631	Special Topics in Process Engineering	3	O	-
35	CME-632	Radioactive Waste Management	3	O	CME-412, CME-413
FIFTH SEMESTER					
36	CME-700	Thesis Project	9	C	CME-699

C : Core / Compulsory Courses

O : Optional Courses

* Courses with NE prefix are subject to change as finalised by Department of Nuclear Engineering

**STREAMS OFFERED
IN
M.Sc. PROCESS ENGINEERING**

1. Chemical & Mineral Processing

- Semester 1: Compulsory from 1 to 5 and 6.
- Semester 2: Compulsory from 1, 2, 3, 4 and 6.
- Semester 3: Compulsory 1, 2, 4, 6 and 7.
- Semester 4: Compulsory 1, 2, 4. Choose two from 6, 8 to 12.

2. Process Modelling and Control

- Semester 1: Compulsory from 1 to 4, 6 and 8.
- Semester 2: Compulsory from 1, 2, 4, 6 and 7.
- Semester 3: Compulsory 1, 3, 4, 5 and 7.
- Semester 4: Compulsory 1, 2 and 3. Choose two from 6, 7, 10 and 11.

3. Environmental Engineering

- Semester 1: Compulsory from 1 to 4, 7 and 8.
- Semester 2: Compulsory from 1, 2, 4, 5 and 6.
- Semester 3: Compulsory 1, 3, 5, 7 and 8.
- Semester 4: Compulsory 1, 2 and 5. Choose two from 9 to 12.

1) *NE-101 Fundamentals of Nuclear Engineering

Role and importance of nuclear energy; Nuclear cross – sections; Reaction Rates; Nuclear fission and chain reaction; Criticality conditions; Conversion and breeding; Reactor components and their characteristics; Classification and design features of research, production and power reactors; Introduction to fast and fusion reactor systems.

Different types of fuel cycles; Core and feed – material preparations; Uranium enrichment; Fabrication of fuel; Reprocessing of Irradiated fuel; Fuel cycle performance of commercially available reactors; In-core fuel management and fuel management strategies.

Recommended Text:

Lamarsh, J. R, Introduction to Nuclear Engineering, Addison Wesley, 1983.

2) *NE-103 Numerical Computing

Finite differences; Lagrange interpolation; Cubic Spline interpolation; System of linear algebraic equations; Solution of non-linear algebraic equations; Numerical differentiation and integration; Gaussian quadrature; Ordinary and partial differential equations.

Recommended Text:

Burden, R. L, Faires, J. D., Numerical Analysis, 5th edition, Webers Schmidt 1993

3) *NE-105 Thermal Engineering Principles

Fundamental Laws of fluid flow; Integral Method of Analysis in Fluid Dynamics, Viscous Flow analysis.

Modes of heat transfer; Temperature distribution in different bodies in 1-D and 2-D;

Revision of the concept of local heat transfer coefficient and overall heat transfer coefficient

Fundamentals of forced convection heat transfer, Theoretical and Empirical correlations and their use in predicting the local and overall heat transfer coefficients.

Recommended Text:

White, F, Fluid Dynamics, 3rd edition, Mc Graw Hill, 1994

Holman, J. P, Heat Transfer, NBF, 1988

4) *NE-106 Applied Mathematics – I

Partial derivatives of explicit and implicit functions; Maxima and minima of functions of several variables; Double and triple integrals; Special functions; Bessel functions; Legendre polynomials; Laplace transforms; Solution of linear differential equations by the Laplace transform method.

Recommended Text:

Kreyszig, E, Advanced Engineering Mathematics, John Wiley, 1988.

5) CME-411 Applied Mineralogy

Introduction; Sampling methods; Mineral liberation and fractionation methods; Mineral determinative schemes; Optical properties of minerals and use of polarising microscope; Theory and application of image analysis for mineral size and composition determination; Radiation-based methods of mineralogical analysis.

Recommended Text:

Jones, Meurig P., Applied Mineralogy: A Quantitative Approach. John Wiley & Sons, 1987

6) CME-511 Mathematical Modelling of Physical Systems

Use of models in process engineering: Model as a working description of a system; Level of detail; types and functions of models: Mechanistic, empirical, stochastic, procedural and qualitative.

Strategy for model building: relationship between engineering and mathematical approximations; Example of dynamic delay of air heater; conceptual models; formulation of functional mechanistic models based on the conservation equations; coordinate free methods based on vector / matrix rotation; models for complex and irregular geometries; Case

study examples for heat exchanger and tubular reactor. Definition of system parameters consistent with the model; averaging and model reduction techniques; numerical procedures based on weighted residuals.

