**Course Curriculum**

**for**

**M. Tech Programme in Green Energy Technology**

**(School of Engineering)**

**SEMESTER-I**

|  |  |  |  |
| --- | --- | --- | --- |
| **CODE** | **SUBJECTS** | **Teaching** **Scheme** | **Credits** |
| **L** | **T** | **P** |
| PGET 101 | Green Energy Technology | 1 | 2 | 2 | 8 |
| PGET 102 | Energy & Environment | 1 | 2 | 2 | 8 |
| PGET 103 | Fundamentals of Energy Technology | 1 | 2 | 2 | 8 |
| PGET 104 | Elective-I | 1 | 2 | 0 | 6 |
| PGET 105 | Elective-II | 1 | 2 | 0 | 6 |
| **Total** | **5** | **10** | **6** | **36** |

**SEMESTER-II**

|  |  |  |  |
| --- | --- | --- | --- |
| **CODE** | **SUBJECTS** | **Teaching Scheme** |  |
| **L** | **T** | **P** | **Credits** |
| PGET 201 | Energy Management & Auditing | 1 | 2 | 2 | 8 |
| PGET 202 | Numerical Methods for Energy Systems | 1 | 2 | 2 | 8 |
| PGET xxx | Elective-III | 1 | 2 | 0 | 6 |
| PGET xxx | Elective –IV | 1 | 2 | 0 | 6 |
| PGET xxx | Elective-V | 1 | 2 | 0 | 6 |
|  | Seminar-I | 0 | 0 | 2 | 2 |
| **Total** | **5** | **10** | **6** | **36** |

**SEMESTER-III**

|  |  |  |  |
| --- | --- | --- | --- |
| **CODE** | **SUBJECTS** | **Teaching** **Scheme** | **Credits** |
| **L** | **T** | **P** |  |
| PGET 331 | Dissertation Phase-I | 0 | 0 | 30 | 30 |
| PGET 332 | Seminar-I | 0 | 0 | 2 | 2 |
| **Total** | **0** | **0** | **32** | **32** |

**SEMESTER-IV**

|  |  |  |  |
| --- | --- | --- | --- |
| **CODE** | **SUBJECTS** | **Teaching Scheme** | **Credits** |
| **L** | **T** | **P** |  |
| PGET 431 | Dissertation Phase-II | 0 | 0 | 32 | 32 |
| **Total** | **0** | **0** | **32** | **32** |

**Total Credits: 36+36+32+32= 136**

**Lists of Electives:**

|  |  |  |  |
| --- | --- | --- | --- |
| **CODE** | **SUBJECTS** | **Teaching** **Scheme** | **Credits** |
| **L** | **T** | **P** |  |
| **PGET 501** | **Power Plant Engineering** | 1 | 2 | **0** | **6** |
| **PGET 502** | **Fuels & Combustions** | 1 | 2 | **0** | **6** |
| **PGET 503** | **Bio-energy & Conversion Systems** | 1 | 2 | **0** | **6** |
| **PGET 504** | **Wind and Hydro Power Systems** | 1 | 2 | **0** | **6** |
| **PGET 505** | **Solar Thermal Energy Conversions** | 1 | 2 | **0** | **6** |
| **PGET 506** | **Nuclear Power Systems** | 1 | 2 | **0** | **6** |
| **PGET 507** | **Hydrogen Energy & Fuel Cells** | 1 | 2 | **0** | **6** |
| **PGET 508** | **Solar PV Energy** | 1 | 2 | **0** | **6** |
| **PGET 509** | **Waste to Energy Conversion** | 1 | 2 | **0** | **6** |
| **PGET 510** | **Sustainable Energy & Materials** | 1 | 2 | **0** | **6** |
| **PGET 511** | **Energy Economics & Planning** | 1 | 2 | **0** | **6** |
| **PGET 512** | **Energy Efficiency & Performance of Electrical Equipment** | 1 | 2 | **0** | **6** |
| **PGET 513** | **Nanotechnology** | 1 | 2 | **0** | **6** |
| **PGET 514** | **Concepts of Green Building** | 1 | 2 | **0** | **6** |
| **PGET 515** | **Engines Technology** | 1 | 2 | **0** | **6** |
| **PGET 516** | **Electrical Machines** | 1 | 2 | **0** | **6** |
| **PGET 517** | **Instrumentations & Control** | 1 | 2 | **0** | **6** |
| **PGET 518** | **Energy Storage** | 1 | 2 | **0** | **6** |
| **PGET 519** | **Prime movers** | **1** | 2 | **0** | **6** |

**DETAILS OF SYLLABUS:**

**PGET 101: GREEN ENERGY TECHNOLOGY: L-T-P: 1-2-2 (Credit: 8)**

Current energy requirements, growth in future energy requirements, Review of conventional energy resources- Coal, gas and oil reserves and resources, Tar sands and Oil Shale, Nuclear energy Option.

Solar energy: radiation measuring instrument, Basics of Flat plate collectors, Concentrators Solar Principle of photovoltaic conversion of solar energy. Application of solar energy.

Wind energy: characteristics and measurement, Wind energy conversion principles, Types and

classification of WECS.

 Biomass Energy: Classification of biomass. Physicochemical characteristics of biomass as fuel. Biomass conversion routes.

Small Hydropower: Overview of micro, mini and small hydro system, types of hydro turbine; Ocean Energy, Principle of ocean thermal energy conversion system, Principles of Wave and Tidal energy conversion.

Geothermal energy: Origin of geothermal resources, type of geothermal energy deposits.

Hydrogen as a source of energy. Types of fuel cell, fuel cell system.

References:

1. D. Y. Goswami, F. Kreith and J. F. Kreider, Principles of Solar Engineering, Taylor and Francis, Philadelphia, 2000.
2. C. S. Solanki, “Solar Photovoltaics: Fundamental Applications and Technologies, Prentice Hall of India, 2009.
3. L.L. Freris, Wind Energy Conversion Systems, Prentice Hall, 1990.
4. D. A. Spera, Wind Turbine Technology: Fundamental concepts of Wind Turbine engineering, ASME Press.
5. S.P. Sukhatme, Solar Energy: principles of Thermal Collection and Storage, Tata McGraw-Hill (1984).

Reference books:

1. Renewable Energy by Godfrey Boyle
2. Renewable Energy Resources by John Twidell and Tony Weir.

**PGET 102: ENERGY & ENVIRONMENT: L-T-P: 1-2-2 (Credit: 8)**

Origin of the earth; Earth’s temperature and atmosphere; Sun as the source of energy Biological processes; photosynthesis; food chains; Energy sources: classification of energy sources, quality and concentration of energy sources; Overview of world energy scenario; Fossil fuel reserves ‐ estimates, duration, overview of India’s energy scenario, energy and development linkage.

Ecological principles of nature, concept of ecosystems; different types of ecosystems; ecosystem theories; energy flow in the ecosystems; biodiversity. Environmental effects of energy extraction, conversion and use; Sources of pollution; primary and secondary pollutants; Consequence of pollution growth; Air, water, soil, thermal, noise pollution‐ cause and effect; Causes of global, regional and local climate change; Pollution control methods; Environmental laws on pollution control.

Global warming; Green House Gas emissions, impacts, mitigation; Sustainability; Externalities, Future energy systems; Clean energy technologies; United Nations Framework Convention on Climate Change (UNFCC); Sustainable development; Kyoto

Protocol; Conference of Parties (COP); Clean Development Mechanism (CDM); Prototype Carbon Fund (PCF).

Text Books:

1. Masters G.  (1991): Introduction to Environmental Engineering and Science, Prentice – Hall International Editions.
2. Ravindranath N.H., Usha Rao K., Natarajan B., Monga P. (2000); Renewable Energy and Environment – A Policy Analysis for India, Tata McGraw Hill,.
3. Fowler, J.M., (1984); Energy and the Environment, 2nd Ed., McGraw Hill, New York,

References:

1. Asian Development Bank (1991); Environmental Considerations in Energy Development, Manila
2. NakicenovicNebojsa, , GrublerArnulf and Alan ed (1998) ; Global Energy Perspectives : McDonald, Cambridge University Press
3. ShaheenEsber I., (1992); Technology of Environmental Pollution Control , PennWell Books
4. Maheshwari A and GeetaParmar, (2002); Textbook Of Energy Ecology Environment & Society, Anmol Publications Pvt Ltd
5. Dave (2008); Textbook Of Environment & Ecology, Thomson Business Information
6. Kaushika N.D. and KaushikKshitij (2004) ; Energy, Ecology and Environment: A Technological Approach. New Delhi, Capital Publishing Company,
7. De A.K., (2005); Environmental Chemistry, New Age International Publishers
8. Reddy AKN, RH Williams, TB Johansson, (1997) ; Energy

**PGET 103:**

**FUNDAMENTALS OF ENERGY TECHNOLOGIES:** **L-T-P: 1-2-2 (Credit: 8)**

Introduction to world energy scenario, Renewable energy resources, Radiation, Solar Geometry, radiation models; Solar Thermal, Optical efficiency, thermal efficiency, concentrators, testing procedures, introduction to thermal systems (flat plate collector),solar architecture, solar still, air heater, panel systems; Photovoltaic; Introduction to semiconductor physics, doping, P\_N junction, Solar cell and its I\_V characteristics, PV systems components, design of a solar PV systems. Biomass, Biomass resources, wood composition, pyrolysis, gasifies, biogas, biodiesel, ethanol; Wind, Introduction, types of wind machines, Cp-λ curve &betz limits, wind recourse analysis; Systems, stand alone, grid connected, hybrid, system design; Hydro systems, Hydro resources, types of hydro turbine, small hydro systems; Other systems, Geothermal, wave energy, ocean energy.

Texts/References:

1. S. P. Sukhatme, Solar Energy - Principles of thermal collection and storage, second edition, Tata McGraw-Hill, New Delhi, 1996
2. J. A. Duffie and W. A. Beckman, Solar Engineering of Thermal Processes, second edition, John Wiley, New York, 1991
3. D. Y. Goswami, F. Kreith and J. F. Kreider, Principles of Solar Engineering, Taylor and Francis, Philadelphia, 2000
4. D. D. Hall and R. P. Grover, Biomass Regenerable Energy, John Wiley, New York,1987.
5. J. Twidell and T. Weir, Renewable Energy Resources, E & F N Spon Ltd, London, 1986.
6. M. A. Green, Solar Cells, Prentice-Hall, Englewood Cliffs, 1982.

**PGET 201 : ENERGY MANAGEMENT & AUDITING:** **L-T-P:1-2-2 (Credit: 8)**

Energy Management: Concept of energy management, energy demand and supply, economic analysis; Duties and responsibility of energy managers.

Energy Conservation: Basic concepts, Energy conservation in household, transportation, agricultural, service and industrial sectors, Lighting, HVAC systems

Energy Audit: Definition, need, and types of energy audit; Energy management (audit) approach: Understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements; Fuel & energy substitution; Energy audit instruments; Energy Conservation Act; Duties and responsibilities of energy managers and auditors.

Material and Energy balance: Facility as an energy system; Methods for preparing process flow; material and energy balance diagrams.

Energy Action Planning : Key elements; Force field analysis; Energy policy purpose, perspective, contents, formulation, ratification; Organizing the management: location of energy management, top management support, managerial function, roles and responsibilities of energy manager, accountability; Motivation of employees: Information system‐designing barriers, strategies; Marketing and communicating: Training and planning.

Monitoring and Targeting: Defining monitoring & targeting; Elements of monitoring & targeting; Data and information analysis; Techniques: energy consumption, production, cumulative sum of differences (CUSUM); Energy Service Companies; Energy management information systems; SCADA systems.

Electrical Energy Management: Supply side: Methods to minimize supply‐demand gap, renovation and modernization of power plants, reactive power management, HVDC, and FACTS.

Demand side: conservation in motors, pumps and fan systems; energy efficient motors. Thermal energy Management: Energy conservation in boilers, steam turbines and industrial heating systems; Application of FBC; Cogeneration and waste heat recovery; Thermal insulation; Heat exchangers and heat pumps; Building Energy Management.

Text Books:

1. Smith CB, (1981); Energy Management Principles, Pergamon Press, NewYork,
2. Hamies,(1980); Energy Auditing and Conservation; Methods, Measurements, Management &Case study, Hemisphere, Washington

References:

1. Krieder J. and Rabi A. (1994): Heating and Cooling of Buildings: Design for Efficiency, McGraw‐Hill.
2. Archie, W Culp (1991); Principles of Energy Conservation, McGraw Hill
3. Gellings C.W. and J.H. Chamberlin (1993): Demand‐Side Management Planning, Fairmont Press.
4. Murphy, W.R and G. Mckay (1982) ; Energy Management, Elsevier
5. Witte, Larry C, (1988); Industrial Energy Management & Utilization, Hemisphere Publishers, Washington
6. Callaghan P. O’ (1993); Energy Management, McGraw ‐ Hill Book Company
7. Bureau of Energy Efficiency (2003); Study material for Energy Managers and Auditors Examination: Paper I to IV.

**PGET 202:**

**NUMERICAL METHODS FOR ENERGY SYSTEM: L-T-P: 1-2-2 (Credit: 8)**

Introduction to Numerical Methods: Solution of algebraic and transcendental equations; Solution of simultaneous algebraic equations; Empirical laws and curve‐fitting; Regression method for forecasting; Interpolation. Finite Difference Method: Methods: Forward difference, backward difference, central difference; The E, μ, ∆, ∇, and δ operators and their interrelations.

Numerical Differentiation and Integration: Differentiation using forward, backward and central difference formulae. Integration using trapezoidal, Simpson’s one‐third and Simpson’s three‐eighth rule. Numerical Solution of Differential Equation :Methods: Taylor’s series, Euler, Modified Euler, Runge‐Kutta and Predictor‐corrector method; Numerical solution of Partial Differential Equation: Solution of Laplace’s equation, Poisson’s equation; Solution of one‐dimensional heat equation using Schmidt and Crank‐Nicholson method; Solution of two‐dimensional heat equation; Solution of wave equation.

Optimization Techniques :Introduction; Linear programming methods: Simplex method, artificial variables and dual phase method.

Computational Techniques: Computer programming using C; Use of computational software packages like MATLAB, Mathematica etc.

Text Books:

1. Balagurusamy, E (1999) Numerical Methods, Tata McGraw Hill , New Delhi
2. Jain M K., Iyengar S R K., Jain R K (1993) ; Numerical Methods for Scientific and Engineering Computation, New Age International (P) Ltd. New Delhi

References:

1. Rajsekaran, S. (1994) Numerical Methods in Science and Engineering,Wheeler, Allahabad.
2. Hilderbrand, F B (1974) Introduction to Numerical Analysis, Tata McGraw Hill, New Delhi.
3. Harman, T. L., J. B. Dabney, N. J. Richert(2000) Advanced Engineering Mathematics with MATLAB.
4. Redfern, Darren and Colin Campbell (1997) The MATLAB­5 Handbook, Springer, NY.
5. Mathews, John H. (1994) Numerical Methods for Mathematics, Science and Engineering, Prentice Hall of India Pvt. Ltd., New Delhi.
6. Sastry, S. S. (1994) Introductory Methods of Numerical Analysis, Prentice Hall of India Pvt. Ltd., New Delhi
7. Deb, Kalyanmoy(1997) Optimization for Engineering Design­ Algorithms and Examples, Prentice Hall of India Pvt. Ltd., New Delhi
8. William H., S. A. Teuklosky and W. T. Vellerling, and B. P. Flannery (1992); Numerical Recipes in C­ The Art of Scientific Computing, Cambridge University Press.

**PGET 501: POWER PLANT ENGINEERING:** **L-T-P: 1-2-0 (Credit: 6)**

Overview of power plant, Types of thermal power plants, Steam power plant based on fossil fuels.

Thermal power plant equipment: boilers, superheaters, reheaters, economise, condensers, and gas loops, turbines etc. Performance of steam power plant and its components.

Gas turbine power plant: different components, operating principles and design of Gas Turbine power plant, Gas Turbine‐Steam Turbine combined cycle power plant.

Diesel electric power plant: different components, operating principles and design of Diesel electric power plant.

Economics, load management and environmental implications; recent advances in power plants: Clean coal technologies such as Fluidized Bed, IGCC etc.

Text Books

1. Veatch B. Drbal L. F. Boston P. G. Westra K. L. and Erickson R. B. (2005); Power Plant Engineering,
2. Nag P. K. (2014); Power Plant Engineering, Fourth Edition, McGraw Hill Education India

Reference Books

1. Rajput R. K. (2007); A Textbook of Power Plant Engineering, Fourth edition, Laxmi
2. EI‐Wakil M. M. (2010); Power Plant Technology, Tata McGraw‐Hill
3. Ganesan, Y. (2003); Internal Combustion Engines, Tata McGraw‐Hill
4. Gupta M. K. (2012); Power Plant Engineering, Prentice Hall India
5. Sarkar D. (2015); Thermal Power Plant: Design and Operation, Elsevier

**PGET 502: FUELS AND COMBUSTIONS:** **L-T-P: 1-2-0 (Credit: 6)**

Basics of fuels: Modern concepts of fuel, Solid, liquid and gaseous fuels, composition, basic understanding of various properties of solid fuels ‐ heating value, ultimate analysis, proximate analysis, ash deformation points; liquid fuels ‐ heating value, density, specific gravity, viscosity, flash point, ignition point (self, forced), pour point, ash composition and gaseous fuels.

Coal as a source of energy: Coal reserves – World and India, Coal liquefaction process, various types of coal and their properties, Origin of coal, composition of coal, analysis and properties of coal, Action of heat on coal, caking and coking properties of coal; Processing of coal: Coal preparations, briquetting, carbonization, gasification and liquefaction of coal, Coal derived chemicals.

Petroleum as a source of energy and chemicals: Origin, composition, classification of petroleum, grading of petroleum; Processing of petroleum: Distillation of crude petroleum, petroleum products, purification of petroleum products – thermal processes, catalytic processes, specifications and characteristics of petroleum products.

Natural gas and its derivatives: Classification of gaseous fuels – natural gas and synthetic gases, Natural gas reserves ‐ World and India, properties of natural gas – heating value, composition, density

Principles of combustion: Chemistry and Stoichiometric calculation, thermodynamic analysis and concept of adiabatic flame temperature; Combustion appliances for solid, liquid and gaseous fuels: working, design principles and performance analysis.

Emissions from fuel combustion systems: Pollutants and their generation, allowed emissions, strategies for emission reduction, Euro and BIS norms for emission, recent protocols.

Text Books:

1. Sarkar S. (2010); Fuels and Combustion, Third Edition, CRC Press
2. Jaccard M. (2006); Sustainable Fossil Fuels, Cambridge University Press

Reference Books:

1. Turns S. R. (2011); An Introduction to Combustion: Concepts and Applications, Third Edition, McGraw Hill
2. Mukunda H. S. (2009); Understanding Combustion, Second Edition, Universities Press
3. Glassman I. and Yetter R. (2008); Combustion, Fourth Edition, Academic Press
4. Sharma B. K. (1998); Fuels and Petroleum Processing, First Edition, Goel publishing
5. Gupta O. P. (1996); Elements of Fuels, Furnaces and Refractories, Third Edition, Khanna Publishers.

**PGET 503:**

**BIO-ENERGY AND CONVERSION SYSTEM:** **L-T-P: 1-2-0 (Credit: 6)**

Biomass: Biomass resources; classification and characteristics; Techniques for biomass assessment; Application of remote sensing in forest assessment; Biomass estimation.

Thermochemical Conversion: Different processes, direct combustion, incineration, pyrolysis, gasification and liquefaction; economics of thermochemical conversion.

Biological Conversion: Biodegradation and biodegradability of substrate; biochemistry and process parameters of biomethanation; chemical kinetics and mathematical modeling of biomethanation process, biogas digester types; digester design and biogas utilization; economics of biogas plant with their environmental and social impacts; bioconversion of substrates into alcohol: methanol & ethanol production, organic acids, solvents, amino acids, antibiotics etc.

Chemical Conversion: Hydrolysis & hydrogenation; solvent extraction of hydrocarbons; solvolysis of wood; bio-crude; biodiesel production via chemical process; catalytic distillation; transesterification methods; Fischer-Tropsch diesel: chemicals from biomass.

Power generation: Utilization of gasifier for electricity generation; operation of spark ignition and compression ignition engine with wood gas, methanol, ethanol & biogas; biomass integrated gasification/combined cycles systems. Sustainable co-firing of biomass with coal.

Biomass productivity: Energy plantation and power programme. Economical impacts; food security and environmental impacts of biomass conversion to energy- energy from waste.

References:

1. Alternate Energy: Assessment & Implementation Reference Book, James J Winebrake, Springer January 2007.
2. Biofuels - Securing the Planet's Future Energy Needs, Edited by ADemirbas Springer 2009.
3. Dictionary of Renewable Resources - 2nd Edition, Revised and Enlarged, Zoebelein, Hans, Wiley-VCH, 2001.
4. Energy Technology and Directions for the Future, John R. Fanchi, Elsevier Science February 2004.
5. Fundamentals of Renewable Energy Processes, Aldo da Rosa, Academic Press September 2005.
6. Renewable Bioresources - Scope and Modification for Non-Food Applications Edited by Stevens, Christian and Verhe, Roland, Wiley June 2004
7. Renewable Energy, Third Edition, Bent Sorensen, Academic Press August 2004
8. Success & Visions for Bioenergy: Thermal processing of biomass for bioenergy, biofuels and bioproducts, Edited by A V Bridgwater, CPL Press September 2007.
9. The Future for Renewable Energy 2, Edited by EUREC Agency, James & James (Science Publishers) LtdMarch 2002.
10. Anthony San Pietro, Biochemical and Photosynthetic aspects of Energy Production, Academic Press, New York, 1980.

**PGET 504: WIND AND HYDRO POWER SYSTEMS: L-T-P: 1-2-0 (Credit: 6)**

Atmospheric circulations, classification, factors influencing wind, wind shear, turbulence, wind speed monitoring, Wind resource assessment, Weibull distribution; Betz limit, Wind energy conversion systems: classification, applications, power, torque and speed characteristics.

Aerodynamic design principles; Aerodynamic theories: Axial momentum, Blade element and combine theory, Rotor characteristics, Maximum power coefficient, Tip loss correction, Wind turbine design considerations: methodology, theoretical simulation of wind turbine characteristics.

Wind pumps, performance analysis of wind pumps, design concept and testing, Principle of WEG: stand alone, grid connected; Hybrid applications of WECS; Economics of Wind energy utilization, Wind energy Programme in India.

Hydrology, Resource assessment, Potential of hydropower in India, Classification of Hydropower Plants, Small Hydropower Systems: Overview of micro, mini and small hydro systems, Status of Hydropower Worldwide and India.

Hydraulic Turbines: types and operational aspects, classification of turbines, elements of turbine, selection and design criteria, geometric similarity operating characteristic curves; Speed and voltage regulation.

Selection of site for hydroelectric plant, Essential elements of hydroelectric power plant, Economics: cost structure, Initial and operation cost, environmental issues related to large hydro projects, Potential of hydro power in North East India.

Text Books:

1. Johnson G. L. (2006); Wind Energy Systems (Electronic Edition), Prentice Hall
2. Wagner H. and Mathur J. (2011); Introduction to Hydro energy Systems : Basics, Technology and Operation, Springer

Reference Books:

1. Hau E. (2000); Wind Turbines: Fundamentals, Technologies, Application and Economics, Springer
2. Mathew S. (2006); Wind Energy: Fundamentals, Resource Analysis and Economics, Springer
3. Burton T. Sharpe D. Jenkins N. and Bossanyi E. (2001); Wind Energy Handbook, John Wiley
4. Nag P. K. (2008); Power Plant Engineering, Third Edition, Tata McGraw Hill
5. Jiandong T. (et al.) (1997); Mini Hydropower, John Wiley.

**PGET 505: SOLAR THERMAL ENERGY CONVERSION: L-T-P: 1-2-0 (Credit: 6)**

Earth & Sun Relation: Solar angles, day length, angle of incidence on tilted surface; Sun path diagrams; Shadow determination; Extraterrestrial characteristics; Effect of earth atmosphere; Measurement & estimation on horizontal and tilted surfaces; Analysis of Indian solar radiation data and applications.

Flat-plate Collectors: Effective energy losses; Thermal analysis; Heat capacity effect; Testing methods; Evacuated tubular collectors; Air flat-plate Collectors: types; Thermal analysis; Thermal drying.

Selective Surfaces: Ideal coating characteristics; Types and applications; Anti-reflective coating; Preparation and characterization.

Concentrating Collector Designs: Classification, design and performance parameters; Tracking systems; Compound parabolic concentrators; Parabolic trough concentrators; Concentrators with point focus; Heliostats; Comparison of various designs: Central receiver systems, parabolic trough systems; Solar power plant; Solar furnaces.

