ENGINEERING PROFESSIONAL PRACTICE

BEG456CI

Year : IV **Semester:VIII**

Teaching Schedule Hours/week			Examination Scheme				Total Marks	Remarks
			Final		Internal Assessment			
L	P	T	Theory	Practical	Theory	Practical		
2	-	-	40	0	10	-	50	

Final Exam Duration: 3hrs

Course Objective:

To familiarize the students with their roles in the society, ethical and legal environment in which engineering is practiced, contract administration, regulatory environment and contemporary issues in Engineering.

1. **History of Engineering Practices** **(3 hours)**

   1.1 Man and Society
   1.2 Technology and Society
   1.3 History of Engineering Practice in Eastern Society
   1.4 History of Engineering Practice in Western society
   1.5 Engineering Practices in Nepal

2. **Profession and Ethics** **(6 hours)**

   2.1 Profession: Definition and Characteristics
   2.2 Professional Institutions
   2.3 Relation of an Engineer with Client, Contractor and Fellow Engineers
   2.4 Ethics, Code of Ethics and Engineering Ethics
   2.5 Moral Dilemma and Ethical Decision Making
   2.6 Detailed Duties of an Engineer and Architect
   2.7 Liability and Negligence

3. **Professional Practices in Nepal** **(3 hours)**

   3.1 Public Sector practices
   3.2 Private Sector Practices
   3.3 General Job Descriptions of Fresh Graduates in both Public and Private Sector

4. **Contract Management** **(6 hours)**

   4.1 Methods of work execution/contracting
   4.2 Types of Contracts
   4.3 Tendering Procedure
   2.5 Contract agreement

3 **5. Regulatory Environment** **(5 hours)**

5.1 Nepal Engineering Council Act
5.2 Labor Law
5.3 Intellectual Property Right
5.4 Building Codes and Bylaws
5.5 Company Registration

6. **Contemporary Issues in Engineering** **(3 hours)**

   6.1 Globalization and Cross Cultural Issues
   6.2 Public Private Partnership
   6.4 Safety, Risk and Benefit Analysis
   6.4 Development and Environment
   6.5 Conflict and Dispute Management

7. **Case Studies based on Engineering Practices** **(4 hours)**

References:

1. Carson Morrison and Philip Hughes "Professional engineering Practice – Ethical Aspects", McGraw-Hill Ryerson Ltd.' Toronto.
2. Rajendra Adhikari, "Engineering Professional Practice – Nepalese and international Perspectives" Pashupati Publishing House, Kathmandu Nepal.
3. M. Govindarajan; S Natarajan and V.S. Senthikumar., " Engineering Ethics" – PHI Learning Pvt. Ltd. New Delhi.
4. Nepal Engineering Council Act
5. Contract Act
6. Labor Act
7. Company Act
8. Copyright Act
9. Public Procurement Act
10. Building By-Laws

Evaluation Scheme:

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table

Chapters	Hours	Marks Distribution*
1, 3	6	10
2	6	10
4	6	8
5 & 6	8	12
Total	25	40

* There may be minor deviation in marks distribution.

HIGH VOLTAGE ENGINEERING
BEG425EL

Year : IV **Semester:VIII**

Teaching Schedule Hours/week			Examination Scheme		Internal Assessment		Total Marks	Remarks
			Final					
L	P	T	Theory	Practical	Theory	Practical		
3	-	1	80	-	20	-	100	

Duration: 3 hrs.

Course Objectives:

To provide knowledge for

- different causes and types of over voltages
- breakdown mechanisms for gaseous, liquid and solid dielectrics
- HVAC/HVDC and impulse testing of Insulation
- safety against high voltage