Recommended Text:

Murthy, D. N. P, Mathematical Modelling, Pergamon Press, 1990

7) CME-412 Environmental Engineering – I

The environment and its segments- atmosphere, hydrosphere and lithosphere, Ecosystem and effects of human activities on it; Biochemical cycles; Dynamics of environmental cycles; Different patterns of air circulation; Coriolis effect; Radiation balance of the earth and green house effect; Environmental engineering principles, Pollution from natural sources and human activities; Solid and radioactive waste management; Miscellaneous topics of current interest in environmental engineering.

Recommended Text:

G. M.Masters, Introduction to Environments Engineering and Science , John Wiley & Sons, 1995., P.W. Purdom and S. H. Anderson, Environmental Science, Charles E. Merrill Publishing Co., Columbus, Ohio, USA, 1983, A.K. De., S. J. Williamson, Fundamentals of Air Pollution, Addison-Wesley Pub., Co., 1973., J. Glynn. Henry and Gary W. Heinke, Environmental Science and Engineering, Prentice Hall, 1996., Introduction to Environmental Engineering, 2nd Ed., Mackenzie L. Devis and David A. Cornell, McGraw-Hill, Inc., GEC (General Electric Company), Solid Waste Management, Van Nostrand Reinhold Co. , 1975., N. J. Sell, Industrial pollution control, Van Nostrand Reinhold Company, 1981

8) CME-413 Fundamentals of Radiation Protection

Radiation sources; interaction of radiation with matter; basic principles of radiation detection; Radiation detectors and their applications; Nuclear Instrumentation Modules; Radiation units, natural and man made radiation sources; Elementary biology and biological effects of radiation; Standards of radiation protection; Calculation of exposure and dose; Attenuation coefficient and buildup factors for gamma rays; Shielding of sources with different geometrical shapes; Shields with internal sources; Multi-layered shields; Concept of removal cross-section; Removal-attenuation and removal diffusion calculations; Dispersion of effluents from nuclear facilities; Radiation doses from nuclear plants.

Recommended Text:

Knoll, G. F, Radiation detection and measurement, John Wiley 1989

Lamarsh, J. R, Introduction to nuclear engineering, Addison Wesley, 1983.

9) CME-512 Process Heat Transfer

Computer based design and analysis of heat exchangers, covering double pipe, shell and tube and compact heat exchangers.

Design and analysis of boilers; fired tube and water tube types.

Design and analysis of condensers

Radiation heat transfer and furnace design

Heat Transfer in Nuclear Reactors

Recommended Text:

Kern D. Q., Process Heat Transfer, McGraw Hill, 1960

Ludwig E. E. , Applied Process Design for Chemical and Petrochemical Plants 3rd Edition, Gulf Publishing, 2001

El Wakil, M. M, Nuclear Heat Transport, International Text Book, 1971

10) CME-513 Transport Phenomena – I

Momentum Transport: Derivation of equation of continuity and motion; Application to laminar flow problems.

Energy Transport: Derivation of energy equation; Application to heat Transfer Problems involving conduction, forced and free convection.

Mass Transport: Derivation of species conservation equations for binary and multi-component mixtures; Application to mass transfer problems with and without chemical reactions.

Recommended Text:

Bird, R. B, Stewart, W. E, and Lightfoot, E. N, Transport Phenomenon, John Wiley, 1960

11) CME-514 Mineral Processing

Objectives of mineral processing. Mine-mill interface. Properties of minerals and ores. Sampling and evaluation. Comminution: fracture, liberation, size criteria, energy-size relationships. Crushing and grinding. Screening and classifying. Concentration processes: density and other physical processes. Interfacial phenomena. Flotation. Liquid-solid separation: flocculation, thickening, filtration. Washability curves. Partition curves. Material balances. Performance prediction.

