POWER ELECTRONICS
BEG421EL

Year : IV **Semester:VII**

Teaching Schedule Hours/week			Examination Scheme				Total Marks	Remarks
			Final		Internal Assessment			
			Theory	Practical	Theory	Practical		
L	P	T						
3	1.5	1	80	0	20	25	125	

Final Exam Duration: 3hrs

Course Objective:

To introduce different types of power electronics based circuits and provide students with knowledge about their applications in power system

1. Characteristics and specification of power electronics devices (10 hours)

1.1. Power Diode: V-I characteristics, switching characteristics , types of diodes , application

1.2. Thyristor:

1.2.1. V-I characteristics, Turn On and Turn Off mechanisms, switching characteristics, protection schemes

1.2.2. Types of thyristors, merits-demerits and application of thyristors,

1.2.3. Firing Circuits : Microcontroller based firing scheme, Long pulse, short pulse and train pulse generation using pulse transformer

1.2.4. Various commutation technique: Load Commutation and Line commutation

1.3. Power Transistor : V-I Characteristics, switching characteristics, merits-demerits and application of transistor

1.4. Power MOSFET – V-I Characteristics, Switching characteristics, merits-demerits and applications of MOSFET

1.5. Insulated Gate Bipolar transistor (IGBT): V-I characteristics, switching characteristics, merits-demerits and application of IGBT, comparison with MOSFET

1.6. Triac : V-I characteristics of Triac, operating modes of Triac, merits-demerits of Triac

1.7. Diac: V-I characteristics and its merits and demerits

2. Single phase ac to dc conversion (6 hours)

2.1. Half wave rectification with power diode using inductive and resistive load

2.2. Half wave rectification with thyristor using inductive and resistive load

2.3. Full wave rectification with diode and thyristor using resistive and inductive load

2.4. Wave form, ripple content .Fourier analysis and filtering scheme

2.5. Single phase semi-converter and full converter

2.6. Power factor improvement

2.6.1. Extinction angle control

2.6.2. Symmetrical angle control

3. Three phase AC to DC conversion (5 hours)

3.1. Three phase AC to DC conversion using diode and the Fourier analysis of waveforms

3.2. Three phase bridge rectification with diodes and the Fourier analysis of waveforms

3.3. Three phase full converter

4. DC chopper (6 hours)

4.1. Introduction

4.2. Step down chopper

4.3. Chopper with dc motor as load

4.4. Step up chopper

4.5. Chopper classification

5. Inverter (8 hours)

5.1. Introduction

5.2. Single phase inverter

5.3. Single phase inverter with ac motor load

5.4. Three phase inverter

5.5. Fourier analysis of three phase inverter

5.6. Pulse width modulated inverter

5.6.1. Single pulse modulation

5.6.2. Multiple pulse modulations

5.6.3. Sinusoidal pulse width modulation

6. AC voltage controller (6 hours)

6.1. Single phase voltage controller with phase control using resistive and inductive load

6.2. Single phase voltage controller in electronic load controller (ELC)

6.3. Principle of operation of single phase cycloconverter

6.4. Step-up and step down single phase cycloconverter

6.5. Three phase to single phase cycloconverter

7. HVDC power transmission **(5 hours)**

7.1. HVDC station configuration (Filter, Converters, Inverters)
7.2. Comparison of HVDC and HVAC transmission
7.3. Reversible power flow and control in dc line
7.4. Series operation of converters
7.5. 12-pulse operation of converter

Practical:

1. Study of single phase rectification with diode and thyristor
2. Study of three phase rectification with diode and thyristor
3. Study of DC conversion using chopper circuit
4. Study of DC to AC conversion with resistive load
5. Study of AC voltage controller with resistive load

References:

1. Muhammad H. Rashid "Power Electronics" Pearson Publications, 2003.
2. B.R Gupta and V.Singhal " Power Electronics" Kataria and Sons
3. Ned Mohan, Undelan and Robbins, "Power Electronics: Converters, Applications, and Design" 3rd Edition, Wiley Sons, 1995.