1. **Evolution of power system** **(6 hours)**
   1.1 Classification of High voltages
   1.2 Emerging Trends in Power Systems
   1.3 High voltage AC and HVDC systems
   1.4 Basic introduction to FACTS devices
   1.5 High voltage power cables: AC and DC
2. **Over voltages in power system (10 hours)**
   2.1 Classification of over voltages; temporary and transient over voltages, internal and external over voltages
   2.2 Temporary Over Voltage ; Unsymmetrical faults in the system, High capacitance of long EHV lines, Ferro-resonance, Load rejection, effective grounding, shunt compensations
   2.3 Switching over voltages; switching surge ratio, Energizing an unloaded transmission line, De-energizing the transmission line, Interruption of capacitive current by circuit breaker, Current chopping by Circuit breaker, Ferro Resonance, countermeasure to reduce switching over voltages
   2.4 Lightning over voltages; lightning phenomena, direct and indirect lightning strokes, effect of ground wire and tower footing resistance in lightning over voltages
   3.5 Protection principle against lightning, lightning and surge arrestors, earth wire, grounding mast
4. **3. Insulation coordination:** **(5 hours)**
   3.1 Basic Insulation level and basic switching level
   3.2 Insulation coordination to different equipments; transformers, bus structures, bushings, transmission lines;
   3.3 Insulation protection level for temporary, switching and lightning over voltages
   3.4 Surge protection: lighting and switching surge characteristics, horn gaps, grading rings, lighting arrestors
5. **4. High stress electric fields** **(10 hours)**
   4.1 Review of electromagnetic field theory : electrostatic potential difference, potential gradient, conducting and dielectric materials in electric fields, polarization, leakage conductance of dielectrics
   4.2 Electromagnetic fields near transmission lines; electromagnetic induction in neighboring facilities such as communication circuits, pipelines or railway tracks
   4.3 Evaluation of electric field distributions, manual and computer flux mapping and field calculations
   4.4 Corona and radio interference
   5. Dielectric breakdowns **(8 hours)**
   5.1 Electrical breakdown in gases: ionization and decay processes, high field cathodic emission, secondary ionization and breakdown, quenching, partial breakdown, the corona effect, polarity effects, surge effects
   5.2 Electrical breakdown in insulating liquids: chemical breakdown of liquids, presence of impurities, polar molecules and dielectric heating in ac field
   5.3 Electrical breakdown in solid materials: surface tracking and carbonization, air voids in solid insulating materials, effects of electrical stress concentration, polarization, energy losses and dielectric heating in ac fields
   6. Introduction to high voltage testing: **(6 hours)**
   6.1 Breakdown testing using high voltage ac and dc voltages and impulse voltages,
   6.2 Measurement of high AC, DC and Impulse voltages, standardization of testing procedures
   6.3 Non-destructive testing of insulations: leakage current, dielectric loss evaluation, partial discharge radio frequency sensing, impurity monitoring of liquid and gaseous insulating materials, insulations testing as routine maintenance procedures

References:

1. Kamaraju & Naidu, “ High voltage engineering”, Tata McGraw-Hill.
2. Rakosh Das Begmudre, “ Extra High voltage AC Transmission”, 2nd edition, New Age International, New Delhi.
3. Kuffel & Abdullah, “High Voltage Engineering”, Pergamon Press, 1970

4. Ravindra Arora and Wolfgang Mosch, “High voltage insulation engineering”, New Age International Publication.

Evaluation Scheme:
The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table

Chapters	Hours	Marks Distribution*
1	6	10
2	10	18
3	5	10
4	10	16
5	8	16
6	6	10
Total	45	80

* There may be minor deviation in marks distribution.

POWER PLANT DESIGN
BEG426EL

Year : IV **Semester:VIII**

Teaching Schedule Hours/week			Examination Scheme		Internal Assessment		Total Marks	Remarks
			Final					
L	P	T	Theory	Practical	Theory	Practical		
3	3	-	80	-	20	50	150	

Final Exam Duration: 3hrs

Course Objectives:

To study technical requirements and economic principles related to design of power plant, electrical systems, switchyards and plant design guidelines

1. **Energy Sources and electric power generation** **(8 hours)**
   1.1 Renewable and non-renewable energy sources, technology of geothermal, tidal, wind, solar thermal, solar photovoltaic, thermal, combustion, bio-thermal, combined cycle, gas turbine and hydro
   1.2 Operational characteristics of each of the technologies in power system on the basis of reliability, forced and scheduled outages, availability, on-grid and off-grid operation, operating range, maintainability
   1.3 Environmental aspects of each of the technologies, scope and feasibility in Nepalese context
   1.4 Co-generation, captive generation, distributed generation

2. **Integrated System Planning in design approach** **(5 hours)**
   2.1 Load forecast, system expansion planning, load uncertainties, system security, balancing load, reserve capacity, spinning reserve,
   2.2 Different technologies for stable system operation, benefits of interconnection of regional utilities

