VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY

(Formerly Uttarakhand Technical University, Dehradun Established by Uttarakhand State Govt. wide Act no. 415 of 2005)

Suddhowala, PO-Chandanwadi, Premnagar, Dehradun, Uttarakhand (Website- www.uktech.ac.in)

SYLLABUS

for

M.TECH.

(Hydro and Renewable Energy)

Effective from – Session 2023-24

COURSE STRUCTURE & EVALUATION SCHEME AND SYLLABUS

M. Tech. Hydro and Renewable Energy

(w.e.f. session 2023-24)

Scheme of Examination of M. Tech. 2 Year Programme									
Semester I									
Sr. No.	**Course Type/Code**	**Course Name**	**Teaching Scheme**			**Credits**	**Internal Marks**	**External Marks**	**Total Marks**
			L	**T**	**P**				
1	HRET - 301	Numerical Techniques & Computation Methods	3	1	0	4	50	100	150
2	HRET – 302	Design of Water Resources Structure	3	1	0	4	50	100	150
3	HRET – 303	Advanced Hydrology	3	1	0	4	50	100	150
4	HRET – 3XX	Professional Elective - I	3	0	0	3	50	100	150
5	HRET – 3XX	Professional Elective - II	3	0	0	3	50	100	150
6	HREP - 301	Numerical Techniques & Computation Methods Lab	0	0	3	1	25	25	50
7	HREP - 302	Advance Hydraulics Lab	0	0	3	1	25	25	50
8	AHT-302	Research Methodology and IPR	2	0	0	2	50	50	100
9	AHT-303	Technical Writing and Presentation Skill	2	0	0	NC	50	0	NC
		Total	**22**	**3**	**8**	**22**	**400**	**600**	**950**
10	TET – 3XX	*Open Elective (Optional)	3	0	0	3	50	100	150

Semester II									
Sr. No.	**Course Type/Code**	**Course Name**	**Teaching Scheme**			**Credits**	**Internal Marks**	**External Marks**	**Total Marks**
			L	**T**	**P**				
1	HRET - 304	Solar Energy and Applications	3	1	0	4	50	100	150
2	HRET – 305	Renewable Energy Technologies	3	1	0	4	50	100	150
3	HRET – 3XX	Professional Elective – III	3	1	0	4	50	100	150
4	HRET – 3XX	Professional Elective - IV	3	0	0	3	50	100	150
5	HRET – 3XX	Open Elective	3	0	0	3	50	100	150
6	HREP – 303	Modeling and Simulation Lab	0	0	3	1	25	25	50
7	HREP – 304	Renewable Energy Lab	0	0	3	1	25	25	50
		Total	**15**	**3**	**6**	**20**	**300**	**550**	**850**
9	HRET – 3XX	*Open Elective (Optional)	3	0	0	3	50	100	150

Professional Elective – I		**Professional Elective – II**	
Course title	**Course code**	**Course title**	**Course code**
Hydro power planning and management	HRET – 306	Energy economics and renewable energy policy	HRET – 310
Climate change and water bodies	HRET – 307	Energy storage systems	HRET – 311
Groundwater hydrology	HRET – 308	Process modeling and simulation in energy systems	HRET – 312
Urban water resource	HRET - 309	Remote sensing and GIS for	HRET - 313

management		renewable energy planning	
Professional Elective – III		**Professional Elective – IV**	
Course title	**Course code**	**Course title**	**Course code**
Hydro-Mechanical Equipment	HRET - 314	Energy conservation and management	HRET – 318
Groundwater hydrology and management	HRET – 315	Energy Audit and Instrumentation	HRET – 319
Instrumentation for small hydro power station	HRET – 316	Hydrogen energy and fuel cell	HRET – 320
Water power and dam engineering	HRET - 317	Wind energy application technology	HRET - 321

Semester III											
Sr. No.	**Course Type/Code**	**Course Name**	**Teaching Scheme**			**Credits**	**Internal Marks**			**External Marks**	**Total Marks**
			L	**T**	**P**		**CT**	**TA**	**Total**		
1	HREP - 305	Seminar	0	0	6	3			150		150
2	HREP – 306	Project	0	0	12	6			150	150	300
3	HREP – 307	Dissertation	0	0	12	6			300		300
		Total	**3**	**0**	**22**	**15**			**550**	**250**	**750**

Semester IV											
Sr. No.	**Course Type/Code**	**Course Name**	**Teaching Scheme**			**Credits**			**Internal Marks**	**External Marks**	**Total Marks**
			L	**T**	**P**						
1	HREP - 308	Dissertation	0	0	30	15			300	450	750
		Total	**0**	**0**	**30**	**15**			**300**	**450**	**750**

Abbreviations: L-No. of Lecture hours per week, T-No. of Tutorial hours per week, P-No. of Practical hours per week, CT-Class Test Marks, TA-Marks of teacher's assessment including student's class performance and attendance.

1 Hr Lecture	**1 Hr Tutorial**	**2 or 3 Hr Practical**
1 Credit	**1 Credit**	**1 Credit**

Numerical Techniques & Computation Methods (HRET - 301)

Credits: 4 **L: T: P: 3 1 0**

Course Objectives

- To impart knowledge of various numerical techniques used to approximate solutions to mathematical problems, including interpolation, numerical integration, linear systems, and ordinary differential equations.
- To understand the concepts of accuracy, stability, and convergence of numerical methods, and analyze the error propagation in computational algorithms.
- To introduce the finite difference method to solve ordinary differential equation.

Course Outcomes

Upon successful completion of the course, the students will be able to:

- CO1. Identify appropriate numerical methods for solving mathematical problems and implement them effectively.
- CO2. Evaluate the accuracy, stability, and convergence properties of numerical methods and assess the impact of approximation errors.
- CO3. Utilize numerical techniques and computation methods to solve complex mathematical problems.
- CO4. Interpret and analyze numerical results obtained from computations.

Unit I

Errors: Accuracy and precision, sources of errors, Floating-point arithmetic and rounding errors, Truncation errors, Error propagation, data uncertainty, Stability and accuracy.

Solution of Algebraic and transcendental equation: Interval Halving (Bisection method), Method of False position, Fixed point iteration method, secant method, Newton-Raphson method for simple and multiple roots, Rate of convergence, Solution of a system of nonlinear equations.

Unit II

Linear Systems and Eigen Values: Gauss elimination method, Gauss-Jordan method, LU decomposition, iterative methods (Jacobi and Gauss-Seidel methods) and their convergence analysis, Rayleigh's power, Jacobi's method, Given's method for Eigen-values and Eigen-vectors.

Unit III

Interpolation and curve fitting: Difference operators and relation between them, Interpolating polynomials, Interpolation for equal intervals: Newton's forward and backwards interpolation formula, Stirling's formula, Bessel's formula, Interpolation for unequal intervals: Lagrange interpolation, Newton interpolation, Hermite interpolation, Spline interpolation,-cubic spline, Bivariate interpolation, Error of the interpolating polynomials, Data fitting and least-squares approximations.

Unit IV

Differentiation and Integration: Numerical differentiation: formulae of derivatives, maxima and minima of a tabulated function, Newton-Cotes formula, Trapezoidal and Simpson's rules, Boole's and Weddle's rule, Gaussian quadrature, Applications of cubic splines. Euler's method, Modified Euler's methods, Runge-Kutta method, Predictor Corrector method: Milne's method, Adams-Bashforth method, Boundary value problems**:** Shooting method, Finite difference method, Galerkin's method.

Unit V

Introduction to FEM

General steps of the finite element method; Engineering applications of finite element method; Advantages of the Finite Element Method; Potential energy method, Rayleigh Ritz method, Galerkin's method, Displacement method of finite element formulation; Discretisation process and types of elements: 1D, 2D and 3D; Derivation of Shape functions and Stiffness matrices; Assembly of Matrices — Solution of problems from solid mechanics; Finite element analysis of 1-D problems: formulation by different approaches (direct, potential energy and Galerkin)

References:

1. Niyogi, Pradip, "Numerical Analysis and Algorithms", Tata McGraw –Hill

2. Balagurusamy,E., "Numerical Methods", Tata McGraw –Hill

3. Dr. B.S. Grewal, "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, New Dehli, 2014.

4. Sastry, S.S., "Introduction Methods of Numerical Analysis", PHI

5. Chapra, S.C. and Canale, R.P., "Numerical Methods for Engineers", Tata McGraw –Hill

6. Seshu P., Textbook of Final Element Method, PHI

7.Chandrupatla T.R., and Belegundu A.D., Introduction to Finite Elements in Engineering, Pearson

Design of Water Resources Structure (HRET - 302)

L: T: P: 3 1 0 **Credits: 4**

Course Objectives

- To impart knowledge about different water resources structures
- To gain knowledge about the fundamentals of dam stability
- To gain knowledge about design fundamentals of irrigation regulating system

Course Outcomes

Upon successful completion of the course, the students will gain the

CO1: Ability to know about Water Resources structures.