Evaluation scheme:

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

Chapters	Hours	Marks distribution*
1	10	18
2, 3	11	18
4, 7	11	18
5	8	14
6	5	12
Total	45	80

* There may be minor deviation in marks distribution.

UTILIZATION OF ELECTRICAL ENERGY
BEG422EL

Year : IV **Semester:VII**

Teaching Schedule Hours/week			Examination Scheme		Internal Assessment		Total Marks	Remarks
			Final					
L	P	T	Theory	Practical	Theory	Practical		
3	1.5	1	80	0	20	25	125	

Final Exam Duration: 3hrs

Course Objective:
To present the basic concepts of utilization of electrical energy on various applications

1. Introduction **[4 hours]**

1.1. Common uses of electrical energy: Domestic, commercial, industrial
1.2. Classification of electrical consumers and their demand
1.3. Roles and advantages of electrical energy over other forms of energy on different applications

2. Electric Drive System **[8 hours]**

2.1. Advantages of electric drive
2.2. Types of electric drives- Individual, group and multi-motor and comparison among them
2.3. Methods of power transfer- Direct coupling/using belt drive, gears, pulleys
2.4. Selection of motors- Factors to be considered, electrical and mechanical characteristics matching.
2.5. Service Type (Continuous, Intermittent), Rating and Sizing of motor
2.6. Motors and their characteristics for particular service- domestic, industrial and commercial

3. Control of Electric Drive **[11 hours]**

3.1. DC Drive Control
 3.1.1. Background of AC Drive System
 3.1.2. Ward Leonard type variable speed drives
 3.1.3. Static Variable DC voltage drives using diodes and/or controlled rectifier
 3.1.4. 4-quadrant reversible voltage and power flow drive
 3.1.5. PID speed and torque controlled drives
3.2. AC Drive Control
 3.2.1. Background of AC Drive System
 3.2.2. Soft start variable ac voltage starter
 3.2.3. Variable frequency supplies for ac drive
 3.2.4. Slip power recovery system for slip ring induction motor

4. Electric Traction **[8 hours]**

4.1. Types of electric traction- self contained unit system, traction system fed from a separate distribution line, DC and AC supply system
4.2. Advantages of electric traction system
4.3. Tramways, trolley, and electric train: description and comparison
4.4. Types of motors used for electric traction
4.5. Starting, Braking and Speed control of traction motors
4.6. Speed-time curve for a traction system: Scheduled and Average speed and factors affecting these speeds

5. Electric Heating **[6 hours]**

5.1. Introduction of Electrical Heating
5.2. Advantages of electric heating
5.3. Building design consideration for electric heating
5.4. Methods of electric heating: Resistance heating, Induction heating, Electric arc heating, Dielectric heating, Infrared heating, and Micro-wave heating

6. Demand Side Management **[8 hours]**

6.1. Introduction and advantages of Demand Side Management
6.2. Consumer Classification and their demand characteristics
6.3. Effective Demand Side Management techniques
6.4. Causes and disadvantages of Low Power Factor and different techniques to improve Power Factor
6.5. Types of tariff: Simple tariff, Flat-rate tariff, Block-rate tariff, Two part tariff, Maximum demand tariff
6.6. Tariff System in Nepal

Laboratory:

1. Speed Control of DC shunt motor by controlled rectifier
2. Speed Control of Induction motor by rotor rheostat method
3. Speed Control of Induction motor by frequency control method
4. Study of PWM controller for an ac machine

References:
1. G Garg, A course in Utilization of Electrical Energy
2. S.K Pillai, "A course in Electrical Drives", 3rd edition, 2012, New Age International, Delhi.
3. O. Taylor," Utilization of electrical energy", Orient Blackshaw
4. J.B. Gupta, "Utilization of electrical energy", Kataria & Sons, 2006.