3. **Hydro Power plant design** **(8 hours)**
   3.1 Power Plant sitting, hydro-power plant selection, hydro-power plant design guidelines, civil structures and mechanical equipment, location and selection of civil structures
   3.2 Run of river (ROR), Pondage run of river (PROR), Reservoir and Pumping station – components , operation and characteristics
   3.3 Discharge exceedance (Q), Plant size and unit size, turbine selection, minimum river discharge and environmental mitigation measures of hydro-projects,

4. **4. Electric system design of a power plant** **(24 hours)**
   4.1 Electrical Single Line diagram, device symbols and numbers, generator and transformer schemes, scheme selection
   4.2 Generator and transformer specification, operation and maintenance viewpoint
   4.3 Governor and Excitation system, mode of operation, brushless and static excitation
   4.4 Protection systems for generator and transformer in different types of plants, generator neutral grounding, protection standards
   4.5 LV switchgear and station service, battery characteristics and battery charger operation, fire-fighting
   4.6 HV and MV Switchgear in power plants, HV switchyard, Switchyard scheme, bus layout, auxiliary and ancillary systems
   4.7 Fault level calculation
   4.8 Earthing system design of power station and sub-station
   4.9 Protection system design of generator
   4.10 Switchyard and synchronizing scheme
   4.11 Power evacuation & transmission line selection

Power Plant Design Laboratory

- Design of a hydro power plant – civil and mechanical components Analysis of hydrological data, topology, determination of discharge and head, site selection
- Selection of plant and unit size, selection and layout of hydraulic structures and approximate sizing, Turbine selection
- Design of a hydro power plant – electrical system design Generator and transformer selection, specification for procurement
- Fault level calculation for switchgear
- Earthing system – grid size and conductor size calculation, earth resistance calculation
- Protection system – connection diagram of generator protection, settings of generator over-current, differential, reverse power, loss of excitation, stator and rotor earth-fault relays
- Switchyard scheme design and layout design
- Auxiliary and Ancillary System

References:

1. Engineering and Design of Hydro electric Power Plants – US Army Corps of EngineersTechnical Manual – Electrical Power Plant Design – Department of the US Army.
2. Wilenbrock and Thomas 'Planning Engineering and Construction of electric Power Generating Facilities" John Wiley and Sons, New York.
3. Marsh 'Economics of Electric Utility power Generation", Clarendon Press
4. Dr.P.C. Sharma "Power Plant Engineering" S.K. Kataria and Sons, Delhi.
5. J.B. Gupta, "Generation and Economic Considerations", Kataria & Sons.
6. A K Raja, Amit Prakash Srivastava, Manish Dwivedi, "Power Plant Engineering", New Age International, M]New Delhi.
7. Deshpande, "Elements of Electrical Power Plant Design," Pitman and Sons

Evaluation Scheme:

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table

Chapters	**Hours**	**Marks Distribution***
1	8	18
2	5	12
3	8	18
4	24	32
Total	45	80

* There may be minor deviation in marks distribution.

POWER TRANSMISSION AND DISTRIBUTION DESIGN
BEG424EL

Year : IV **Semester:VIII**

Teaching Schedule Hours/week			Examination Scheme		Internal Assessment		Total Marks	Remarks
			Final					
L	P	T	Theory	Practical	Theory	Practical		
3	3	-	80	-	20	50	150	

Final Exam Duration: 3hrs

Course Objectives:

To address general matters of electrical power and energy demand load characteristics, technical requirements and economic principles related to design of transmission lines and distribution systems.

1. **1. Introduction** **(5 hours)**
1.1 Advantages of grid systems
1.2 Transmission line design & planning
1.3 Technical and economic comparison of ac and dc transmission
1.4 Physical structures of transmission lines: capacities, towers, size choices, insulation and protection against lightning, shielding, grounding, sagging and clearances
1.5 Right-of-way and other design and construction problems, terrain and weather implications
1.6 Transmission system design for Nepal

2. **2. Transmission voltage level and number of circuit selection** **(4 hours)**
2.1 Effect of voltage level in power and energy loss, conductor and insulator economy
2.2 Technical aspects of alternating current overhead lines: power and VAR transmission capability as functions of line length, line impedance and voltage level,
2.3 choice of voltage level for transmission for single and multiple circuit