Recommended Text:

Kelly, Errol G. and Spottiswood, David J., Introduction to Mineral Processing. John Wiley & Sons, 1989
Wills, B.A., Mineral Processing Technology, Pergamon Press. 1985

12) CME-414 Process Engineering Laboratory – I

- a) Conduction heat transfer experiment
- b) Double pipe heat exchanger experiment
- c) Friction loss experiment
- d) Pumping experiment
- e) Size reduction experiment
- f) Gravity separation experiment
- g) Study of G. M. counter and NaI(Tl) scintillation detector
- h) Calibration and use of health physics instruments.
- i) Basic Experiments of Environmental Analysis
- j) Determination of Biological and Chemical Oxygen Demand of Waste Water

13) CME-515 Environmental Pollution Assessment & Control

Analytical techniques used in environmental pollution monitoring; Sampling, sample preparation and storage; Chemical methods of analysis of common pollutants; Instrumental methods of monitoring/analysis of exhaust gases from automobiles, stacks and chimneys; Performance and structure of analytical techniques; Environmental quality testing for NEQS; Pollution control laws, regulations and policies; River and Marine Pollution, Pollution in Agriculture.; Prediction and assessment of impact of pollution and noise environment; Environmental management systems.

Recommended Text:

Gary D. Christian, Analytical Chemistry, John Wiley and sons, 1984.
Roy M. Harrison (Editor) Pollution, causes, effects and control, The Royal Society of Chemistry, 1996.
Noel De. Neverse, Air Pollution Control, McGraw Hill Inc., 1995
Lain L. Marr and Malcom S. Cresser, Environmental Chemical analysis, International Text book Company, 1983.
J. Glynn. henry and Gary W. Heinke, Environmental Science and Engineering, Prentice hall, 1996.

14) CME-516 Process Mass and Momentum Transfer

Design of absorption with and without chemical reaction; binary and multi-component distillation, cooling towers, knockout drums, heat exchangers and liquid extraction columns; Study of water treatment plants with particular emphasis on ion exchange columns and reverse osmosis process; Industrial applications of compressor and pumps including design calculations; Study of process flow, piping, instrumentation and layout diagrams; Brief study of process control.

Recommended Text:

Traybal, V. G., Mass transfer operations, McGraw Hill, 1984

15) *NE-312 Applied Mathematics – II

Complex numbers; Analytic functions; Cauchy-Riemann equation; Cauchy integral formula; Residue theorem; Contour integration; Introduction to the calculus of variations; Euler-Jacobi equations. Orthogonal functions; Fourier series and its convergence; Dirichlet's conditions; Complex Fourier series; Fourier transform theorems; Discrete data systems; z-transform theorems; Limitation of the z-

transform method, Solution of difference equations by the z-transform method.

Recommended Text:

Churchill, R. V, and J. W. Brown, Complex Variables and Applications, McGraw Hill, 1984
C, R. V, and J. W. Brown, Fourier Series and boundary value problems, McGraw Hill, 1978

16) *NE-307 Numerical Methods in Engineering

Systems of non-linear algebraic equations; Eigenvalues and Eigenvectors; Higher order differential equations and system of first order differential equations; Numerical algorithm for the determination of state-transition matrix of the system of differential equations; Partial differential equations; Finite element techniques; Recent developments in approximate methods.

Recommended Text:

Burden, R. L, Faires, J. D., Numerical Analysis, 5th edition, Webers Schemidt 1993

17) CME-611 Nuclear Chemical Engineering

Chemical engineering and nuclear power industry; Review of Decay chains, Growth and decay of fission products in and out of the reactor; Buildup of heavy actinides

Nuclear fuel cycles; Feed requirements; Burn up and reactivity changes for mixed and unmixed fuel; Plutonium recycle; Nuclear fuel reprocessing; Solvent extraction; McCabe-Thiele diagrammatic solution of problems in separation processes; Equipment for reactor materials processing; Hafnium and Zirconium; Important isotopes, their uses and methods of separation; General cascade theory; Ideal, close-separation and squared-off cascades; Separative duty and separation potential; Enrichment costs; Heavy water production, its analysis and process optimization; Uranium enrichment process its analysis and optimization.

Recommended Text:

Benedict, M, Pigford, T. H, Levi, H. W, Nuclear Chemical Engineering, McGraw Hill, 1981.

18) CME-612 Transport Phenomena – II

In depth aspects of Momentum heat and mass transfer not already covered in Transport Phenomenon-I including: Hydrodynamic and thermal boundary layer analysis; Momentum heat and mass transport in turbulent flow , Compressible flow: The speed of sound; Adiabatic and isentropic steady flow; Isentropic flow with area changes; The normal shock wave; Operation of converging-diverging nozzles; Compressible duct flow with friction; Frictionless duct flow with heat transfer; Two-dimensional supersonic flow; Prandtl-Meyer expansion waves.