CO2: Ability to know about different elements of storage structure and able to design the sections of gravity and earthen dams.

CO3: Ability to design different elements of Irrigation regulating structure.

CO4: Ability to know about operation, management and limitations of Irrigation structure and to develop understanding of irrigation water distribution system.

Course Contents:

Unit I

Dams: Different kinds of dams and the choice criteria, Environmental considerations Gravity Dams: various forces acting and their analysis and representation, stability requirements, two-dimensional analysis, distribution of normal and shear stress, principal stresses, joints and their treatment.

Unit II

Foundation treatment: grouting, drainage wells, drainage galleries, types of galleries, design concepts of galleries, stress concentration.

Embankment dams: homogeneous and zoned earthen embankments, foundation requirements, typical cross-sections.

Unit III

Stability analysis of earthen dams: slip circle method, wedge method, seepage through and beneathdams, Casagrande's base parabola and determination of top flow line, calculation of seepage rate, flow net during steady seepage and during sudden drawdowns, pore pressures and their significance, design of filters and rock toes, slope protection, Foundation problems of various soilstrata of earthen dams and their remedies.

Rockfill dams and earth rock dams: construction techniques of embankment dams. Modes of failure.

Unit IV

Spillways: Different types of spillways and their design criteria, design of crest profile, reinforcement, selection criteria for downstream arrangement, trajectories and bucket arrangements, buckets; design of stilling basins, Spillway aerators.

Unit V

Gates: Various types of gates and their merits and demerits; design requirements of radial, vertical, low head gates and automatic gates. Design of vertical lift and sector gates, flow-induced vibrations and down-pull forces. Gate seals. Design of outlet sluices through dams.

Canals: Basic concepts of various canal design theories and their limitations. Design of weirs andcanal structures on permeable foundations, Khosla's theory and applications. Design of canal falls and regulators, cross drainage works, canal outlets and river training works. Design of siltexcluders, silt extractors. Layout and design of water courses. Canal lining.

References

1. Asawa, G.L. "Irrigation Engineering" John Wiley & Sons Australia, Limited
2. Creager, W.P., Justin, J. De. W, and Hinds, J. "Design of Dams" J. Wiley & Sons, Incorporated
3. Modi, P.N. "Irrigation & Water Power Engineering"
4. Sherard "Design of Earthen Dams"
5. Singal, S.K., Small Hydropower: Design & Analysis, Elsevier, 2023.
6. Warnick, C.C., 'Hydropower Engineering', Prentice-Hall Inc., Enlewood Cliffs, New Jersey, 1984

Advanced Hydrology (HRET - 303)

L: T: P: 3 1 0 Credits: 4

Course Objective

- To impart knowledge hydrological process
- To gain knowledge about the fundamentals of surface water channel flow modeling
- To gain knowledge about design fundamentals of unit hydrographs

Course Outcomes

Upon successful completion of the course, the students will gain the

CO1: Ability to know about hydrological cycle and processes

CO2: Ability to know about different elements of atmospheric hydrology

CO3: Ability to design channel flow modeling

CO4: Ability to know about operation, management and limitations of Irrigation structure and to develop irrigation water distribution system.

UNIT I

Introduction:

Hydrologic cycle, water budget equation, world water quantities, systems concept, transfer functionoperators, hydrologic model classification.

Hydrologic Processes

Reynold's transport theorem, continuity, momentum and energy equations, discrete time continuity.

UNIT II

Atmospheric Hydrology:

Atmospheric circulation, water vapour, formation of rainfall, types and forms of precipitation, monsoon characteristics in India, rainfall measurement, density and adequacy of rain gauges, Thunderstorm Cell model, IDF relationships, Spatial averaging methods of rainfall. Factors affecting evaporation, estimation and measurement of evaporation, energy balance method, aerodynamic method, Priestly-Taylor method, and pan evaporation.

UNIT III

Sub-Surface Water

Soil moisture, porosity, saturated and unsaturated flow; Richard's equation, infiltration, Horton's Phillip's and Green Ampt methods, parameter estimation.

Surface Water

Catchment storage concept, Hortonian and saturation overland flow, stream flow hydrographs, baseflow separation. Phi-index, ERH & DRH, algorithm for abstraction using Green-Ampt equation, SCSmethod, overland and channel flow modelling, time area concepts and stream networks.

UNIT IV

Unit Hydrograph

General hydrologic system model, response functions of a linear hydrologic systems and their interrelationships, convolution equation; definition and limitations of a UH. Derivation of UH from singleand complex storms; UH optimization using regression. matrix & LP methods. Synthetic unithydrograph, S-Curve, IUH.

UNIT V

Hydrologic Statistics

Probability concepts, random variables, laws of probability, PDFs & CDFs. Normal and Binomial distributions; Statistical parameters.

Fitting of a probability distribution, methods of moments and maximum likelihood: Testing the goodness of fit, Chi-square test.

Frequency analysis: Return period, probability plotting, Extreme value distributions, frequency factors, Log-Pearson distribution, confidence limits.

Flood Analysis

Flood estimation by various methods, forecasting of floods, flood frequency analysis,Gumbel's, Pearson type I, II, and III distribution, Log-normal method, design flood forvarious hydraulic structures.

References:

1. Fluid Mechanics by F. M. White.

2. Fluid Mechanics by Streeter

3. Fluid Mechanics by K.L. Kumar

4. Fluid Mechanics by A.K. Jain

5. Viscous fluid flow by White

6. Computational Fluid Dynamics by Anderson

Numerical Techniques & Computation Methods Lab (HREP - 301)

L: T: P: 0 0 3 Credits: 1

Course Objective

To gain hands-on experience in applying various numerical methods to solve complex engineering and mathematical problems.

Course Outcome

The students will be able to implement algorithms, analyzing numerical solutions, and interpreting results.

LIST OF EXPERIMENTS (Minimum 8 Experiments)

Utilizing MATLAB, Python, or similar software for implementing numerical methods and solving computational problems:

1. Bisection method for finding roots of an equation
2. Newton-Raphson method for solving nonlinear equations
3. Gaussian elimination for solving systems of linear equations
4. Lagrange interpolation for data interpolation
5. Least squares regression for curve fitting
6. Matrix multiplication and inversion
7. Trapezoidal rule for numerical integration
8. FEM analysis of a Bar of Constant Cross-section and variable cross-section using ANSYS
9. FEM analysis of a four bar truss using ANSYS

Advanced Hydraulics Lab (HREP - 302)

L: T: P: 0 0 3 **Credits: 1**

Course Objective

To expose the students to experimental learning of fluid phenomena both in air and water, practical aspects of aquifer mapping and parameters.

Course Outcome

The students will be able to design and construct experimental models related to open channel hydraulics and coastal engineering. The students will be able to conduct experiments to explore groundwater potential

LIST OF EXPERIMENTS (Minimum 8 Experiments)

1. Wave length, profile and group velocity as a function of wave period, water depth and wave height.
2. Wave forces n cylinders and piers.
3. Drag and lift characteristics of aerofoils.
4. Hydraulic jump studies.
5. Hele – Shaw model.
6. Geophysical survey.
7. Electrical Resistivity Method: Wenner and Schlumberger Configuration.
8. Aquifer parameter Estimation: Infiltration test and Permeability Test.
9. Borehole Dilution Method.
10. Drum Culture Experiment.

Hydro Power Planning and Management (HRET - 306)

L: T: P: 3 0 0 **Credits: 3**

Course Objective

- To gain knowledge about the fundamentals of hydro power planning
- To gain knowledge about techno-economic evaluation of hydropower project

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1. Understand principles and components of hydropower systems and their role in the energy sector.

CO2. Assess the hydropower potential of a site and apply hydrological analysis techniques for resource estimation.

CO3. Analyze feasibility studies and perform technical and economic assessments for hydropower projects.

CO4. Analyze the environmental and social impacts of hydropower projects, incorporating mitigation measures and stakeholder engagement.

CO5. Analyze dam safety principles and risk assessment techniques to ensure the safe operation of hydropower facilities.

Unit I

Introduction to hydropower, basics of hydropower generation, types of hydropower plants and their characteristics, hydropower potential assessment, hydrological analysis and data collection, flow duration studies, assessment of power potential and determination of installed capacity, site selection criteria and resource estimation techniques.

Unit II

Hydropower project planning, feasibility analysis, feasibility studies and technical assessments, economic analysis and risk assessment, hydropower economics and financial analysis, cost estimation and financial modeling, project financing and revenue generation, economic viability.

Unit III

Hydropower plant design, components of a hydropower plant, design considerations and optimization techniques, equipment selection, layout design, hydropower operation and maintenance, operational strategies, control systems, maintenance planning and reliability analysis, performance monitoring and optimization.