3. **3. Overhead line insulator design** **(9 hours)**
3.1 Factors affecting insulator design
3.2 Air clearance computations, shield wires and tower grounding
3.3 Overhead line insulator material, types of overhead line insulators
3.4 Advantages of string insulators, string efficiency, string insulator configurations
3.5 Selection of overhead line insulators considering continuous operating voltage and over voltages

4. **4. Conductor & support structure selections** **(10 hours)**
4.1 Electrical, mechanical and economical requirements
4.2 Conductor material and preliminary size selection
4.3 Meeting electrical requirements; voltage regulation, efficiency, corona etc.
4.4 conductor choices, wire types and size, bundled conductors
4.5 economical size determination
4.6 Route selection for transmission lines
4.7 Surveying requirements for transmission line design and construction
4.8 mechanical aspects; tensioning and sagging, stringing chart, supports at unequal level
4.9 tower design: span selection, ground clearance, moments acting on tower and tower strength computation

5. Electric power Distribution **(4 hours)**
5.1 Underground and overhead lines systems
5.2 Radial and networked systems.
5.3 Distribution equipment: overhead lines, single phase and there phase cables, distribution transformers, switcher
5.4 Voltage levels, regulation, compensation
5.5 Urban and rural distribution system
5.6 Right-of-way, effects of terrain and weather and other construction problems
5.7 Distribution practices in rural and urban Nepal

6. Electrical loads Characteristics & Load forecast **(8 hours)**
6.1 Characterization of loads: domestic, commercial, industrial
6.2 Time dependence of electrical loads: load duration curves, load factor, daily variation, seasonal and annual variation, long and short term prediction of load, effects of conservation, effects of rates, diversity, load uncertainty
6.3 Characteristics of electric loads in Nepal
6.4 Load forecasting techniques, small area load forecast

7. Distribution system design **(5 hours)**
7.1 Load center selection
7.2 Selection of distribution transformer locations, their sizes and primary voltage level
7.3 selection of distribution line layout, distribution transformers, overhead lines and/or cables protection
7.4 evaluation of capital and operation costs

Practical:

A . Design of an overhead transmission line **(25 hour)**

1. Evaluation Of Electrical Requirements
2. Choice Of AC Or DC, Voltage Level, Conductors, Insulators
3. Route Selection Form Maps
4. Civil And Mechanical Engineering Aspects: Right-Of-Way, Tower Design, Tensioning, Sagging, Construction Aspects
5. Electrical performance: regulation, stability compensation, protection

B. Design of a distribution system **(15 hour)**

1. Evaluation Of Loads: Growth, Geographical Distribution
2. Selection Of Distribution Line Layout, Distribution Transformers, Overhead Lines And/Or Cables Protection
3. Evaluation Of Capital And Operation Costs

References:

1. Elgerd, "Electric Energy Systems Theory," McGrow Hill.
2. Stevnsion, "Elements of Power System Analysis," McGrow Hill.
3. Deshpande, "Elements of Electrical Power system Design," Pitman and Sons.
4. Marsh, Economics of Electric Utility Power Generation," Clarendon Press.

Evaluation Scheme:

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table

Chapters	Hours	Marks Distribution*
1	5	10
2&3	13	22
4	10	18
5&6	12	20
7	5	10
Total	45	80

PROJECT-II
BEG4P2EL

Year : IV **Semester:VIII**

Teaching Schedule Hours/week			Examination Scheme		Internal Assessment		Total Marks	Remarks
			Final					
			Theory	Practical	Theory	Practical		
L	P	T						
-	6	-	-	50	-	50	100	

Course Objectives:

To complete an electrical engineering project Planned in Project – I under the supervision of an instructor. During the project students have to come up with final output.

Tasks: In the development of the project each group of students will be expected to:

1. This will be the continuation of project-I, start with fulfillment comment(s) in project-I
2. Initiate and maintain contact through regular progress meetings with the immediate faculty supervisor
3. prepare periodic progress reports for the project supervisor
4. carry out such laboratory or field tests as are appropriate for the project, It is important to that industry be involved in this area as much as possible to enhance contacts and provide a mechanism for interaction between university and industry, and to encourage direct relevance of the projects to real world situations
5. prepare a formal written report in good engineering style at the conclusion of the project
6. present an oral report to faculty and peers on the results of the project exercise