Solar Heating & Cooling System: Liquid based solar heating system; Natural, forced and gravity flow, mathematical modeling, Vapour absorption refrigeration cycle; Water, ammonia & lithium bromide-water absorption refrigeration systems; Solar operated refrigeration systems; Solar desiccant cooling.

Solar Thermal Energy Storage: Sensible storage; Latent heat storage; Thermo-chemical storage.

Performances of solar collectors: ASHRAE code; Modeling of solar thermal system components and simulation; Design and sizing of solar heating systems: f – chart method and utilizability methods of solar thermal system evaluation; Development of computer package for solar heating and cooling applications;

Solar Energy for Industrial Process Heat: Industrial process heat: Temperature requirements, consumption pattern; Applications of solar flat plate water heater & air heater for industrial process heat; Designing thermal storage; Transport of energy.

Solar Thermal Energy Systems: Solar still; Solar cooker: Solar pond; Solar passive heating and cooling systems: Trombe wall; Greenhouse technology: Fundamentals, design, modeling and applications.

References:

1. Solar Cell Device Physics, by Stephen Fonash, ISBN:9780123747747, Publisher: Academic Press, Publication Date: April 2010
2. Sukhatme S P., A Text Book on Heat Transfer, University Press, 1996
3. Renewable Energy Resources, John W Twidell and A D Weir, ELBS
4. Garg H P., Prakash J., Solar Energy: Fundamentals & Applications, Tata McGrawHill, New Delhi, 1997
5. Solar Energy, S P Sukhatme, Tata McGraw Hill
6. Solar Energy Handbook, J F Kreider and Frank Kreith, McGraw Hill
7. Principles of Solar Engineering, D Y Goswami, Frank Kreith and J F Kreider, Taylor & Francis.
8. Solar Engineering of Thermal Processes, J A Duffie and W A Beckman, John Wiley and Sons, New York
9. Tiwari G.N., Suneja S., Solar Thermal Engineering System, Narosa Publishing House, New Delhi, 1997.
10. Tiwari G.N., Goyal R.K., Greenhouse Technology: Fundamentals, Design Modeling and Application, Narosa Publishing House, 1998.
11. Renewable Energy: Power for a sustainable future, Godfrey Boyle (Ed), The Open University, Oxford University Press.

**PGET 506: NUCLEAR POWER SYSTEMS: L-T-P: 1-2-0 (Credit: 6)**

Introduction to Nuclear Engineering:

Introduction, Why Nuclear Power for Developing Countries, Atomic Nuclei, Atomic Number and Mass Number, Isotopes, Atomic Mass Unit, Radioactivity and Radioactive Change Rate of Radioactive Decay, Mass – Energy Equivalence, Binding Energy, Release of Energy by Nuclear Reaction, types of Nuclear Reactions, Initiation of Nuclear Reaction, Nuclear Cross – section, Nuclear Fission, The Fission Chain Reaction, moderation, Fertile Materials and Breeding.

Nuclear Reactors:

Introduction, General Components of Nuclear Reactor, General Problems of Reactor Operation, Different Types of Reactors, Pressurized Water Reactors (PWR), Boiling Water Reactors (BWR), Heavy Water – cooled and Moderated CANDU (Canadian Deuterium Uranium) Type Reactors, Gas-cooled Reactors, Breeder Reactors, Reactor Containment Design, Location of Nuclear Power Plant, Nuclear Power Station in India, India’s 3-stage Programme for Nuclear Power Development, Comparison Nuclear Plants with Thermal Plants.

Nuclear Materials:

Introduction, Fuels, Cladding and Structural Materials Coolants, Moderating and Reflecting Materials, Control Rod Materials, Shielding Materials.

Nuclear Waste & Its Disposal:

Introduction, Unit of Nuclear Radiation, Types of Nuclear Waste, Effects of Nuclear Radiation, Radioactive Waste Disposal System, Gas Disposal System.

Safety Rules:

Personal Monitoring, Radiation Protection (Radiation Workers, Non-Radiation Workers, Public at large), Radiation Dose (Early effect, Late effect hereditary effect)

Text Books:

1. P.K.Nag “ Power Plant Engineering “, Tata McGraw Hill
2. Arora &Domkundwar“ Power Plant Engineering “, DhanpatRai& Co.
3. Combined Power Plants by J.H.HorlockPergamonPress .

References:

1. Black / Veatch, “ Power Plant Engineering “ , CBS Published & Distributors.
2. Gas Turbine Theory –by Sh. H.Cohen, G.F.C. Rogers. H.I.H.Saravanamuttoo.
3. Longman Scientific & Technical.

**PGET 507: HYDROGEN ENERGY AND FUEL CELLS: L-T-P: 1-2-0 (Credit: 6)**

Fuel cells: Introduction and overview, operating principle, polarization curves, components, types of fuel cell, low and high temperature fuel cells, fuel cell stacks.

Thermodynamics of fuel cell: application of the first and second law to fuel cells, significance of the Gibbs free energy, concept of electrochemical potential and EMF, Nernst equation, thermodynamic efficiencies of fuel cell in comparison to Carnot efficiencies, thermodynamic advantage of electrochemical energy conversion.

Electrochemistry of fuel cell: electrochemical cells, oxidation and reduction processes, half-cell potentials and the electrochemical series, Faraday’s law, faradaic and non-faradaic processes, current and reaction rate, Butler–Volmer theory for electrode kinetics, exchange current, polarization and over potential, cell resistance, mass transport in electrochemical cells

Fuel cell technology: Types of Fuel Cells, Fuel Cell systems and sub-systems, system and subsystem integration; Power management, Thermal management; Pinch analysis

Fuel cell electrolytes: different types of electrolytes used, ionomeric membrane in PEFC, mechanism of ion transfer in ionomeric membranes, relation between proton conductivity and water content, alternative membranes.

Fuel cell electro catalysts: types of catalysts, synthesis and characterization, HOR and ORR kinetics of catalysts, half-cell and full cell reaction, and effect of impurities

Fuel cell characterization: In-situ and Ex-situ; System and components’ characterization

modeling a Fuel Cell

Hydrogen Production: fossil fuels, electrolysis, thermal decomposition, nuclear, photochemical, photocatalytic, hybrid; Hydrogen Storage: Metal hydrides, chemical hydrides, carbon Nano-tubes; sea as the source of Deuterium, methane hydrate, etc.

Hydrogen Economy: Hydrogen as an alternative fuel in IC engines; Suitability of Hydrogen as a fuel, and techno-economic aspects of fuel cell as energy conversion device; Hydrogen fuel for transport.

Text Books:

1. O'Hayre R. P., Cha S. W., Colella W., and Prinz F. B., (2008); Fuel cell fundamentals, JohnWiley
2. Larminie J., Dicks A. and McDonald M. S. (2003); Fuel cell systems explained. Vol. 2, Wiley

Reference Books:

1. Zhang J. (2008); PEM Fuel Cell Electrocatalysts and Catalyst Layers: Fundamentals andApplications, Springer
2. Spiegel C. (2011); PEM Fuel Cell Modeling and Simulation Using Matlab, Elsevier Science.
3. Vielstich W., Lamm A., and Gasteiger H. A. (2003); Handbook of Fuel Cells: Fundamentals, Technology, Applications, Vol (1-4), Wiley
4. Gupta R. B. (2008); Hydrogen Fuel: Production, Transport and Storage, CRC Press
5. Bard A. J., Faulkner L. R., Leddy J., and Zoski, C. G. (1980). Electrochemical methods: fundamentals and applications (Vol. 2), Wiley

**PGET 508: SOLAR PV ENERGY: L-T-P: 1-2-0 (Credit: 6)**

Solar PV module: Solar PV modules – selection criteria – Testing and evaluation – module interconnects – array design and assembly – array characteristics and output conditioning – DC-DC converters and maximum power point tracking (MPPT).

SPV systems & components: Introduction to PV systems - system components: module and array – Charge controllers – inverters – Batteries – power conditioning and Regulation – Mechanical assemblies – Balance of System Components

SPV power systems: Types of SPV power systems: MW general power systems – Grid connected power systems – Remote area power systems – Specific purpose Photovoltaic systems: Space – Marine – Telecommunication – water pumping – refrigeration etc.

Power system design and installation: Power considerations and system design – Array integration: mechanical integration – electrical integration – utility integration – Inspection and commissioning - Distributed power generation & smart Grids - Hybrid systems.

Economics: SPV power system maintenance: cleaning, shadowing, stability etc., and troubleshooting – Economics

Text books:

1. 1 Fundamentals of Photovoltaic Modules & Their Applications, by GopalNath Tiwari, ISBN:9781849730204, Publisher: Royal Society of Chemistry, 2010.
2. Photovoltaic Systems, 2nd Edition, by James P. Dunlop, ISBN:9780826913081, Publisher:American Technical Publishers, Inc. 2010
3. Photovoltaics: Design and Installation Manual, by Solar Energy International, ISBN: 9780865715202, Publisher: New Society Publishers, (2004).
4. Ben G. Streetman, Solid State electronic devices, , , Prentice-Hall of India Pvt. Ltd., New delhi 1995.
5. M. D. Archer, Clean electricity from photovoltaics, R. Hill, Imperial College Press, 2001.
6. Photovoltaic Systems Engineering, Roger Messenger and Jerry Vnetre, CRC Press, 2003.
7. C.L.Wadhwa, Generation Distribution and utilization of Electrical Energy, Wiley Eastern Ltd., India(1989)
8. Roger C.Dugan , Mark .F. McGranaghan, Surya Santaso, H.WayneBeaty, “Electrical Power Systems Quality”, Second Edition, McGraw Hill, 2002.

**PGET 509: WASTE TO ENERGY CONVERSION: L-T-P: 1-2-0 (Credit: 6)**

Solid Waste : Definitions: Sources, types, compositions; Properties of Solid Waste; Municipal

Solid Waste: Physical, chemical and biological property; Collection, transfer stations; Waste minimization and recycling of municipal waste

Waste Treatment & Disposal : Size Reduction: Aerobic composting, incineration; Furnace type & design; Medical / Pharmaceutical waste incineration; Environmental impacts; Measures of mitigate environmental effects due to incineration; Land Fill method of solid waste disposal; Land fill classification; Types, methods & siting consideration; Layout & preliminary design of land fills: Composition, characteristics, generation; Movement and control of landfill leachate & gases; Environmental monitoring system for land fill gases

Energy Generation Form Waste: Types: Biochemical Conversion: Sources of energy generation, Industrial waste, agro residues; Anaerobic Digestion: Biogas production; Types of biogas plants; Thermochemical conversion: Sources of energy generation, Gasification; Types of gasifiers; Briquetting; Industrial applications of gasifiers; Utilization and advantages of briquetting; Environment benefits of biochemical and thermochemical conversion

References:

1. Municipal Solid Waste to Energy Conversion Processes: Economic, Technical, and Renewable Comparisons, by Gary C. Young, ISBN:9780470539675, Publisher: John Wiley & Sons, Publication Date: June 2010.
2. Recovering Energy from Waste Various Aspects Editors: Velma I. Grover and Vaneeta Grover, ISBN 978-1-57808-200-1; 2002
3. Shah, Kanti L., Basics of Solid & Hazardous Waste Management Technology, Prentice Hall, 2000.
4. Rich, Gerald et.al., Hazardous Waste Management Technology, Podvan Publishers, 1987.
5. Waste-to-Energy by Marc J. Rogoff, DEC-1987, Elsiever, ISBN-13: 978-0-8155-1132-8, ISBN-10: 0-8155-1132-9.
6. Parker, Colin, & Roberts, Energy from Waste - An Evaluation of Conversion Technologies, Elsevier Applied Science, London, 1985.
7. ManojDatta, Waste Disposal in Engineered Landfills, Narosa Publishing House, 1997.
8. Bhide A. D., Sundaresan B. B., Solid Waste Management in Developing Countries, INSDOC, New Delhi, 1983.
9. From Waste to Energy, Robert Green, Cherry Lake Pub. ISBN: 1602795096, 2009.

**PGET 510: SUSTAINABLE ENERGY AND MATERIALS: L-T-P: 1-2-0 (Credit: 6)**

Unit 1: Silicon processing methods, dry and wet chemical processes used to develop new materials and micro-engineered products.

Unit 2: Gas-solid and liquid-solid reactions, and their role in micro engineering. Various reactors and methods of fabrication methods, such as physical and chemical vapour deposition techniques, photolithography, electroless and electrochemical deposition, etching, and through mask plating and common models to describe these processes.

Unit 3: Principles for electrochemical power sources, photovoltaics and their relevance in current energy industry. Environmental and sustainability issues for the production of high-tech components and materials

References:

1. A First Course in Electrochemical Engineering, The Electrochemical Consultancy Arlesford Press.
2. W. Menz, J. Mohr and O. Paul, Microsystems Technologies, VCH Verlag.
3. R Kirkwood and A Longley, Clean Technology and the Environment, Blackie October 1994.
4. P. White, I. Franke, P. Hindle, Integrated Solid Waste Management: A Lifecycle Inventory pub. Chapman & Hall 1994.
5. A. Johansson, Clean Technology”, Lewis 1992.
6. M. Charter and U. Tischner, Sustainable Solutions, Greenleaf.
7. J Fiksel, Design for Environment, Mcgraw Hill, 1996.
8. Ed K. Mulder, Sustainable Development for Engineering, Greenleaf Publishing.

**PGET 511: ENERGY ECONOMICS AND PLANNING: L-T-P: 1-2-0 (Credit: 6)**

Energy economics: Basic concepts, energy data, energy cost, energy balance.

Energy accounting framework; Economic theory of demand, production and cost market structure; National energy map of India, Energy subsidy – National and international perspectives

Concepts of economic attributes involving renewable energy, Calculation of unit cost of power generation from different sources with examples, different models and methods

Application of econometrics; input and output optimization; energy planning and forecasting - different methods

Concepts of economic attributes involving renewable energy, Calculation of unit cost of power generation from different sources with examples, different models and methods

Application of econometrics; input and output optimization; energy planning and forecasting - different methods

Evaluation of National and Regional energy policies; oil import, energy conservation, rural energy economics, integrated energy planning

Conflict between energy consumption and environmental pollution, Economic approach to environmental protection and management, Energy-Environment interactions at different levels, energy efficiency, cost-benefit risk analysis; Project planning and implementation,

Planning for energy security and renewable energy innovations; Regional, National and Global aspirations and requirements; Role of Governments, Societies and NGOs.

Text Books:

1. Bhattacharyya S. C. (2011); Energy Economics, Springer
2. Ferdinand E. B. (2000); Energy Economics: A Modern Introduction, First Edition, Kluwer

Reference Books:

1. Kandpal T. C. and Garg H. P. (2003); Financial Evaluation of Renewable Energy Technology, Macmilan
2. Stoft S. (2000); Power Systems Economics, Willey-Inter Science
3. Munasinghe M. and Meier P. (1993); Energy Policy Analysis and Modeling, Cambridge University Press
4. Samuelson P. A. and William D. N. (1992); Economics, 14th edition, McGraw Hill
5. Thuesen G. J. and Fabrycky W. J. (2001); Engineering Economy, Ninth Edition, PrenticeHall India.

**PGET 512:**

**ENERGY EFFICIENCY AND PERFORMANCE OF ELECTRICAL EQUIPMENTS:**

**L-T-P: 1-2-0 (Credit: 6)**

Energy Efficiency: Energy Conservation, Need for Energy Efficiency , Indian Energy Conservation Act 2001 and its Features, Energy Star Rating of buildings and Equipments, Bureau Of Energy Efficiency Guidelines and Programmes

National Energy Building Code: Energy Building Code, Guidelines: Thermal Insulation, Heating, Ventilation and Air Conditioning System, Building Lighting Design: Lighting levels, light efficient options, CFL, LEDs, Fixtures, Day lighting timers, Building Energy Management

Energy Efficiency Improvement in Electrical Systems: Improving Energy Efficiency in Electrical Systems, Electrical load management, maximum demand control.

Power Factor: Power factor, power factor correction, selection and location of capacitors, performance assessment of PF capacitors and energy conservation opportunities

Electric Motors: motor efficiency, factor affecting motor performance, Energy saving opportunities in motors, energy efficient motors, soft starter with energy savers, motor efficiency measurements.

Transformers: Energy efficient transformers, factor affecting the performance of transformers

Electric Distribution: Energy conservation opportunities, cables, switch gears, distribution losses, energy conservation in house electrical distribution system

Compressed Air Systems: compressor efficiency, efficient compressor operation, leakage test, factors affecting the performance and energy savings

Pumps and Pumping System: Energy conservation opportunities, Agricultural pumps, Solar PV Pumps

Fans and Blowers: Energy Efficient system operation, flow control strategies and energy conservation opportunities, Solar PV fans

Energy Conservation in Boilers, Steam Turbines and Industrial heating Systems

Energy Audit: Energy Management in Buildings and Industry, Energy Audit: Methodology, Data Collection, Techno-economic Analysis, Energy Audit Measurements : Energy Audit Instruments, Combustion Analysis, Temperature , Pressure Flow, Humidity, Energy, Power, Light Level measurements, HVAC, Furnaces and Ovens, Boilers and Steam Lines, Air Compressor and Compressed Air Distribution Lines, Chillers and Chilled Water Distribution Lines, Process Water Generation and Distribution Lines, Electrical Distribution, Transformers and Lines, Pumps, Fans and Blowers, Cooling Towers, Electrical Motors, Waste Heat Sources, Material Transport, Peak Load Equipments, Duties and responsibilities of Energy managers and Auditors ,Case Studies of Energy Audit.

Text Books/References:

1. LC Witte, PS Schmidt, DR Brown, Industrial Energy Management and Utilization, Hemisphere Publication, Washington, 1988
2. Industrial Energy Conservation Manuals, MIT Press, Mass, 1982
3. IGC Dryden, Butterworths (Ed), The Efficient Use of Energy, London, 1982
4. WC Turner (Ed), Energy Management Handbook, Wiley, New York, 1982
5. Technology Menu for Efficient energy use- Motor drive systems, Prepared by National Productivity Council and Center for Environmental Studies- Princeton University, 1993
6. Frank, Kreith, Ronald E West Hand Book of Energy Efficiency, CRC Press
7. Bureau of Energy Efficiency Study Material for Energy Managers and Auditors Examination Paper I to IV
8. BG Desai, BS Vaidya DP Patel and R Parman,Savings Electricity in Utility Systems of Industrial Plants Efficient use of electricity in industries

**PGET 513: NANOTECHNOLOGY: : L-T-P: 1-2-0 (Credit: 6)**

Nanomaterials: Nanostructured materials: zero dimensional, one-dimensional and two dimensional nanostructures- clusters of metals and semiconductors, nanowires, nanostructured beams, and nanocomposites - artificial atomic clusters – quantum size effects – Electronic Structure of Nanoparticles- size dependent optical absorption and electron transport properties – porous materials – ionic materials - membranes – catalysts.

Nanomaterials for Energy conversion: Challenges in energy conversion – role of nanostructures & materials – nanomaterials in solar Photovoltaic Technology: Band gap engineering & optical engineering - Tandem structures - quantum well and quantum dot solar cells - photo-thermal cells – Organic solar cells.

Nanomaterials for Hydrogen production & storage: Introduction to Hydrogen engine – Hydrogen production methods – Nanomaterials for hydrogen purification & storage – Hydrogen Sponge - volumetric and gravimetric storage capacities –automotive applications

Fuel cell Technology: Fuel cell Principles – types of fuel cells (Proton exchange, Alkaline Electrolyte, Phosphoric acid, Molten Carbonate, solid oxide and direct methanol fuel cells)- Principle and operation of Proton Exchange Membrane fuel cell- Materials and fabrication methods for fuel cell technology- micro fuel cell power sources

Energy Efficient Nano devices: Energy efficient devices –fabrication and applications of LED as light device – OLED – Semiconductor laser – single electron & single photon devices – energy efficient electronic switches & devices – MEMS & NEMS and their energy efficiency – Nanorobotics.

References:

1. Prof. Dr. Manfred Stiebler Wind Energy Systems for Electric Power Generation ISBN: 978-3-540-68762-7 e-ISBN: 978-3-540-68765-8, Springer Series in Green Energy and Technology ISSN 1865-3529.
2. Renewable Energy Technology, Economics and Environment, Kaltschmitt, Martin; Streicher, Wolfgang; Wiese, Andreas (Eds.), 2007, XXXII, 564 p. 270 illus., Hardcover, ISBN: 978-3-540-70947-3.
3. Green Manufacturing, Fundamentals and Applications Series: Green Energy and Technology Dornfeld, David (Ed.) 1st Edition., 2010, 260 p., Hardcover, ISBN: 978-1-4419-6015-3 Due: June 28, 2010.
4. Boyle, Godfrey. 2004. Renewable Energy (2nd edition). Oxford University Press, 450 pages (ISBN: 0-19- 926178-4).
5. Boyle, Godfrey, Bob Everett, and Janet Ramage (eds.) 2004. Energy Systems and Sustainability: Power for a Sustainable Future. Oxford University Press, 619 pages (ISBN: 0-19-926179-2)
6. Renewable Energy: Its Physics, Engineering, Environmental Impacts, Economics & Planning. 2004. Bent Sørensen. 3rd edition. ELSEVIER Academic Press.
7. Renewable and Efficient Electric Power Systems. 2004. Gilbert M. Masters. John Wiley & Sons, Inc. NJ.
8. Kibert, C. (2005) Sustainable Construction: Green Building Design and Delivery (Hoboken, NJ: John Wiley.
9. G. J. Levermore. 2000. Building Energy Management Systems (2nd ed.), E & FN Spon.

**PGET 514: CONCEPT OF GREEN BUILDING: L-T-P: 1-2-0 (Credit: 6)**

Environmental implications of buildings energy, carbon emissions, water use, waste disposal; Building materials: sources, methods of production and environmental Implications. Embodied Energy in Building Materials: Transporation Energy for Building Materials; Maintenance Energy for Buildings.

Implications of Building Technologies Embodied Energy of Buildings: Framed Construction, Masonry Construction. Resources for Building Materials, Alternative concepts. Recycling of Industrial and Buildings Wastes. Biomass Resources for buildings.

Comforts in Building: Thermal Comfort in Buildings- Issues; Heat Transfer Characteristic of Building Materials and Building Techniques. Incidence of Solar Heat on Buildings-Implications of Geographical Locations.

Utility of Solar energy in buildings concepts of Solar Passive Cooling and Heating of Buildings. Low Energy Cooling. Case studies of Solar Passive Cooled and Heated Buildings.

Green Composites for buildings: Concepts of Green Composites. Water Utilisation in Buildings, Low Energy Approaches to Water Management. Management of Solid Wastes. Management of Sullage Water and Sewage. Urban Environment and Green Buildings. Green Cover and Built Environment.

Text Books:

1. K.S.Jagadish, B. U. Venkataramareddy and K. S. Nanjundarao. Alternative Building Materials and Technologies. New Age International, 2007.
2. Low Energy Cooling For Sustainable Buildings. John Wiley and Sons Ltd, 2009.
3. Green My Home!: 10 Steps to Lowering Energy Costs and Reducing Your Carbon Footprint, by Dennis C. Brewer, ISBN:9781427798411, Publisher: Kaplan Publishing, Publication Date: October 2008.
4. B. Givoni, Man, Climate and Architecture Elsevier, 1969.
5. T. A. Markus and E. N. Morris Buildings Climate and Energy. Pitman, London, 1980. ArvindKishan et al (Ed)
6. Climate Responsive Architecture. TataMcGraw Hill, 2001.
7. Sustainable Building Design Manual. Vol 1 and 2, Teri, New Delhi, 2004.
8. O. H. Koenigs Berger, T. G. Ingersoll, Alan Mayhew and S. V. Szokolay. Manual of Tropical Housing and Building. Orient Long man, 1975.

Reference Books:

1. Osman Attmann Green Architecture Advanced Technologies and Materials. McGraw Hill, 2010.
2. Michael F. Ashby Materials and the Environment, Elsevier, 2009.
3. Jerry Yudelson Green building Through Integrated Design. McGraw Hill, 2009.
4. Mili M. Ajumdar (Ed) Energy Efficient Building in India. Teri and Mnes, 2001/2002.
5. T. N. Seshadri et al Climatological and Solar Data for India. CBRI and SaritaPrakashan, 1968.

**PGET 515: ENGINES TECHNOLOGY: L-T-P: 1-2-0 (Credit: 6)**

Working of I.C. Engines, Combustion in IC Engines;

Engine parameters affecting combustion, Homogeneous Charge Compression Ignition Engine, Ultra Lean Burn Engines,

Fuel Injection in SI Engines, Multi valve engines, Variable valve timing. Direct and Indirect injection systems, Combustion chambers, Turbo charging, Formation and control of NOX , HC/CO and Particulate emissions,

Alternative fuels; Combustion and Emission Characteristics of SI and CI Engines using alternate fuels.