Unit IV

Social considerations in hydropower projects, social and stakeholder engagement strategies, resettlement and indigenous peoples' rights, dam safety and risk management, principles of dam safety and risk assessment, emergency response planning, contingency measures.

Unit V

Environmental impact assessment, mitigation measures, hydropower regulations and policy frameworks, licensing procedures, regulatory requirements, policies for hydropower development.

References

1. Warnick, C.C., ‘Hydropower Engineering’, Prentice-Hall Inc., Enlewood Cliffs, New Jersey, 1984
2. Gulliver, J.S. and Arndt, E.A., “Handbook of Hydro Electric Engineering”, McGraw Hills
3. “Civil Engineering Guidelines for Hydroelectric Projects”, (Vol. 4-Small Hydro), ASCE.
4. Nigam, P.S., “Handbook of Hydroelectric Engineering”, Nem Chand and Bros.
5. Singal, S.K., Small Hydropower: Design & Analysis, Elsevier, 2023.

Climate Change and Water Bodies (HRET - 307)

L: T: P: 3 0 0 **Credits: 3**

Course Objective

To understand different processes and interplay between climate system to understand the climate change influences on water resources and the associated vulnerabilities and risks

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Understand different processes and interplay between climate system and the global water cycle

CO2: Understand the climate change influences on water resources and the associated vulnerabilities and risks

CO3: Understand the concept of Integrated Water Resources Management in relation to climate change

CO4: Understand the necessity for integrated assessment, alternative policy and innovative management solutions, framework for water policy guidelines; building resilience; adaptation strategies and interventions needed in sustainable response to changing climate

CO5: Perform risk assessment and suggest necessary policy interventions at various levels to

improve resilience

UNIT I

General Overview of Climate Change and Global Water Cycle:

Climate variability, drivers of climate change; Observed and future changes in global patterns of precipitation and evaporation; Understanding the water cycle, global water distribution and quantitative and qualitative spatio-temporal changes

UNIT II

Hydrological Impacts of Climate Change and Variability:

Estimating impacts of climate change on precipitation variability, extreme precipitation events, droughts, floods, evapotranspiration, soil moisture, surface and sub-surface water resources, runoff and river discharge, glacial hydrological regime, fluvial landforms

UNIT III

Modelling Impacts on Hydrological Systems:

Modelling climate-induced changes in hydrology; Water resource availability and demand, modelling runoff, flood frequency analysis, soil erosion; Socio-economic and environmental impacts; indicators of climate risks to water resources; vulnerability; Factors affecting the vulnerability of water resources

UNIT IV

Mitigation and Adaptation Strategies for water management:

Scale dependent vulnerability-local, regional, global; Vulnerability assessment and adaptation framework – all intra-national governance levels, transboundary water resources; critical knowledge gaps

UNIT V

Importance of IWRM for adaptation; integrated drought management; Potential water resource conflicts, Implications for policy and sustainable development; Risk management

References

1. Bates, B.C., Kundzewicz, Z.W., Wu, S. and Palutikof, J.P., Eds. (2008) Climate Change and Water.Technical Paper of the Intergovernmental Panel on Climate Change VI (IPCC), IPCC Secretariat, Geneva.
2. Vörösmarty, C.J., Green, P., Salisbury, J. and Lammers, R.B. 2000. Global water resources: vulnerability from climate change and population growth. Science, 289(5477), pp.284-288.

3. Xu, J., Grumbine, R.E., Shrestha, A., Eriksson, M., Yang, X., Wang, Y.U.N. and Wilkes, A., 2009. The melting Himalayas: cascading effects of climate change on water, biodiversity, and livelihoods. Conservation Biology, 23(3), pp.520-530.
4. Immerzeel, W.W., Van Beek, L.P. and Bierkens, M.F., 2010. Climate change will affect the Asian water towers. Science, 328(5984), pp.1382-1385.
5. Milly, P.C., Betancourt, J., Falkenmark, M., Hirsch, R.M., Kundzewicz, Z.W., Lettenmaier, D.P. and Stouffer, R.J., 2008. Stationarity is dead: Whither water management? Science, 319(5863), pp.573-574.
6. Arnell, N.W., 1999. Climate change and global water resources. Global environmental change, 9, pp. S31-S49.
7. Arnell, N.W., 2004. Climate change and global water resources: SRES emissions and socioeconomic scenarios. Global environmental change, 14(1), pp.31-52.
8. Gosling, S.N. and Arnell, N.W., 2016. A global assessment of the impact of climate change on water scarcity. Climatic Change, 134(3), pp.371-385.

Groundwater Hydrology (HRET - 308)

L: T: P: 3 0 0 **Credits: 3**

Course Objective

- To understand the fundamentals of ground water hydrology, which includes mechanics of well flow and ground water modelling.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Apply knowledge of mathematics, science, and engineering to groundwater flow problems

CO2: Identify, formulate, and solve groundwater engineering problems

CO3: Communicate effectively, understand economic, environmental, social, and sustainability issues

CO4: Use the modern engineering tools for engineering practice

CO5: Understand the fundamentals of ground water development and management

UNIT I

Fundamentals of Groundwater Flow: Occurrence of Ground Water, Vertical Distribution of G.W.Darcy's Law, Permeability, Porosity, Anisotropic Aquifers, Differential equations of G.W. flow.

UNIT II

Potential Flow: Flownets, Boundary conditions, Flow-net construction for confined & unconfined flow systems.

UNIT III

Mechanics of Well Flow: Steady & unsteady flow in confined & unconfined aquifers, Leakyaquifers, Partial penetration of wells, Multiple well systems, Boundary effects & method of images. Characteristics Well Loses.

UNIT IV

Ground water Modelling: Sand Tank, Heleshaw, Electrical analogous models, Finite Element/Difference models, Analytical models, Basics of conformal mapping, Schwarz Christoffel transformation, Zhukovsky's function and velocity hodograph.

UNIT V

Ground Water Development and Management: Design of wells, construction of wells, Well Development, Artificial recharge, Conjunctive use, Salinity of G.W., Ground water pollution, Infiltration galleries.

Rainwater Harvesting (Recharge to Aquifers), Groundwater mapping and assessment.

References

1. De Weist "Geohydrology" Wiley
2. Harr, M.E. "Groundwater and Seepage" Dover Publications Inc., New York
3. Pinder, G.F., and Celia, M.A. "Subsurface Hydrology" Wiley-Interscience
4. Polubarinova-Kochina, P. Ya. "Theory of Ground Water Movement" Princeton University Press
5. Todd, D.K. "Groundwater Hydrology" Wiley India

Urban Water Resources Management (HRET - 309)

L: T: P: 3 0 0 **Credits: 3**

Course Objective

- To introduce the concepts of urbanization and its impact on the natural water cycle
- To expose the students to use the urban storm water models for better storm water management.
- Students will also be exposed for the preparation of urban storm water master plan and different types of operation and maintenance.

Course Outcomes

On successful completion of this course, students should be able to:

CO1: Understand the concept of urban hydrological cycle

CO2: Apply management technique for flow rate and control rate models

CO3: Understand storm water management practices

CO4: Apply management concept on planning and organizational aspects

CO5: Understand the operation and maintenance in urban water system

UNIT I

Urban Hydrologic Cycle

Water in the urban eco-system – Urban Water Resources – Major problems – Urban hydrological cycle – Storm water management objectives and limitations – Storm water policies – Feasibility consideration.

UNIT II

Urban Water Resources Management Models

Types of models – Physically based – conceptual or unit hydrograph based – Urban surface run off models – Management models for flow rate and volume control rate – Quality models.

UNIT III

Urban Storm Water Management

Storm water management practices (Structural and Non-structural Management measures) –Detention and retention concepts – Modelling concept – Types of storage – Magnitude of storage –Hydraulic analysis and design guidelines – Flow and storage capacity of urban components – Templetanks.

UNIT IV

Master Plans

Planning and organizational aspects – Inter dependency of planning and implementation of goals andmeasures – Socio – economics financial aspects – Potential costs and benefit measures – Measures of urban drainage and flood control benefits – Effective urban water user organizations.

UNIT V

Operation and Maintenance

General approaches to operations and maintenance – Complexity of operations and need for diagnostic analysis – Operation and maintenance in urban water system – Maintenance Management System – Inventories and conditions assessment – Social awareness and involvement.

References

1. Geiger, W.F., Marsalek, F., and Zuidena, F.C., (Ed), manual ondrainage in urbanized areas – Vol.1 and Vol.II, UNESCO, 1987.
2. Hengeveld, H. and C. De Voch.t (Ed)., Role of Water in Urban Ecology, 1982.
3. Martin, P. Wanelista and Yousef, A. Yousef., Storm Water Management, John Wiley and sons,1993.
4. Neil S. Grigg., Urban Water Infrastructure Planning, Management and Operations, John Wileyand Sons, 1986.
5. Overtens D.E. and Meadows M.E., Storm Water Modelling, Academic Press, New York, 1976.