ELECTIVE II

ADVANCED POWER SYSTEM ANALYSIS
BEG428EL

Year : IV **Semester:VIII**

Teaching Schedule Hours/week			Examination Scheme		Internal Assessment		Total Marks	Remarks
			Final					
L	P	T	Theory	Practical	Theory	Practical		
3	1.5	1	80	-	20	25	125	

Final Exam Duration: 3hrs

Course Objectives:

To make student familiar with different methods of transmission line compensation

1. **1. Review of transmission Line** **(5 hours)**
   1.1 Basic relationship in transmission line
   1.2 Uncompensated line
   1.3 Load compensation and System compensation
   1.4 Symmetrical line and mid point voltage of Symmetrical line
2. **2. Conventional method of transmission line compensation** **(8 hours)**
   2.1 Shunt compensation
   2.2 Series compensation
   2.3 Phase angle control
   2.4 Effects f compensations on voltage regulation, transient stability and voltage stability.
3. **3. Compensation Using Power electronic Devices** **(20 hours)**
   3.1 Thyristor Controlled Reactor (TCR)
   3.2 Thyristor Switched Capacity (TSC)
   3.3 fixed Capacitor Thyristor Controlled Reactor
   3.4 Switching Converter type Var generator (STATCOM)
   3.5 GTO Controlled Series Capacitor (GCSC)
   3.6 Static Synchronous Series Capacitor (SSSC)
   3.7 Unified Power Flow Controller (UPFC)
   3.8 Static voltage and phase angle controller
4. **4. Computer Simulation Study** **(12 hours)**
   4.1 Study on TCR, Fixed Capacitor Thyristor Controlled Reactor, STATCOM
   4.2 Modeling of synchronous machine in d-g-0 frame
   4.3 Use of Mat-Lab Simulink in power system analysis
   4.4 Load flow analysis – Gauss Seidel method, Newton-Raphson method and Fast-Decoupled method.
   4.5 Rotor Angle Stability
   4.6 Voltage Stability

Practical: Exercised on computer simulation

References

1. John J. Grainger and William D. Stevenson Jr., "Power system Analysis", Mc Graw Hill Inc.
2. Narain G. Higorani and Laszlo Gyugai, Understanding FACTS", IEEE Press
3. Hadi Saadat, "Power System analysis", TATA Mc Graw Hill.
4. R.H. Miller, "Reactive power compensation in power system", Mc. Graw Hill
5. P.S. Kundur, "Power System Stability and control", Mc. Graw Hill. Inc

APPLIED PHOTOVOLTAIC ENGINEERING

BEG……EL

Year : IV **Semester:VIII**

Teaching Schedule Hours/week			Examination Scheme				Total Marks	Remarks
			Final		Internal Assessment			
L	P	T	Theory	Practical	Theory	Practical		
3	1.5	1	80	-	20	25	125	

Final Exam Duration: 3hrs

Course Objectives:

To be familiar with solar photovoltaic principle, design and application.

1. **The sun and the solar spectrum** **(4 hours)**
   1.1 Electromagnetic spectrum
   1.2 Effects of Earth atmosphere, orbit and rotation on insolation
   1.3 Estimation and measurement of solar radiation
   1.4 Calculation of energy available in a place; radiation on inclined and horizontal plane, yearly energy available in place
   1.5 Models and Software for assessing the solar energy
2. **Semiconductors for photovoltaic** **(5 hours)**
   2.1 p-n junction for solar cell, fundamental concept; I-V and P-V characteristics
   2.2 Model of PV cells; short circuit current, open circuit voltage, four parameter model, equivalent circuit, effect of temperature
   2.3 Fill factor, efficiency series
   2.4 Cell to panel, effect of shading and mitigation
   2.5 Testing of PV panel
   2.6 Model and simulation
3. **Modern PV cell technology** **(4 hours)**
   3.1 Thin film technology
   3.2 Polycrystalline silicon
   3.3 Thin film solar cell
   3.4 Epitaxial films including GaAs modern cell
   3.5 Solar panel standards
4. **Power electronics and control of photovoltaic system** **(9 hours)**
   4.1 Dc-Dc converter (buck, boost, isolating converters)
   4.2 Inverter topology
   4.3 Single stage and two stage power electronics configuration
   4.3.1 Control of dc-dc converters :Maximum power point tracking techniques
   4.4 Control of Inverters
   4.4.1 Isolated operation
   4.4.2 Grid connected operation