Reference books:

1. Heywood, J., Internal Combustion Engine Fundamentals, McGraw Hill Publication
2. J. G. Speight, Synthetic Fuels Handbook: Properties, Process, and Performance, McGraw‐Hill, 2008
3. AyhanDemirbas, Biodiesel: A Realistic Fuel Alternative for Diesel Engines, Springer,
4. 2010John B Heywood,” Internal Combustion Engine Fundamentals”, Tata McGraw-Hill 1988
5. Gupta H.N, “Fundamentals of Internal Combustion Engines” ,Prentice Hall of India, 2006

Reference:

1. Ferguseaon, Internal Combustion Engines, John Wiley & Sons, 1986.
2. Ganesan, V., Internal Combustion Engines, Tata McGraw Hill, New Delhi, 2001.
3. James G. Speight, Sudarshan K. Loyalka , Handbook of Alternative Fuel Technologies, CRC Press, 2007

**PGET 516: ELECTRICAL MACHINES: L-T-P: 1-2-0 (Credit: 6)**

Electro mechanical Energy Conversion: Principles, Forces and Torques in Magnetic Field Systems, Energy Balance, Energy and Force in Singly Excited Magnetic Field System, Co-energy, Multiply Excited Magnetic Field Systems.

D.C. Generators: Principle of Operation, Constructional Features, emf Equation of a D.C. Generator, Collection and Flow of Current from Armature, Armature Reaction, Methods to Reduce Effects of Armature Reaction and Commutation Process, Armature Winding Diagram (Lap and Wave), Methods of Excitation, Generator Characteristics, Parallel Operation, Losses occur in DC Generator, Efficiency and Applications.

D.C. Motors: Principle of operation, Types of DC Motors, Back emf of a DC Motors, Torque and Speed Equations, DC Motor characteristics, Speed Control Methods of a D.C. Motors, Starting and Starters, Efficiency and Applications.

Testing of D.C. Motors: Brake Test, Swinburne’s Test, Hopkinson’s Test, Retardation Test, Field’s Test and Separation of Losses.

Transformers: Principle of operation, Constructional features, Types of Transformers, EMF equation of a Transformer, Transformer on No-Load and Load and its vector diagrams, Equivalent Circuit of a Transformers, Losses in a Transformer, Voltage Regulation and Efficiency, OC and SC Tests of a Transformer, Three Winding Transformers, Three Phase Transformer Connections, Parallel Operation and Load Sharing, Three Phase to Two Phase Conversion and Vice-Versa.

TEXT BOOKS:

1. Electrical Machinery by DR.P.S.BIMBHRA, KHANNA PUBLISHER.
2. Electrical Machines by D P KOTHARI and I J NAGRATH, McGraw Hill Education (India) Private Limited.

Reference Books:

1. Electrical Machines, by J B Gupta, S K Kataria& Sons
2. Electrical Machines by U A Bakshi and M V Bakshi, Technical Publications

**PGET 517: INSTRUMENTATION AND CONTROL: L-T-P: 1-2-0 (Credit: 6)**

Overview of Instruments and Measurement Systems: Principles of measurements and measurement errors, Classification of instruments, static and dynamic characteristics, Input

output configurations of measurement system

Sensor and transducers: Types, characteristics and applications of Mechanical transducers, Types, characteristics and applications of electrical transducers, Principles of Modern sensors and typical applications

Introduction to Control Systems: Overview of control systems, types and components, Feedback and non-feedback systems and their applications, Transfer function, block diagram representation and reduction techniques

Signal conditioning: Operational amplifier types and characteristics, Application circuits inverter, adder, substractor, multiplier and divider, Analog /digital/analog conversion techniques

Data Acquisition Systems: Types of Instrumentation Systems and components, working principle and application of Single Channel A /D converter, Working principle and application of multi-channel A/D converter, Digital data processing and display

Microcontrollers and compilers: Overview of microprocessor and microcontroller, Microcontroller Types and architecture, Use of compilers for data acquisition, processing and display, typical microcontroller Applications for monitoring and control of electrical and non–electrical parameters/processes.

Text Books:

1. Morris A. S. (1998); Principles of Measurements and Instrumentation, Prentice Hall of India
2. Sawhney A. K. (2011); A Course in Electrical and Electronics Measurements and Instrumentation, DhanpatRai

Reference Books:

1. Bentley J. P. (2005); Principles of Measurement Systems, Fourth Edition, Pearson Prentice Hall
2. Jain R. P. (1998); Modern Digital Electronics, McGraw Hill
3. Gaonkar R. (2012); Microprocessor Architecture, Programming and Applications with 8085, Penram International Publishing
4. Raman C. S., Sharma G. R., and Mani V. S. V. (1983); Instrumentation Devices and systems, Tata McGraw Hill
5. Babu J. C. and Xavier S. E. (2004); Principles of Control Systems, S Chand and Co Ltd.

**PGET 518: ENERGY STORAGE SYSTEM: L-T-P: 1-2-0 (Credit: 6)**

Energy availability, Demand and storage, Need for energy storage, Different types of energy storage; Mechanical, Chemical, Electrical, Electrochemical, Biological, Magnetic, Electromagnetic, Thermal; Comparison of energy storage technologies.

Thermal energy storage: principles and applications, Sensible and Latent heat, Phase change materials; Energy and exergy analysis of thermal energy storage, solar energy and thermal energy storage, case studies.

Flywheel and compressed air storage; Pumped hydro storage; Hydrogen energy storage, Capacitor and super capacitor, Electrochemical Double Layer Capacitor: Principles, performance and applications.

Electrochemical energy storage: Battery – fundamentals and technologies, characteristics and performance comparison: Lead-acid, Nickel-Metal hydride, Lithium Ion; Battery system model, emerging trends in batteries.

Hydrogen as energy carrier and storage; Hydrogen resources and production; Basic principle of direct energy conversion using fuel cells; Thermodynamics of fuel cells

Fuel cell types: AFC, PEMFC, MCFC, SOFC, Microbial Fuel cell;

Fuel cell performance, characterization and modeling; Fuel cell system design and technology, applications for power and transportation.

Application of Energy Storage: Food preservation, Waste heat recovery, Solar energy storage: Greenhouse heating; Drying and heating for process industries.

Text Books:

1. Dincer I., and Rosen M. A. (2011); Thermal Energy Storage: Systems and Applications, Wiley
2. Huggins R. A. (2015); Energy Storage: Fundamentals, Materials and Applications. Springer

Reference Books:

1. O'Hayre R., Cha S., Colella W., and Prinz F. B. (2009); Fuel Cell Fundamentals, Second Edition, Wiley
2. Narayan R. and Viswanathan B. (1998); Chemical and Electrochemical Energy System, Universities Press
3. Rahn C. D. and Wang C. (2013); Battery Systems Engineering, First Edition, Wiley
4. Moseley P. T., and Garche J. (2014); Electrochemical Energy Storage for Renewable Sourcesand Grid Balancing, Elsevier Science.
5. Miller F. P., Vandome A. F., and John M. B. (2010); Compressed Air Energy Storage, VDMPublishing.

**PGET 519: PRIME MOVERS: : L-T-P: 1-2-0 (Credit: 6)**

Properties of Steam: Formation of steam on temperature-enthalpy diagram, types of steam: wet, dry, Super-heated steam, dryness and wetness fraction, specific enthalpy, specific volume of steam

Steam Boilers: Introduction, classification of various high pressure boilers e.g. Lamont, Velox, Schmidt, Loeffler etc., their characteristics and working principle

Steam Turbines: Classification, compounding, velocity diagrams, work done, diagram and stage efficiency in impulse turbine, impulse reaction turbine, degree of reaction, governing of steam turbines, problems.

Steam Condensers: Introduction, types of condensers, vacuum efficiency, effect of vacuum, effect of air leakage, condenser efficiency, Dalton’s law of partial pressure, amount of cooling water, problems

Gas Turbine: Introduction, applications, types of gas turbines, cycles, thermal efficiency, air rate, work ratio, effect of operating variables on thermal efficiency of gas turbine, methods to improve thermal efficiency of gas turbine, gas turbine fuels, starting of plant, comparison with diesel and steam power plants. Diesel Power Plant –Introduction, diesel engine working principle, diesel fuels, diesel electric plant main components.

Hydraulic Turbines: Introduction, Classification of hydraulic turbines, Main components of Pelton wheel, Working, Work done and power produced, Efficiency, Working of Francis turbine, components, Work done & power produced, Efficiency, Working of Propeller & Kaplan Turbine, Main parts & components, Function of components, Work done & power produced by Kaplan Turbine, Efficiency of Kaplan turbine, Governing of Impulse & Reaction Turbine, characteristics curves of impulse & reaction turbine, Draft Tube Theory.

References:

1. Thomas Elliott, Kao, Chen, Robert, Swanekamp –Standard Handbook of Power Plant Engineering, McGraw Hill Publication.
2. P K Nag – Power Plant Engineering, TMH publication
3. Teploenergetika- Thermal Engineering, Springer

Reference Books:

1. R. K. Rajput – Power plant engineering
2. R. K. Rajput – A text book of Hydraulic Machines
3. R.Yadav – Thermodynamics & Heat Engines
4. P K Nag – Power Plant Engineering
5. P C Sharma – Power plant Engineering
6. P S Desai & S B Soni – Elements of mechanical Engineering

**Course Structure for M. Tech programme**

**Programme name: M. Tech in Water Resources and Hydraulic Engineering**

**Department: Civil Engineering Department**

**Date: 23-05-2019**

**Semester I**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sl. No.** | **Course Code** | **Subject** | **Teaching Scheme (Hrs/week)** | **Examination Scheme** | **Credits****C** |
| **L** | **T** | **P** | **ESE** | **MSE** | **S** |
| **Theory** |
| 1 | PWRE101 | Ground water hydrology | 3 | 1 | 0 | 100 | 50 | 20 | 8 |
| 2 | PWRE102 | Open Channel Flow | 3 | 1 | 0 | 100 | 50 | 20 | 8 |
| 3 | PWRE103 | Applied Hydrology | 3 | 1 | 0 | 100 | 50 | 20 | 8 |
| 4 | PWRE111\* | Elective - I | 3 | 0 | 0 | 100 | 50 | 20 | 6 |
| 5 | PWRE112\* | Elective - II | 3 | 0 | 0 | 100 | 50 | 20 | 6 |
| 6 | PWRE171 | Water Resources Engineering Laboratory–I | 0 | 0 | 4 | 60 | 20 | 20 | 4 |
| **Total** | 15 | 3 | 4 | 660 | 270 | 120 | **40** |
| Total Contact Hours : 22 |
| Total Credit : 40 |

|  |
| --- |
| **Elective - I Subjects** |
| **Sl. No.** | **Subject Code (PWRE111\*)** | **Subject** |
| 1 | PWRE1111 | Water resources systems analysis |
| 2 | PWRE1112 | Human resource Management for water resources projects |
| 3 | PWRE1113 | Project engineering and management |
| 4 | PWRE1114 | Economic aspects of water resources development |
| 5 | PWRE1115 | Financing infrastructure projects |
| 6 | PWRE1116 | Any other subject offered from time to time with the approval of the competent authority. |

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| --- |
| **Elective - II Subjects** |
| **Sl. No.** | **Subject Code****(PWRE112\*)** | **Subject** |
| 1 | PWRE1121 | Hydropower engineering |
| 2 | PWRE1122 | Surface water quality modelling and control |
| 3 | PWRE1123 | Eco-hydraulics and hydrology |
| 4 | PWRE1124 | Environmental dynamics and control |
| 5 | PWRE1125 | Industrial Water Pollution Control |
| 6 | PWRE1126 | Any other subject offered from time to time with the approval of the competent authority. |

**Semester II**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sl. No.** | **Course Code** | **Subject** | **Teaching Scheme (Hrs/week)** | **Examination Scheme**  | **Credits****C** |
| **L** | **T** | **P** | **ESE** | **MSE** | **S** |
| **Theory** |
| 1 | PWRE201 | Advanced computational hydraulics | 3 | 1 | 0 | 100 | 50 | 20 | 8 |
| 2 | PWRE202 | Hydraulics of sediment transport | 3 | 1 | 0 | 100 | 50 | 20 | 8 |
| 3 | PWRE211\* | Elective - III | 3 | 0 | 0 | 100 | 50 | 20 | 6 |
| 4 | PWRE212\* | Elective - IV | 3 | 0 | 0 | 100 | 50 | 20 | 6 |
| 5 | PWRE271 | Water Resources Engineering Laboratory–II | 0 | 0 | 4 | 60 | 20 | 20 | 4 |
| 6 | PWRE291 | Seminar | 0 | 0 | 4 | 100 | - | - | 4 |
| **Total** | 12 | 2 | 8 | 660 | 270 | 120 | **36** |
| Total Contact Hours : 22 |
| Total Credit : 36 |

|  |
| --- |
| **Elective - III Subjects** |
| **Sl. No.** | **Subject Code****(PWRE211\*)** | **Subject** |
| 1 | PWRE2111 | Optimization techniques in Water Resources Engineering |
| 2 | PWRE2112 | Integrated watershed management |
| 3 | PWRE2113 | Soft computing techniques in water resources |
| 4 | PWRE2114 | Turbulent Fluid Flow |
| 5 | PWRE2115 | Any other subject offered from time to time with the approval of the competent authority. |

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| --- |
| **Elective - IV Subjects** |
| **Sl. No.** | **Subject Code****(PWRE212\*)** | **Subject** |
| 1 | PWRE2121 | Statistical techniques and computer programming |
| 2 | PWRE2122 | GIS and remote sensing for land and water resources |
| 3 | PWRE2123 | River engineering |
| 4 | PWRE2124 | Hydraulic structures |
| 5 | PWRE2125 | Any other subject offered from time to time with the approval of the competent authority. |

**Semester III**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sl. No.** | **Course Code** | **Subject** | **Teaching Scheme (Hrs/week)** | **Examination Scheme** | **Credits****C** |
| **L** | **T** | **P** | **ESE** | **MSE** | **S** |
| 1 | PWRE371 | Project-I | 0 | 0 | 20 | 100 | - | 50 | 20 |
| **Total** | 0 | 0 | 20 | 200 |  - | 50 | **20** |
| Total Contact Hours : 20 |
| Total Credit : 20 |

**Semester IV**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sl. No.** | **Course Code** | **Subject** | **Teaching Scheme (Hrs/week)** | **Examination Scheme** | **Credits****C** |
| **L** | **T** | **P** | **ESE** | **MSE** | **S** |
| 1 | PWRE471 | Project-II | 0 | 0 | 30 | 200 | - | 100 | 30 |
| **Total** | 0 | 0 | 30 | 200 | - | 100 | **30** |
| Total Contact Hours: 30 |
| Total Credit: 30 |

**Overall credits: 126**

**Total contact hours: 94**

Acronyms:

L: Lecture

T: Tutorial

P: Practical

ESE: End Semester Examination of 3 hours duration

MSE: Mid Semester Examination of 2 hours duration

S: Sessional

C: Credit

**\*\*\*\*\*\*\***

**Course Syllabi for M. Tech programme**

**Name of the Programme: M. Tech in Water Resources and Hydraulic Engineering**

**Name of the Department: Civil Engineering Department**

**Semester I**

**Compulsory courses**

**PWRE101: Ground Water Hydrology 8 Credits (3-1-0)**

Occurrence and movement of groundwater including subsurface investigations of groundwater. Flow through saturated and unsaturated media. Well Hydraulics and aquifer parameters. Pumping wells and their design, construction, monitoring and rehabilitation of wells. Recharge of groundwater by various means. Salt water intrusion and coastal aquifer hydraulics. Analog and numerical models and application of Finite Difference method to groundwater, case studies.

**Course Outcomes:** By the end of the course the student is expected to: a) learn basics of flow through porous media, groundwater flow and well hydraulics; b) understand contaminant transport, salt water intrusion phenomena in groundwater hydraulics; c) gain knowledge about remediation and restoration techniques for better aquifer management.

**Reference / Text Book (s):**

1. Ground Water Hydrology by David Keith Todd (1959), Wiley.

**PWRE102: Open channel flow 8 Credits (3-1-0)**

Energy and momentum of flow; critical flow; channel control and transitions; discharge measurement methods; uniform flow and flow resistance; composite roughness and compound channels; gradually varied flow; classifications and computations of free surface profiles; spatially varied flow; supercritical flows and oblique flows; rapidly varied flow; hydraulic jump; continuity and dynamic equations of unsteady flow; wave propagation and surge; method of characteristics; dam-break problem; flow in channel bends; buoyant and submerged jets.

**Course Outcomes:** By the end of the course the student is expected to: (a) apply knowledge of mathematics, science, and engineering in the analysis of flow to be conveyed in channels and canals, (b) design a system, component, or process to meet desired needs within realistic constraints, such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability (c) identify, formulate, and solve engineering problems.

**Reference / Text Book (s):**

1. Flow in open channels by K. Subramanya (1982), Tata McGraw-Hill Education.
2. Open-Channel Flow by M. Hanif Chaudhry (1993), Springer.

**PWRE103: Applied Hydrology 8 Credits (3-1-0)**

*Hydrologic Processes*: System concept of watershed; components of hydrologic cycle; atmospheric circulation, water vapor, precipitation, evaporation, and evapotranspiration. *Hydrologic Analysis*: Response functions of a linear system, unit hydrograph, synthetic unit hydrograph and instantaneous unit hydrograph, flood routing and frequency analysis, droughts. *Hydrologic Statistics*: Analysis of hydrologic data, parameter estimation, commonly used distribution function in hydrology, concept of uncertainty and risk, Introduction to time series analysis and forecasting.

*Hydrologic Design*: Estimated Limiting Value, Hydrologic design scale and design level; Design storms – Design precipitation, IDF and DAD relationships, Design hyetograph, Estimated limiting storms and PMP; Flood plain analysis and flood control measures.

**Course Outcomes:** By the end of the course the student is expected to: a) apply various data processing techniques including statistical methods for analysis of hydrometeorological and climatological data; b) use various methods of estimation and analysis of rainfall data, b) use techniques to assess stream flow, c) analyse and predict extreme events, such as floods and droughts, c) use various modelling techniques for hydrological simulation and forecasting.

**Reference / Text Book (s):**

Applied Hydrology by Ven T Chow, David R. Maidment and Larry Mays (1988), McGraw-Hill Education.

**Semester I**

**Elective-I courses**

**PWRE1111: Water Resources Systems Analysis 6 Credits (3-0-0)**

The nature of water resources systems: Systems analysis - the jargon used. Methods of systems analysis. Linear programming models - concept of simplex tableau, its working principles - the two phases of simplex method - revised simplex method - duality, decomposition principle - post optimality analysis. Transportation problem. Non-linear programming of simple cases. Dynamic programming - multi stage decision process - computational procedure in Dynamic programming - basic concepts of probability - Stochastic linear and Dynamic programming - application of systems analysis to water resources systems in particular.

**Course Outcomes:** By the end of the course the student is expected to: a) understand the fundamentals of economic theory as applied to water resources, b) be familiar with optimization and simulation modelling, c) be able to design and solve optimization models of water systems.

**Reference / Text Book (s):**

1. Water resources systems analysis by Mohammad Karamouz and Ven Te Chow (2003), CRC press.

**PWRE1112:**

**Human resources management for water resource projects 6 Credits (3-0-0)**

*Introduction to Human Resource Management*

The focus of the first unit is on identifying what the personnel and human resource function is all about. It explores the typical responsibilities of HR departments and how they are affected by the corporate culture, environmental forces, and government regulations. It also introduces the topics of strategic and employment planning.

*Staffing*

Once the organization has determined its strategic and human resource objectives and analyzes the jobs to be filled, it is ready to fill them. Unit 2 reviews the two steps in the staffing process: recruitment and selection. Recruitment aims at identifying and attracting the largest possible number of qualified applicants to hire for each job.

*Compensation & Benefits*

This unit focuses on compensation and related issues. Among the topics to be covered are forms of and bases for compensation, job evaluation and compensation/evaluation systems.

*Performance Management*

This unit discusses and examines performance evaluation as a system including process and procedures used in developing reliable and valid standards, criteria, and evaluation mechanisms. A good performance management system is fair to the employee while also serving the goals and interests of the organization.

*Human Resource Development*

Employee training and development is another important HR function. More specifically, Unit 5 focuses on deciding who is to be trained, in what and how they are to be trained, and how effective was the training for the employee and her/his organizational component. To be effective, training and development programs must be matched to types of employees with specific skill deficiencies and to new skills anticipated to be needed by the organization.

*Global Human Resource Management & Future Issues*

Declining productivity, substantial demographic shifts, changing employee attitudes and expectations, innovation technologies, and government regulations will continue to affect human resource management into the 21st century. This final unit deals with the most significant trends in human resource management and how they can be addressed through innovative and effective organizational strategies.

Case studies involving water resources engineering projects.

**Course Outcomes:** By the end of the course the student is expected to: a) gain understanding of an office setup in respect of employees either in the private or in the government sector: b) develop, implement, and evaluate employee orientation, training, and development programs. c) facilitate and support effective employee and labour relations in both non-union and union environments, d) research and support the development and communication of the organization's total compensation plan; and e) succeed as a team leader or an office manager in any organization involving water resources development.

**Reference / Text Book (s):**

1. A Handbook of Human Resource Management Practice by Michael Armstrong (2017), Kogan Page Publishers.
2. Human Resource Management by Gary Dessler (1997), Prentice Hall.

**PWRE1113: Project Engineering and Management 6 Credits (3-0-0)**

Introduction: Foundations of Project Management, Project Life Cycle, The Project Environment, Project Selection, Project Proposal, Project Scope, Work Breakdown Structure. Network Scheduling, Critical Path Method, Program Evaluation & Review Technique, Planning and Scheduling of Activity Networks, Assumptions in PERT Modelling, Time-cost Trade-offs, Linear Programming and Network Flow Formulations, PERT/COST Accounting. Scheduling with limited resources, Resource Planning, Resource Allocation, Project Schedule Compression, Project Scheduling Software, Precedence Diagrams, Decision CPM, Generalized Activity Networks, GERT. Estimation of Project Costs, Earned Value Analysis, Monitoring Project Progress, Project Appraisal and Selection, Recent Trends in Project Management.

**Course Outcomes:** By the end of the course the student is expected to: a) recognise the constituent parts of a project life cycle and the relevant parties involved; b) demonstrate understanding of the importance project demand and client responsibility in project success; c) be able to analyse basic project cost and time information and produce simple estimates and plans; d) develop competence in applying application software, such as Primavera or Microsoft Project, for efficient project management.

**Reference / Text Book (s):**

1. Projects: Planning, Analysis, Selection, Implementation & Review, Prasanna Chandra, 5th Ed., 2002.
2. Project Management: A systems approach to planning and controlling, Harold Kerzner, CBS Publisher, New Delhi, 2nd Ed., 2000.

**PWRE1114: Economic Aspects of Water Resources Development 6 Credits (3-0-0)**

Economics of water and development, Basic economic concepts, Financial analysis of a project, Pricing concepts, Benefit-cost-sensitivity analysis, Capital budgeting and cost allocation, Economics of natural resources management, Hydro economic model, Hydro-economic risk assessment, Economics of river restoration, Economics of trans-boundary water resources management.

**Course Outcomes:** By the end of the course the student is expected to: a) analyse policy and planning frameworks for water resources management; b) identify and critically review the conflicting interests to be considered in making water resource management decisions; c) design approaches to reconcile competing interests in water; d) analyse and make provision for sustainability limits; e) evaluate requirements for the resource consenting process and apply in practice.

**Reference / Text Book (s):**

1. Economics of Water Resource Planning by L. Douglas James and Robert R. Lee. McGraw-Hill Book Company, 1971.

**PWRE1115: Financing Infrastructure Projects 6 Credits (3-0-0)**

Investment decisions in infrastructural projects: benefit cost analysis, measurement problems, examples from past projects, indirect estimation methods of benefits. Cost of capital: private and public money, different schools of thought on social capital- cases. Multiple projects and constraints: linear and integer programming models, goal programming formulation. Financing infrastructure projects: venture capital, sources of capital–private and public participation, modes of cooperation such as BOOT and BOT national and international sources, international agencies, borrowing terms and conditionalities. Public policy issues, leasing and mortgaging, evaluation issues, infrastructural mutual funds, valuation aspects. Risk coverage, risk evaluation and containment of public projects. Real options, value of option for delay, abandonment and vacant land – judgmental assessment of options. post review and administrative issues in project management, international (cross country) projects, implementation issues.

**Course Outcomes:** By the end of the course the student is expected to: a) demonstrate a systematic understanding of how to use project finance methods to fund and value water resources and other large-scale projects; b) assess how to mitigate specific risks and provide incentives in infrastructure projects, including optimal restructuring of projects in distress; c) demonstrate a critical ability to analyse and structure project risks.