Energy Economics and Renewable Energy Policy (HRET - 310)

L: T: P: 3 0 0 **Credits: 3**

Course Objective

- The course is designed to aware about the fundamentals of energy economics and renewable energy policy.

Course Outcomes

On successful completion of this course, students should be able to:

CO1: Understand the fundamentals of energy economics

CO2: Apply the economic performance indices

CO3: Understand the national and regional energy policies

CO4: Understand the electricity regulations

CO5: Understand environment interactions at different levels

UNIT I

Energy economics: Basic concepts, Energy data and energy balance. Energy Accounting framework; Economic theory of demand, production and cost market structure.

UNIT II

Costing: Time value of money – present worth and future worth; Economic performance indices – simple anddiscounted payback, Levelised cost - calculation of unit cost of power generation.

UNIT III

Cost-benefit ratio, E/D ratio, net present value, Internal rate of return. Energy-GDP elasticity; National and regional energy policies - RE certificate, RE purchase obligation.

UNIT IV

Subsidyand taxation, Renewable Recovery Fund, Energy Exchange- deregulated power market, electricity regulations,Grid Code.

UNIT V

Energy- Environment interactions at different levels; Energy security issues.

References

1. Bhattacharyya S. C., "Energy Economics", Springer, 2011.
2. Ferdinand E. B., "Energy Economics: A Modern Introduction", Kluwer, 2000.
3. Kandpal T. C. and Garg H. P., "Financial Evaluation of Renewable Energy Technology", Mac Milan, 2003.
4. Munasinghe M. and Meier P., "Energy Policy Analysis and Modeling", Cambridge University Press, 1993.

Energy Storage System (HRET - 311)

L: T: P: 3 0 0 Credits: 3

Course Objective

The course is designed to make students aware of energy storage systems.

Course Outcomes

On successful completion of this course, students should be able to:

CO1: Understand the fundamentals of thermal energy storage

CO2: Understand the electromagnetic energy storage

CO3: Aware about the principle of fuel cells

CO4: Aware of energy storage integration

CO5: Understand the concept of optimizing regimes for energy storage in power systems

UNIT I

Introduction, Thermal Energy Storage, Energy Storage in Organic Fuels, Mechanical Energy Storage.

UNIT II

Pumped Hydro Storage, Electromagnetic Energy Storage, Capacitor and Magnetic Systems, Super Conducting Magnetic Energy Storage.

UNIT III

Electrochemical Energy Storage, Hydrogen and synthetic fuels, Fuel Cells.

UNIT IV

Consideration on the choice of Energy Storage Systems, Integration of Energy Storage Systems.

UNIT V

Optimizing Regimes for Energy Storage in Power Systems, Distributed energy storage with grid interface.

References

1. Robert A. Huggins, "Energy Storage", Springer New York Heidelberg Dordrecht London, 2010.
2. A. Ter-Gazarian, "Energy Storage for Power Systems", IET Energy Series 6, London, 2008.
3. Richard Baxter, "Energy Storage – A Non-Technical Guide", Penn Well, Oklahoma, 2006.
4. Ralph Zit, "Energy Storage- A New Approach", Wiley – Scrivener, Wiley Publishers, 2010.
5. Ahmed Faheem Zobaa, "Energy Storage – Technologies and Applications", In Tech Publisher, 2013.

Process Modeling and Simulation in Energy Systems (HRET - 312)

L: T: P: 3 0 0 **Credits: 3**

Course Objective

The course is designed to make students aware about modeling and simulation in energy systems.

Course Outcomes

On successful completion of this course, students should be able to:

CO1: Understand the fundamentals for modeling and simulation

CO2: Analyze the mechanical fluid flow system

CO3: Understand the grey box model

CO4: Aware of solution for lumped models

CO5: Understand the solution strategies for distributed parameter models

UNIT – I

Introduction to modeling, a systematic approach to model building, classification of models. Modeling Techniques-Response function and Numerical methods- Conservation principles, thermodynamic principles of process systems

UNIT-II

Introduction to development of steady state and dynamic lumped and distributed parameters models based on first principles, Analysis of ill-conditioned systems, Block diagrams and computer simulation, Modeling of process elements consisting of Mechanical (translational and rotational) electro-Mechanical, fluid flow, thermal and chemical reaction system elements

UNIT-III

Development of grey box models. Empirical model building. Statistical model calibration and validation. Population balance models. Examples.

UNIT-IV

Solution strategies for lumped parameter models. Stiff differential equations. Solution methods for initial value and boundary value problems. Euler's method. R-K method. shooting method, finite difference methods. Solving problems using MATLAB/ SCILAB

UNIT- V

Solution strategies for distributed parameter models. Solving parabolic, elliptic and hyperbolic partial differential equations. Finite element and finite volume methods.

References

1. K.M. Hangos and I.T Cameron," Process Modelling and Model analysis"academic Press 2001.
2. W. L Luyben, " Process Modelling, Simulation and control for chemical Engineers" 2ndEdn, McGraw Hill Book Co, New York,1990.
3. W.F Ramirez " Computational Methods for Process Simulation" Butterworths,20NOV,1997
4. Mark E. Davis," Numerical Methods and Modelling for Chemical Engineers" JohnWiley& Sons,1984.
5. Singiresu S. Rao "Applied Numerical Methods for Engineers and Scientists" Prentice hall,Upper saddle River , NJ 2001
6. Francis Vanek, Louis D. Albright," Energy systems Engineering" McGraw- Hill bookCompany, N.Y 2008
7. "Power System Engineering" 2nd Ed.D.P Kothari, I.J. Nagrath, Tata MaGraw- Hill Co2008.

Remote Sensing and GIS for Renewable Energy Planning (HRET - 313)

L: T: P: 3 0 0 **Credits: 3**

Course Objective

This course is design to make students aware about GIS integration for renewable energy systems.

Course Outcomes

On successful completion of this course, students should be able to:

CO1: Understand the fundamentals of remote sensing

CO2: Aware of Pre-processing and enhancement

CO3: Understand the fundamentals of GPS, digitization and layers creation

CO4: Aware of managing data errors

CO5: Implement RS&GIS based case study for development of renewable energy projects

UNIT – I

Remote sensing: introduction, satellite platforms and sensors, data acquisition, Indian satellite system, Application of Drone in data acquisition, Satellite image: format, resolution, multispectral images, image processing software, geo-referencing.

UNIT – II

Pre-processing and enhancement. information extraction: supervised and unsupervised classification, Geographical information system: introduction, components, coordinate system, projection system, Data sources and data collection for renewable energy projects: field survey, topographic maps, satellite images.

UNIT – III

GPS, digitization and layers creation, Data types – spatial, non-spatial, vector and raster data, topological relationship, Data base development for renewable energy projects: database structure, editing, data retrieval and query.

UNIT – IV

Managing data errors: rubber sheeting, edge matching and removal of sliver polygon, Digital elevation model: characteristics, DEM generation, parameters extraction from DEM, Renewable energy projects data analyses – overlay analyses.

UNIT – V

Buffering, neighborhood operation, and distance and area measurement, network based analysis, RS&GIS based case study for development of renewable energy projects.

References

1. Weng, Q. (Ed.). (2016). Remote Sensing for Sustainability. Crc Press.
2. Nastasi, B., & Majidi Nezhad, M. (2021). GIS and Remote Sensing for Renewable Energy Assessment and Maps. Energies, 15(1), 14.
3. Gemelli, A., Mancini, A., Diamantini, C., & Longhi, S. (2013). GIS to Support Cost-effective Decisions on Renewable Sources: Applications for low temperature geothermal energy. Springer Science & Business Media.
4. Weng, Q. (2010). Remote sensing and GIS integration.

Solar Energy and Applications (HRET - 304)

L: T: P: 3 1 0 **Credits: 4**

Course Objective

- To discuss the aspects of solar radiation to enable learners to analysis and estimate solar radiation at different location.
- To discuss theories and parameters for designing solar energy system
- To dissipate the knowledge for estimating different losses in solar energy systems.

Course Outcomes

On successful completion of this course, students should be able to:

CO1: Understand the fundamentals of solar energy

CO2: Implement the solar energy conversion using collectors

CO3: Aware of collector designs

CO4: Use simulation software in solar system designs

CO5: Understand the fundamentals of solar photovoltaics

UNIT – I

Solar radiation: Extra-terrestrial and terrestrial radiation; Earth-Sun relation: Solar angles, Sun path diagram; Shadow determination, Solar spectrum, Effect of earth atmosphere on solar radiation, Measurement and estimation of solar radiation on horizontal and tilted surfaces, Solar radiation measurement devices, Solar radiation data analysis.

UNIT – II

Solar thermal conversion: Theory and Basics; Introduction to different solar thermal energy systems: Solar flat plate collector, Concentrating collector, Solar cooker, Solar pond, Solar passive heating and cooling system.