5. Isolated PV systems **(6 hours)**
5.1 Storage devices: different type of batteries
5.2 Charge controller; principle and circuit diagram
5.3 UPS system with PV: back to back converter topology, charging scheme of UPS by PV and grid, setting priority
3.4 Water pumping

6.Grid Connected PV system **(9 hours)**
6.1 Phase, frequency and voltage matching6.1.1 Grounding
6.1.2 Protection
6.1.3 Transient response
6.1.4 Power Flow analysis with PV units;
6.1.5 Short Circuit analysis with PV units;
6.1.6 Voltage profile
6.1.7 Guideline for PV integration; penetration level
6.2 Interconnection standards, codes and practices
6.2.1 IEEE
6.2.2 IEC
6.2.3 UL
6.2.4 Voltage ride through requirements
6.2.5 others

7.Design of PV system **(4 hours)**
7.1 Isolated PV system for residence
7.2 Grid connected PV system
7.3 Solar water pump

8. Socio-economic aspects **(4 hours)**
8.1 Economic assessment of PV power system (Payback period, Total Ownership cost -TOC, Present worth factor-PWF)
8.2 Environmental Impact analysis (EIA) and safety of PV system
8.3 Production, recycling and disposal of PV system (PV panel and batteries)
8.4 Large scale integration of PV into power grid

Practical Works (Experiment and Simulation)

- Study of characteristics of PV cell and module Plotting of I-V, P-V curve on different insolation
- Determination of parameters of PV panel: short circuit current, open circuit voltage, series and shunt resistance

- Design and simulation of stand-alone photovoltaic system: use suitable numerical tools (such as Maltlab Simulink, PSCAD)
- Design and simulation of grid connected PV system: use suitable numerical tools (such as Maltlab Simulink, PSCAD)

1. Case study: Study of large scale PV system (one from *world and Nepal* each)
2. Field visit

Reference

1. AK Mukharji, “Photovoltaic System Analysis and Design”, Prentice Hall India.
2. Kalogirou, S. A. “Solar Energy Engineering: Processes and Systems”, Academic Press.
3. G Masters, “Renewable and Efficient Electric Power Systems”, Wiley Publication.
4. Messenger, R. A., Ventre, J., “Photovoltaic Systems Engineering”, CRC Press.
5. Foster, R.; Ghassemi, M.; Cota, A.; “Solar Energy: Renewable Energy and the Environment”, CRC Press.

ELECTIVE III

MICRO-HYDRO POWER
BEG429EL

Year : IV **Semester:VIII**

Teaching Schedule Hours/week			Examination Scheme		Internal Assessment		Total Marks	Remarks
			Final					
			Theory	Practical	Theory	Practical		
L	P	T						
3	1.5	1	80	-	20	25	125	

Final Exam Duration: 3hrs

Course Objectives:

To introduce operation, maintenance and design aspect of Micro Hydro power plant including basic hydrology and geology.

1. **Micro hydro basics and status in Nepal** **(2 hours)**
   1.1 Necessity of micro hydro power, Power from water, typical layout, isolated /mini grid or grid connected scheme, Micro hydro design approach, Status of micro hydro power development in Nepal and agencies involved .

2. **Hydrological and demand survey** **(7 hours)**
   2.1 Plant factor and load factor, Hydrograph and flow duration curve, Hydrological cycle, Matching power supply with demand, Capability and demand survey, Methods of finding ADF (annual average daily flow), Methods of head measurements, Methods of flow measurements, load demand curves of various loads, Peak demand forecasting, Optimum generating installed capacity, Geological consideration.
3. **Turbines, drive system and governors** **(9 hours)**
   3.1 Turbine types for micro hydro, their constructional features and operational characteristics, Effect on efficiency during part flow conditions, Nomogram and turbine selection, Comparison of costs of the turbines
   3.2 Introduction to drive system, Various drive arrangements and their features, Drive problem, Design parameters for a drive system
   3.3 purpose of speed governing, Various governing mechanisms, Electrical load controller as a governor in micro hydro, Ballast load, water cooled and air cooled ballasts, Effect of ballast on generator sizing, Ballast sizing.
4. **Generators and voltage regulators** **(9 hours)**
   4.1 Choice between AC and DC, Synchronous generator specifications, Brushless synchronous generator and its operational features, voltage regulation, Automatic voltage regulator(AVR), Practical consideration for AVR, Induction generator specifications and its operation, Induction generator controller, Induction generator sizing, Sizing of excitation capacitance, comparison of induction generator with other systems, Mechanical consideration to be given to the induction generators.