Evaluation scheme:

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

Chapter	Hours	Marks Distribution*
1, 5	10	18
2	8	14
3	11	18
4	8	16
6	8	14
Total	46	80

* **There may be minor deviation in marks distribution.**

POWER PLANT EQUIPMENT
BEG423EL

Year : IV **Semester:VII**

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 Objective:

To present information on the equipment used in power generating plant including electrical as well as mechanical

Part – A (Electrical)

1. Hydro Power Plant (5 hours)

1.1. Energy Conversion from hydraulic to electrical terminologies
1.2. Steady State operation of hydro power plant
1.3. Water hammer and surge tank in hydro power plant
1.4. Control of water delivery to turbine
1.5. Transient in turbine –generator system
1.6. Pump storage plant
1.7. Generator for hydro power plants

2. Power/frequency control in hydro generator system (8 hours)

2.1. f and Q-V control loop of hydro generating system
2.2. Modeling of turbine
2.3. Special characteristics of hydraulic turbine
2.4. Modeling of governor
 2.4.1. Fundamentals of speed governing
 2.4.2. Generator response to load change
 2.4.3. Isochronous Governor
 2.4.4. Governor with droop characteristics
 2.4.5. Load sharing by parallel unit
 2.4.6. Requirement of transient droop

3. Var/Voltage control in hydro-generating systems (4 hours)

3.1. Types of excitation systems-
 3.1.1. DC excitation system
 3.1.2. AC excitation system
 3.1.3. Static excitation system
3.2. Modeling of excitation systems

4. Substation equipments (6 hours)

4.1. Power transformer and its various components
4.2. Concept of unit transformer
4.3. Potential transformer and current transformer used in substation
4.4. Reactor used in generating station and substation
4.5. Fire fighting system in power station
4.6. Power Line Carrier Communication (PLCC)
4.7. PLC Application
4.8. Supervisory Control and Data Acquisition (SCADA) System and communication with load dispatch center

Part – B (Mechanical)

5. Diesel Power Plant (8 hours)

5.1. Diesel Cycle
5.2. Diesel Engine Operation, Starting, Fuel Storage and Supply System, Cooling System, Noise Abatement and Governing
5.3. Performance of Diesel Power Plant
5.4. Applications of Diesel Power Plant
5.5. Advantages and Disadvantages of Diesel Power Plant

6. Gas Turbine Power Plant (5 hours)

6.1. Gas Turbine Cycle; Open and Closed Cycles
6.2. Performance Improvement of Gas Turbine Power Plants; Intercooling, Regeneration and Reheating
6.3. Starting, Fuel Storage and Supply System, Cooling System, Noise Abatement and Governing
6.4. Advantages and Disadvantages of Gas Turbine Power Plant

7. Thermal (Steam) Power Plant (5 hours)

7.1. Ranking cycle
7.2. Performance Analysis, superheating reheating and regeneration
7.3. Steam Turbine: Classifications, Compounding, Governing and Lubrication systems for Steam Turbines
7.4. Advantages and Disadvantages Thermal Power Plants

8. **Combined Power Plant** **(4 hours)**

8.1. Gas and Steam Turbine Combined Cycle

8.2. Advantages of Combined Cycle

8.3. Performance and Economics of Combined Cycle

Practical:

1. Mini hydro Unit Control (Isolated Load)
   - Study the start –up and control of speed and generated voltage on the mini hydro unit, operating the generator on isolated load (not synchronized to the lab bus)
2. Mini hydro Unit Control (Synchronized)
   - Start up and synchronized to system bus
   - Study power and var control of the unit while synchronized and delivering energy to the system
3. Diesel Unit Control (Isolated Load)
   - As per lab #1
4. Diesel Unit Control (Synchronized)
   - As per lab #2
5. Load sharing between parallel units
   - Operate mini hydro and diesel generating units in parallel to supply a common load.
   - Examine control problems associated with load and Var sharing
6. Field trip to generating plant (3 days trip)
   - visit a full size operating generating plant
   - study the specific component and its operating mechanism of the visited power plant
   - Prepare a formal report on power plant installation describing specific major component

Reference:

1. S.C. Arora, S. Domkundwar " A course in power plant Engineering", Dhanpat Rai & Sons, Delhi, 1988
2. P.C. Sharma "Power Plant Engineering" Kataria & Sons, Delhi
3. P.Kundur "Power System Stability and Control" Mc Graw Hill.
4. D.P. Kothari and I J Nagarath, "Power System Engineering", Tata McGraw Hill

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	9	16
2	8	14
4	6	8
5	8	14
6	5	10
7	5	10
8	4	8
Total	45	80

* There may be minor deviation in marks distribution.