UNIT – III

Design and components and flat plat collector; Flat plate collectors-liquid and air type; Development of solar thermal collectors; Solar cooling and refrigeration; Concentrating solar collector: optical design of concentrators, solar water heaters, solar dryers; Solar thermal power generation and economics; Solar Energy Mission

UNIT – IV

Simulation in Solar Process Design- TRANSYS- Design of active systems- f chart methods for liquid and air heaters- phi bar, of chart method - sensible, latent heat and thermo-chemical storage-pebble bed etc. materials for phase change- Glauber's salt-organic compounds –solar ponds.

UNIT V

Photovoltaic: Principle of photovoltaic conversion; Solar cell basics and materials; Different solar cell technologies: Crystalline silicon solar cell, Thin Film solar cell, Tandem solar cell; Photovoltaic system: Component and configurations; off grid and grid connected PV systems, PV system design and economics.

Solar Photo-catalysis: Solar photo-catalysis mechanism, kinetics and application.

References

1. Duffie J. A. and Beckman W. A. (2013); Solar Engineering of Thermal Processes, John Wiley
2. Solanki C. S. (2009); Solar Photovoltaics: Fundamentals, Technologies and Applications, Prentice Hall India Page | 9
3. Garg H. P. and Prakash S. (2000); Solar Energy: Fundamental and Application, Tata McGraw Hill
4. Nayak J. K. and Sukhatme S. P. (2006), Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw Hill
5. Goswami D. Y. (2015); Principles of Solar Engineering, Taylor and Francis
6. Green M. (1992), Solar Cells: Operating Principles, Technology and System Applications Springer
7. Tiwari G. N. (2002); Solar Energy: Fundamentals, Design, Modeling and Applications, Narosa

8. Edward E. Anderson, "Fundamentals for Solar Energy Conversion", Addison Wesley pub CO.,1983.
9. Fank Kreith, Jan F.Kreider, Principles of Solar Engg", 1978.
10. Koushika M.D," Solar Energy Principles and Applications", IBT publications and distributors, 1988.

Renewable Energy Technologies (HRET - 305)

L: T: P: 3 1 0 **Credits: 4**

Course Objective

- Describe the fundamentals and main characteristics of wind, small hydro, fuel cell, geothermal energy and other new renewable energy technologies

Course Outcomes

At the end of the course learner will be able to

CO1: Develop basic knowledge about Wind energy conversion Technology and its terminologies.

CO2: Design and assess the small wind turbine and its performance.

CO3: Enumerate the Small mini Hydro plants for Energy generation.

CO4: Selecting the Hydro power plant capacity for the given circumstances.

CO5: Develop the basic technological idea about various New & Renewable energyconversion Technology.

UNIT – I

Wind Energy Conversion - Wind energy conversion principles; General introduction; Types and classification of WECS; Power, torque and speed characteristics. – Site Selection Criteria – Advantages – Limitations – Wind Rose Diagram – Indian Wind Energy Data – Organizations like NIWE etc., Wind Energy Conversion System - Design – Aerodynamic design principles; Aerodynamic theories; Axial momentum, blade element and combine theory; Rotor characteristics; Maximum power coefficient; Prandlt's tip loss correction.

UNIT – II

Design of Wind Turbine - Wind turbine design considerations; Methodology; Theoretical simulation of wind turbine characteristics; Test methods. Wind Energy Application – Wind pumps: Performance analysis, design concept and testing; Principle of WEG; Stand alone, grid connected and hybrid applications of WECS; Economics of wind energy utilization; Wind energy in India; Case studies.

UNIT – III

Small Hydropower Systems - Overview of micro, mini and small hydro systems; Hydrology; Elements of pumps and turbine; Selection and design criteria of pumps and turbines; Site selection and civil works.

UNIT – IV

Speed and voltage regulation; Investment issues load management and tariff collection;Distribution and marketing issues: case studies; Potential of small hydro power in India. –SHP – Renovation and Modernization – Testing Methods

UNIT – V

OTEC- Tidal Energy- Geothermal- MHD - Thermionic- Thermoelectric energy conversion system- Fuel Cells – Batteries – Micro Alge – Biodiesel from Alge

References

1. G L Johnson, Wind Energy Systems, Prentice Hall Inc, New Jersey, 1985.
2. David A. Spera, (Editor) Wind Turbine Technology: Fundamental Concepts of Wind Turbine Engineering, American Society of Mechanical Engineers; (1994)
3. Erich Hau, Wind Turbines: Fundamentals, Technologies, Application and Economics, Springer Verlag; (2000)
4. Paul Gipe , Karen Perez, Wind Energy Basics: A Guide to Small and Micro Wind Systems, Chelsea Green Publishing Company; (1999)
5. J. F. Manwell, J. G. McGowan, A. L. Rogers, Wind Energy Explained, John Wiley &Sons; 1st edition (2002)
5. Tony Burton, David Sharpe, Nick Jenkins, Ervin Bossanyi, Wind Energy Handbook ,John Wiley & Sons; 1st edition (2001)
6. Mukund R. Patel, Wind and Solar Power Systems , CRC Press; (1999)
7. Tong Jiandong(et al.) , Mini Hydropower , John Wiley, 1997
8. John F. Walker and Nicholas Jenkins, Wind Energy Technology, John Wiley, 1997

Modeling and Simulation Lab (HREP - 303)

L: T: P: 0 0 3 **Credits: 1**

Course Objective

- To develop experimental skills for energy related measurements and experiments.
- To understand the practical utilities of the different theories of energy component and system.
- To develop the skill for using different simulation software for energy system performance analysis

List of Experiments

Main content (Matlab, OrCAD, PSpice, PSCAD, EMTDC, DigSILENT, ANSYS and EMTP – applications in electric power system, SPV system and solar/bio thermal systems)

1. Integration Techniques: Trapezoidal method, Simpson's 1/3 rd rule, Simpson's 3/8 rule

2. Finding root of Arithmetic Equation

3. Optimization Techniques

4. LPP methods

5. Transportation problems.

6. Image process of Bio gasification process

7. Energy system Simulation: Photovoltaic system performance analysis using PVsystem simulation tool

8. Hybrid energy systems using HOMER simulation tool

9. Building design and thermal performance analysis using TRANSYS simulation tool

Renewable Energy Lab (HREP - 304)

L: T: P: 003 Credits: 1

Course Objective

To carry out the performance evaluation of solar thermal, solar photovoltaic and wind energy conversion devices.

List of Experiments

1. Study on green house effect on solar flat plate collector
2. Estimation of instantaneous efficiency of a solar liquid flat plate collector
3. Study on solar flat plate collector in series and parallel combination
4. Estimation of efficiency of solar air heaters
5. Estimation of efficiency of solar still
6. Performance evaluation of concentrating solar collector
7. Performance evaluation of solar cooker
8. Estimation of efficiency of solar photovoltaic panels
9. Effect of Shadow & tilt angle on solar photo voltaic panel
10. Study on solar photo voltaic panel in series and parallel combination
11. Study on charging characteristics of a lead acid battery using solar photo voltaic panel.
12. Performance Evaluation of Wind Electric Generator
13. Performance Evaluation of Wind Water Pumping System
14. Study on Grid Integration of Wind Electric Generator

Hydro-Mechanical Equipment (HRET - 314)

L: T: P: 3 1 0 **Credits: 4**

Course Objective

To provide students with a comprehensive understanding of the principles, design methodologies, and practical applications of hydro-mechanical equipment used in hydropower projects.

Course Outcomes

At the end of this course the students will be able to:

CO1: Understand the fundamental principles of fluid mechanics as applied to hydro-mechanical equipment.
CO2: Analyze the design considerations and factors affecting the efficiency and performance of hydro-mechanical systems.
CO3: Demonstrate knowledge of different types of hydro-mechanical equipment and their applications.
CO4: Design and evaluate hydro-mechanical equipment for specific engineering purposes.

UNIT – I

Importance of hydro-mechanical equipment in water management, Historical development, Overview of common types of equipment and their functions, Properties of fluids and their behavior in hydro-mechanical systems, Fluid statics and dynamics, Bernoulli's equation, Flow measurement techniques and hydraulic losses.

UNIT – II

Hydraulic Turbines: Classification and working principles, Components of impulse and reaction turbines, Design concepts of hydro turbines, Specific speed, Performance characteristics and efficiency analysis geometric similarity, main characteristic and operating characteristic curves, Hill curves. Model Testing, Performance testing of turbines at site, Cavitation, Silt erosion and their combined effect.

UNIT – III

Governing of Turbines, mechanical and electro-mechanical governors, electronic load controller, Selection of hydro turbines based on specific speed and their optimal selection, Operation & Maintenance, Turbine selection for small & micro-hydropower.

UNIT – IV

Centrifugal Pumps, Energy conversion, Types, Characteristics, Pump performance curves and system analysis, Pump selection, sizing, and operational considerations, Hydraulic Scaling, Pump-as-Turbine, Pump mode and Pump running in Reverse mode, Turbine performance of pump.