5. Switchgear, protection and measurement **(4 hours)**
5.1 Isolators, fuses, main switches, Moulded case circuit breakers(MCCB), Oil and air CB, earth leakage CB, contactors, Under voltage trips, Over voltage trips, Over current trips, temperature trips, lightening protection, Earthing system, metering equipment, voltmeter, ammeter-AC and DC, Energy meter, speed meter, pressure gauge, frequency meter, appropriate choice of switchgear, protection and measurement.

6. Testing , Commissioning, Operation and Maintenance **(5 hours)**
6.1 Head works, Electro-mechanical equipment, Alternator, Loading machine on main load, Taking readings, Setting up trips.
6.2 Types of manuals-operation manual, component manual, installer manual, preventive maintenance schedule, log sheet, repair manual, training manual, responsibility of designers, installer and users as regards to O and M.

7. Financial Evaluation, Tariff design and Issues in Micro hydro **(9 hours)**
7.1 Cost elements, The time value of money, compounding and discounting, Future and present values, Cash flows , Benefit cost ratio, Net present value, Internal rate of return, Comparison with alternatives
7.2 Tariff category, Principals of tariff design, Unit energy cost, Flat power tariff VS energy tariff.
7.3 Issues: Reliability, funding requirement, Subsidy policy and mechanism, Cost per KW, Sustainability, Operation and maintenance, Local people's participation, End use of electricity for project viability.

Practical:

1. Flow and head measurement in actual site, load demand survey in actual site.
2. Calculating and forecasting the peak demand and its matching by water supply.
3. Turbine and generator sizing and selection-various alternatives.
4. Approximate design of unit or wattage subscription category(primary tariff)
5. Designing the basic hydraulic structures such as diversion weir, intakes, desiliting basins, canal tunnel, penstock pipe, reservoir etc.
6. To find out the total capital cost investment and calculate the cost per KW.
7. To find out total annual costs (annual fixed costs and annual operating costs).
8. To design tariff category and fix the charges for each categories.

References

1. Adam Harvey with Andy Brown, Priyantha Hettiarachi and Allen Inversin, "Micro Hydro Design Manual, A Guide to Small Scale Water Power Schemes", ITDG Publication
2. D.P. Kothari, K.C. Singal and Rakesh Ranjan, "Renewable Energy Sources and Emerging Technologies", Prentice Hall of India Ltd.

ARTIFICIAL NEURAL NETWORK

BEL…...EL

Year : IV **Semester:VIII**

Teaching Schedule Hours/week			Examination Scheme		Internal Assessment		Total Marks	Remarks
			Final					
L	P	T	Theory	Practical	Theory	Practical		
3	1.5	1	80	-	20	25	125	

Final Exam Duration: 3hrs

Course Objective:

To introduce the concept of artificial network as an alternative options for solving engineering problems.

1. **1. Working with data: Data types; data, information and knowledge; concept of data mining; Dimension reduction of data matrix: Principal component analysis.(4 hours)**
2.
3. **2. Introduction of Artificial Neural Network (ANN): Biological Analogy, Historical development; ANN terminology; network structure; basis functions; activation functions; advantages of ANN; application areas of ANN. (6 hours)**
4.
5. **3. Learning process & optimization techniques (10 hours)**

3.1 supervised learning: Error correction learning, memory based learning
3.2 unsupervised learning: Hebian learning, competitive learning
3.3 learning with critic
3.4 gradient descent and least mean square
3.5 Derivative free optimization techniques: advantages of derivative free techniques; genetic algorithm: fundamental of GA and biological background.; GA operators & GA operation.
3.6 Simulated annealing: theoretical background and algorithm.