Recommended Text:

Bird, R. B, Stewart, W. E, and Lightfoot, E. N, Transport Phenomenon, John Wiley, 1960
Anderson, J. D, Introduction to Aerodynamics John Wiley, 1986

19) CME-518 Process Dynamics and Control

Introduction to Process Control; Process Dynamics and Laplace Transform; First Order Systems; Second Order Systems; Inverse Response and Time Delay; Frequency Domain; Linearization and Nonlinear Systems; Stability; Process Identification; Feedback Control Systems; Conventional Design; Inverse Response and Time Delay; Feed forward, Inverse Response, and Time Delay; Model-based Control; Digital Control - Sampling; Z Transforms and Digital Block Diagrams; Digital Controller Design; Model Predictive Control; Multivariable Control; RGA and Modal Analysis; SVD and Decoupling; Multivariable Examples.

Recommended Text:

Smith, C. A, Corripio, A. B, Principles and Practice of Automatic Process Control, John Wiley, 1985.

20) CME-613 Combustion Emission & Control

Fundamental Concepts in Combustion, Primary and Secondary Fuels and Fuel Testing, Energy Conversion with Combustion, Combustion technology of gas, oil and coal, Operation of combustion plant, Pollutants formation in combustion systems, Production and emission of nitrogen oxide and sulphur oxide gases from combustion engines, Emission from coal fired power plants,

Combustion calculations, staged combustion, Recent Development in control technologies, Chemical kinetics of reactions; multi-component reacting systems and their equations; coupling of chemical and thermal analysis of reacting systems; Constant pressure fixed mass reactor model; Constant volume fixed mass reactor model; perfectly stirred reactor model; Plug flow reactor model; Application to combustion system modelling; Combustion and chemical kinetic modelling softwares; Introduction to chemical kinetic codes for plug flow reactors, perfectly stirred reactors, shock tubes and premixed flames.

Recommended Text:

Glassman, Combustion, Academic Press, 1994
 E. N. Goodger, Combustion Calculation, MacMillan, 1977.
 R. A. Strehlow, Combustion Fundamentals, McGraw Hill, 1988.
 S. Brame and J. G. King, FUELS, Solid, Liquid and Gaseous by, St Martin's Press, NewYork.
 Marion L. Smith and Karl W. Stinson, Fuels and Combustion, McGrawHill Book Company.
 Smith, J. M., Chemical Engineering Kinetics, McGraw Hill, 1985..

21) CME-519 Extractive Metallurgy

Thermodynamics and reaction kinetics of extractive metallurgical processes; Thermodynamic stability diagrams. Pyrometallurgy: Roasting, agglomeration, calcination; oxidation-reduction reactions; smelting and converting; refining. Hydrometallurgy: Leaching under atmospheric and elevated pressures; microbial leaching; purification of leach liquors (ion exchange and solvent extraction); cementation and gaseous precipitation; kinetics of hydrometallurgical processes. Electrometallurgy: Electrowinning and electrorefining of metals from aqueous and fused salt systems.

Recommended Text:

Rosenquis, T., Principles of Extractive Metallurgy. McGraw Hill. 1983
 Jackson, E., Hydrometallurgical Extraction and Reclamation. Jackson/ Ellis Horwood Ltd. 1986

22) CME-531 Process Engineering Laboratory – II

- a) Feedback control experiment
- b) Water demineralization experiment
- c) Distillation experiment
- d) Liquid-liquid extraction experiment
- e) Cascade Control
- f) Conventional Flotation experiment
- g) Column Flotation experiment
- h) Mixer-settler experiment
- i) Cooling Tower
- j) Analysis of Lead impurities by Atomic Absorption Spectrometry
- k) Use of High Performance Liquid Chromatography in organic Analysis
- l) Determination of iron(Fe^{+3}) by UV-Visible spectrophotometer

23) CME-532 Instrumental Analysis

Sampling and sample preparation, Chromatographic Methods: Gas chromatography; High Performance Liquid Chromatography; Ion exchange chromatography; Molecular Exclusion Chromatography. Spectroscopic Methods: Atomic Absorption and Emission Spectroscopy; Molecular Spectroscopy; Microwave spectroscopy; Neutron Activation and Mass Spectrometry. Electroanalytical Techniques: Ion Selective Electrodes; Potentiometry; Voltametry and Polarography; Conductometry and Coulometry

Recommended Text:

Skoog, D. A., Principles of Instrumental Analysis, Saunders College Publishing. 1985
 Christian, G.D. and O'Reilly J. E., Instrumental Analysis, Allyon and Bacon, 1986.