PROJECT MANAGEMENT FOR ENGINEERS

BEG4…CE

Year : IV **Semester:VII**

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

Final Exam Duration: 3hrs

Course Objective:

To introduce the basic knowledge on project and project environment

To make the students able to prepare feasibility study report and project proposal.

To provide the sound knowledge of project planning, implementation and controlling.

To provide knowledge on risk associated with the project

To provide the knowledge of project finance and

To provide the concept of modern trends and techniques of project management.

1. Introduction of Project and Project Management (6 hours)

1.1 Definition of Project, its characteristics, and example of project.
1.2 Classification of Project
1.3 Project Objective and Goal
1.4 Project Life Cycle Phases
1.5 Project Environment
1.6 Introduction to Project Management

2. Project Appraisal and Project Formulation (8 hours)

2.1 Concept of Project Appraisal
2.2 Project Proposal (technical and financial)
2.3 Procedure for Developing Project Proposal
2.4 Techniques of Project Formulation Feasibility analysis
2.4.1 Cost Benefit analysis
2.4.2 Input analysis
2.4.3 Environmental analysis

3. **3.Project Planning and Scheduling (12 hours)**

3.1 Concept of Project Planning and its Importance
3.2 Project Planning Process
3.3 Work Breakdown Structure (WBS)
3.4 Project Scheduling with Bar Chart, CPM & PERT
3.5 Project Scheduling with Limited Resources (Resource Leveling and Smoothing)
3.6 Introduction to Planning Soft ware - MS Project

4. Project Implementation and Controlling. (7 hours)

4.1 Introduction to Monitoring, Evaluation and Controlling
4.2 Project Control
4.3 Project Control Cycle
4.4 Elements of Project Control (time, cost and quality)
4.5 Project Schedule Control
4.6 Project Cost Control: Methods and procedure (Earned value analysis)
4.7 Project Quality Control
4.8 Introduction to Project Management Information System (PMIS)

5. Project Risk Analysis and Management (7 hours)

5.1 Introduction to Project Risk
5.2 Types of Project Risk
5.3 Analysis of Major Sources of Risk
5.4 Effective Management of Project Risk:

Risk Management planning
. Risk Identification
. Qualitative and Quantitative Risk Analysis
. Risk Response Planning
. Risk Monitoring and Controlling

6. Introduction to Project Financing (5 hours)

6.1 Project finance
6.2 Capital Structure Planning
6.3 Capital Budgeting Decision

Tutorials:

1. Writing project Proposal [2 hours]
2. Scheduling Using Bar chart & CPM [4 hours]
3. Scheduling Using Planning Software [4 hours]
4. Project Control Method (EVA) [1 hour]
5. Capital Structure Planning Exercise [2 hours]
6. Capital Budgeting Exercise [2 hours]

References:

1. IshwarAdhikari and Santosh Kr. Shrestha, “A text book of Project Engineering”, Chandeshwori Publication.
2. Dhurba P. Rizal, “Project Management”, Ratna Pustak Bhandar.
3. E.R. Yescombe, “Principles of Project Finance” Yescombe-Consulting Limited.
4. K. Nagarajan, “Project Management”, ISBN: 81-224-1340-4, New Age International (P) Limited, New Delhi, India.
5. Dr. Govinda Ram Agrawal, “Project Management in Nepal”, M.K. Publishers and Distributors, Kathmandu, Nepal

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	12
2	8	14
3	12	20
4	7	14
5 &6	12	20
Total	45	80

* There may be minor deviation in marks distribution.