6. **4. Supervised network (8 hours)**

4.1 McCullotch and Pitt Neuron; LTUs, simple perceptron and perceptorn learning. Limitation of simple perceptron.
4.2 ADDALINE network and delta rule
4.3 Multilayer perceptron: Needs of multilayer network, generalized delta rule (error-backpropagation), effect of momentum term and learning rate
4.4 Error.back propagation learning of sigmoidal units; drawbacks of error-backpropagatin

7. **5. Unsupervised network (4 hours)**

5.1 competitive network: network structure & working;
5.2 dissimilarity measures;
5.3 Self Organizing Map and Kohonen learning;
5.4 applications

6. Special networks (4 hours)

6.1 Radial basis function network: structure and working procedure, advantages
6.2 LVQ network: structure and learning approach
6.3 Hopefield network
6.4 Autoassociative memory network: general structure and Purpose, Autocorrelator; Heterocorrelator

6. **7. Application of ANN in Electrical Engineering (9 hours)**

7.1 Fault diagnosis
7.2 Control application
7.3 Network planning
7.4 Forecasting task.
7.5 State estimation
7.6 Unit commitment

Practical:

1. Computer simulation of PCA.
2. Computer simulation of perceptron network
3. computer simulation of back propagation network
4. A Short term case study demonstrating ANN application for a specific purpose.

References:

1. Simon Hykin, "Neural networks: A Comprehensive Foundation", second edition; Pearson Education.

WIND ENERGY CONVERSION SYSTEM

BEL…..EL

Year : IV **Semester:VIII**

Teaching Schedule Hours/week			Examination Scheme		Internal Assessment		Total Marks	Remarks
			Final					
			Theory	Practical	Theory	Practical		
L	P	T						
3	1.5	1	80	-	20	25	125	

Final Exam Duration: 3hrs

Course Objectives:

To introduce the technology, grid integration and energy assessment for the wind power system to the final year BE student.

1. **1. Wing Power Basics** **(8 hours)**

1.1 Historical evolution of wind power system
1.2 Change in size and output
1.3 Wind energy conversion system: turbine, generator, power electronics, grid
1.4 Wind power plant and wind mill
1.5 Economics
1.6 Economics1.6.1 Wind fluctuations
1.6.2 Capacity credits
1.6.3 Embedded generation benefits
1.6.4 Storage
1.7 Future trend: Cost, capacity, integration issues.

2. **2. Wind energy assessment** **(10 hours)**

2.1 Power in the Wind : temperature, altitude correction, impact of Tower Height
2.2 Maximum Rotor Efficiency
2.3 Average Power in the Wind2.3.1 Discrete Wind Histogram
2.3.2 wind Power Probability Density Functions
2.3.3 Weibull and Rayleigh Statistics
2.3.4 Average Power in the Wind with Rayleigh Statistics
2.3.5 Wind Power Classification
2.4 simple Estimates of Wind Turbine Energy
2.5 Annual Energy using Average Wind Turbine Efficiency
2.6 Wind Farms
2.7 Specific wind Burtine Performance Calculation: aerodynamics, power curve and Weibull statistics
2.8 Wind Turbine Economics 3712.8.1 Capital Costs and
2.8.2 Annual Costa 371
2.8.3 Annualized cost of Electricity from Wind Turbines

3. **3. Technology of wind energy conversion system** **(9 hours)**

3.1 Wind Turbines
3.2 Generators
3.3 Power Electronics Interfaces
3.4 Classification of WECS3.4.1 Fixed speed based wind turbines
3.4.2 Partially rated Converter-based (FRC) Wind Turbines
3.4.3 Fully Rated converter-based (FRC) Wind Turbines

4. Integration of WECS **(9 hours)**

4.1 Interconnection issues
4.2 Operation of off-grid model hybrid system
4.3 Operation in grid connected mode
4.4 Fault ride through

5. Wind power and electricity markets **(9 hours)**

5.1 Introduction
5.2 The electrical energy market
5.3 Balancing, capacity and ancillary services
5.4 Support mechanisms
5.5 Costs
5.6 Investment and risk
5.7 The future

Practical Works

1. Wind Energy assessment of the particular location
2. Analysis of different wind turbine generation systems
3. Case Study on technology and issues related grid integration of WECS
4. Market Analysis of WECS

Reference:

1. Thomas Ackermann(ed), Wind Power in Power Systems, Wiley publication, 2nd edition.
2. Mathew Sathyajith, “Wind Energy: Fundamentals, Resource analysis and Economics”, Springer, 2006.
3. James F. Manwell, Jon G. McGowan, Anthony L. Rogers, “Wind Energy Explained: theory, Design and Application”, Wiley Sons 2009.