24) *NE-427 Project Management

Management Principles; Project management versus line management; interdisciplinary and multidisciplinary skills of a project manager;

balance between cost, time and project scope quality; economic analysis; siting and environmental considerations; regulatory control and licensing; safety analysis reports; turnkey contracts versus owner controlled management; bid specification; technical bid evaluation; quality assurance and quality control; project inspection; schedule control; maintaining cost, schedule and project functional integrity; revision of estimates; plant acceptance testing; staffing for operations and maintenance.

Recommended Text:

Hajek, V. G., Management of engineering projects, McGraw Hill, 1984.

25) CME-699 Seminar Project

26) CME-614 Computational Fluid Dynamics

General Differential Equations; Numerical solution of energy and Navier-Stokes Equations; Numerical schemes and algorithms; Methods of obtaining convergence; Transient analysis; finite difference and finite element methods applied to fluid mechanics; Matrix solving Techniques; Recent developments in CFD; Development of computer programs for CFD problems.

Recommended Text:

Patankar. S. V. Numerical heat transfer and fluid flow, Hemisphere, 1980.

27) CME-615 Advanced Topics in Mineral Processing

Feed characterization: float-sink separation, release analysis, tree procedure. Vector representation for samples: Mayer curves and release curves. Physics and chemistry of surfaces. Measurement of surface properties. On-stream and laboratory analyses and measurements. Laboratory and pilot testing. Flow-sheet design. Equipment selection and plant layout. Materials handling, storage and blending. Rejects and tailings disposal. Sampling: sampling theory, sources of error in sampling, design of sampling plants. Process optimisation and control. Process simulation.

Recommended Text:

Kelly, Errol G. and Spottiswood, David J., Introduction to Mineral Processing. John Wiley & Sons. 1989
 Wills, B.A., Mineral Processing Technology, Pergamon Press. 1985
 SME Mineral Processing Handbook. American Institute of Mining, Metallurgy and Petroleum Engineers Inc., 1985

28) CME-616 Advanced Topics in Environmental Engineering

Environmental behaviour of noxious Industrial effluents, Atmospheric Chemistry, Photochemical and Sulphurous smog, Acid rains, Global warming, Ozone layer depletion, Particulate emission from industries, Adverse effects of pollutants and pollution economics Control of particulate emission, Design and working of particulate emission control equipment i.e. Gravity settlers, Cyclonic separators, Electrostatic precipitators, Fabric filters, Industrial scrubbers, Gaseous Effluent Treatment Processes, Environmental Assessment and Audits.

Recommended Text

Gerard Kiely, Environmental Engineering, McGrawHill, International Edition 1998.
 A. C. Stern, Air pollution, Academic press, 1977.
 Industrial pollution control, Van Nostrand Reinhold Company, 1981
 J. Glynn. Henry and Gary W. Heinke, Environmental Science and Engineering, Prentice Hall, 1996.
 Noel De. Neverse, Air Pollution Control, McGraw Hill Inc., 1995.
 Gary W. Canter, Environmental Impact Assessment, McGraw Hill Inc., 1996.

29) CME-617 Advanced Process Control

Introduction; Frequency Response Review; Classical Feedback Control Synthesis; Multivariable Control Review; Multivariable Control Formulation; Linear System Theory; SISO Performance Limitations; SISO Performance Limitations; SISO Performance Limitations; MIMO Performance Limitations; MIMO Performance Limitations; Uncertainty; Frequency Domain Uncertainty; SISO Robust Stability & Robust Performance; Robust Stability; Structured Singular Value; Robust Performance; MIMO/LQG Control Design; H_2 and H_∞ Control Design; Control Variable Selection; Hierarchical Control; Plant-wide Control; Model Reduction.

Recommended Text:

Smith, C. A, Corripio, A. B, Principles and Practice of Automatic Process Control, John Wiley, 1985.

Seborg, D. E, Edgar, T. F, and Mellichamp, D. A, Process Dynamics and Control, John Wiley, 1989

30) CME-618 Turbulence Modelling & Grid Generation

Turbulence Modelling: Turbulent flows; laminar/turbulent transition, turbulent boundary layers, separated flows, Nature of turbulence, Statistical description, Length scales, turbulent transport

Reynolds-averaged Navier-Stokes equations, turbulent closure, Reynolds stress, Kinetic energy balances, turbulence models; Application in CFD; Large eddy simulation. Measurement and model evaluation

Grid Generation: Introduction; geometry modelling and surface grids; algebraic mesh generation; structured meshes from partial differential equations; automatic generation of unstructured meshes; multiblock mesh generation; unstructured grids by the default triangulation; mesh adaptation on unstructured grids; unstructured grids for viscous flows.