HAZARD ANALYSIS AND SAFETY MANAGEMENT
BEG424EL

Year : IV **Semester:VII**

Teaching Schedule Hours/week			Examination Scheme		Internal Assessment		Total Marks	Remarks
			Final					
L	P	T	Theory	Practical	Theory	Practical		
2	-	1	40	0	10	-	50	

Final Exam Duration: 1.5hrs

Course objective:

To present concepts of safety and hazard management in electrical engineering projects and systems.

1. **Effects of non-ionizing electromagnetic fields on humans** **(4hrs)**
   1.1. Low level fields, research and results to date
   1.2. Evaluation of field levels with usual exposure of personnel
2. **Electrical shock hazards** **(4hrs)**
   2.1. Physiological effects of electric shock
   2.2. First aid for electric shock
   2.3. Safety precautions and regulations
3. **Earthing and shielding techniques for electrical equipments** **(4hrs)**
   3.1. High gradient fields
   3.2. Earth fault detectors
   3.3 Fast circuit breakers
4. **Electrical induction into communication and Other systems near transmission lines** **(8hrs)**
   4.1. Electric field coupling and electrostatic induction
   4.2. Electric field shielding
   4.3. Earthing at power frequencies
   4.4 Magnetic field coupling and magnetic induction
   4.5. Electromagnetic field near transmission line
   4.6. Electromagnetic induction from power lines into communication circuits, shielding and earthing practices
5. **Lightning Protection** **(4hrs)**
   5.1. Characteristics of lightning
   5.2. Typical voltage and current levels in electric network and apparatus due to lightning
   5.3. Protection against lightning voltages: shielding, earthing techniques, lightning arrestors
6. **Chemical and radiation hazards** **(4hrs)**
   6.1. Biological hazards of polychlorinated biphenols
   6.2. Uses of PCB and alternative materials in electrical equipment
   6.3. Clean-up and disposal of PCBs and other toxic wastes
   6.4. Industrial radiation hazards
   6.5. Clean-up and disposal of radioactive hazards
7. **Fire hazards and fire-fighting techniques in electrical equipment** **(2hrs)**

References:

1. John A. Alloca, Harold E. Levenson: Electrical & Electronic Safety, Reston Publishing Company , A Prentice- Hall Company, Reston, Virginia, 1982
2. *V. Manoioiv*: Fundamentals Of Electrical Safety, Mir Publishers Moscow, 1975

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*
1,2	8	10
3,7	6	8
4	8	12
5,6	8	10
Total	30	40

* There may be minor deviation in marks distribution.

PROJECT-I
BEG425EL

Year : IV **Semester:VII**

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

Course Objective:
To plan a electrical engineering project under the supervision of an instructor. During the project students have to design functional project.

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

1. Students will form a small group (maximum of four students per group) projects
2. Project concept development (field selection, hardware/software, scope etc.) , attention will be paid to the suitability of the project topics for the technical level of the students and the practical applicability of the subject topics to the local situation. Wherever possible, projects will include aspect of computer applications in electrical engineering will be encouraged.
3. Perform literature review and prepare a specific written project proposal including a clear statement of objective and purpose of the project along with preliminary methodology, expected outcome, time plan and resources estimate.
4. Initiate and maintain contact through regular progress meetings with the initiator of the project or the immediate faculty supervisor
5. At the end of this semester students will come up with a report with a complete literature review and final methodology to be adopted with sample analysis.
6. At the end of semester, student should defense the final project.

ELECTIVE I

ELECTRICAL ENERGY SYSTEM MANAGEMENT

BEG…..EL

Year : IV **Semester:VII**

Teaching Schedule Hours/week			Examination Scheme		Internal Assessment		Total Marks	Remarks
			Final					
			Theory	Practical	Theory	Practical		
L	P	T						
3	1.5	1	80	0	20	25	125	

Final Exam Duration: 3hrs

Course Objective:

To study planning and management aspects of electrical energy supply and to gain some familiarity with demand characteristics and load forecasting.