**Reference / Text Book (s):**

1. Financing Infrastructure Projects by Cyrus Njiru and Tony Merna. Thomastelford, 2002.

**Semester I**

**Elective-II courses**

**PWRE1121: Hydropower Engineering 6 Credits (3-0-0)**

Hydropower development schemes and their various configurations; Planning for firm Capacities, Peak Load and Base Load configurations; role of Hydropower development in a mixed power systems; Governing of Hydropower systems; Study of hydraulic transients in Penstocks. Surge analysis and dynamics of Surge tanks; design of hydropower installation components - intake structures; water conductor systems tunnels; surge-tanks; penstocks; valves and anchor-blocks; types of powerhouse - underground and semi-underground; turbines and their foundations; introduction to structural and geotechnical aspects of powerhouse design - CAD applications; similitude and models; Mini and Micro hydro power developments.

**Course Outcomes:** By the end of the course the student is expected to: a) discover principles of operation and design of storage, run-of-the-river and pumped storage types of hydropower projects, b) learn about specific types of turbines and installation of the necessary accessories for a specific location; b) develop competence in preparing Due-diligence Report, Pre-feasibility study report, Feasibility Report, Detail Project Report, etc.; c) undertake detailed design and engineering of hydropower projects, d) develop understanding of electric power systems and competence to assess hydropower potential of projects, determine optimal installed capacity, recommend suitable number, type and size of generating units, and e) estimate quantum of annual energy generation, load factor, firm power, secondary power, etc.

**Reference / Text Book (s):**

1. Water power development by Mosonyi, Emil (1991), Akademia Budapest.
2. Hydro Power – The Design, Use and Function of Hydromechanical, Hydraulic, and Electrical Equipment by Prof. Dr.-Ing. J. Raabe. VDI-Verlag GmbH, 1985.
3. Guidelines for preparation of Detailed Project Reports of Irrigation and Multipurpose Projects. Working Group Report. Government of India, Ministry of Irrigation, 1980.
4. Micro Hydroelectric Power Stations by L. Monition, M. LE NIR and J. Roux, Translated by J. McMullan. John Wiley & Sons, 1981.
5. Micro-Hydro Design Manual – A Guide to Small-Scale Water Power schemes by A. Harvey with a. Brown, P. Hettiarachi and A. Inversin. ITDG Publishing, 2002.
6. Relevant publications and Guidelines of Central Electricity Authority, Central Water Commission and Central Board of Irrigation and Power, Government of India.
7. Guide on How to Develop a Small Hydropower Plant, Part 1 and 2. by European Small Hydropower Association (ESHA), 2004.

**PWRE1122: Surface water quality modelling and control 6 Credits (3-0-0)**

River hydrology and derivation of Stream Equation, Derivation of Estaury equation, Distribution of water quality in rivers and estuaries. Physical and Chemical characteristics of Lakes, Finite Difference steady state river, estaury and Lake models., Dissolved Oxygen models in rivers, estuaries and Lakes, Fate of Indicator Bacteria and pathogens in water bodies. Basic Mechanism of Eutrophication, Lake Phytoplankton models, eutrophication in rivers and estuaries. Elements of Toxic substance analysis.

**Course Outcomes:** By the end of the course the student is expected to: a) understand the idea, methodology and basic tools of water quality modelling; b) understand the different modelling approaches, their scope and limitations; c) understand the fate and transport of pollutants in different water bodies.

**Reference / Text Book (s):**

1. Principles of Surface Water Quality Modelling and Control by Robert V. Thomann, John A. Mueller (1987), Harper & Row.

**PWRE1123: Eco-hydraulics and hydrology 6 Credits (3-0-0)**

Classification of Hydro environmental systems, governing equations for open surface flow domains, pollutant transport equations in hydro-environmental flow systems, computational methods and solution techniques. Study of ecological descriptors, numerical ecology, multi-objective definitions of environmental flows, Hydrologic indices for e-flows and river health assessment. Riverine habitat characterization and habitat simulation models. Anthropogenic triggers for changes in riverine habitat.

**Course Outcomes:** By the end of the course the student is expected to: a) get advanced knowledge of impacts of encroachments on river systems; b) have knowledge on the most recent methods for impact analysis and mitigation using Eco hydrological and Eco hydraulic tools; c) know the most common modelling tools that is applied within the field and how they are applied.

**Reference / Text Book (s):**

1. ‘Eco hydraulics: An Integrated Approach’ By Ian Maddock, Atle Harby, Paul Kemp, Paul J. Woo (2013), Willey.
2. ‘Environmental hydrology & hydraulics’ By S.N. Ghosh and V.R. Desai; Science Publishers (2006), Enfield, NH, USA.

**PWRE1124: Environmental dynamics and Control 6 Credits (3-0-0)**

Environmental property and processes, Environmental simulation models, Elements of environmental impact analysis, Impact assessment methodologies, Framework of environmental assessment, Environmental impact of water resources projects, Assessment of hydrological hazards, Environmental management, Case studies.

**Course Outcomes:** By the end of the course the student is expected to: a) recognise the complex structure of environmental systems and apply qualitative modelling techniques to describe and analyse the influence and feedback structures within these systems; b) Comprehend fundamental dynamic systems theory concepts (phase-line and phase-space representations, null clines, equilibria and stability analysis) and apply them to analyse 1- and 2-D dynamic systems.

**Reference / Text Book (s):**

1. Adaptive Management: From Theory to Practice by James Oglethorpe. IUCN-The World Conservation Union, 2002.
2. Modelling Environmental Dynamics: Advances in Geomatic Solutions edited by Martin Paegelow, María Teresa Camacho Olmedo. Springer, 2008.

**PWRE1125: Industrial Water Pollution Control 6 Credits (3-0-0)**

Introduction of pollutants: characteristics and classification of water pollutants.

Liquid Waste Management: Industrial Waste Water (in terms of Quality & Quantities), Environmental aspect of Dyes & Pigment, Drug Industry, Glass & Ceramics, Rubber, Polymer, Leather and tannery, Nuclear Power Plant, Energy Industries etc. Special Waste Water (Toxic & Nuclear Power plant). Effluent Treatment processes and plants.

**Course Outcomes:** By the end of the course the student is expected to: a) recognise the complex nature of environmental pollutants released by different industries, b) assess the impacts of industrial pollutants, c) identify and design processes for controlling water pollution caused by industrial effluents, d) provide decision support for environmental protection from industrial pollutants.

**Reference / Text Book (s):**

1. Industrial Water Pollution Control by W. Eckenfelder Jr., McGraw-Hill, 1966.
2. Environmental Engineering and Water Resources, McGraw-Hill, 1999.

**Semester II**

**Compulsory courses**

**PWRE201: Advanced Computational hydraulics 8 Credits (3-1-0)**

Ordinary and partial differential equations; finite difference schemes - implicit and explicit types; accuracy, convergence and stability; method of characteristics; finite element method - variational and weighted residual formulations; applications to steady and unsteady flows; pollutant dispersion; flood wave propagation; tidal model; applications with computer programming.

**Course Outcomes:** By the end of the course the student is expected to: a) acquire understanding of numerical approximations and solutions of physical systems, especially in open channel hydraulics, but with more general application in hydraulics and fluid mechanics, b) develop competence in understanding the fundamentals and applying application software for Computational Fluid Dynamics analysis, and obtain solutions of real-life problems.

**Reference / Text Book (s):**

1. Computational Hydraulics by Vreugdenhil, Cornelis B. (1989), Springer.

**PWRE202: Hydraulics of Sediment Transport 8 Credits (3-1-0)**

Sediment properties; initiation of motion; bed load; bed forms; effective bed roughness; armouring; suspended load; total load; transport of sediment due to unsteady flow; meandering of rivers; braided river; local scour at different structures; sediment sampling; density current; mathematical models of sediment transport; effect of coherent turbulence on sediment transport.

**Course Outcomes:** By the end of the course the student is expected to: 1) gain knowledge about nature of sediment problems, origin and properties of sediment particles, fall velocity concept. 2) have knowledge on suspended sediment, bed load and total load transport in streams. 3) have knowledge on bed form mechanics and resistance to flow, and 4) apply the knowledge in design of hydraulic systems conveying sediment-laden flow.

**Reference / Text Book (s):**

1. Hydraulics of Sediment Transport by Walter Hans Graf (1971), Water Resources Publication, LLC.
2. Fluvial Hydrodynamics: Hydrodynamic and Sediment Transport Phenomena by S Dey (2014), Springer.

**Semester II**

**Elective-I courses**

**PWRE2111:**

**Optimization Techniques in Water Resources Engineering 6 Credits (3-0-0)**

Optimization techniques commonly used in water resources planning & management, water infrastructures, and irrigation and hydropower projects; Linear programming and duality, Network flow algorithms, Dynamic programming, Nonlinear programming, Geometric and Goal programming, Introduction to modern heuristic methods like genetic algorithm and simulated annealing, Multi-objective optimization, Applications and case studies in water resources, agriculture, environment and other areas of science & engineering.

**Course Outcomes:** By the end of the course the student is expected to: a) gain knowledge of water demand management concepts; b) use techniques to assess water demand for various sectors; c) examine various optimization techniques used for maximising allocation of water resources for satisfying water demand to various sectors.

**Reference / Text Book (s):**

1. Water Resource Systems Planning and Management: An Introduction to Methods, by Daniel P. Loucks and Eelco van Beek (2005), Springer.
2. Water Resources Systems: Modelling Techniques and Analysis, Vedula, S. and Mujumdar, P. P., (2005), Tata-McGraw Hill.

**PWRE2112: Integrated Watershed Management 6 Credits (3-0-0)**

Introduction to integrated approach for the management of watersheds; preparation of land drainage schemes; types and design of surface drainage as well as subsurface drainage in coastal and interior basins; controlling of soil erosion and soil salinity; types and design of water conservation and water harvesting structures for different types of catchments; estimation of design storm and design flood for spillways and other outlet structures; flood routing through channels and reservoirs; flood control through single purpose and multipurpose reservoir operation; types and design of flood forecasting and protection systems; flood damage case studies.

**Course Outcomes:** By the end of the course the student is expected to: a) experience in collaborative IWM, particularly in Participatory Action Research; b) know about Sustainable Land Management (SLM) knowledge sharing.

**Reference / Text Book (s):**

1. Integrated Watershed Management by Isobel W. Heathcote (2009), John Wiley & Sons.

**PWRE2113: Soft computing techniques in water resources 6 Credits (3-0-0)**

Artificial Intelligence; Expert Systems; Artificial Neural Networks: Introduction, Training, Applications in Hydrology; Genetic Algorithms; Fuzzy Logic Systems, Fuzzy Set Theory, Predictive and Descriptive Data Mining; Classification Methods: Decision trees, NN, Bayesian, ANN, SVM, Applications; Association Analysis; Cluster Analysis - K-means, Fuzzy, Self-Organising maps; Anomaly detection; Applications in Water Resources - Forecasting, Regionalization.

**Course Outcomes:** By the end of the course the student is expected to: a) apply various optimization techniques, Fuzzy logic, Data Mining, Decision trees etc. for solving problems related to water resources engineering and management; b) learn mathematical model for various real time problem-solving.

**Reference / Text Book (s):**

1. Soft Computing in Water Resources Engineering: Artificial Neural Networks, Fuzzy Logic and Genetic Algorithms by G. Tayfur. WIT Press, 2014.

**PWRE2114: Turbulent Fluid Flow 6 Credits (3-0-0)**

Statistical structures of turbulence; two-dimensional flow structures and effect of roughness; measurements of turbulence; three-dimensional flow structures driven by turbulence; secondary currents; diffusion and dispersion; turbulence model calculations; Coherent structures; bursting phenomena; large scale vortical motions; physical models of coherent structures; numerical simulations of coherent structures; wave boundary layer.

**Course Outcomes:** By the end of the course the student is expected to: a) apply various analytical methods and modelling concepts for solving real-life problems related to turbulent flow, b) gain competence in physical modelling of hydraulic structures characterized by turbulent flow.

**Reference / Text Book (s):**

1. Turbulent Flows by S.B. Pope. Cambridge University Press, 2000.
2. Computational Fluid Dynamics: Incompressible Turbulent Flows by Takeo Kajishima and Kunihiko Taira. Springer, 2017.

**Semester II**

**Elective-II courses**

**PWRE2121: Statistical Technique & Computer Programming 6 Credits (3-0-0)**

Estimation and hypothesis testing, correlation and regression, analysis of variance (one way and two way classification). Programming preliminaries, some simple program in C, numeric constants and variables, arithmetic expression, input and output conditional statements, loops, arrays, logical expressions, functions, character strings enumerated data type and stacks, structures.

**Course Outcomes:** By the end of the course the student is expected to: a) formulate complete, concise, and correct mathematical proofs; b) frame problems using multiple mathematical and statistical representations of relevant structures and relationships and solve using standard techniques; c) create quantitative models to solve real world problems in appropriate contexts.

**Reference / Text Book (s):**

1. Statistical Analysis in Water Resources Engineering by [Mamdouh Shahin](https://www.google.co.in/search?tbo=p&tbm=bks&q=inauthor:%22Mamdouh+Shahin%22), [H. J. L. van Oorschot](https://www.google.co.in/search?tbo=p&tbm=bks&q=inauthor:%22H.+J.+L.+van+Oorschot%22), [S. J. de Lange](https://www.google.co.in/search?tbo=p&tbm=bks&q=inauthor:%22S.+J.+de+Lange%22). A.A. Balkema, 1993.

**PWRE2122: GIS and Remote Sensing for Land and Water Resources 6 Credits (3-0-0)**

What is GIS. Geographic concepts for GIS. Spatial relationships, topology, spatial patterns, spatial interpolation. Data storage, data structure, non-spatial database models. Populating GIS, digitizing, data conversion. Spatial data models, Raster and Vector data structures and algorithms. Digital Elevation Models (DEM) and their application. Georeferencing and projection systems, GIS application areas, Spatial analysis, quantifying relationships, spatial statistics, spatial search.

Physics of remote sensing: Electromagnetic spectrum, atmospheric effects, energy interaction with earth surface features. Platforms and remote sensing sensors: Photographic camera, scanners, earth resources satellites, active and passive microwave sensors. Digital image processing: Image rectification, image enhancement, image classification and accuracy. Image interpretation. Geographical Information System (GIS): Map data representation, geographic database concepts and analysis. Application of remote sensing and GIS in land and water resources system and evaluation.

**Course Outcomes:** By the end of the course the student is expected to: a) learn about satellite remote sensing, GIS, DEM and GPS; b) learn about digital image processing for image rectification, enhancement and information extraction; c) apply Remote Sensing, GIS, DEM and GPS is various domains including rainfall-runoff modelling, Snow mechanics, Watershed management, Irrigation management, soil moisture estimation, Drought and Flood monitoring, Environment and ecology.

**Reference / Text Book (s):**

1. GIS and Remote Sensing Techniques in Land- and Water-management by A. van Dijk, M.G. Bos (2013), Springer.

**PWRE2123: River Engineering 6 Credits (3-0-0)**

River characteristics; use of rivers for navigation, hydropower, water supply and irrigation; river hydraulics - water waves, flow classification, regime of flow, type of flow; formulating hydraulic studies - date requirement, calibration of hydraulic analysis models, multidimensional flow analysis, limitations of one-dimensional analysis, two-dimensional conditions, available computer programs and their applications, theory of routing models for unsteady flow, diffusion of wave and kinematic wave approximations, Muskingum-Cunge models, water surface profiles for mobile boundaries; river morphology - planform, longitudinal profile, river bends, bifurcation and confluences, quality of water; river survey - water levels, bed levels, discharge, stage-discharge relationships, sediments and water quality, introduction to scale models in rivers.

**Course Outcomes:** By the end of the course the student is expected to: a) know qualitative behaviour of river and estuarine dynamics (e.g. river meanders); b) know relevant hydrodynamic equations of open channel flows; c) know about sediment transport mechanics and modelling approaches.

**Reference / Text Book (s):**

1. River Hydraulics by U. S. Army Corps of Engineers (2004), University Press of the Pacific.

**PWRE2124: Hydraulic Structures 6 Credits (3-0-0)**

Storage, Diversion, Conveyance and Distribution structures: An Introduction.

Reservoirs behind dams and pond area behind barrages: determination of capacities (influence of sedimentation). Dead and Live storages. Design of storage structures: Gravity dam: Spillway and Non-overflow sections and their design. Concrete dam details: joints, water-seals, galleries and adits, instrumentation: purpose and techniques; sluices. Foundation treatment for concrete dams (curtain and consolidation grouting). Other types of concrete dams (Arch, Buttress, Hollow, etc.).

Types of spillways (adaptations for concrete and embankment dams). Flow characteristics of gated/ungated spillways / breast-walled gates. Types of energy dissipators (Hydraulic Jump / Ski-Jump / Roller bucket). Influence of tail water rating curve on choice of energy Dissipater.

Design flood for dams (according to the size of dams and reservoir capacities). PMF, SPF, Return Period; Gumbel distribution. Flood routing through spillways (Pul's method). Backwater curve analysis for reservoirs.

Typical sections of earth and rockfill dams (homogeneous / zoned). Analysis and design of embankment dams.

Types of gates for dams and barrages (radial and vertical lift types). Diversion structures: Barrages and weirs on permeable foundations. Design consideration of barrages for surface and sub-surface flows (raft foundation on alluvial rivers). Retrogression and flow concentration effects on barrage design. Design consideration of barrages (gravity design on boulder bed rivers). Sedimentation characteristics for barrage ponds and its influence by gate operation; management of sedimentation in barrage ponds. Barrage components: Glacis, Rigid apron, Flexible (concrete block) apron. End-sill arrangements for energy dissipation for weir and under-sluice sections of a barrage. Pier, Divide wall, Sheet Piles.

Canal structures: Head regulator, Cross regulator and Falls. Canal section design (unlined and lined); in cutting and filling. Aqueducts; Super-passage; Syphon Aqueducts. Distribution structures for conveying water from canals to irrigation fields. Canal capacity determination from field water requirements. Guide bunds for flow control of rivers (for barrages and bridges); its design features.

Principal components of a hydropower station: Intakes and Trash racks, Water conductor system, Tunnels, Surge tanks, Penstocks, Anchor blocks. Turbine foundation. Structures for prevention of riverbank and coastal erosion (considerations for toe scour; provision of filter to prevent subsidence).

**Course Outcomes:** By the end of the course the student is expected to: a) have in-depth knowledge of professional practices and design codes; b) formulate and solve multi‐variable hydraulic design problems in an open‐ended solution space; c) develop understanding of the basic principles and concepts of analysis and design of different types of conventional as well as innovative hydraulic structures.

**Reference / Text Book (s):**

Water Resources Engineering Vol. II Irrigation Engineering & Hydraulic Structures by S K Garg (2017), Khanna Publishers

**Course Structure of M. Tech in Food Engineering & Technology**

**SEMESTER-I**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **CODE** | **SUBJECTS** | **Teaching****Scheme****(per week)** | **Contact****hours** | **Credits** |
| **L** | **T** | **P** |  |  |
| PFET101 | Research Methodology and IPR | 0 | 2 | 4 | 6 | 8 |
| PFET102 | Recent Trends in Food Engineering and Technology  | 1 | 2 | 0 | 3 | 6 |
| PFET103 | Recent Advances in Enzyme and Microbial Technology  | 1 | 2 | 0 | 3 | 6 |
| PFET104 | Food Product Development and Entrepreneurship | 3 | 0 | 0 | 3 | 6 |
| PFET105 | Elective-I | 3 | 0 | 0 | 3 | 6 |
| PFET106 | Elective-II | 3 | 0 | 0 | 3 | 6 |
| **Total** | **20** | **0** | **4** | **21** | **38** |

**Total Credits in Semester-I=38**

**SEMESTER-II**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **CODE** | **SUBJECTS** | **Teaching Scheme****(per week)** | **Contact hours** | **Credits** |
| **L** | **T** | **P** |
| PFET201 | Emerging Food Processing Technologies-I; Beverages and Dairy | 1 | 2 | 2 | 5 | 8 |
| PFET202 | Emerging Food Processing Technologies-II; Fats, Oils, Bakery & Confectionary | 1 | 2 | 2 | 5 | 8 |
| PFET203 | Recent Trends in Food Safety and Quality Management | 3 | 0 | 0 | 3 | 6 |
| PFET204 | Elective-III | 3 | 0 | 0 | 3 | 6 |
| PFET205 | Elective-IV (open elective) | 3 | 0 | 0 | 3 | 6 |
| PFET206 | Seminar-I | 0 | 0 | 4 | 4 | 4 |
| **Total** | **17** | **0** | **8** | **23** | **38** |

**Total Credits in Semester-II=38**

**SEMESTER-III**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **CODE** | **SUBJECTS** | **Teaching****Scheme** | **Contact hours** | **Credits** |
| **L** | **T** | **P** |
| PFET301 | Dissertation-I | 0 | 0 | 28 | 28 | 28 |
| PFET302 | Seminar-II | 0 | 0 | 2 | 2 | 2 |
| **Total** | **0** | **0** | **30** | **30** | **30** |

 **Total Credits in Semester-III=30**

**SEMESTER-IV**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **CODE** | **SUBJECT****S** | **Teaching Scheme** | **Contact hours** | **Credits** |
| **L** | **T** | **P** |
| PFET401 | Dissertation-II | 0 | 0 | 32 | 32 | 32 |
| **Total** | **0** | **0** | **34** | **32** | **32** |

 **Total Credits in Semester-IV=32**

**Total Credits in (Semester I to Semester IV): 38+38+30+32=138**

**As per CIT Academic Ordinance:**

|  |  |
| --- | --- |
| 1 h Lecture (L) per week | 2 credit |
| 1 h Tutorial (T) per week | 2 credit |
| 1 h Studio Project | 2 credit |
| 1 h Practical (P) per week | 1 credit |
| 1 h Project Work | 1 credit |
| 1 h Seminar / Training /Industrial Training | 1 credit |

**Elective-I**

|  |  |
| --- | --- |
| **CODE** | **SUBJECTS** |
| PFET1051 | Modern Fruits & Vegetables Processing Techniques |
| PFET1052 | Refrigeration and Cold Chain Management |
| PFET1053 | Technology of Food Flavors and Spices |
| PFET1054 | Instrumental Analytical Techniques |

**Elective-II**

|  |  |
| --- | --- |
| **CODE** | **SUBJECTS** |
| PFET1061 | Food Biotechnology |
| PFET1062 | Functional Food and Nutraceuticals |
| PFET1063 | Modern Separation and Purification Technologies in Food Processing |
| PFET1064 | Advanced Food Process Equipment and Design  |
| PFET1065 | Recent Trends in Muscle Foods and Poultry Processing |

**Elective-III**

|  |  |
| --- | --- |
| **CODE** | **SUBJECTS** |
| PFET2041 | Utilization of Food Industries Byproducts |
| PFET2042 | Novel Food Packaging Technologies and Regulations |
| PFET2043 | Indigenous Fermented Food Products |
| PFET2044 | Engineering Properties of Biological Materials |

**Elective-IV (Open electives)**

|  |  |
| --- | --- |
| **CODE** | **SUBJECTS** |
| PFET2051 | Waste to energy |
| PFET2052 | Nanomaterials Synthesis and Characterization Techniques |
| PFET2053 | Cost Management of Engineering Project |
| PFET2054 | Industrial Safety |
| PFET2055 | Environmental Engineering |

**DETAILED SYLLABUS**

**PFET101: Research Methodology and IPR**

**Code: PFET101**

**Credits: 08**

**L-T-P: 0-2-4**

**Syllabus Contents:**

**UNIT-I:** Meaning of research problem, Sources of research problem, Criteria Characteristics of a goodresearch problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, data analysis, interpretation

**UNIT-II:** Effective literature studies approaches, analysis. Plagiarism and Research ethics, Effective technical writing, how to write a report, a paper? Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

**UNIT-III:** Overview of Intellectual Property; introduction and the need for intellectual property right (IPR), IPR in India – Genesis and Development, IPR in abroad**,** International cooperation on Intellectual Property, Licensing and transfer of technology.

**UNIT-IV:** Patent and kind of inventions protected by a patent, Patent document, How to protect your inventions? Granting of patent Rights of a patent, Searching a patent, Drafting of a patent, Filing of a patent, The different layers of the international patent system (national, regional and international options), Patents, Designs, Trade and Copyright.

**References:**

* T. M Murray and M.J. Mehlman, Encyclopedia of Ethical, Legal and Policy issues in Biotechnology, John Wiley & Sons 2000
* Ajit Parulekar and Sarita D’ Souza, Indian Patents Law – Legal & Business Implications; Macmillan India ltd , 2006
* Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students’”
* Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”
* Ranjit Kumar, 2nd Edition , “Research Methodology: A Step by Step Guide for beginners”
* Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007

**PFET102: RECENT TRENDS IN FOOD ENGINEERING & TECHNOLOGY**

**Code: PFET102**

**Credits: 06**

**L-T-P: 1-2-0**

**Syllabus Contents:**

**UNIT-I:** Recent advances in Food Technology on different Techniques of foodpreservation including thermal processing- canning,pasteurization, sterilization.Design of various sterilizes for food processing, asepticsterilization, Plate heat exchanger, Evaluation of process time in canning.