UNIT – V

Penstock and its types, Design of Penstock, Diameter & thickness, Penstock Alignment, Moody Diagram, Hydraulic Gates, Application of gates in open channels, Hydraulic valves, Hoisting arrangement, Requirement, Hoist mechanism& components, Hoisting arrangement, Cranes

References

1. Lal, J., "Hydraulic Machines", 3rd edition (reprint), Metropolitan Book Co. Private Limited
2. Nigam, P.S., "Handbook of Hydroelectric Engineering", Nem Chand and Brothers
3. Warnick, C.C., 'Hydropower Engineering', Prentice-Hall Inc., Enlewood Cliffs, New Jersey, 1984
4. Singal, S.K., Small Hydropower: Design & Analysis, Elsevier, 2023.
5. Roger Kinsky, "Fluid Mechanics Advanced Applications", McGraw-Hill Education Europe, 1997

Instrumentation for Small Hydro Power Station (HRET - 315)

L: T: P: 3 1 0 **Credits: 4**

The course is designed to familiarize the student with the functions and instrumentation available in a modern power generation plant.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Understand the fundamental of transducers and their applications

CO2: Understand the principle for electronic voltmeters used in power plant

CO3: Understand the fundamentals of sensors and actuators

CO4: Understand the measurement of self-inductance

CO5: Understand the principle of turbine-controlling speed

UNIT I

Industrial instrumentation, transducers and their applications; Instrumentation for power system, analog and digital instruments, principles of measurement of voltage, current and power.

UNIT II

Electronic voltmeters for non-sinusoidal voltages, dc voltmeter, mechanical and electrical tachometer, altimeter; Current transformers and potential transformers, AC/DC current probs; Digital instrumentation.

UNIT III

Technology of regulators, sensors and actuators, recorders, signal processing circuits, data acquisition system; Types of a.c. bridges, equation for bridge balance.

UNIT IV

Measurement of self-inductance, capacitance, mutual inductance and frequency; Case study of the instrumentation scheme used in small hydro power development.

UNIT V

Turbine – Monitoring and Control Speed, vibration, shell temperature monitoring and control – Steam pressure control – Lubricant oil temperature control – Cooling system.

References

1. Sam G. Dukelow, 'The Control of Boilers', Instrument Society of America, 1991.

2. P.K. Nag, 'Power Plant Engineering', Tata McGraw Hill, 2001.

3. S.M. Elonka and A.L. Kohal, 'Standard Boiler Operations', Tata McGraw Hill, New Delhi,1994.

4. R.K.Jain, 'Mechanical and Industrial Measurements', Khanna Publishers, New Delhi, 1995.

5. E.Al. Wakil, 'Power Plant Engineering', Tata McGraw Hill, 1984.

Ground Water Hydrology and Management (HRET - 316)

L: T: P: 3 1 0 **Credits: 4**

Course Objective

To introduce the students to the application of management models to estimate the ground water quantity and qualities. After the completion of the course, the student should able to understand the inputs, system parameters, policy, variables and outputs of a groundwater management models.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Understand the fundamentals of ground water prospects

CO2: Implement the groundwater flow model

CO3: Implement the contaminant transport model

CO4: Understands the aquifer system

CO5: Implement groundwater management models

UNIT I

GROUND WATER PROSPECTING

Investigation and evaluation – Geophysical methods- Electrical Resistivity methods – Interpretation of data – Seismic method – Subsurface investigation – Test drilling – Resistivity logging – Application of remote sensing techniques.

UNIT II

GROUND WATER FLOW MODEL

Physical models – Analog models – Mathematical modeling – Unsaturated flow models Numerical modeling of groundwater flow – Finite difference equations and solutions – Successive over Relaxation, Alternating direction implicit procedure – Crank Nicolson equation – Iterative methods -Direct methods - Inverse problem – Finite element method

UNIT III

CONTAMINANT TRANSPORT MODEL

Contaminant transport theory – Advection, dispersion equation – Longitudinal and transverse dispersivity – Hydrodynamic dispersion – Analytical models – Numerical simulation of solute transport– Solution methods - Sorption model – Density driven flow - Heat transport.

UNIT IV

MODEL APPLICATIONS

Data requirements – Conceptual model design : Conceptualization of aquifer system – Parameters, Input-output stresses, Initial and Boundary conditions - Model design and execution: Grid design, Setting boundaries, Time discretization and Transient simulation – Model calibration : steady state and unsteady state – sensitivity analysis – Model validation and prediction – Uncertainty in the model prediction.

UNIT V

GROUNDWATER MANAGEMENT MODELS

Optimal groundwater development – Indian GEC norms – Conjunctive use models Modeling multilayer groundwater flow system -Modeling contaminant migration – Modeling fracture flow system – Artificial recharge feasibility through modeling – Simulation of movements of solutes in unsaturated zone – Stochastic modeling of groundwater flow - Groundwater contamination, restoration and management

References

1. Anderson M.P., and Woessner W.W., "Applied Groundwater Modelling : Simulation of flow and advective transport", Academic Press, Inc., 1992
1. Fetter C.W., "Contaminant Hydrogeology", Prentice Hall, 1999
2. Rushton K.R., "Groundwater Hydrology" : Conceptual and Computational Models, Wiley, 2003
3. Elango L. and Jayakumar, R. "Modelling in Hydrology", Allied Publishers Ltd., 2001
4. Remson I., Hornberger G.M. and Moltz F.J., "Numerical Methods in Subsurface Hydrology", Wiley, New York, 1971

5. Robert Willis and William W.G.Yenth, "Groundwater System Planning and Management", Prentice Hall, Englewood Cliffs, New Jersey, 1987.
6. "Groundwater Hydraulics and Pollutant Transport", Randall J.Charbeneau, Printice Hall, 2000
7. A.K. Rastogi, "Numerical Groundwater Hydrology", 2011

Water Power and Dam Engineering (HRET - 317)

L: T: P: 3 1 0 **Credits: 4**

Course Objective

- The student is exposed to the design aspects of hydro-power plants, various components of hydropower plants and their layout.
- Different types of dams design taking into account the suitability of the site and the different type loads that are likely to be encountered.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Understand the developments in hydroelectric power

CO2: Understand the design of hydro power installation

CO3: Aware about the different types of power house

CO4: Understand about the embankment dam engineering

CO5: Understand about the concrete dam engineering

UNIT I

HYDROELECTRIC POWER DEVELOPMENT

Introduction – Types of power development – Classification. Planning – Environmental Considerations - Data requirement for assessment of hydropower. Components of hydropower.

UNIT II

DESIGN OF HYDROPOWER INSTALLATION

Components – Intake structure – water conductor systems – tunnels – surge tanks – penstocks – valves – anchor blocks.

UNIT III

TYPES OF POWER HOUSE

Underground – semi-underground. Turbines and their foundations – structural and geotechnicalaspects of power house design.

UNIT IV

EMBANKMENT DAM ENGINEERING

Introduction. Nature and classification of engineering soils. Principles of design. Materials and construction. Internal seepage. Stability and stress. Settlement and deformation. Rock fill and rock fillembankments.

UNIT V

CONCRETE DAM ENGINEERING

Loading: Concepts and criteria. Gravity dam analysis. Buttress dam analysis. Arch dam analysis. Design features and construction. Concrete for dams. Roller Compacted Concrete (RCC) Dams. Dam safety and instrumentation. Foundation measurements. Analysis of strain data.

References

1. Novak, P., Moffat, A.I.B., Nalluri, C. and Narayanan, R. Hydraulic Structures Unwin Hyman Ltd., London 1989.
2. Dandekar, M.M. and Sharma, K.N. Water Power Engineering Vikas Publishing House, New Delhi 1994.
3. USBR Design of Small Dams Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi 1974.
4. Sharma, H.D. Concrete Dams Metropolitan New Delhi 1981
5. Varshney, R.S. Concrete Dams Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi 1982.
6. Varshney, R.S. Hydro Power Structures – Nem Chand Bros. Roorkee 1973 Guthrie, Brown J. (ed) Hydro Electric Engineering Practice Blackie and Son, Glasgow 1970.

Energy Conservation and Management (HRET - 318)

L: T: P: 3 0 0 **Credits: 3**

Course Objective

To apply energy conservation principles and management techniques to different energy conversion systems

Course Outcomes

After learning the course, the students should be able to:

CO1: Outline energy scenario, audit and management.

CO2: Apply energy conservation policy, regulations in industrial practices.

CO3: Evaluate energy economics.

CO4: Identify opportunities for rational use of energy.

CO5: Analyze electrical systems for energy conservation.

UNIT I

Energy Scenario:

Introduction to energy & power scenario of world, National Energy consumption data and environmental aspects associated with energy utilization; Energy Auditing- need, types, methodology and barriers, role of energy managers, instruments of energy auditing.