1. **Power utilities and power sector development** **(9 hours)**

   1.1 Functional block model
   1.2 Classifications: Centralized government owned, Locally owned, private/public, foreign investor owned
   1.3 Power sector development in Nepal: History, growth of government and private utilities, achievements, various utilities in existence and their organization
   1.4 Nepalese Power industry Regulatory framework: Company act, Industrial enterprises act, Hydropower development policy, Water resource act and regulation, Electricity act and regulation, Foreign investment and technology transfer act, Factory act
   1.5 Power sector restructuring : Goals, constraints, pre-requisites and different models.

2. **Financial Analysis and project funding** **(9 hours)**
   2.1 Basic accounting principles: Cash basis and Accrual basis of accounting,
   2.2 Depreciation: straight line method, declining balance method and sum of years digit method, inflation and depression
   2.3 Investment decisions: Interest and discount rates, inflation and depression, Present worth, Future worth, NPV, B/C ratio, IRR, Payback period , decision criteria
   2.4 Electric utility funding requirements: capital requirement, operating requirement, Cash flow
   2.5 Sources of project funding: Public finance, corporate finance and project finance

3. **Electrical load forecasting** **(9 hours)**
   3.1 Load curves and load factor, demand factor, diversity factor, coincidence factor
   3.1.1 Load and their characteristics : Domestic, industrial, commercial, non commercial, transport, irrigation etc.
   3.2 Objectives and classification of load forecasting
   3.3 Tools and approaches
   3.4 Errors and uncertainties
   3.5 A accuracy and error analysis based on time series approach
   3.6 Forecasting methods: mean and single moving average method, mathematical models: Linear , Parabolic and Exponential method of extrapolation and the method of survey, SIMCRED equation

4. Power system security and reliability **(9 hours)**
   4.1 Security definitions
   4.2 Security measures
   4.3 Maintaining reserves: spinning reserve, scheduled or offline reserve, static reserve, Sources of reserves
   4.4 Physical constrains to system security
   4.5 Effects of system diversity, system interconnection, import/export.
   4.6 Approaches to reliability, Reliability and quality, Repairable and non repairable components, The bathtub curve , Reliability function, Properties of reliability, Reliability indices: Mean Time to Failure, Mean Time Between Failures, Availability/Unavailability, Forced outage rate, Loss of Load Probability, Loss of Load Expectation
   4.7 System reliability models: Series system, parallel system, Series parallel system, Parallel series system, Non series parallel system
   4.8 Cost of reliability and unreliability.

5. Unit Commitment and Economic load dispatch of generating units **(9 hours)**
   5.1 Understanding Unit commitment problem, solution approaches, Priority list scheme, Unit commitment schedule for a particular load curve.
   5.2 Elements of a constrained optimization problem, LaGrange theorem as a tool to solve optimization problem
   5.3 Characteristics of generating units (thermal and hydro): , Incremental fuel cost, incremental cost of production
   5.4 Economic dispatch problem of thermal units excluding and including transmission losses, Graphical solution, Penalty factor and its physical insight, Use of penalty factor in power transaction
   5.5 Economic dispatch of energy and VARs as an operational problems: Problems in new loading conditions, effect of power factor, VAR compensation techniques

Practical:

1. Presentation on Nepalese power utilities and regulatory environments
2. Solving economic dispatch problem of hydro units for loss minimization
3. Exploring demand supply situation of certain sector of the Nepalese power system and forecast the power and energy demand
4. Reliability evaluation (calculating LOLP) of a certain load center fed by different hydro units in Nepalese system
5. Exploring the security situation of a typical power system through N-1 contingency criteria.
6. Preparing unit commitment schedule for a particular load centre fed by different hydro unit in Nepalese system

References

1. Robert N Anthony and James S Reece, "Management Accounting Principles", 3rd edition, Homewood, Irwin, 1975.
2. Allen J Wood and Bruce W Woollenberg, "Power Generation Operation and Control", Wiley Sons, 1995.
3. C. L. Wadhwa, "Electrical Power Systems", Willey Eastern Limited
4. V. N. A. Naikan: Reliability Engineering and Life Testing, Prentice Hall of India Ltd.
5. S. Makridakis, S.C. Wheelwright, V.E. Mc Gee, "Forecasting Methods and Applications", 3rd ed, Wiley Sons, 1997.
6. I.G. Nagarath and D.P. Kothari, "Power System Engineering", Tata McGraw Hill Publishing Company

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	9	16
2	9	18
3	9	14
4	9	18
5	9	14
Total	45	80

* There may be minor deviation in marks distribution.