**UNIT-II:** Design of storage units, freezing system in food, slow and quick-freezing, Different freezes used in foodindustry including cryogenic freezing system. Modified Atmospheric Packaging (MAP) and Controlled Atmosphere Storage (CAS) systems.Basics of hurdle technology – Mechanism, Application to foods, Newer Chemical and Biochemical hurdles

**UNIT-III:** Food flavour and flavour evaluation, Colour of Food and colour measurement, Rheological properties of foods, Modern design used in food industryincluding freeze drying, spray drying, Microwave processing of food, Extrusion technology- single & twin screw system.

**UNIT-IV:** Supercritical fluid extraction (SCFE/SFE) technology. Freeze concentration, Homogenization, Membrane separation process, Reverse osmosis, Purification of component by crystallization, filtration, and centrifugation. Modern techniques of food processing and quality control

**References:**

1. *Novel Food Processing Technologies* (Food Science and Technology Series) (2004). Gustavo V. Barbosa-Canovas, Maria S. Tapia, M. Soledad Tapia, M. PilarCano, Publisher: CRC Press,
2. *Hand Book of Microwave Technology for Food Applications*. (1999). Dutta AK & Anantheswaran RC.1999.
3. *Hurdle Technologies – Combination treatments for foodstability safety and quality*, (2002).Leistner L. and Gould G. Kluwer Academics / Plenum Publishers, New York
4. *New Methods of Food Preservation*,(2000) Gould GW. CRC.
5. *Trends in Food Engineering*, (2000). Jorge E. Lozano, Cristina Anon, Efren Parada-Arias, Gustavo V. Barbosa-Canovas, Contributor Jorge E. Lozano, Published by CRC Press.

**PFET103: RECENT ADVANCES IN ENZYME AND MICROBIAL TECHNOLOGY**

**Code: PFET103**

**Credits: 06**

**L-T-P: 1-2-0**

**Syllabus Contents:**

**UNIT-I:** Morphology and physiology of industrial microorganisms (Bacteria, yeasts, molds and actinomycetes). Isolation, identification and quantitative estimation ofmicroorganisms, Microbiological assay, Genetics of someindustrial microorganisms, Microbiology of soil, Selection, development andmaintenance of cultures.

**UNIT-II:** Large scale production and purification of biomolecules. Application of biocatalysts fornew reactions and organic synthesis. (Immobilised enzymes and synzymes –Application in organic synthesis). Immobilisation of living microbial cells andtransformation of steroids. Enzyme kinetics and mass transfer or two liquid phase,Heterogeneous systems. New immobilisation techniques of biomaterials and theirapplication.

**UNIT-III:** Industrial applications of immobilised biomaterials. Biomass conversion with energyproduction, Analytical application of immobilised enzymes. Recent studies on Antibioticsand low molecular weight Enzyme inhibitor.Recent development and future aspects of enzyme Engineering.

**UNIT-IV:** Chemistry and biosynthesis of microbial products e.g. vitamins, amino acids, enzymes,steroids, antibiotics and polymers. Metabolic regulations in industrial fermentation.Microbial transformation of alkanes, alkaloids, terpenes, aromatic compounds andnaturally occurring polymers. Microbial food production. Spoilage microorganisms in foodsand their control. Mycotoxins and Microbialinsecticides.

**References:**

1. Fundamentals of Enzymology: Nicholas Price & Lewis Stevens

2. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry- Trevor Palmer

3. Biochemistry text books by Stryer, Voet and Lehninger (Relevant Chapters)

4. Fermentation Microbiology and Biotechnology, Second Edition by E. M. T. El-Mansi, C. F. A. Bryce,Arnold L. Demain, A.R. Allman

5. Principles of Fermentation Technology by P F Stanbury, A Whitaker, S Hall,

**PFET104: FOOD PRODUCT DEVELOPMENT AND ENTREPRENEURSHIP**

**Code: PFET104**

**Credits: 06**

**L-T-P: 3-0-0**

**Syllabus Contents:**

**UNIT-I:** Introduction to food product development, need, importance and objectives of product development in food industry; factors affecting food product development-extrinsic and intrinsic; steps in food product development; methodology involved in food product development; Concept Development: context and planning, frameworks for understanding customer needs, Concept generation, Translating the voice of the customer, Concept Selection, Concept testing overview.

**UNIT-II**: Food laws in food product development; process control parameters and scale up of developed products, market testing and marketing plans for developed products, costing and economic evaluation of developed products. Customer and user need assessment, market research- prototype development – market testing – feedback- commercial production- feedback- improvement.

**UNIT-III**: An Overview and Key Concepts of Project Management, Project planning & Project Feasibility Studies.DPR preparation for the project. Structures & techniques adopted by Project Management Institute (PMI). Human Aspects in Project Management, Project Scheduling with PERT/CPM, contingencies arrangement or plan ‘B’ preparation. Time-Cost-Trade-Off and Crashing of Projects.Human Resources Management.

**UNIT-VI**: Introduction to entrepreneurship: History, evolution and definitions of entrepreneurship, entrepreneur, entrepreneurial characteristics; Sequential stages of development of an entrepreneurship – Case studies; Definitions and classification of large, medium and small scale business. Trade license and registration; Selection of land for business and/or industries. Source of finance(s); Sources of machine(s) and equipment(s); Agencies for business promotion for food processing industries. Project report, market feasibility report, techno-economic feasibility report on food businesses

**References:**

1. Accelerating New Food Product Design and Development- Backley, 2007, Blackwell publishing, Oxford, UK.
2. Sensory and Consumer Research in Food Product Design and development- Moskowitz, 2006, Blackwell publishing, Oxford, UK.

**Elective-I**

|  |  |
| --- | --- |
| **CODE** | **SUBJECTS** |
| PFET1051 | Modern Fruits & Vegetables Processing Techniques |
| PFET1052 | Refrigeration and Cold Chain Management |
| PFET1053 | Technology of Food Flavors and Spices |
| PFET1054 | Instrumental Analytical Techniques |

**PFET1051: MODERN FRUITS & VEGETABLES PROCESSING TECHNIQUES**

**Code: PFET1051**

**Credits: 06**

**L-T-P: 3-0-0**

**Syllabus Contents:**

**UNIT-I:** Principles and methods of fruit and vegetable preservation. Advanced techniques for fruits and vegetables preservation. Low cost methods of preservation. Use of additives inproduct development. Enzyme and its application in fruits and vegetables processing, Ripening of fruits and role of enzyme.

**UNIT-II:** Measurement of colour, texture and other physico-chemical characteristics of fruits and vegetables. Characterisation of furit flavour, retention of flavour. Analyses and detection of contaminants and adulterants, Microbiology of fresh and processed products and its control.

**UNIT-III:** Fruit and vegetable juices, preparation of syrups, cordials and nectars, juice concentrates, pectin and related compounds, jams, jellies, marmalades, preserves, theory of gel formation. Pickles, chutneys and vinegar production, tomato products.

**UNIT-IV:** Fruits and Vegetables processing equipments, Factory sanitation and hygiene. Legislation of processed fruit and vegetable products. Utilisation of fruits and vegetables processing waste.

**References:**

1. Gustavo V. Barbosa-Cánovas, María S. Tapia and M. Pilar Cano, *Novel Food Processing Technologies,* CRC Press, 2005

2. Rachna Sehrawat, Khursheed A. Khan, Megh R. Goyal, Prodyut K. Paul, Technological Interventions in the Processing of Fruits and Vegetables

3. Özlem Tokuşoğlu, Barry G. Swanson, Improving Food Quality with Novel Food Processing Technologies

**PFET1052: REFRIGERATION AND COLD CHAIN MANAGEMENT**

**Code: PFET1052**

**Credits: 06**

**L-T-P: 3-0-0**

**Syllabus Contents:**

**UNIT-I:** Refrigeration – Ton of refrigeration, refrigeration cycles, Vapour Compression and Vapour Absorption cycles, Refrigerants, characteristics of different refrigerants, Ozone Depletion Potentials, Green house Potential Refrigerants, use of non polluting refrigerants

**UNIT-II:** Design of cold storage and air conditioning systems - types of loads in cold storage and their calculations, design of cold storage for food products, construction of cold storage, equipment selection, insulating materials, vapor barriers, care and maintenance of cold storage, Cold Storage practices, Stacking and handling of materials, Optimum temperatures of storage for different food materials.

**UNIT-III:** Frozen storage and temperatures, insulation of freezer rooms: Freezing rates, ice crystal growth, crystal size and its effect on texture and quality of foods, Freezing equipment; Freezer types, Blast freezers, Contact Plate Freezers, conveyorized quick freezers, Individual quick freezing. Cryogenic Freezing, Freezingpractice for meat, poultry, fruits and vegetables

**UNIT-IV:** Cold chain system - Important Factors to consider, logistic supply- Protocols for Domestic, Sea and Airfreight; Product Temperature and Moisture monitoring, transportation via land, air and sea, Grocery stores and display cases, Storage and packaging

**References:**

1. Anand, M.L. “Refrigeration and Air-conditioning”, Asian Books,
2. Clive D.J.Dellino: Cold and Chilled Storage Technology Publisher: KluwerAcademic Publishers
3. Andrew D Althouse and others: Refrigeration and air Conditioning Goodheart –Willcox Company Inc. 1982
4. E.R.Hollowell: Cold Storage and Freezer Storage Manual AVI Publishing Co.
5. AurelGobaneu and GabrialaLaseha and others (1976) Cooling Technology in theFood Industry: Abacus Press, Tunbridge Wells, U.K.
6. Dellino, C.V.J “Cold and Chilled Storage Technology”, Chapman Hall India

**PFET1053: TECHNOLOGY OF FOOD FLAVORS AND SPICES**

**Code: PFET1053**

**Credits: 06**

**L-T-P: 3-0-0**

**Syllabus Contents:**

**UNIT-I:** Introduction to flavor and flavor profile. Natural and synthetic flavoring substances and their chemical characteristics. Olfactory perception of flavor- Classification of flavors, Flavor potentiators, Flavor components/constituents of fruit and vegetables,coffee, tea and cocoa bean, spices and condiments, Measurement of flavor

**UNIT-II:** Effect of storage, cooking condition, processing, transportation andenvironmental condition on flavor components. Extraction, isolation and characterization of flavoring compounds of plant sources, and their utilization andapplication in food industries; Recent developments in flavor research, processing and technology

**UNIT-III:** Total component analysis; methods, recent developments. Head space analysis; static and dynamic methods, basic principles, method and developments, Solid phase micro extraction of aroma components; Electronic Nose (E-nose) technology.

**UNIT-IV:** Scope of spice processing in India, Types, qualities.Uses and physiological effects; components, antimicrobial and antioxidant properties, Medicinal value of condiments and spice products.Major spices- Pepper, cardamom, ginger, chili and turmeric–Oleoresins and essential oils; method of manufacture; chemistry of the volatiles; enzymatic synthesis of flavouridenticals; quality control; fumigation and irradiation of spices

**References:**

1. *Food Flavor and Chemistry: Explorations into the 21st Century*,(2005), Spanier, A.M *et al*.,

RSC.

1. *Food Flavours – Biology and Chemistry*, (1997). Carolyn Fisher, Thomas R. Scott, RSC

Publishin

1. *Handbook of Flavor Characterization (Food Science and Technology)*, Kathryn D. Deibler, Jeannine Delwiche, Marcell Dekker Inc.
2. *Spice Science and Technology*, (1998). Hirasa, K and Takemasa, M. Marcel Dekker,
3. *Handbook on Spices*. National Institute of Industrial Research Board (NIIR), Asia Pacific Business Press Inc.

**PFET1054: INSTRUMENTAL ANALYTICAL TECHNIQUES**

**Code: PFET1054**

**Credits: 06**

**L-T-P: 3-0-0**

**Syllabus Contents:**

**UNIT-I:** Introduction to spectroscopic techniques, UV - Vis Spectrophotometry, Turbidimetry, Reflectance Spectrometry, Fluorescence, Phosphorescence Spectrometry.

**UNIT-II:** Principle, Instrumentation and analytical applications of following techniques; Atomic Absorption spectroscopy , Flame photometry, Inductively coupled plasma-Atomic Emission spectroscopy, Scanning Electron Microscopy

**UNIT-III:** Chromatography: Gas solid Chromatography, Gas liquid Chromatography, ion exchange chromatography, paper chromatography, thin layer chromatography, column chromatography, gel permeation chromatography, High performance liquid chromatography (HPLC)

**UNIT-IV:** Infrared spectrometry, Introduction to X-Ray techniques, XRF, Introduction to NMR spectroscopy and mass spectrometry, Electroanalytical techniques: Potentiometry, Voltametry, Polarography.

**References:**

1. Principles of InstrumentalAnalysis,Skoog, Holler, Nieman, Saunders College Publishing.

2. Instrumental Methods ofAnalysis, Willard, Merritt, Dean, Settle, Wadsworth Publishing Company.

**Elective-II**

|  |  |
| --- | --- |
| **CODE** | **SUBJECTS** |
| PFET1061 | Food Biotechnology |
| PFET1062 | Functional Food and Nutraceuticals |
| PFET1063 | Modern Separation and Purification Technologies in Food Processing |
| PFET1064 | Advanced Food Process Equipment and Design  |
| PFET1065 | Advances in Muscle Foods and Poultry Processing |

**PFET1061: FOOD BIOTECHNOLOGY**

**Code: PFET1061**

**Credits: 06**

**L-T-P: 3-0-0**

**Syllabus Contents:**

**UNIT-I:** Advances in preservation of Food by various biotechnological processes. Technology on fermented foods for fruits, vegetables, cereals, legumes, milk, meat, fish etc. Role of lactic acid bacteria on preservation of food items.

**UNIT-II:** Extraction and clarification of fruit/vegetable juice by enzymes. Fermentative production of enzymes like amylase, proteases, pettiness, glucose isomers, glucose oxidazes cellulase, xylanase, lipases etc.

**UNIT-III:** Purification of enzymes by down stream processing. Production of alcohol, lactic acid and acetic acid from various food materials. Bacteriocin production and uses in food preservation,

**UNIT-IV:** Biotechnological processes for manufacture of functional foods: nutraceaticals and probiotics. Biotechnological process for food fortification, prebiotics & oligosaccharides. Improvement of quality of food by biotechnological processes. Treatment of waste from food indutries by biotechnological application.

**References:**

1. Anthony Pometto, Kalidas Shetty, Gopinadhan Paliyath, Robert E. Levin, Food Biotechnology, CRC press

2. Byong H. Lee, Fundamentals of Food Biotechnology, Wiley

3. Vinod K. Joshi, R. S. Singh, Food Biotechnology: Principles and Practices

**PFET1062: FUNCTIONAL FOODS AND NUTRACEUTICALS**

**Code: PFET1062**

**Credits: 06**

**L-T-P: 3-0-0**

**Syllabus Contents:**

**UNIT-1**: Introduction to Nutraceuticals as Science: Historical perspective, classification, scope & future prospects. Sources of Nutraceuticals. Properties, structure and functions of various Nutraceuticals: Glucosamine, Octacosanol, Lycopene, Carnitine, Melatonin and Ornithine alpha ketoglutarate. Use of proanthocyanidins, grape products, flaxseed oil as Nutraceuticals. Role of Probiotics and Prebiotics as nutraceuticals

**UNIT-II**: Food as remedies: Nutraceuticals bridging the gap between food and drug, Nutraceuticals in treatment for cognitive decline, Nutraceutical remedies for common disorders like Arthritis, Bronchitis, circulatory problems, hypoglycemia, Liver disorders, Osteoporosis, Psoriasis, Ulcers, obesity, immune enhancement, age-related macular degeneration, endurance performance and mood disorder etc.

**UNIT-III**: Manufacturing aspects of selected nutraceuticals such as lycopene, isoflavonoids, prebiotics and probiotics, glucosamine, phytosterols etc.; formulation of functional foods containing nutraceuticals – stability and analytical issues, labelling issues. Anti-nutritional Factors present in Foods

**UNIT-IV**: Functional foods, vitamin- and mineral-enriched products, products containing added fibre, and omega-3 fatty acids/oils. Fortified beverages with calcium or omega-3 oils, yogurts with probiotics and drinks with herb blends as well as omega-3 eggs.

**References:**

# 1. Rotimi E. Aluko, Functional Foods and Nutraceuticals, Springer

2. R.C. Wildman, Handbook of Nutraceuticals and Functional Foods, CRC Press

**PFET1063: MODERN SEPARATION AND PURIFICATION TECHNOLOGIES IN FOOD PROCESSING**

**Code: PFET1063**

**Credits: 06**

**L-T-P: 3-0-0**

**Syllabus Contents:**

**UNIT-I**: Introduction: Separation process in chemical and Biochemical industries, Categorization of separation process, equilibrium and rate governed processes.

**UNIT-II**: Modern separation techniques e.g. Membrane based separation technique (MBSTs): Historical background, physical and chemical properties of membranes, Techniques of membrane preparation, membrane characterization, various types of membranes and modules. Membrane separation, supercritical extraction, liquid membrane,

**UNIT-III**: Osmosis and osmotic pressure. Working principle, operation and design of reverse osmosis, ultrafiltration, microfiltration, electrodialysis and pervaporation. Gaseous separation by membranes.

**UNIT-IV**: Ion Exchange: Basic principle and mechanism of separation, Ion exchange resins, regeneration and exchange capacity. Exchange equilibrium, affinity, selectivity and kinetics of ion exchange. Design of ion exchange systems and their uses in removal of ionic impurities from effluents. Introduction to foam separation, Ion-exchange foam separation, micellar separation, liquid membrane permeation and chromatographic separation.

**References:**

1. King, C. J. Separation Processes, (Tata McGraw-Hill)

2. Sourirajan, S. and Matsura, T. Reverse Osmosis and Ultra-filtration – Process Principles

3. Porter, M. C. Handbook of Industrial Membrane Technology, (Noyes Publication)

4. Hatton, T. A., Scamehorn, J. F. and Harvell, J. H. Surfactant Based Separation Processes, (Marcel Dekker Inc.)

**PFET1064: ADVANCED FOOD PROCESS EQUIPMENT AND DESIGN**

**Code: PFET1064**

**Credits: 06**

**L-T-P: 3-0-0**

**Syllabus Contents:**

**UNIT-I: Machine Design**: Introduction to equipment or machine design, Basic requirements for machine elements and machines, classification of engineering materials, selection of materials for engineering purposes, mechanical properties of metals, Manufacturing considerations in machine design; introduction to load, stress, strain, Young Modulus of Elasticity or Stress modulus or Modulus of rigidity, Stress strain diagram, Factor of safety, Theories of failure under static load, Corrosion mechanism and its control.

**UNIT-II: Riveted Joints**: Introduction Riveted points, kinds of riveted joints, failures of riveted joints, strength of riveted joint, Riveted value, efficiency of riveted joint, assumption for design of riveted joint, Design of riveted joint, Numerical problems. **Welded Joints**: Introduction to welding, advantages of welded joints over riveted joints, disadvantages of welding joints, classification of welding processes, types of welded joints, strength of welded joints, numerical problems. **Shafts, Keys & Coupling**: Different types of shafts, failures in shafts, design of strength shafts and axels, Types of keys, strength of keys, types of shafts coupling & their designs

**UNIT-III: Heat Exchangers**: Concept of overall heat transfer coefficient, LMTD, efficiency of parallel and counter current flow heat exchanger, design of double pipe heat exchanger, design of hair pin heat exchanger, multitude finned inner tubes, design of shell and tube heat exchanger

**UNIT-IV:** Design of Pipes: Different types of pipes, fabrication method of different types of pipes, testing of piping material, colour codes, different types of piping pints, different types of flow regulators)

**References:**

1. M V Joshi, Process equipment design
2. DR Heldman and R P Singh : Food Engineering and Operations
3. R C Sachdeva: Fundamentals of Engg. Heat andMass Transfer.

**PFET1065: ADVANCES IN MUSCLE FOODS AND POULTRY PROCESSING**

**Code: PFET1065**

**Credits: 06**

**L-T-P: 3-0-0**

**Syllabus Contents:**

**UNIT-I:** Composition, classification, and color of meat, slaughtering techniques, meat cuts, Nutritional value of meat, Meat microbiology and safety, Post mortem changes in meat; Conversion of muscle to meat; Freshness and quality assessment of raw and processed meat

**UNIT-II:** Meat and poultry processing- curing and smoking; Fermented meat products (sausages and sauces); Frozen meat & meat storage. Beef Mutton, Pork Sausages and other meat products, Meat plant hygiene – GMP and HACCP, Byproduct utilization in meat and poultry processing

**UNIT-III:** Nutritional and Functional characteristics of Egg. Manufacturing of egg white, Egg yolk and Whole Egg solids/powder.

**UNIT-IV:** Classification of fresh water fish and marine fish; Commercial handling, storage and transport of raw fish. Methods of processing and preservation of fish- Canning, Freezing, Drying, Smoking and Curing. Fish products – fish meal, fish protein concentrate etc.

**References:**

1. R. A. Lawrie, Lawrie’s Meat Science, Woodhead Publishing Limited

2. Y. H. Hui, Wai-Kit Nip, Robert Rogers, Meat Science and Applications, CRC Press

**PFET201: EMERGING FOOD PROCESSING TECHNOLOGY-I; BEVERAGES AND DAIRY**

**Code: PFET201**

**Credits: 08**

**L-T-P: 1-2-2**

**Syllabus Contents:**

**UNIT-I**

Fruit Juices Squashes & Cordials: Equipment for fruit juices, double operations process, Pulping equipment, flash pasteurization, hurdle technology, fruit beverage -preparation & preservation, Straining, filtration & clarification - Preservation of fruit juices by addition of sugar, freezing, carbonation, filtration and others. Tea-Coffee-Production; processing of coffee beans into powder, instant coffee, decaffeination- Tea-Leaf processing, various classes of tea, changes during processing of tea leaves, instant tea

**UNIT-II**

Processing technologies of Wines; red & white table wine, sherry sparkling wine, desert wine vermouth wine, flavored wine, fruit wine etc. Non-bacterial & bacterial spoilage of wine, winery byproducts, Processing technologies of Beer –Brewing, raw material & manufacture, storage finishing & packaging, Brandy & whisky production - Composition & methods for manufacturing

**UNIT-III**

Composition of milk; Varieties of milk; Handling and storage of fresh milk. Rapid tests for milk purity, Pasteurization of milk; HTST and UHT techniques; Packaging of milk; Processing of milk products like evaporated milk, condensed milk, milk powder, ice cream, Infant food formula, and Indigenous dairy sweets.

**UNIT-IV**

Milk fermentation and fermented milk products such as- Yogurt, Curd, Cheese, Fermented milk beverages, and other, Milk plant hygiene and sanitation.

**References:**

1. Varman Alan, and Sakesland, Technology, Chemistry and Microbiology of food beverages, Springer (sie) Publisher, 2 nd edition, 2009 REFERENCES

2. Girdharilal and Siddappa, Preservation of Fruits and Vegetables, Kalyani Publishers, 2001.

3. W.V.Cruees, Commercial fruits and Vegetable products, Agrobios Publishers, 2009.

**PFET202: EMERGING FOOD PROCESSING TECHNOLOGY-II; OILS, FATS, BAKERY AND CONFECTIONARY**

**Code: PFET202**

**Credits: 08**

**L-T-P: 1-2-2**

**Syllabus Contents:**

**UNIT-I**

**Oils and Fats**; Sources; chemical composition; physicochemical characteristics; functional and nutritional importance of dietary oils and fats, Post-harvest handling storage and processing of oilseeds for directs use and consumption. Extraction of oil by mechanical expelling and solvent extraction, Processing of other plant sources of edible oils and fats like coconut, cottonseed, rice bran, maize germ, etc.

**UNIT-II**

**Refining:** Clarification, degumming, neutralization (alkali refining), bleaching, deodorization techniques / processes. Blending of oils. **Processing of refined oils**: Hydrogenation, fractionation, winterzation, inter-esterification etc. for obtaining tailor-made fats and oils. Production of butter, lard, tallow, margarine, Cocoa butter, peanut butter, etc., Specialty fats and designer lipids for nutrition and dietetics,

**UNIT-III**

Current status, growth rate, and economic importance of Bakery and Confectionary Industry in India. Bakery Products: Ingredients and Processing Technologies for breads, biscuits, cookies & crackers, cakes & other baked products. Equipments used, product quality, pertinent standards & regulations for above bakery products.