Recommended Text:

Bradshaw, P, Cebeci, T, Whitelaw, J. H, Engineering calculation methods for turbulent flows, Academic Press, 1981. Thompson, M., Grid Generation, John Wiley, 1988.

31) CME-533 Explosives and Propellants

Explosion theory and types of explosions; The chemistry of explosive compounds and mixtures; The concept of fuel and oxidant, oxygen balance; Thermo-chemistry, simple prediction of heat, temperature and pressure of explosion; Introduction to deflagration, detonation and classification of explosives; Commercial and military HE, power, brisance; Aluminized HE; Introduction to wave shaping and shaped charges; Principles of propellant chemistry, solid and liquid propellants for guns, rockets and mortars; Primary explosives, initiation, effect of heat on explosives, explosives trains; Principles and applications of pyrotechnics.; Safety, reliability and testing of explosives; Management of explosive including classification and storage.

Recommended Text:

Bailey, A. and Murray, S.G., Propellants, Explosives, Pyrotechnics. 3rd Edition. 2001

32) CME-534 Water Treatment Technology

Quality of water supplies, Systems for treating waste water and drinking water, Physical Treatment Systems, Chemical Treatment Systems, Biological Treatment Systems, Design of Sewer System, Sewer materials, Sewer Appurtenances, Sewer construction and Maintenance, Characteristics of waste water, Sewage disposal, Primary and Secondary Treatment Systems, Sludge treatment and disposal, Advanced waste water treatment, Miscellaneous waste water treatment techniques, Financial considerations

Recommended Text

M. J. Hammer and M. J. Hammer Jr., Water and Wastewater Technology, Prentice Hall, 1996.

McGhee, Terence J., Water Supply and Sewerage. 6th Edition, McGraw Hill Inc. 1991

W. Viessman, Jr and M. J. Hammer Water Supply and Pollution control, 5th edition, Harper Collins Publishers.

Eckenfelder, W. W. Jr., Industrial Water Pollution Control. McGraw Hill Inc. 1966.

Manahan, S.E., Environmental Chemistry. 6th Edition, Lewis Pub. 1994

33) CME-629 Meteorology & Atmospheric Dispersion

Introduction to Meteorology, Temperature, Moisture and Atmospheric Stability, Forms of condensation and Precipitation, Air pressure and winds, Circulation of the Atmosphere, Air Masses, Weather Pattern, Thunderstorms, Tornadoes and Hurricanes, Weather Analysis and forecasting, El-nino and La-nina processes, Moonsoons and Weather of South Asia, World Climates.

Meteorological factors affecting pollution dispersion; Steady state solution of the diffusion equation; Gaussian plume model for point, line and area sources; Calculation of plume rise; Trajectory analysis and long range transport; Emission inventories; Dispersion of pollutants released to water bodies and soil; Pollutants dispersion modeling in atmosphere and surface waters.

Recommended Text:

Frederick K. Lutgens and Edward J. Tarbuck, The Atmosphere, Prentice Hall, 1995.

David R. Patrick (Editor), Toxic Air Pollution Handbook, Van Nostrand Reinhold, New York, 1994

IAEA, Hydrological Dispersion of radioactive Materials, IAEA Safety Series No. 50-SG-S6, Vienna, 1985.

C. Stern, Air pollution, Academic press, 1977.

34) CME-631 Special Topics in Process Engineering

35) CME-632 Radioactive Waste Management

Major sources of nuclear waste; Waste classification; Waste management steps; Waste pre-treatment techniques; Waste treatment processes; Waste conditioning processes; Waste disposal options with special reference to cementation and vitrification; Safety assessment (Mathematical modelling); Waste from decommissioning; DRS management; Pakistan perspective

Recommended Text:

Benedict, M, Pigford, T. H, Levi, H. W, Nuclear Chemical Engineering, McGraw Hill, 1981.

Proceedings of the Management of Radioactive Wastes from the Nuclear Fuel Cycle, IAEA, Viena, 1976.

Mawsor, G.A., Management of Radioactive Waste, Van Nostrand, 1965.

TRS IAEA