RELIABILITY ENGINEERING

BEG....EL

Year : IV **Semester:VII**

Teaching Schedule Hours/week			Examination Scheme				Total Marks	Remarks
			Final		Internal Assessment			
L	P	T	Theory	Practical	Theory	Practical		
3	1.5	1	80	0	20	25	125	

Final Exam Duration: 3hrs

Course Objective:

To strengthen the knowledge of probability theory by introducing the concept of reliability engineering applicable to the physical systems especially at different level of electric power systems.

1. Review of probability theory (4 hours)

1.1 Probability concepts, permutation and combination, practical engineering concepts, Venn diagrams

1.2 Rules for combining probabilities, independent, mutually exclusive, complimentary, conditional events, application of conditional probability

1.3 Probability distributions: random variables, density distribution functions, mathematical expectation, variance and standard deviation.

2. Binomial distribution and its Applications (4 hours)

2.1 Binomial distribution: concepts, properties, general characteristics, binomial coefficients, expected value and standard deviation

2.2 Applications in engineering system evaluation, economic implications, identical and non-identical units, COPT

3. Network modeling and analysis of simple systems (4 hours)

3.1 Modeling concepts for reliability evaluations

3.2 Series, parallel and series-parallel systems

3.3 Redundancy: standby redundancy, impact of redundancy, perfect and imperfect switching

4. Modeling and analysis of complex systems (8 hours)

4.1 Modeling and evaluation concepts for complex systems

4.2 Conditional probability approach, cut set and tie set methods, connection matrix techniques, event tree and fault tree methods

5. Probability distribution in reliability evaluation (4 hours)

5.1 Distribution concepts, terminology, general reliability functions, evaluation techniques, shapes

5.2 Poisson distribution, relationship with binomial distribution

5.3 Normal and exponential distributions, probability density functions, a priori and a posterior probability, normal distribution and probability density function, mean value and mean time to failure.

5.4 Other distributions: Weibull, Gamma, Rayleigh and Log Normal distribution and their application in electric power change.

6. System reliability evaluation using probability distribution (4 hours)

6.1 Series, parallel and partially redundant systems, mean time to failure

6.2 Standby systems: perfect and imperfect switching, effect of spare components, failure in standby mode

7. Discrete Markov chains (4 hours)

7.1 General modeling concept, STPM, time dependent probability evaluation

7.2 Limiting state probability, absorbing states, applications of discrete Markov techniques in system reliability evaluation

8. Continuous Markov processes (5 hours)

8.1 General modeling concepts, transition rates, time dependent and limiting state probabilities, STTP

8.2 State space diagram: single, two and three components repairable systems, mission oriented systems

8.3 Evaluation of time dependent state probabilities by differential equations method and matrix multiplication methods

8.4 Reliability evaluation of repairable systems, MTTF, application in complex system

9. Frequency and duration techniques for reliability evaluation (8 hours)

9.1 Basic concepts of F&D techniques, application in multi-state problems, frequency of encountering individual states, mean duration of individual states, frequency of encountering cumulated states, frequency balance approach

9.2 Approximate reliability evaluation: series and parallel systems, network reduction techniques, minimum cut set method

Practical:

1. Evaluate the reliability of simple and complex systems using various techniques like series/parallel, cut set and tie set methods
2. Application of discrete Markov chain and continuous Markov process, F&D techniques, approximate reliability evaluation for complex engineering system

References:

1. Roy Billinton and Ronald Allan, "Reliability Evaluation of Engineering Systems: Concepts and Techniques", Plenum Publishers, New York, 1992.