**UNIT-IV**

Confectionary Products: Hard-boiled candies, toffees, fruit drops, chocolates and other confections:- ingredients, equipments & processing technologies, product quality, Production & quality of chewing and bubble gums, cocoa products, breakfast cereals,

**References:**

1. Hamm, W. and Hamilton, R. J. Edible oil Processing, (CRC Press, 2000)

2. Lawson, H. Food oils and fats: technology, utilization, and nutrition, (Chapman & Hall, 1994) 3. Rajah, K. K. Fats in Food Technology, (Sheffield Academic Press, 2002)

4. Matz, S. A. Bakery Technology and Engineering, (CBS Publications, 2003)

5. Pyler, E. J. Baking Science and Technology, (Sosland Publishing Company, 2009)

6. Fereidoon Shahidi, Bailey’s Industrial Oil and Fat Products, Wiley & Sons

**PFET203: RECENT TRENDS IN FOOD SAFETY AND QUALITY MANAGEMENT**

**Code: PFET203**

**Credits: 06**

**L-T-P: 3-0-0**

**Syllabus Contents:**

**UNIT-I:** Advances in scientific basis of biological, chemical and physical hazards: Emerging toxicology, food allergens, and foodborne pathogens; Current scenario on major food safety research emphasis; Emerging areas of public health issues associated global food safety scenario

**UNIT-II:** Advances in food laws and regulations: FSSRs, amendments, and additions / supplements; Recently passed and/or enacted food laws and regulations (e.g. Trustea); Recent updates in pre-requisie programs for HACCP implementation – a food sector-wise overview

**UNIT-III:** Recent updates in global food safety standards and FSMS: ISO 22000, FSSC 22000, BRC Global Standards on Food Safety (Issue 7), etc.

**UNIT-IV:** Application of advanced technologies to ensure food safety and quality: On-line, rapid detection, and predictive modeling; Emerging personal hygiene and consumers’ behavior towards food safety; Introduction to food safety audit and certification of FSMS

**References:**

1. BRC. 2016. *BRC Global Standards for Food Safety – Issue 7*

2. FSSA. 2011. *Food Safety and Standards Rule*

3. FSSC. 2010. *Food Safety System Certification 22000*. Foundation for Food Safety Certifiation

4. ISO. 2005. *Food Safety and Management System ISO 22000: 2005*

### 5. ISO. 2013. *Food safety management systems -- Requirements for bodies providing audit and certification of food safety management systems*

6. Sofos, J. N. Ed. 2013. *Advances in microbial food safety*.Woodhead Publishing

**Elective-III**

|  |  |
| --- | --- |
| CODE | SUBJECTS |
| PFET2041 | Utilization of Food Industry Byproducts |
| PFET2042 | Novel Food Packaging and Regulations |
| PFET2043 | Indigenous Fermented Foods and Beverages |
| PFET2044 | Engineering Properties of Biological Materials |

**PFET2041: Utilization of Food Industry By products**

**Code: PFET2041**

**Credits: 06**

**L-T-P: 3-0-0**

**Syllabus Contents:**

**UNIT-I**: Introduction about Food Industry Waste Utilization; Waste from rice mill industry – agricultural waste based furnace- types, design. Utilization of rice husk- cement preparation, ceramic materials. Utilization of rice bran - problems in processing of rice bran-stabilization methods of utilization- rice bran stabilizers-extraction of rice bran-refining uses of bran, bran oil and defatted bran.

**UNIT-II**: Fruit Industry Waste Utilization; Different sources of wastes from fruit and vegetable industries and their availability in India- Status and types of waste available- possible byproducts. Utilization of mango, citrus, apple, guava, grape waste-vinegar production. SCP production, organic acid production from vegetable waste. Utilization of moringa, potato, leafy vegetable waste.

**UNIT-III:** Tuber Crops Waste Utilization; Waste from tuber crops - effluent safe disposal- effluent treatment plant waste recycling plant - feasibility report for food industries using food waste and by products. Alcohol production from cane sugar industry waste.

**UNIT-IV:** Fish and Poultry Water Utilization; Fish industry by products- methods and production of fish meal, fish protein concentrate-fish and body oils. Poultry waste- recycling. Tapioca waste utilization- furfural production methods-paper making from cellulosic waste.

**References:**

1. P. N. Chereminoff & A.C Morresi, "Energy from Solid Wastes" 1976,

2. Chakravarthy & De, "Agricultural Waste and By Product Utilisation".

3. Bor S. Luli (ed), "Rice Production and Utilisation"

4. E. Beagle, "Rice Husk Conversion to Energy".

5. Waldron, K. Handbook of Waste Management and Co-product Recovery in Food Processing, (Woodhead Publishing, 2007)

**PFET2042: Novel Food Packaging and Regulations**

**Code: PFET2042**

**Credits: 06**

**L-T-P: 3-0-0**

**Syllabus Contents:**

**UNIT-I:** Introduction To Food Packaging; Packaging requirements and problems - functions of package- design of packages for various foods. Development of protective packaging- shelf life studies using packaging materials-methods of shelf life estimation.

**UNIT-II:** Food Packaging Equipments: Equipment and method- packaging equipment for solid, liquid semi-liquid food, types of fillers; filler for glass bottle, paper bottle, pouches, plastic cup, thermoforming equipments, form-fill-seal equipment, sealing equipment, labelling, capping, canning and cartoning equipment.

**UNIT-III:** Food Safety and Standards Act, 2006 (FSSA) - Need, Scope and Definitions (Chapter I of FSSA, 2006)

**UNIT-IV:** Food Packaging Laws and Regulation; Nutritional Labelling and Health claims, Edible Oils Packaging (Regulation) Order, 1998. - Need, Scope, Functions & Enforcement

**References:**

1. Patricia and Curtis A, An operational Text Book, Guide to Food Laws and Regulations.

2. The Food Safety and Standards act, 2006 along with Rules & Regulations 2011, Commercial Law Publishers (India) Pvt. Ltd.

**PFET2043: Indigenous Fermented Foods and Beverages**

**Code: PFET2043**

**Credits: 06**

**L-T-P: 3-0-0**

**Syllabus Contents:**

**UNIT-I:** Introduction to traditional fermented foods of India, composition and nutritive values, microbial and biochemical diversity, quality and food safety challenges,

**UNIT-II:** Processing & Preservation methods of Traditional fermented foods: Idli, dosa, Vada, khamman, dhokla, Dahi (Curd), Srikhand.

**UNIT-III:** Processing & Preservation methods of Indigenous Alcoholic Beverages,

**UNIT-IV:** Industrialization, Socioeconomic Conditions and Sustainability of Traditional Fermented Foods.

**References:**

1. Handbook of Indigenous Fermented Foods. K.H. Steinkrus (Ed), Marcel Dekkar Inc. 2nd Edition, 1998.

2. The Food of India. P. Wickramasinghe, and C. Selva Rajah (Eds), Oberoi Group,Periplus, 1st Edition, 2001

**PFET2044 : Engineering Properties of Biological Materials**

**Code: PFET2044**

**Credits: 06**

**L-T-P: 3-0-0**

**Syllabus Contents:**

**UNIT-I:** Importance of engineering properties of biological materials, Study of different physical and thermal characteristics of important biological materials like shape, size, volume, density, roundness, sphericity, surface area, specific heat, thermal conductivity, thermal diffusivity, etc. measurement of colour, flavour, consistency, viscosity, texture and their relationship with food quality and composition.

**UNIT-II:** Rheological characteristics like stress, strain time effects, rheological models and their equations. Aerodynamic characteristics and frictional properties. Application of engineering properties in handling processing machines and storage structures.

**UNIT-III:** Thermal, Electrical and Optical Properties; Specific heat, thermal conductivity, thermal diffusivity, electrical resistance and conductance, dielectric constant, reflectivity, transitivity and absorptivity of incident rays.

**UNIT-IV:** Applications; Application of engineering properties in process development as well as design and operation of equipment and structures associated with handling, processing and storage of raw as well as processed food products

**Recommended Books**

1. Rao, M. A., Rizvi, S. S. H. and Datta. A. K. Engineering Properties of Foods, (CRC Press, 2005)
2. Sahin S. and Sumnu, S. G. Physical Properties of Foods, (CRC Press, 2006)
3. Mohesenin, N. N. Thermal Properties of Foods and Agricultural Materials, (Gordon and Breach Science Publishers, 1980)

**Elective-IV (Open elective)**

|  |  |
| --- | --- |
| CODE | SUBJECTS |
| PFET2051 | Waste to energy |
| PFET2052 | Nanomaterials Synthesis and Characterization Techniques |
| PFET2053 | Cost management of engineering project |
| PFET2054 | Industrial Safety |
| PFET2055 | Environmental Engineering |

**PFET2051: WASTE TO ENERGY**

**Code: PFET2051**

**Credits: 06**

**L-T-P: 3-0-0**

**Syllabus Contents:**

**UNIT-I:** Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

**UNIT-II:** Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods -Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers-Fluidized bed gasifiers – Design, construction and operation

**UNIT-III:** Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design,construction and operation - Operation of all the above biomass combustors.

**UNIT-IV:** Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technologyand status - Bio energy system - Design and constructional features - Biomass resources and theirclassification - Biomass conversion processes - Thermo chemical conversion - Direct combustion -biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion -Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production -Urban waste to energy conversion - Biomass energy programme in India.

**References:**

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd.,

2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd.,

3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd.,

4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons,

**PFET2052: NANOMATERIALS SYNTHESIS AND CHARACTERIZATION TECHNIQUES**

**Code: PFET2052**

**Credits: 06**

**L-T-P: 3-0-0**

**Syllabus Contents:**

**UNIT-I:** NANODIMENSIONAL MATERIALS; 0D, 1D, 2D structures – Size Effects – Fraction of Surface Atoms – specific Surface Energy and Surface Stress – Effect on the Lattice Parameter – Phonon Density of States – the General Methods available for the Synthesis of Nanostrutures – precipitative – reactive – hydrothermal/solvothermal methods – suitability of such methods for scaling – potential Uses

**UNIT-II**: PHYSICO-CHEMICAL METHODS OF NANOSTRUCTURED MATERIALS Solution growth techniques of 1D-2D nano structures:- Synthesis of metallic, semiconducting and oxide nanoparticles – homo- and hetero-nucleation growth methods – template-based synthesis (electrochemical, electrophoretic, Melt and solution, CVD, ALD) – Gas Phase Synthesis of Nanopowders: – Vapor (or solution) – liquid – solid (VLS or SLS) growth – the Need for Gas/vapor State Processing – Main Stages of Gas Phase Synthesis – Applicability of the methods.

**UNIT-III:** CHARACTERIZATION OF NANOPHASE MATERIALS Fundamentals of the techniques – experimental approaches and data interpretation – applications/limitations of X-ray characterization: – X-ray sources – wide angle, extended x-ray absorption technique – Electron microscopy: SEM/TEM – high resolution imaging – defects in nanomaterials – Spectroscopy: – electron energy-loss mechanisms – electron filtered imaging – prospects of scanning probe microscopes – optical spectroscopy of metal/semiconductor nanoparticles

**UNIT-IV:** NANOSCALE PROPERTIES Magnetism:- Magnetic Moment in clusters/Nanoparticles – Magnetic Order – coercivity – Magnetocrystalline Anisotropy – thermal activation and Superparamagnetic effects – Electronics and Optoelectronics:- Quantum Confinement of Superlattices and Quantum Wells – Dielectric Constant of Nanoscale Silicon – Doping of a Nanoparticle – Excitonic Binding and Recombination Energies – Capacitance in a Nanoparticle – Diffusion in

**References:**

1) C. N. R. Rao, A. Mu¨ller, A. K. Cheetham, The Chemistry of Nanomaterials :Synthesis, Properties and Applications, Volume 1, Wiley-VCH, Verlag GmbH

2) Guozhong Cao, Nanostructures & Nanomaterials Synthesis, Properties G;Z: Applications, World Scientific Publishing Private, Ltd., Singapore (2004).

3) Carl C. Koch, Nanostructured Materials: Processing, Properties and Potential Applications, Noyes Publications, William Andrew Publishing Norwich, New York, U.S.A (2002).

**PFET2053: COST MANAGEMENT OF ENGINEERING PROJECT**

**Code: PFET2053**

**Credits: 06**

**L-T-P: 3-0-0**

**Syllabus Contents:**

**UNIT-I:** Introduction and Overview of the Strategic Cost Management, Process Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System, Inventory valuation, Creation of a Database for operational control, Provision of data for Decision-Making.

**UNIT-II**: Project: meaning, Different types, cost overruns centres, various stages of project execution: conception to commissioning, Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities. Pre project execution main clearances anddocuments Project team: Role of each member. Importance Project site: Data required with significance. Project contracts; Types and contents.

**UNIT-III**: Cost Behaviour and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Targetcosting, Life Cycle Costing. Costing of service sector. Just-in-time approach, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets.

**UNIT-IV**: Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

**References:**

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi

2. Charles T. Horngren and George Foster, Advanced Management Accounting

3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting

4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher

5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

**PFET2054: INDUSTRIAL SAFETY**

**Code: PFET2054**

**Credits: 06**

**L-T-P: 3-0-0**

**Syllabus Contents:**

**UNIT-I:** Industrial safety: Accident, causes, types, results and control, mechanical and electricalhazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and fire fighting, equipment and methods.

**UNIT-II:** Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reductionmethods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

**UNIT-IV:** Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree forproblems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment, Types of faults in machine tools and their general causes.

**UNIT-V:** Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing,cleaning and repairing schemes, overhauling of mechanical components, overhauling of electricalmotor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

**References:**

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.

2. Maintenance Engineering, H. P. Garg, S. Chand and Company.

3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.

4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

**PFET2055: ENVIRONMENTAL ENGINEERING**

**Code: PFET2055**

**Credits: 06**

**L-T-P: 3-0-0**

**Syllabus Contents:**

**UNIT-I**: Wastes: types and sources, Water pollution: characterization of liquid wastes and effects, Stream sanitation, Treatment methods. Indian standards for drinking water, Water borne diseases and their control.

**UNIT-II**: Air Pollution: Composition, Classification and sources of air pollutants. Effects of air pollution on human, plant and animals, Air pollution control methods, equipment and safety. Salient features of the Air (Prevention and control of pollution) Act – 1981.

**UNIT-III**: Solid Wastes Management: Characterization, disposal methods. Environmental Acts and Regulations.

**UNIT-IV**: Noise Pollution: Measurement of sound, Sources, Effects and control of noise pollution. Introduction to: “The environment (Protection) Act – 1986.

**References:**

1. H.S. Peavy, D.R. Rowe and G. Tchbanoglous, Environmental Engineering, McGraw Hill

2. M. L. Davis, Water and waste water Engineering, Mc Graw Hill education (India) Pvt. Ltd.

3. H.C. Parkins, Air Pollution, McGraw-Hill Pub.

4. L.W. Canter, Environmental Impact Assessment, McGraw Hill Pub.

5. M.L. Davis and D.A. Cornwell, Introduction to Environmental Engineering,

6. Metcalf and Eddy,(Revised by G. Tchobanoglous Wastewater Engineering:

**(M. Des. Course Structure in Multimedia Communication and Design)**

|  |
| --- |
| **SEMESTER - 1** |
| **Sl. No.** | **Course Code** | **Course Title**  | **L** | **T** | **P/S** | **C** |
| 01 | PMMD 101 | Design: An Introduction | 1 | 1 | 4 | 8 |
| 02 | PMCD 102 | Communication Design | 1 | 1 | 4 | 8 |
| 03 | PMCD 103 | Understanding [**Aesthetics**](http://srishti.ac.in/disciplines/aesthetics-and-critical-studies)**: Analytical studies** | 0 | 1 | 6 | 8 |
| 04 | PMCD 191 | Semester Project - 1*(A hypothetical Project should be based on students’ preference on subjects taught)* | 0 | 0 | 12 | 12 |
|  |  | **Total** | 2 | 3 | 26 | 36 |

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| **SEMESTER - 2** |
| **Sl. No.** | **Course Code** | **Course Title**  | **L** | **T** | **P/S** | **C** |
| 01 | PMMD 201 | Design research | 1 | 1 | 4 | 8 |
| 02 | PMCD 202 | Approach to New media Technologies | 1 | 1 | 4 | 8 |
| 03 | PMCD 291 | Semester Project - 2*(Experimental / Developmental Animation / Digital media Project: Production)* | 0 | 0 | 12 | 12 |
| 04 | PMCD 21\* | ***Elective-I*** (*Practical Based Course*)1. 3D Sculpture & Visualization Techniques
2. Animation & Visual Effects
3. Documentary film and mass media
4. Animation Production Techniques
 | 0 | 0 | 4 | 4 |
|  |  | **Total** | 2 | 2 | 24 | 32 |

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| **SEMESTER - 3** |
| **Sl. No.** | **Course Code** | **Course Title**  | **L** | **T** | **P/S** | **C** |
| 01 | PMCD 391 | Semester Project - 3*(Experimental / Developmental Animation / Digital media Project: Production)*Minor Thesis Project(Based on specialization) | 0 | 0 | 22 | 22 |
| 02 | PMCD 31\* | ***Elective-II*** (*Practical Based Course*)1. Game Design for digital media
2. Digital Technology in Video Production
3. Internet media: Web and beyond
 | 0 | 0 | 12 | 12 |
|  |  | **Total** | 0 | 0 | 34 | 34 |

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| **SEMESTER - 4** |
| **Sl. No.** | **Course Code** | **Course Title**  | **L** | **T** | **P/S** | **C** |
| 01 | PMCD 491 | Major Thesis Project (Based on specialization) | 0 | 0 | 22 | 22 |
| 02 | PMCD 492 | Colloquium Paper/Seminar | 0 | 0 | 8 | 8 |
|  |  | **Total** | 0 | 0 | 30 | 30 |

(Abbreviation: PMMD / PG in Multimedia Main Design, PMCD / PG in Multimedia Communication and Design)

\*Elective subject/course which is directly related with the programme/decided by the department shall be added in the semesters in future.

**\*The Colloquium Paper/Seminar/Project is Practical/Studio based, so they may be taught based on instructors teaching plan along with hands on experiences and assignments.**

Consolidated statement of total credits in each semester

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Semester** | **L** | **T** | **P/S** | **Credit** |
| 1 | 2 | 3 | 26 | 36 |
| 2 | 2 | 2 | 24 | 32 |
| 3 | 0 | 0 | 34 | 34 |
| 4 | 0 | 0 | 30 | 30 |
| Total | 4 | 5 | 114 | 132 |

**As per CIT Academic Ordinance:**

|  |  |
| --- | --- |
| 1 h Lecture (L) per week  | 2 credit |
| 1 h Tutorial (T) per week  | 2 credit |
| 1 h Studio Project  | 2 credit |
| 1 h Practical (P) per week  | 1 credit |
| 1 h Project Work  | 1 credit |
| 1 h Seminar / Training /Industrial Training | 1 credit |

**SYLLABUS CONTENTS**

**SEMESTER – I**

**PMMD 101 / Design: An Introduction L-1, T-1, P/S-4, C-8**

*Early Classical Period*

Prehistoric Cave paintings – Primitive Designs- Interiors during Egyptian, Greek, Roman, Gothic, Early Christian & Renaissance Periods. Interiors in Romanesque, Gothic, and renaissance periods

*Colonial to the beginning of the 20th Century*

Colonial, Victorian designs, Arts & Crafts movement, Art Nouveau, Elitism, Frank Lloyd Wright.

*Design Vocabulary*

Form – point, line, volume, shape, texture & colour – in relation to light, pattern etc. and application of the same in designing interiors.

*Design Principles*

Ratio; proportions – golden section; relationships; scale; Balance – symmetrical, radial, occult; harmony; unity; variety; rhythm; emphasis.

*Anthropometrics*

Definition, theory of standard dimension based on human figures for activities, functions, circulation, furniture design, spatial requirements etc. Study of Ergonomics Design of Furniture for Living, Dining, Kitchen, Office etc.

*Design Control*

Design process – Analysis, synthesis, design evaluation; Design criteria – function and purpose, utility and economy, form and style; human factors - human dimensions, distance zones, activity relationships; fitting the space – plan arrangements, function, aesthetics.

**Texts/References:**

1. Francis. D. K. Ching, Interior design Illustrated, Van Nostrand Reinhold

2. John. F. Pile, Interior Design, Harry Abrams Inc.

3. Sam. F. Miller, Design process – a primer for Architectural and Interior Design, Van Nostrand Reinhold.

4. Gary Gordon, Interior lighting for designers, John Wiley & Sons Inc.

5. Harold Linton, Colour in Architecture, McGraw Hill

6. Jonathan Poore, Interior Colour By Design, Rock Port Publishers.

7. Sherrill Winton, Interior Design and Decoration, Prentice Hall.

8. Johanness Itten, The Art of Colour, John Wiley and Son

**PMCD 102 / Communication Design L-1, T-1, P/S-4, C-8**

Understanding  design  as  applied  to  solving  communication  problems   within  the  context  of our  society.

Structuring information in terms of classifications, hierarchy, order,   sequence, etc.

Design  of  magazine,  textbook,  picture  books,  Children’s  books,   exhibition,  website,  e-book,  etc.

**Text/References:**

1. Meggs,  Phillip  B.;  Type  and  Image:  the  language  of  graphic  Design,   VNR,  1992
2. R.  Carter,  D.  B.  Meg  Phillip,  Typographic  Design:  Form  and   Communication,  John  Wiley  &  Sons,  2000
3. Kimberly  Elam  ,  Grid  Systems:  Principles  of  Organizing  Type  (Design   Briefs),  Princeton  Architectural  Press,  2004
4. Erik  Spiekermann,  E.M  Ginger;  Stop  Stealing  Sheep  &  Find  Out  How   Type  Works,  Second  Edition,  Adobe  Press;  2  edition,  2002

**PMCD 103 / Understanding** [**Aesthetics**](http://srishti.ac.in/disciplines/aesthetics-and-critical-studies)**: Analytical studies L-0, T-1, P/S-6, C-8**

***This course explores philosophical accounts of the nature of art, aesthetic experience, creative activity, imagination, expression, interpretation, and aesthetic evaluation. Kant’s writings on judgements of the beautiful and the sublime will be closely examined along with more recent influential thinkers in* the field of aesthetics.**

**Rigorous in analysis, critique and reflection, Capable of effective communication, Capable of life-long learning, Culturally aware and capable of respecting diversity and acting in socially just/responsible ways.**

**Texts/References:**

1. **Immanuel Kant, The Critique of Judgement, trans. James Creed Meredith (Oxford: Oxford University Press, 2008).**
2. **Gilles Deleuze and FélixGuattari, Kafka: Toward a Minor Literature, trans. Dana Polan (Minneapolis: University of Minnesota Press, 1986).**
3. **ARTS2367 Course Reader.All of the above are available from the UNSW bookshop.**

**SEMESTER - II**

**PMMD 201 / Design Research L-1, T-1, P/S-4, C-8**

The course is preparatory for the thesis and focuses on the appropriate use of theory and methods in writing a master’s thesis. The course pays particular attention to developing their ability to read research literature and to conduct an advanced literature review. It is designed to help train students as both researchers in academia, as well as in other fields of professional life. The course content includes critical discussions of research in the field of global political studies as well as techniques of communicating social science research issues.

**Texts/References:**

1. Farr, Mihael; Design Management, Hoddar and Stoughton, London, 1966.
2. Goslet Dorothy, The Professional Practice of Design, Batszford, London 1971.
3. Pulos, Arthur J, Contract Selling Industrial DesignServices, Office of Design, Department of Industry, Trade and Commerce, Ottawa, 1975.
4. Abbott Howard, Safer by Design, Design Council, London, 1987.
5. Brustein David & Frank Stasiowski, Project Management for the Design, Professional, Whitney
6. Library of Design New York, 1982.
7. Staurt W Rose, Achieving Excellence in Your Design Practice, Whitney Library of Design, New York, 1987.
8. Oakley, Mark (ED.), Design Management a Handbook of Issues and Methods, Basil Blackwell Ltd. 1990.
9. Case studies by Design Management Institute, USA

**PMCD 202 / New media Technologies L-1, T-1, P/S-4, C-8**

Nature and Characteristics of Communication: Communication: definition, nature and scope- Human needs of communication- Functions of communications - Types of communication: intrapersonal- interpersonal, group and mass communication- Indian concept of communication.

Process of Communication Elements and process of communication- Communication flows: one-step, two-step, and multi-steps- Barriers in communication- Verbal and non-verbal communication

Introduction to Media Characteristics of media- Print, electronic, new media and traditional media, Print & Digital Technologies, Media Management (Print & Radio), Film Production Analesis, Cinematography tolls & Techniques, Media research & evaluation, Video Production & Technologies, Wed Technology, Multimedia communication, Tools & Techniques of still photography, Graphics Design, Web Design & Social Media, Virtual Environments, Printing Technology, TV Satellite Communication.