UNIT II

Energy Conservation Act 2001 and related policies:

Energy conservation Act 2001 and its features, notifications under the Act, Schemes of Bureau of Energy Efficiency (BEE) including Designated consumers, State Designated Agencies, ECBC code for Building Construction.

Financial Management:

Energy Economics- discount period, payback period, internal rate of return, netpresent value; Life Cycle costing- ESCO concept.

UNIT III

Energy Monitoring and Targeting:

Defining monitoring & targeting, elements of monitoring & targeting, data andinformation-analysis, techniques – energy consumption, production, cumulativesum of differences (CUSUM).

UNIT IV

Energy Conservation in Electrical Utilities :

Components of EB billing, HT and LT supply, transformers, cable sizing; Concept of capacitors, power factor improvement, harmonics; Electric motors motor efficiency computation, energy efficient motors; Illumination- Lux, Lumens, types of lighting, efficacy, LED lighting and scope of energy conservation in lighting.

UNIT V

Energy Efficiency in Thermal Utilities and systems:

Thermal systems, Boilers, Furnaces, Heat exchangers and Thermic Fluid heaters- efficiency computation and energy conservation measures; Steam distribution and usage, steam traps, condensate recovery, flash steam utilization; Insulation & Refractories. Energy conservation in major utilities; pumps, fans, blowers, compressed air systems, Refrigeration& Air Conditioning systems, Cooling Towers, DG sets.

References

1. Witte L.C., Schmidt P.S. and Brown D.R., “Industrial Energy Management and Utilization”, Hemisphere Publ., Washington, 1988..
2. Callaghan P.W., “Design and Management for Energy Conservation”, Pergamum Press, Oxford
3. Murphy W.R. and McKay G., “Energy Management”, Butterworth’s, London, 1987.
4. Bureau of Energy Efficiency, “Energy Manager Training Manual”, Reference book No:1 to 4.
5. Dale R Patrick, Stephen W Fardo, “Energy Conservation Guidebook”, 2nd Edition, CRC Press.
6. Shobh Nath Singh, "Non-Conventional Energy Resources", Pearson Education India; Firstedition (2015).

Energy Audit and Instrumentation (HRET - 319)

L: T: P: 3 0 0 **Credits: 3**

Course Objective

- To understand energy efficiency, scope, conservation and technologies.
- To design energy efficient lighting systems.
- To estimate/calculate power factor of systems and propose suitable compensation techniques.
- To understand energy conservation in HVAC systems.
- To calculate life cycle costing analysis and return on investment on energy efficient technologies.

Course Outcomes

After the completion of the course the student should be able to:

CO1: explain energy efficiency, conservation and various technologies.

CO2: design energy efficient lighting systems.

CO3: calculate power factor of systems and propose suitable compensation techniques.

CO4: explain energy conservation in HVAC systems.

CO5: calculate life cycle costing analysis and return on investment on energy efficient technologies.

UNIT I

Energy consumption – world energy reserves – prices – alternative sources – power – energy policies – choice of fuels.

Energy conservation schemes: Short term – Medium term – Long term energy conservation schemes – Industrial energy use – Energy index – Cost index.

Representation of energy consumption: Pie charts – Sankey diagrams – Load Profile.

Energy auditing: General Auditing, Detailed Energy Audit.

UNIT II

Heat – Heat content – Rate of heat transfer – Heat transfer coefficient – Conduction – Convention and radiation. Thermal insulation & its importance – space heating – HVAC system – Heating of Buildings – District heating – Factors & affecting the choice of district heating.

UNIT III

Digital Energy Meter – Data loggers – Thermo couples – Pyranometer – Lux meters – Tong testers – Power analyzers – Power factor – effects with non-linear loads – effect of harmonics on power factor – Power Factor Improvement – Capacitor rating – Effects of power factor improvements – Electric lighting – Types of lighting – Luminaries – Energy efficient lighting.

UNIT IV

Costing Techniques – cost factors – break-even charts – sources of capital and hire charges – capital recovery – depreciation – budgeting and standard costing – charging energy – cash flow diagrams and activity charts.

UNIT V

Financial appraisal and profitability: investment decision- methods of investment appraisal- discounted cash flow – summary of investment appraisal techniques – Cost optimization – optimization with one variable – optimization with more than one variable.

References

1. Electric Energy Utilization and Conservation by S C Tripathy, Tata McGraw hill publishing company Ltd. New Delhi.

2. Energy management by Paul o' Callaghan, Mc–Graw Hill Book company–1st edition,1998.

3. Energy management hand book by W.C.Turner, John wiley and sons.

4. Energy management and conservation –k v Sharma and pvenkataseshaiah-I KInternational Publishing House pvt.ltd, 2011.

5. Industrial Energy Management Systems by Arry C. White, Philip S. Schmidt, David R. Brown, Hemisphere Publishing Corporation, New York, 1994.

6. Fundamentals of Energy Engineering by Albert Thumann, Prentice Hall Inc, Englewood Cliffs, New Jersey, 1984.

7. Economic Analysis of Demand Side Programs and Projects – California Standard Practise Manual, June 2002 – Free download available online

Hydrogen Energy and Fuel Cell (HRET - 320)

L: T: P: 3 0 0 **Credits: 3**

Course Objective

- To impart knowledge on use of hydrogen for achieving sustainable growth and facilitate analysis of the challenges in transition to hydrogen economy.

Course Outcomes

After the completion of the course the student should be able to:

CO1: Understand and demonstrate the hydrogen production technologies, storage methods and strategies for transition to hydrogen economy.

CO2: Know the concepts and characteristics of various types of fuel cell.

CO3: Consist and demonstrate the working of fuel cells

CO4: Understand the polarization in PEMFC

CO5: Know the application of fuel cells with economic and environment analysis.

UNIT I

Introduction to hydrogen economy, production, storage and transportation systems, hydrogen from fossil fuels, electrolysis of water, thermo chemical cycles, transmission and infrastructure requirements, safety and environmental impacts, economics of transition to hydrogen systems.

UNIT II

Concept, key components, physical and chemical phenomena in fuel cells, advantages and disadvantages, different types of fuel cells and applications, characteristics.

UNIT III

Nernst equation, the relation of the fuel consumption versus current output. Stoichiometric coefficients and utilization percentages of fuels and oxygen, mass flow rate calculation for fuel and oxygen in single cell and fuel cell stack.

UNIT IV

Total voltage and current for fuel cells in parallel and serial connection, over-potential and polarizations, DMFC operation scheme, general issues-water flooding and water management, polarization in PEMFC

UNIT V

Fuel cell usage for domestic power systems, large scale power generation, automobile, space applications, economic and environmental analysis on usage of fuel cell, future trends of fuel cells.

References

1. Fuel cell Fundamentals, John Wiley and sons, Willey
2. Fuel cells: Principles and Applications, Viswanathan B and AuliceScibioh, University Press
3. Hydrogen – A fuel for Automatic Engines, Prashu kumar G P, ISTE
4. Fuel Cells: Theory and Applications, Hart A B and Womack G J, Chapman and Hall
5. Tomorrow’s Energy – Hydrogen Fuel Cells and the Prospects for Cleaner Planet, Peter Hoffman, MIT

Wind Energy Application Technology (HRET - 321)

L: T: P: 3 0 0 **Credits: 3**

Course Objective

- The course is designed to aware about the fundamentals of wind energy application technology.

Course Outcomes

On successful completion of this course, students should be able to:

CO1: Aware about the wind scenario in India

CO2: Understand the different types of wind turbines used commercially

CO3: Understand the fundamentals of regulating and control systems used in wind mills

CO4: Get knowledge of wind energy conversion system

CO5: Understand the cost estimation of wind energy conversion

UNIT I

Wind energy scenario in India, properties of wind, wind velocity and wind rose diagram, estimation of power in wind.

UNIT II

Types of wind turbines, characteristics, construction of wind mills. Aerodynamic considerations of wind mill design, wind stream profile, rotor blade profile and cross section.

UNIT III

Drive system-gears, wind electric generators, regulating and control systems for wind mills.

UNIT IV

Performance evaluation and recent technologies of wind energy conversion system.

UNIT V

Wind energy potential estimation and site selection; wind farms, cost estimation of the energy from wind energy conversion system.

References

1. Wind Energy Explained: Theory, Design, and Application, By James F. Manwell, Jon G. McGowan, and Anthony L. Rogers, Wiley; 2 edition (February 2010)
2. Wind Power Plants: Fundamentals, Design, Construction and Operation, Gasch, Robert, Twele, Jochen (Eds.) Springer-Verlag Berlin Heidelberg; 2 edition (2012)

OPEN ELECTIVES

Bio-Energy Engineering (HRET - 322)

L: T: P: 3 0 0 **Credits: 3**

Course Objective

- The course is designed to aware about the fundamentals of bio energy engineering technology.