**Texts/References:**

1. Mass Communication & Journalism in India -D S Mehta,
2. Mass Communication in India -Keval J. Kumar, Jaico Publishing House.
3. International Communication – N. Prabhakar & N. Basu, Commonwealth publishers, New Delhi.
4. Understanding Development Communication – Uma Joshi.Mcquail’s Mass Communication Theory – Denis Mcquail, Sage Publication.Mass Communication Models-Uma Narula
5. T. Thyagarajan, K.P. Sendur Chelvi and T.R. Rangaswamy, “Engineering Basics” 3rd Edition, New Age International Publishers,2001
6. T. Thyagarajan, “Fundamentals of Electrical and Electronics Engineering”, Scitech Publications (Ind) Pvt. Ltd., Fourth Edition August 2006.
7. Paranjothi S.R.,“Electric Circuit Analysis” New Age International Ltd., Delhi, 2nd Edition, 2000.
8. Peter ward “Studio and outside broadcast Camera”
9. BernardWilkie “Creating special effects for TV & Video”
10. Roy Thomson “Grammar of the shot”
11. Der Lyur & Graham “Basics of Video Production”
12. Steven Katz “Film Directing: Cinematic Motion “ Focal Press publishers
13. Antony Friedman “Writing for media”–Focal press
14. Dwight V Swain “ Film Scriptwriting” Focal Press publishers
15. Steve Katz “Film Directing Shot” Focal Press publishers
16. The Ultimate Multimedia Handbook, Tata Mc Graw Hill
17. Multimedia at Work, Tata Mc Graw Hill
18. Adobe Photoshop Unleashed, Tata Mc Graw Hill
19. Guide to Radio Journalism, Kendall / Hunt, Dubuque, Iowa, USA.
20. Sr.Mary Peter Claver & Sr.Mary Jyosita “First steps to TV-video production”
21. Margarette Mehring, Blending of content and form.
22. Basu, Law of the Press in India, Practice Hall of India(2003)
23. Basu, Introduction to Indian Constitution, Practice hall of india(2003)
24. R.K Ravindran, Press in the Indian Constitution, Indian Publishers, Distributors (1997)
25. Radha Krishna Murthi , Indian Press Laws.
26. Promotion & Marketing for Broadcasting Cable ofthe web by Eastman , Susantylen
27. Consumer Behavior by Leon G. Schiffman and Leslie Lazar Kanuk, Prentice Hall. India
28. The Basic Book of Photography (Fourth Edition) (Paperback)-by Tom Grimm (Author), Michele Grimm (Author)
29. Research Methods in Mass Communication by Stempell and Westley Prentice Hall,1981.
30. ‘Communication Theories: Origins, Methods and Uses’ by Severin and Tankard, hastings House Publishers, 1979.
31. ‘Mass Media Research– an introduction’ by Roger Wimmer and Joseph Dominick, (III EDITION), Wadsworth Pub., 1991.
32. ‘Handbook of Radio and TV Broadcasting’ Ed. By James Fletcher, Van Nostrand Reinhold Company, London, 1981.
33. ‘Studies in Mass Communication and Technology’ Ed. By Sari Thomaas, Ablex Publishing Company.1984.

**PMCD 214 / Animation Production Techniques (*Elective subject)* L-0, T-0, P/S-4, C-4**

Animation Principles And History, Animation History, Animation Process - Preproduction, Production, Post Production, Visual Form- exploring the look and feel for animation through concept art Planning character design, layout design, illustration style, composition, staging, backgrounds ,A study of indigenous design and painting, both contemporary and traditional to understand and analyze a variety of styles and visual language, Life Drawing- o become fluent with capturing the human and animal form Proportions, structure, volume and shading techniques.

**Texts/References:**

1. K. Laybourne, *The animation book: a complete guide to animated filmmaking*, *from filp-books to sound cartoons*, Revised Edition, Three Rivers Press, 1998.
2. S. Roberts, *Character Animation in 3D: Use of traditional drawing techniques to produce stunning CGI animation*, Focal Press, 2004
3. *Beginner’s Guide to Animation* – by Mark Murphy; Watson-Guptill Publication
4. O. Johnston, and F. Thomas, *The Illusion of Life: Disney Animation*, Walter Foster Publishing
5. W. T. Foster, *Cartooning: Animation Basics*, Revised Edition, Walter Foster Publishing
6. M. Nicholas, *Introduction to Visual Culture*, Routledge, London.
7. Chawdhary, Nirmal Kumar, How to write film screenplay, Kanishka publishers, distributers, New Delhi- 110002, 2009,ISBN 978-81-8457-112-7.
8. Rubenstein, Paul Max, Martin Jo Maloney, Writing For the Media, Film Television, Video And Radio, Prentive Hall, Englewood Clifts, New Jersey 07632, 1988, ISBN: 0-13-971508-7-01
9. Whitaker, Harold, John Halas, Updated by Tom Sito, Timing for Animation, Focal Press Elsevier, New York & Singapore, 2009 ISBN: 978-0-240-52160-2
10. Renee Dunlop, Production Pipeline Fundamentals for Film and Games, Focal Press
11. Eve Light Honthaner, The Complete Film Production Handbook, Focal Press
12. Thomas, Frank and Ollie Johnston, The Illusion of life Disney Animation, Walt Disney production, New York, NY 10011, Revised Edition of Disney Animation, Popular Edition 1984 ISBN 0-7868-6070-70
13. “Principle of Traditional Animation applied to 3D computer Animation” pixer son Rofael California In ACM Computer Graphics (21) 4th July 1987Rubenstein, Paul Max, Writing for Media, Prentice Hall, Englewood Cliffs, New Jersey 07632, 1988. ISBN 0- 13-971508-8.
14. Murdock, Kelly C., 3ds Max 7 Bible, Wiley Dreamtech India Pvt. Ltd. New Delhi, 2005, ISBN: 81-265-0597-4
15. Kulagin, Boris, Dmitry Morozou, 3Ds Max & Animation with Character Studio 4 and Plug-Ins, Firewall Media, New Delhi, 2006, ISBN: 81-7008-820-8
16. Kulagin, Boris, 3ds, Max 8 From Modeling To Animation, BPB Publications, B-14, Connaught Place, New Delhi-110001, 2007, ISBN: 81-8333-201-3.
17. Jeremy Birn, *Digital Lighting & Rendering*, Third Edition, New Riders, 2014.
18. Darren Brooker, *Essential CG Lighting Techniques with 3DS Max*, Third Edition, Focal Press, 2008.
19. Lee Lanier, *Advanced Maya Texturing and Lighting*, Third Edition, Autodesk Maya Press, Wiley Publishing Inc., 2015.
20. Chuck Gloman and Tom Letourneau, *Placing Shadows – Lighting Techniques for Video Production*, Third Edition, Focal Press, 2013.
21. Gerald Milerson, *Lighting for Television & Film*, Third Edition, Focal Press, 2013.
22. The Animator’s Survival Kit - by Richard Williams.
23. Mastering 3D Animation, by Peter Ratner (Author)
24. Acting in Animation: A Look at 12 Films by [Ed Hooks](http://www.amazon.com/Ed-Hooks/e/B001H6UGTQ/ref%3Ddp_byline_cont_book_1)
25. Digital Character Animation 3 - by George Maestri
26. Timing for Animation - by Harold Whitaker and John Halas
27. Inspired 3D Advanced Rigging and Deformations by Brad Clark, John Hood & Joe Harkins
28. The Green Screen Handbook. Author: Jeff Foster
29. Maya Studio Projects Dynamics. Author: Toddo Palamar
30. The Visual Effects Arsenal, Author: Bill Byrne

\*\*\* End of Syllabus contents \*\*\*\*

**Department of Computer Science and Engineering**

***M. Tech. programme***

Total Credit Points Requirements: **130**Total Credit Hours Requirements: **95**Total Number of Semesters: **4**

CURRICULUM BROCHURE

Curricula of courses running since the academic year 2019-20





**Electives for M. Tech (CSE)**

**Odd Semester Elective courses list:**

**1st Semester:**1. PCSE111– Artificial Intelligence.
2. PCSE112– Automata Theory
3. PCSE113– Distributed Systems.
4. PCSE114– Embedded Systems and Real Time System.
5. PCSE115– Mobile and Pervasive Computing.
6. PCSE116– Natural Language Processing.
7. PCSE117– Object Oriented Programming and Design.
8. PCSE118– Remote Sensing and Digital Image Processing.

**3rd Semester:**1. PCSE311– Advanced Cryptography and Information Security
2. PCSE312– Advanced Digital Image Processing.
3. PCSE313– Big Data Analytics.
4. PCSE314– Computational Biology.
5. PCSE315– High Performance Computing.
6. PCSE316– Information Retrieval.
7. PCSE317– Ubiquitous Computing.
8. PCSE318 - Software Defined Networking

**Even Semester Elective courses list:**

**2nd Semester:**1. PCSE211– Cloud Computing.
2. PCSE212– Data Mining and Data Warehousing.
3. PCSE213– Human Computer Interaction.
4. PCSE214– Machine Learning.
5. PCSE215– Optimization Method.
6. PCSE216– Robotics and Computer Vision.
7. PCSE217– Soft Computing.
8. PCSE218 - Image Processing and Pattern Recognition

**PROGRAMME CORE COURSES**

**PCSE101 Mathematical Foundation of Computer Science 3-1-0-8**

**UNIT -I:** Mathematical Logic:

Propositional Calculus: Statements and Notations, Connectives, Well-Formed Formulas, Truth Tables, Tautologies, Equivalence of Formulas, Duality Law, Tautological Implications,
Normal Forms, Theory of Inference for Statement Calculus, Consistency of Premises, Indirect Method of Proof. Predicate Calculus:Predicative Logic, Statement Functions, Variables and
Quantifiers, Free and Bound Variables, Inference Theory for Predicate Calculus.

**UNIT -II:** Set Theory:

Introduction, Operations on Binary Sets, Principle of Inclusion and Exclusion, Relations:
Properties of Binary Relations, Relation Matrix and Digraph, Operations on Relations,
Partition and Covering, Transitive Closure, Equivalence, Compatibility and Partial Ordering
Relations, Hasse Diagrams, Functions: Bijective Functions, Composition of Functions, Inverse
Functions, Permutation Functions, Recursive Functions, Lattice and its Properties.

**UNIT- III:** Algebraic Structures and Number Theory:

Algebraic Structures: Algebraic Systems, Examples, General Properties, Semi Groups and
Monoids, Homomorphism of Semi Groups and Monoids, Group, Subgroup, Abelian Group,
Homomorphism, Isomorphism, Number Theory: Properties of Integers, Division Theorem,
The Greatest Common Divisor, Euclidean Algorithm, Least Common Multiple, Testing for
Prime Numbers, The Fundamental Theorem of Arithmetic, Modular
Arithmetic (Fermat‘s Theorem and Euler‘s Theorem)

**UNIT -IV:** Combinatorics:

Basic of Counting, Permutations, Permutations with Repetitions, Circular Permutations,
Restricted Permutations, Combinations, Restricted Combinations, Generating Functions of
Permutations and Combinations, Binomial and Multinomial Coefficients, Binomial and
Multinomial Theorems, The Principles of Inclusion Exclusion, Pigeonhole Principle and its
Application.

**UNIT -V:** Recurrence Relations:

Generating Functions, Function of Sequences, Partial Fractions, Calculating Coefficient of
Generating Functions, Recurrence Relations, Formulation as Recurrence Relations, Solving
Recurrence Relations by Substitution and Generating Functions, Method of Characteristic
Roots, Solving Inhomogeneous Recurrence Relations

**UNIT -VI:** Graph Theory:

Basic Concepts of Graphs, Sub graphs, Matrix Representation of Graphs: Adjacency Matrices,
Incidence Matrices, Isomorphic Graphs, Paths and Circuits, Eulerian and Hamiltonian Graphs,
Multigraphs, Planar Graphs, Euler‘s Formula, Graph Colouring and Covering, Chromatic
Number, Spanning Trees, Algorithms for Spanning Trees (Problems Only and Theorems
without Proofs).

**Text & Reference Books:**1. Lawvere and Bosebrugh, Sets for Mathematics, Cambridge.
2. Sheldon Axler, Linear Algebra Done Right, Springer
3. Michael Artin, Algebra, Prentice-Hall India.
4. RP Stanley. Enumerative Combinatorics, Cambridge.
5. I Anderson, Combinatorics of Finite Sets, Oxford Science Publications.
6. B. Bollobas, Combinatorics, Cambridge.
7. JH van Lint and RM Wilson, A course in Combinatorics, Cambridge.
8. S Jukna. Extremal Combinatorics. Springer.

**PCSE102 ALGORITHMS AND ALGORITHMIC COMPLEXITY**

**3-1-0-8**

**Review:** Fundamentals of Algorithmic: Classification of Problems, Complexity, Asymptotic
Notations, Amortized analysis

**Recurrences:** Master Theorem Probabilistic Analysis: Sort, Search, Random Binary Search
trees, Red-black trees, Priority Queues - Binary heaps, Binomial heaps, Bipartite Matching,
Common Subsequence Problem, Flow Networks, Ford-Fulkerson Method, Knuth-Morris-Pratt Algorithm.

**Algorithm design techniques:** Divide and conquer, Dynamic programming, Greedy method

**Data compression algorithms**: Huffman compression, Lempel-Ziv compression

**Approximation Algorithms**: Concept, Design, Applications. Inapproximability.

**Number-Theoretic Algorithms**: RSA data encryption, Primality testing

**NP completeness:** Polynomial-time reductions, Cooke's theorem

**Text & Reference Books:**1. Introduction to Algorithms - T. H. Cormen, et al. (PHI, 1990)
2. Algorithms for Hard Problems - J. Hromkovic (Springer)
3. Anany V. Levitin, Introduction to the Design and Analysis of Algorithms, Addison Wesley

**PCSE103 Advanced DBMS 3-1-0-8**

**Objective**

• To understand the basic concepts and terminology related to DBMS and Relational Database Design
• To the design and implement Distributed Databases.
• To understand advanced DBMS techniques to construct tables and write effective queries,
forms, and reports

**Unit I**Formal review of relational database and FDs Implication, Closure, its correctness

**Unit II**3NF and BCNF, Decomposition and synthesis approaches, Review of SQL99, Basics of query processing, external sorting, file scans

**Unit III**Processing of joins, materialized vs. pipelined processing, query transformation rules, DB
transactions, ACID properties, interleaved executions, schedules, serialisability

**Unit IV**Correctness of interleaved execution, Locking and management of locks, 2PL, deadlocks,
multiple level granularity, CC on B+ trees, Optimistic CC

**Unit V**T/O based techniques, Multiversion approaches, Comparison of CC methods, dynamic
databases, Failure classification, recovery algorithm, XML and relational databases.

**Outcome**• Exposure for students to write complex queries including full outer joins, self-join, sub
queries, and set theoretic queries.
• Knowhow of the file organization, Query Optimization, Transaction management, and
database administration techniques

**Text Books**1. R. Ramakrishnan, J. Gehrke, Database Management Systems, McGraw Hill, 2004
2. A. Silberschatz, H. Korth, S. Sudarshan, Database system concepts, 5/e, McGraw Hill,
2008.

**Reference Books**1. K. V. Iyer, Lecture notes available as PDF file for classroom use.

**PCSE172 Advanced DBMS Lab 0-0-3-3**

**Objective:**• To explore the features of a Database Management Systems
• To interface a database with front end tools
• To understand the internals of a database system

**Experiments**

• Basic SQL
• Intermediate SQL
• Advanced SQL
• ER Modeling
• Database Design and Normalization
• Accessing Databases from Programs using JDBC
• Building Web Applications using PHP & MySQL
• Indexing and Query Processing
• Query Evaluation Plans
• Concurrency and Transactions
• Big Data Analytics using Hadoop

**Outcome:**• Ability to use databases for building web applications.
• Gaining knowledge about the internals of a database system.

**References**1. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, “Database System Concepts”,
6th edition, Tata McGraw Hill, 2011
2. Ramez Elmasri, Shamkant B. Navathe, “Fundamentals of Database Systems”,
4th Edition, Pearson/Addision wesley, 2007

**PCSE201 Advanced Computer Network 3-1-0-8**

**Internet Design & Architecture:** Overview of network building blocks, Network architecture, layers
and protocols, Internet design: Challenges and Solutions

**Basic Protocols:** Overview of IPv4, TCP, IPv6, ICMP, ARP, DHCP;

**Routing Protocols:** OSPF, RIP, BGP, Ad hoc network routing (AODV, DSR);

**Traffic Management:** Congestion control principles, TCP congestion control, Traffic Engineering
Principles, MPLS Routing

**Software Defined Networks (SDNs):** SDN Controllers, Network Programmability, Network Function Virtualization, SDN Frameworks, Use cases for traffic monitoring & classification, bandwidth scheduling and monitoring

**Wireless Networks:** Wireless Networks fundamentals, Mobile IP and Micromobility Protocols, TCP
performance in Wireless Networks

**IP Security:** NAT, IPSEC, SSL

**Text books :**1. Kurose James F and Keith W. Ross: Computer Networking: A Top-Down Approach Featuring the
Internet
2. Adolfo Rodriguez, et. al, TCP/IP Tutorial and Technical Overview, IBM Redbook, available online
at http://www.redbooks.ibm.com/pubs/pdfs/redbooks/gg243376.pdf, 2001.

**Reference Books:**1. Charles. M.Kozierek, TCP/IP Guide, Shroff Publishers, Mumbai, 2005.
2. Uyless Black, MPLS and Label Switching Networks, Pearson Education (LPE), 2002.

**PCSE202 ADVANCED OPERATING SYSTEMS 3-0-0-6**

Study of major Operating System issues such as:
• Memory Management,
• Process Management and Scheduling,
• File Systems,
• Networking by looking at the internals of actual systems such as Unix, Linux, NT etc.
• Issues in design of distributed operating systems.
• Selected case studies such as Amoeba, Chorus, Mach etc.

**Text Books:**1. B. Goodheart and J. Cox, The Magic Garden Explained: The Internals of Unix System V Release
4, Prentice Hall 1994.
2. M. K. McKusick et al., The Design and Implementation of the 4.4 BSD Operating System, Addison
Wesley, 1996.
3. U. Vahalia, Unix Internals: The New Frontiers, Prentice Hall, 1996.
4. P. K. Sinha, Distributed Operating Systems, Wiley-IEEE Press, 1996.
5. H. Custer, Inside Windows NT, 2nd Ed, Microsoft Press, 1998.
6. Selected papers and reports and source code.

**PCSE271 ADVANCED OPERATING SYSTEMS LAB 0-0-3-3**

Experiments would be designed to provide hands-on experience in computer systems, to learn unix
system calls, posix threads, operating system concepts, network programming and simulations.

**Texts & References Books:**1. W. R. Stevens, UNIX Network Programming, Volume 1: Networking APIs: Sockets and XTI,
Prentice Hall, 1998.
2. W. R. Stevens, UNIX Network Programming, Volume 2: Interprocess Communications, Prentice
Hall, 1999.
3. W. R. Stevens, Advanced Programming in the UNIX Environment, Addison Wesley, 1992.

**ELECTIVE COURSES**

**PCSE317 UBIQUITOUS COMPUTING 3-0-0-6**

Introduction, Overview, Challenges, Networking Basics, NFC, Wireless LAN, Location in ubiquitous computing: Personal assistants, Location aware computing, Location tracking, Architecture, Location based service and applications, Location based social networks (LBSN), LBSN, Recommendation, Context-aware computing: Context and Context-aware Computing, Issues and Challenges, Developing Context-aware Applications, System Architecture, Privacy and security in ubiquitous computing, Energy constraints in ubiquitous computing, Wearable computing, Glass and Augmented Reality, Eye-Tracking, Digital Pen and Paper, Mobile social networking & crowd sensing, Event based social network, Mobile affective computing: Human Activity and Emotion Sensing, Health Apps, Mobile p2p computing, Smart Homes and Intelligent Buildings, Mobile HCI, Introduction to IoT, Definition, trend, IOT components, IOT Applications, Cloud centric IOT, Open challenges, Architecture, Energy Efficiency, Participatory sensing, New Protocols, QoS, QoE, IoT and data analytics IOT and Data Management, Data cleaning and processing, Data storage models, Search techniques, Deep Web, Semantic sensor web, Semantic Web Data Management, Searching in IOT, Real-time and Big Data Analytics for The Internet of Things, Heterogeneous Data Processing, High dimensional Data Processing, Parallel and Distributed Data Processing.

**Text Books:**• Ubiquitous Computing Fundamentals, John Krumm, CRC Press, 2010

**PCSE311 Advanced Cryptography and Network Security 3-0-0-6**

Principles of Security, Basic Cryptographic techniques, Classification of attacks, Virus, Worm, Trojan Horse, Spam etc. Symmetric Key Cryptography: Algorithm types and modes, Cryptographic, Algorithms Asymmetric, Key Cryptographic Algorithms, Digital Signature Digital Envelope, Message Authentication Code, Message Digest Public-Key Infrastructure (PKI) Authentication: Classifications, Mutual authentication, Algorithms, Kerberos Security in layers and domains: IPsec, Secure Socket Layer (SSL), E-mail Security Electronic transactions.

**Books:**1. Cryptography and Network Security: rinciples & Practices: William Stallings, 4th Edition Pearson
& Prentice Hall
2. Network Security: Kaufman, Perlman, Speciner, Pearson Education
3. Papers from the ACM and IEEE digital libraries

**PCSE217 SOFT COMPUTING 3-0-0-6**

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| --- | --- | --- |
| **UNIT**  | **Contents**  | **Hours** |
| **I** | Soft Computing: Introduction, requirement, different tools and techniques, usefulness and applications. | **2** |
| **II** | Fuzzy sets and Fuzzy logic: Introduction, Fuzzy sets versus crisp sets, operations on fuzzy sets, Extension principle, Fuzzy relations and relation equations, Fuzzy numbers, Linguistic variables, Fuzzy logic, Linguistic hedges, Applications, fuzzy controllers, fuzzy pattern recognition, fuzzy image processing, fuzzy database. | **6** |
| **III** | Artificial Neural Network: Introduction, basic models, Hebb’s learning, Adaline, Perceptron, Multilayer feedforward network, Backpropagation, Different issues regarding convergence of Multilayer Perceptron, Competitive learning, Self Organizing Feature Maps, Adaptive Resonance Theory, Associative Memories, Recurrent Networks, RBF Network, Different Design issues, Applications. | **8** |
| **IV** | Evolutionary and Stochastic techniques: Genetic Algorithm (GA), different operators of GA, analysis of selection operations, Hypothesis of building blocks, Schema theorem and convergence of Genetic Algorithm, Simulated annealing and Stochastic models, Boltzmann Machine, Applications. | **6** |
| **V** | Rough Set: Introduction, Imprecise Categories Approximations and Rough Sets, Reduction of Knowledge, Decision Tables, and Applications. | **4** |
| **VI** | Hybrid Systems: Neural-Network-Based Fuzzy Systems, Fuzzy Logic-Based Neural Networks, Genetic Algorithm for Neural Network Design and Learning, Fuzzy Logic and Genetic Algorithm for Optimization, Applications. | **6** |
| **Total hours**  | **32** |

**Text and Reference Books:**1. Neural Fuzzy Systems, Chin-Teng Lin & C. S. George Lee, Prentice Hall PTR.
2. Fuzzy Sets and Fuzzy Logic, Klir & Yuan, PHI, 1997.
3. Neural Networks, S. Haykin, Pearson Education, 2ed, 2001.
4. Genetic Algorithms in Search and Optimization, and Machine Learning, D. E. Goldberg,
AddisonWesley, 1989.
5. Neural Networks, Fuzzy logic, and Genetic Algorithms, S. Rajasekaran & G. A. V. Pai, PHI.
6. Neuro-Fuzzy and Soft Computing, Jang, Sun, & Mizutani, PHI
7. Learning and Soft Computing, V. Kecman, MIT Press, 2001.
8. Rough Sets, Z. Pawlak, Kluwer Academic Publisher, 1991.
9. Intelligent Hybrid Systems, D. Ruan, Kluwer Academic Publisher, 1997.
10. Papers from the ACM and IEEE digital libraries

**ARTIFICIAL INTELLIGENCE**

1. Subject Code**: PCSE111**2. Course Title**: Artificial Intelligence**3. Contact Hours: **L:3 T:0 P:0**4. **Credits: 06**5. Semester: **Autumn Spring (July-Dec)**6. Pre-requisite**: Data Structure and algorithms**7. Objective: **To acquaint the students with the theoretical and computational techniques
in Artificial Intelligence**.

8. Details of the Course:

|  |  |  |
| --- | --- | --- |
| **UNIT**  | **Contents**  | **Hours** |
| I | **Introduction**: AI problems, foundation of AI and history of AI intelligentagents: Agents and Environments, the concept of rationality, the nature ofenvironments, structure of agents, problem solving agents, problem formulation. | **3** |
| II | **Searching:** Searching for solutions, **uniformed search strategies** – Breadthfirst search, depth first search, Depth limited search, Iterative deepening depthfirst search bi-direction search - comparison. **Search with partial information (Heuristic search**) Greedy best first search, A\* search, Memory bounded heuristic search, Heuristic functions. **Local search Algorithms**, Hill climbing, simulated, annealing search, local beam search, genetic algorithms. | **8** |
| III | **Game Playing**: Adversial search, Games, minimax, algorithm, optimaldecisions in multiplayer games, Alpha-Beta pruning, Evaluation functions,cutting of search. | **5** |
| IV | **Knowledge Representation & Reasons logical Agents**, Knowledge – BasedAgents, the Wumpus world, logic, propositional logic, Resolution patterns inpropositional logic, Resolution, Forward & Backward Chaining.**First order logic**. Inference in first order logic, propositional Vs. first orderinference, unification & lifts, forward chaining, Backward chaining, Resolution. | **9** |
| V | **Planning** – Classical planning problem, Language of planning problems,Expressiveness and extension, planning with state – space search, Forward states spare search, Backward states space search, Heuristics for stats space search. Planning search, planning with state space search, partial order planning Graphs. | **2** |
| VI | **Learning** – Forms of learning, Induction learning, Learning Decision Tree,Statistical learning methods, learning with complex data, learning with Hiddenvariables – The EM Algorithm, Instance Based learning, Neural Networks. | **4** |
| VII | **Advanced Topics:** Introduction to Natural language processing and expertsystems  | **1** |
| **Total hours** | **32** |

***Text Books:
T1.*** *Artificial Intelligence – A Modern Approach. Second Edition, Stuart Russel, Peter
Norvig, PHI/Pearson Education.****T2.*** *Artificial Intelligence, 3rd Edition, Patrick Henry Winston., Pearson Edition.****Reference books:
R1.*** *Artificial Intelligence , 2nd Edition, E.Rich and K.Knight (TMH).****R2.*** *Artificial Intelligence and Expert Systems – Patterson PHI.****R3.*** *Expert Systems: Principles and Programming- Fourth Edn, Giarrantana/ Riley,
Thomson.****R4.*** *PROLOG Programming for Artificial Intelligence. Ivan Bratka- Third Edition –
Pearson Education.*

**Object Oriented Programming and Design**

1. Subject Code**: PCSE117**2. Course Title**: Object Oriented Programming and Design**3. Contact Hours: **L:3 T:0 P:0**4. **Credits: 06**5. Semester: **Autumn Spring (July-Dec)**6. Pre-requisite**: Object Oriented Programming**7. Objective: **To acquaint the students with the theoretical and design techniques**

8. Details of the Course:

|  |  |  |
| --- | --- | --- |
| UNIT  | Contents  | Hours |
| I | **Introduction to UML:** Importance of modeling, principles of modeling,object oriented modeling, conceptual model of the UML, Architecture,Software Development Life Cycle. | 4 |
| II | **Basic Structural Modeling:** Classes, Relationships, common Mechanisms, and diagrams. Advanced Structural Modeling: Advanced classes, advanced relationships, Interfaces, Types and Roles, Packages. | 6 |
| III  | **Class & Object Diagrams:** Terms, concepts, modeling techniques for Class & Object Diagrams. | 3 |
| IV  | **Basic Behavioral Modeling-I**: Interactions, Interaction diagrams.  | 2 |
| V  | **Basic Behavioral Modeling-II**: Use cases, Use case Diagrams, ActivityDiagrams. | 3 |
| VI  | **Advanced Behavioral Modeling**: Events and signals, state machines,processes and Threads, time and space, state chart diagrams. | 4 |
| VII | Architectural Modeling: Component, Deployment, Component diagramsand Deployment diagrams.Case Study: The Unified Library application. | 4 |
| Total hours | 26 |

**TEXT BOOKS :***1. Grady Booch, James Rumbaugh, Ivar Jacobson : The Unified Modeling Language User
Guide, Pearson Education.
2. Hans-Erik Eriksson, Magnus Penker, Brian Lyons, David Fado: UML 2 Toolkit, WILEYDreamtech India Pvt. Ltd.*

**REFERENCE BOOKS:***1. Meilir Page-Jones: Fundamentals of Object Oriented Design in UML, Pearson Education.
2. Pascal Roques: Modeling Software Systems Using UML2, WILEY-Dreamtech India Pvt.
Ltd.
3. Atul Kahate: Object Oriented Analysis & Design, The McGraw-Hill Companies.
4. Mark Priestley: Practical Object-Oriented Design with UML,TATA McGrawHill
5. Appling UML and Patterns: An introduction to Object – Oriented Analysis and Design and
Unified Process, Craig Larman, Pearson Education.*

**Robotics and Computer Vision**

1. Subject Code**: PCSE216**2. Course Title**: Robotics and Computer Vision**3. Contact Hours: **L:3 T:0 P:0**4. **Credits: 06**5. Semester: **(Jan- June)**6. Pre-requisite**: Mathematics, Control system & Image processing**7. Objective: **To acquaint the students with the theoretical and design techniques**

8. **Details of the Course:**

The scope of industrial Robotics – Definition of an Industrial Robot – Need for Industrial
Robots – Applications – Fundamentals of Robot Technology – Automation and Robotics –
Robot Anatomy – Work Volume – Precision of movement End effectors – Sensors.

Robot Programming – Methods – Interlocks textual languages – Characteristics of Robot level languages, characteristics of task level languages.

Puma Robot Arm Control – Computed Torque Technique – Near minimum time control –
Variable structure control – Non-linear decoupled feedback control – Reserved motion control – Adaptive control.

Robot Cell Design and control – Remote center Compliance – Safety in Robotics.
Advanced Robotics, Advanced Robotics in Space – Specific features of Space Robotics
systems -

Long term technical developments – Advanced Robotics in underwater operations – Robotics
Technology of the future – Future applications.

Digital image fundamentals, digitization and 2-D parameters, types of operation; Basic tools:
Convolution, Fourier transforms and statistical approaches**.**

Image analysis and processing, basic enhancement and restoration techniques, unsharp
masking, noise suppression, distortion suppression, segmentation, thresholding, edge finding,
binary mathematical morphology, grey-value mathematical morphology.

**TEXT BOOK:**1. Barry Leatham Jones, “Elements of Industrial Robotics” Pitman Publishing, 1987.
2. Pratt, W.K., “**Digital Image Processing**”, 2nd Ed., John Wiley & Sons, 1991

**REFERENCE:***1. Mikell P. Groover, Mitchell Weiss, Roger N.Nagel, Nicholas G. Odrey, “Industrial
Robotics Technology, Programming And Applications”, McGraw Hill Book Company,
1986.
2. Fu K.S., Gonzalez R.C and Lee C.S.G., “Robotics – Control, Sensing, Vision and
Applications”, McGraw Hill International Editions, 1987.
3. Bernard Hodges and Paul Hallam, “Industrial Robotics”, British Library Cataloging in
Publication, 1990.*

**Data Mining & Data Warehousing**

1. Subject Code**: PCSE212**2. Course Title**: Data Mining & Data Warehousing**3. Contact Hours: **L:3 T:0 P:0**4. **Credits: 06**5. Semester: **(Jan- June)**6. Pre-requisite**: DBMS and Statistics**7. Objective: **To acquaint the students with the theoretical and design techniques**

8. **Details of the Course:**

|  |  |  |
| --- | --- | --- |
| **UNIT**  | **Contents**  | **Hours** |
| I | Overview, Motivation (for Data Mining), Data Mining-Definition & Functionalities, Data Processing, Form of Data Preprocessing, Data Cleaning: Missing Values, Noisy Data, (Binning, Clustering, Regression, Computer and Human inspection),Inconsistent Data, Data Integration and Transformation. Data Reduction:-Data Cube Aggregation, Dimensionality reduction, Data Compression, Numerosity Reduction, Clustering, Discretization and Concept hierarchy generation | **3** |
| II | Concept Description:-Definition, Data Generalization, Analytical Characterization, Analysis of attribute relevance, Mining Class comparisons, Statistical measures in large Databases. Measuring Central Tendency, Measuring Dispersion of Data, Graph Displays of Basic Statistical class Description, Mining Association Rules in Large Databases, Association rule mining, mining Single-Dimensional Boolean Association rules from Transactional Databases– Apriori Algorithm, Mining Multilevel Association rules from Transaction Databases and Mining Multi-Dimensional Association rules from Relational Databases | **5** |
| III | *Classification and Predictions:*What is Classification & Prediction, Issues regarding Classification and prediction, Decision tree, Bayesian Classification, Classification by Back propagation, Multilayer feed-forward Neural Network, Back propagation Algorithm, Classification methods K-nearest neighbor classifiers, Genetic Algorithm. | **8** |
| IV | *Cluster Analysis*:Data types in cluster analysis, Categories of clustering methods, Partitioning methods. Hierarchical Clustering- CURE and Chameleon, Density Based Methods-DBSCAN, OPTICS, Grid Based Methods STING, CLIQUE, Model Based Method –Statistical Approach, Neural Network approach, Outlier Analysis | **10** |
| V | *Data Warehousing*:Overview, Definition, Delivery Process, Difference between Database System and Data Warehouse, Multi Dimensional Data Model, Data Cubes, Stars, Snow Flakes, Fact Constellations, Concept hierarchy, Process Architecture, 3 Tier Architecture, Data Marting. | **4** |
| VI | Aggregation, Historical information, Query Facility, OLAP function and Tools. OLAP Servers, ROLAP, MOLAP, HOLAP, Data Mining interface, Security, Backup and Recovery, Tuning Data Warehouse, Testing Data Warehouse. | **4** |
| **Total hours** | **34** |

**Text Books :
1.** Jiawei Han, Micheline Kamber, ”**Data Mining Concepts & Techniques**” Elsevier

**References Books:
1.** M.H.Dunham,”**Data Mining:Introductory and Advanced Topics**” Pearson Education
**2.** Sam Anahory, Dennis Murray, “**Data Warehousing in the Real World : A Practical Guide
for Building Decision Support Systems**”, Pearson Education
**3.** Mallach,”**Data Warehousing System**”,McGraw –Hill
**4.** Arun K. Pujari “**Data Mining Techniques**”, Universities Press, 01-Jul-2001

**IMAGE PROCESSING AND PATTERN RECOGNITION**1. Subject Code**: PCSE218**2. Course Title**: IMAGE PROCESSING AND PATTERN RECOGNITION**3. Contact Hours: **L:3 T:0 P:0**4. **Credits: 06**5. Semester: **(Jan- June)**6. Pre-requisite**: Signal Processing and Statistics**7. Objective: **To acquaint the students with the conceptual and theoretical knowledge of
image processing and Pattern recognition**

8. **Details of the Course:**

|  |  |  |
| --- | --- | --- |
| **Unit**  | **Contents**  | **Hours** |
| **I** | **Basic Concepts:**Pattern Recognition Systems, Fundamental Problems in pattern recognition system design, Design concepts and Methodologies: Character recognition, Speech recognition, Finger print Recognition. Pattern Recognition Model |  |
| **II** | **Decision Functions:**Linear Decision functions, Distance functions. Minimum distance and Maximumdistance classification, clustering concepts, Cluster seeking algorithms, K- meansAlgorithms |  |
| **III** | **Baye's Classifier:**Baye’s classified decision function for Baye’s classifier, Baye’s Classifier for normal patterns. Trainable pattern classifiers — deterministic approach, perception, and approach - reward— punishment concept |  |
| **IV** | **Gradient Approach:**Gradient approach, Gradient Descent algorithms, LMSE Algorithms, Multi category classification. |  |
| **V** | **Trainable Pattern Classifiers**Trainable pattern classifiers, statistical approach, stochastic approximation methods, Robbin Minro algorithms, increment correction algorithms, LMSE algorithms. Syntactic patter recognition, formulation — syntax directed recognition — picture descript. |  |
| **VI** | **Digital Image Fundamentals**A simple image model, Sampling and Quantization, Imaging Geometry, DigitalGeometry, Image Acquisition Systems, Different types of digital images. |  |
| **VII** | **Bilevel Image Processing**Basic concepts of digital distances, distance transform, medial axis transform,component labeling, thinning, morpho-logical processing, extension to grey scalemorphology. |  |
| **VIII** | **Binarization and Segmentation of Grey Level Images**Histogram of grey level images, Optimal thresholding using Bayesian classification, multilevel thresholding, Segmentation of grey level images, Watershade algorithm for segmenting grey level image. |  |
| **IX** | **Detection of Edges and Lines in 2d Images**First order and second order edge operators, multi-scale edge detection, Canny'sedge detection algorithm, Hough transform for detecting lines and curves, edgelinking. |  |
| **X** | **Images Enhancement**Point processing, Spatial Filtering, Frequency domain filtering, multi-spectralimage enhancement, image restoration. |  |

**Text Books:**1. R.C.Gonzalez and R.E.Wood, **Digital Image Processing**, Addison Wesley.
2. J.T. Tou, R.C. Gonzalez, **Pattern Recognition Principles**, Addison Wesley.
3. Anil Ku Jain, **Fundamentals of Digital Image Processing**, PHI.

**References Books :**1. S. Theodoridis and K. Koutroumbas, **Pattern Recognition**, 4th Edition, Academic
Press, 2009.demic Press, 2002.
2. B.Channda and D.Dutta, **Digital Image Processing and Analysis**, Prentice Hall.
3. Richard O. Duda, Peter E. Hart and David G. Stork, **Pattern Classification**, 2nd
Edition, John Wiley, 2006.
4. C. M. Bishop, **Pattern Recognition and Machine Learning**, Springer, 2009.

**Remote Sensing and Digital Image Processing**1. Subject Code**: PCSE118**2. Course Title**: Remote Sensing and Digital Image Processing**3. Contact Hours: **L:3 T:0 P:0**4. **Credits: 06**5. Semester: **(July-Dec)**6. Pre-requisite**: image processing**7. Objective: **To introduce the concepts of Remote Sensing and Digital Image Processing**

8. **Details of the Course:**

|  |  |  |
| --- | --- | --- |
| **UNIT**  | **Contents**  | **Hours** |
| I | **Introduction:** History of Remote Sensing, Remote sensing components,Sources of Energy, EMS and Radiation, Black body and associated lawsInteraction of EMR with Atmosphere—Scattering, Refraction, Absorption, Transmission, Atmospheric windows, Interaction of EMR with Earth Surface—Spectral reflectance curves, Radiation Calculation, | 4 |
| II | **Platforms and Sensors:** Orbit al movement and Earth coverage. Sun synchronous and Geosynchronous satellites, Active and passive sensors,PAN, Multi High resolution and Hyper spectral Sensors, Thermal andMicrowave sensors, Sensors characteristics, Indian Remote Sensing Satellite Programme, Other satellites | 6 |
| III  | Image compression, Pixel and sub-pixel level target detection and classification, Data fusion methods and applications. | 5 |
| IV  | DEM generation from stereo-satellite images, CARTOSAT DEM, SRTMDEM, ASTER DEM, Parameter extraction | 5 |
| V  | Empirical modelling of biophysical parameters from multi and hyperspectral remote sensing data, 3D visualisation of data | 8 |
| VI  | ANN, Fuzzy Logic, Object based classification from satellite images  | 8 |
| VII | **Applications** of multi and hyperspectral remote sensing data in water resources, forestry, earth sciences, resource management and planning,military target detection. | 6 |
| **Total** | **42** |

**Suggested Books:**1) Thomas Lillesand, Ralph W. Kiefer, Jonathan Chipman, “Remote Sensing and Image
Interpretation”, 7th Edition, Wiley, 2015.
2) Chen, C.H., “Information Processing for Remote Sensing”, World Scientific. 1999.
3) Landgrebe, D., “Signal Theory Methods in Multi-spectral Remote Sensing”, John Wiley. 2003
4) Richards, John A. and Xiuping, Jia., “Remote Sensing Digital Image Analysis : An
Introduction”, Springer-Verlag. 1999.

**Advanced Digital Image Processing**1. Subject Code**: PCSE312**2. Course Title**: Advanced Digital Image Processing**3. Contact Hours: **L:3 T:0 P:0**4. **Credits: 06**5. Semester: **(July-Dec)**6. Pre-requisite**: Remote Sensing and Digital Image Processing**7. Objective: **To introduce the concepts of multi and hyper-spectral remote sensing**.

8. **Details of the Course:**

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| **UNIT**  | **Contents**  | **Hours** |
| I | **Various types of images:** PAN, Multispectral, Hyperspectral and Highresolution images, Feature and intensity based image registration of images, Open Source Image Processing software and image data | 4 |
| II  | **Advanced Spatial Filtering techniques:** Spatial and Frequency domain(e.g., Fourier, wavelets), Texture Images | 6 |
| III  | Image compression, Pixel and sub-pixel level target detection and classification, Data fusion methods and applications. | 5 |
| IV  | DEM generation from stereo-satellite images, CARTOSAT DEM,SRTM DEM, ASTER DEM, Parameter extraction | 5 |
| V  | **Empirical modelling** of biophysical parameters from multi and hyperspectral remote sensing data, 3D visualisation of data | 8 |
| VI  | ANN, Fuzzy Logic, Object based classification from satellite images  | 8 |
| VII | **Applications** of multi and hyperspectral remote sensing data in waterresources, forestry, earth sciences, resource management and planning,military target detection. | 6 |
| **Total** | **42** |

**List of Practical’s:**1. Study of different types of remote sensing data
2. Hands on experience on images processing modules
3. Data visualization tools – study of images
4. Feature and intensity based image registration of images
5. Spatial enhancement of remote sensing images
6. Data dimensionality reduction using feature selection and feature extraction methods
7. Advanced pattern recognition algorithms for extraction of information from images
8. Derivation of biophysical parameters from multi and hyperspectral remote sensing images

**Suggested Books:**5) Chen, C.H., “Information Processing for Remote Sensing”, World Scientific. 1999.
6) Cheng, Chein I., “Hyperspectral Imaging : Techniques for Spectral Detection and
Classification”, Kluwer Academic. 2003
7) Landgrebe, D., “Signal Theory Methods in Multi-spectral Remote Sensing”, John Wiley. 2003
8) Richards, John A. and Xiuping, Jia., “Remote Sensing Digital Image Analysis : An
Introduction”, Springer-Verlag. 1999
**9)** Varshney, P.K. and Arora, Manoj K., “Advanced Image Processing Techniques for
Hyperspectral Remote Sensing Data”, Springer-Verlag. 2004

**PCSE112 Automata Theory 3-0-0-6**

|  |  |  |
| --- | --- | --- |
| **UNIT**  | **Contents**  | **Hours** |
| I  | Automata and Languages: finite automata and regular expressions,pushdown automata and context-free grammars | 4 |
| II  | pumping lemmas and closure properties of regular and context-freelanguages, non-context-free languages; | 4 |
| III  | Computability theory: the Church-Turing thesis, Hilbert's problem,decidability, halting problem, reducibility | 6 |
| IV  | Complexity theory: time and space complexity, Classes P, NP, NPcomplete, PSPACE, and PSPACE-complete | 3 |
| V  | Intractability: hierarchy theorem, Relativization, Circuit complexity  | 3 |
| Total hours | 20 |

**TEXT BOOK:**1. Barry Leatham Jones, “Elements of Industrial Robotics” Pitman Publishing, 1987.
2. Pratt, W.K., “**Digital Image Processing**”, 2nd Ed., John Wiley & Sons, 1991

**PCSE116 Natural Language Processing 3-0-0-6**

Introduction- Human languages, models, ambiguity, processing paradigms; Phases in natural
language processing, applications. Text representation in computers, encoding schemes.

Linguistics resources- Introduction to corpus, elements in balanced corpus, TreeBank, PropBank, WordNet, VerbNet etc.

Resource management with XML, Management of linguistic data with the help of GATE,
NLTK. Regular expressions, Finite State Automata, word recognition, lexicon. Morphology,
acquisition models, Finite State Transducer. N-grams, smoothing, entropy, HMM, ME, SVM,
CRF. Part of Speech tagging- Stochastic POS tagging, HMM, Transformation based tagging
(TBL), Handling of unknown words, named entities, multi word expressions.

A survey on natural language grammars, lexeme, phonemes, phrases and idioms, word order,
agreement, tense, aspect and mood and agreement, Context Free Grammar, spoken language
syntax.

Parsing- Unification, probabilistic parsing, TreeBank. Semantics- Meaning representation,
semantic analysis, lexical semantics, WordNet Word Sense Disambiguation- Selectional
restriction, machine learning approaches, and dictionary based approaches. Discourse Reference resolution, constraints on co-reference, algorithm for pronoun resolution, text coherence, discourse structure. Applications of NLP- Spell-checking, Summarization
Information Retrieval- Vector space model, term weighting, homonymy, polysemy, synonymy, improving user queries.

Machine Translation– Overview.

**PCSE214 Machine learning 3-0-0-6**

* Introductory Topics: What is machine learning, why machine learning, Machine learning vs Conventional Algorithm
* Linear Regression and Feature Selection
* Linear Classification, Bayesian Learning and Decision Trees, Hidden Markov Model,
Support Vector Machines and Artificial Neural Networks
* Evaluation Measures
* Hypothesis Testing
* Ensemble Methods
* Clustering
* Graphical Models
* Learning Theory and Expectation Maximization

**PCSE314 Computational Biology 3-0-0-6**

Molecular sequences, Genome sequencing: pipeline and data, Next generation sequencing
data, Biological databases: Protein and Nucleotide databases, Sequence Alignment, Dynamic
Programming for computing edit distance and string similarity, Local and Global Alignment,
Needleman Wunsch Algorithm, Smith Waterman Algorithm, BLAST family of programs,
FASTA algorithm, Functional Annotation, Progressive and Iterative Methods for Multiple
sequence alignment, Applications.

Introduction to Phylogenetics, Distance and Character based methods for phylogenetic tree
construction: UPGMA, Neighbour joining, Ultrametric and Min ultrametric trees, Parsimonous
trees, Additive trees, Bootstrapping.

Protein Structure Basics, Visualization, Prediction of Secondary Structure and Tertiary
Structure, Homology Modeling, Structural Genomics, Molecular Docking principles and
applications, Molecular dynamics simulations.

Machine learning techniques: Artificial Neural Networks and Hidden Markov Models:
Applications in Protein Secondary Structure Prediction and Gene Finding, Introduction to
Systems Biology and its applications in whole cell modelling, Microarrays and Clustering
techniques for microarray data analysis, informatics in Genomics and Proteomics, DNA
computing.

Variables, Data types, control flow constructs, Pattern Matching, String manipulation, arrays,
lists and hashes, File handling, Programs to handle biological data and parse output files for
interpretation

**PCSE316 Information Retrieval 3-0-0-6**

Introduction - History of IR - Components of IR - Issues – Open source Search engine
Frameworks - The impact of the web on IR - The role of artificial intelligence (AI) in IR – IR
Versus Web Search - Components of a Search engine - Characterizing the web

Boolean and vector-space retrieval models - Term weighting - TF-IDF weighting - cosine
similarity – Preprocessing - Inverted indices - efficient processing with sparse vectors –
Language Model based IR - Probabilistic IR – Latent Semantic Indexing - Relevance feedback and query expansion.

Web search overview, web structure, the user, paid placement, search engine optimization/
spam. Web size measurement - search engine optimization/spam – Web Search Architectures
- crawling - meta-crawlers- Focused Crawling - web indexes –- Near-duplicate detection -
Index Compression – XML retrieval

Link Analysis – hubs and authorities – Page Rank and HITS algorithms - Searching and
Ranking – Relevance Scoring and ranking for Web – Similarity - Hadoop & Map Reduce -
Evaluation - Personalized search - Collaborative filtering and content-based recommendation
of documents and products – handling “invisible” Web - Snippet generation, Summarization,
Question Answering, Cross-Lingual Retrieval

Information filtering; organization and relevance feedback – Text Mining - Text classification
and clustering - Categorization algorithms: naive Bayes; decision trees; and nearest neighbor – Clustering algorithms: agglomerative clustering; k-means; expectation maximization (EM).

**PCSE215 Optimization Method 3-0-0-6**

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| **UNIT**  | **Contents**  | **Hours** |
| I | Introduction to Operation Research: Operation Research approach, scientific methods, introduction to models and modeling techniques, general methods for Operation Research models, methodology and advantages of Operation Research, history of Operation Research. | 3 |
| II | Linear Programming (LP): Introduction to LP and formulation of LinearProgramming problems, Graphical solution method, alternative or multiple optimal solutions, Unbounded solutions, Infeasible solutions, Maximization – Simplex Algorithm, Minimization – Simplex Algorithm using Big-M method, Two phase method, Duality in linear programming, Integer linear programming. | 6 |
| III | Transportation & Assignment Problems: Introduction to Transportationproblems, various methods of Transportation problem, Variations inTransportation problem, introduction to Assignment problems, variations in Assignment problems. | 3 |
| IV | Network Analysis: Network definition and Network diagram, probability in PERT analysis, project time cost trade off, introduction to resource smoothing and allocation. | 3 |
| V | Sequencing: Introduction, processing N jobs through two machines, processing N jobs through three machines, processing N jobs through m machines. | 2 |
| VI  | Inventory Model: Introduction to inventory control, deterministic inventory model, EOQ model with quantity discount. | 2 |
| VII | Queuing Models: Concepts relating to queuing systems, basic elements of queuing model, role of Poison & exponential distribution, concepts of birth and death process. | 3 |
| VIII | Replacement & Maintenance Models: Replacement of items, subject to deterioration of items subject to random failure group vs. individual replacement policies. | 3 |
|  | **Total hours** | **25** |