Course Outcomes

On successful completion of this course, students should be able to:

CO1: Aware about the fundamentals of bio fuels

CO2: Classified the sources of bio energy

CO3: Aware of dry and wet fermentation process

CO4: Understand the thermos-chemical principle

CO5: Understand the concept of cogeneration in biomass processing industries

UNIT I

Bio fuels: types, Properties and sources- Bio fuels first, second and third generation production processes and technologies- Bio diesel comparison with diesel - Biofuel applications – Bio diesel and Ethanol as a fuel for I.C. engines - Relevance with Indian Economy - Bio-based Chemicals and Materials - Commercial and Industrial Products - Govt. Policy and Status of Bio-fuel technologies in India.

UNIT II

Biomass: Sources and Classification. – Properties - Energy plantation - Preparation of biomass.Size reduction- Briquetting of loose biomass - Drying, storage and handling of biomass.Conversion of biomass. Biomass processing for liquid and gaseous fuel production. Effect ofparticle size, temperature, on products obtained – Processing of various biomass for gasproduction for Thermal and Electrical application.

UNIT III

Feed stock for biogas production, animal residues, Aqueous wastes containing bio degradable organic matter- Microbial and biochemical aspects- factors and operating parameters for bio gasproduction-Kinetics and mechanism-Dry and wet fermentation. Digesters-types-digesters forrural application – High rate digesters for industrial waste water treatment

UNIT IV

Thermo chemical Principles: Effect of pressure, temperature and introducing, steam and oxygen.Design and operation of fixed and fluidized bed Gasifier, circulating fluidized bed gasifiers, Safety aspects, operating characteristics of moving bed and fluidized bed gasifier- different types- advantages and disadvantages- performance analysis of gasifiers.

UNIT V

Combustion of woody biomass – theory, calculations and design of equipment’s, Cogeneration inbiomass processing industries. – Economic Case studies: Combustion of rice husk. Use of bagasse for cogeneration.

References

1. Chakraverthy A, “Biotechnology and Alternative Technologies for Utilisation of Biomass or Agricultural Wastes”, Oxford & IBH publishing Co, 1989.
2. Mittal K.M “ Biogas Systems : “Principles and Applications” New age international publishers (P) Ltd, 1st Jan 1997
3. Nijaguna, B.T Biogas Technology, New age International publishers (P) Ltd
4. Venkata Ramana P and Srinivas S.N, “Biomass Energy Systems”, ISBN 81-85419- 25-6, Tata Energy Research Institute, 1996.
5. Klass D.L and Emert G.M, “Fuels from Biomass and Wastes”, Ann Arbor Since Publ. Inc.Michigan, 1985.
6. O.P.Chawla, “Advances in Bio-gas Technology” I.C.A.R., New Delhi, 1970.

STATISTICAL TOOLS FOR DATA ANALYSIS (HRET - 323)

L: T: P: 3 0 0 **Credits: 3**

Course Objective

- The course is designed to aware about the different statistical tools used for analysis of data.

Course Outcomes

On successful completion of this course, students should be able to:

CO1: Understand the different types of research

CO2: Aware of offline search

CO3: Understand the statistical fundamentals

CO4: Understand the cure fitting and regression analysis

CO5: Understand and implement the error analysis

UNIT I

Objectives – types: descriptive, analytical, applied fundamental, quantitative, qualitative, conceptual, empirical – approach – significance – methods – process – Research design – need –concepts – sampling design.

UNIT II

Offline search: Abstracts-subject index, author index, formula index and other indices-examples current. Contents – organization – titles and index. On line Search: Computer browsing for literature search and down loading-basics of internet services-sources of abstracts, articles for browsing for literature search and down loading – basics of internet services-sources of abstracts, articles for browsing and downloading, technique for conversion form one format to another.

UNIT III

The seven tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma, New seven Management tools.

UNIT IV

Treatment and interpretation of engineering data. Curve fitting non linear least square regression. Tests of significance – test of hypothesis, chi square test, analysis of variance and covariance. Introduction to factorial designs- 2^k factorial designs, introduction-Blocking and confounding in two level factorial designs- 2^{k-p}fractional factorial designs, introduction -Random factors in experiments - Random factors in factorial experiments, mixed models.

UNIT V

Types of errors-Precision and accuracy-Statistical tests on the accuracy of results-Binomial distribution-Gaussian distribution T-tests, Comparison of precision of two methods by test.

References

1. C.R.Kothari, Research Methodology – Methods and techniques, Wishwa Prakashan, New Delhi,third edition, new age publisher,2014.
2. Design and Analysis of Experiments, by D.C. Montgomery, John Wiley & Sons, New York, 8 th edition, 2013
3. W.I.Cochron, ‘Statistical methods’, Oxford and IBH publishers.
4. http://www.sciencedirect.com/science/journal
5. James R.Evans & William M.Lidsay, The Management and Control of Quality, (5thEdition), South-Western (Thomson Learning), 2002 (ISBN 0-324-06680-5

Waste to Energy (HRET - 324)

L: T: P: 3 0 0 **Credits: 3**

Course Objective

The course deals with the production of energy from different types of wastes through thermal, biological and chemical routes. It is intended to help the young scientist professionals to keep their knowledge upgraded with the current thoughts and newer technology options along with their advances in the field of the utilization of different types of wastes for energy production.

Course Outcomes

At the end of this course, the student will be able to

CO1: Define and explain important concepts in the field of waste management, such as waste hierarchy, waste prevention, recirculation, municipal solid waste etc.

CO2: Suggest and describe suitable technical solutions for biological and thermal treatment of the waste. The student should also be able to discuss the drawbacks and prerequisites for a chosen solution.

CO3: Formulate protocol to convert agricultural waste into energy also discuss the various techniques to describe the waste to energy conversion system.

CO4: Discuss social aspects connected to handling and recirculation of waste from a local as well as global perspective.

CO5: Analyze and describe the potential as a secondary raw material, and thereby associated problems.

UNIT I

Introduction to energy from waste: characterization and classification of waste as fuel – Agro based, characterization of wastes, forest residues, industrial waste, Municipal solid waste.

UNIT II

Waste to energy options: Energy production form wastes through incineration, combustion (unprocessed and processed fuel), gasification, anaerobic digestion, fermentation, pyrolysis, Energy production from wastes through fermentation and transesterification.

UNIT III

Conversion devices: Combustors (Spreader Stokes, Moving grate type, fluidized bed), gasifier, digesters. Briqueting technology: Production of RDF and briquetted fuel. Properties of fuels derived from waste to energy technology: Producer gas, Biogas, Ethanol and Briquettes, Comparison of properties with conventional fuels.

UNIT IV

Energy production from organic wastes through anaerobic digestion and fermentation, Introduction to microbial fuel cells, Densifications of solids, efficiency improvement of power plant and energy production from waste plastics.

UNIT V

Power generation using waste to energy technologies: Cl and Sl engines, IGCC and IPCC concepts, Landfills: Gas generation and collection in landfills, Environmental monitoring system for land fill gases, Environmental impacts; Measures to mitigate environmental effects due to incineration, Introduction to transfer stations.

References

1. M.M. EL-Halwagi, Biogas Technology- Transfer and diffusion, Elsevier Applied science Publisher, New York, 1984.
2. D.O Hall and R.P. Overeed, Biomass – regenerable energy, John Willy and Sons Ltd. New York. 1987.
3. Fay JA, Golomb DS. Energy and Environment, Oxford University Press (2002).
4. Brown RC and Stevens C, Thermo-chemical Processing of Biomass: Conversion into Fuels, Chemicals and Power, Wiley and Sons (2011).

Industrial Safety (HRET - 325)

L: T: P: 3 0 0 **Credits: 3**

Course Objective

Students will be able to recognize and evaluate occupational safety and health hazards in the workplace, and to determine appropriate hazard controls following the hierarchy of controls. Students will furthermore be able to analyze the effects of workplace exposures, injuries and illnesses, fatalities and the methods to prevent incidents using the hierarchy of controls, effective safety and health management systems and task-oriented training.

Course Outcomes

At the end of this course, the student is able to

CO1: Evaluate workplace to determine the existence of occupational safety and health hazards. Also describes the different safety considerations.

CO2: Identify the scope of maintenance engineering along with best practices that are applicable.

CO3: Understand the wear and corrosion analysis of different industrial equipment and various types of maintenance.

CO4: Analyze the fault tracing-concept and importance of decision tree concept. Also study about the different industrial equipment.

CO5: To understand the periodic and preventive maintenance to avoid the industrial hazards.

UNIT I

Industrial Safety: Accident, causes, types, results and control, mechanical and electrical hazards, 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, Service life of equipment.

UNIT III

Wear and Corrosion and their Prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, 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 for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, 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 electrical motor, 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 of: i. Machine tools, ii. Pumps iii. Air compressors, iv. Diesel generating (DG) sets, 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.