RURAL ELECTRIFICATION

BEG…..EL

Year : IV **Semester:VII**

Teaching Schedule Hours/week			Examination Scheme				Total Marks	Remarks
			Final		Internal Assessment			
			Theory	Practical	Theory	Practical		
L	P	T						
3	1.5	1	80	0	20	25	125	

Final Exam Duration: 3hrs

Course Objectives:

To present a summary of rural livelihood and to present the basic concepts of rural electrification and its impact upon the development of rural communities

1. **Rural livelihood and Social, cultural and human factors in development** **(4 hours)**
   1.1 Components of rural livelihood and livelihood indicators
   1.2 Social, cultural and human factors in development
   1.3 Industrialization and urbanization
2. **Electricity and rural development** **(5 hours)**
   2.1 Rural electrification – National objectives, targets and key players (National Water Plan)
   2.2 Impact of electrification on rural and village life
   2.3 End use of electricity
3. **Rural electrification technologies – Nepalese context** **(8 hours)**
   3.1 Grid based rural electrification
   3.1.1 Utility operated: Voltage levels, Investment modality, Construction and operation modality, Consumer services, tariffs
   3.1.2 Community operated (CBRE, CBOM etc): Voltage levels, Investment modality, Construction and operation modality, Consumer services, tariffs
   3.2 Electrification through Isolated hydropower stations3.2.1 Micro Hydro components (Civil, Mechanical and Electrical components including T&D network)
   3.3 Electrification through alternative energy sources3.3.1 Solar (Components of Solar Home system)
   3.3.2 Wind (Components of Wind Power)
4. **Environmental concerns, safety considerations and reliability indices in RE** **(4 hours)**
   4.1 Environmental concerns in rural electrification
   4.2 Equipment and human safety in construction and operation of Rural electrification network as per Electricity regulation Nepal
   4.3 Plant factor of Micro Hydro Schemes, load factor, load curve and reliability indices in Rural Electrification, SAIFI, SAIDI, CAIDI, ASAI
5. **Design of Rural Electrification network** **(10 hours)**

5.1 Load points fixation in contour map and load calculation
5.2 Transformer installation point and Line route fixation
5.3 Selection criteria of distribution system – single or three phase
5.4 Hardware in RE Networks: Poles and supporting accessories, Conductors and Fixtures (Cross arm, clamps etc), Insulators, Transformers, HT Metering units, Energy Meters, Current limiters, Service wire, Power cables, Isolators, Load break switches
5.5 Protection system of RE Networks : 5.5.1 11/33 kV Feeder protection: Lightning arrestors, Circuit breakers with tripping provision on Over current, Short circuit, Earth Fault
5.5.2 LV feeder protection: ACBs, MCCBs, HRC/Kitkat fuses
5.5.3 Transformer (33/0.4 and 11/0.4 kV) protection: Lightning arrestors, Drop out fuses, MCCBs/ HRC fuses
5.6 Load flow diagram preparation and Voltage drop calculation: kVA-km conductor loading / Voltage drop calculation
5.7 Economic analysis of RE

6. **RE Network operation** **(10 hours)**

6.1 Load management: Load switching, Load shedding, Peak load tariff
6.2 Energy loss measurement and monitoring
6.2.1 Load curve, Load factor, loss factor and Energy Loss calculation
6.2.2 Metering and measurement
6.2.3 Condition monitoring of RE network components: Poles, Jumpers, Insulators, Transformers, Distribution boxes, Clearances, Feeder loading
6.3 Types of faults frequently occur in RE Network
6.4 Correction, Corrective action and preventive actions
6.5 Metering, Billing and revenue collection
6.6 Inventory management

Practical

. Case studies in rural electrification Technical Aspects of Energy loss of the network
. Quality of the service provided – Voltage, frequency and interruption frequency and duration
. Condition monitoring and Repair and maintenance of RE network
. Economic Aspects of Revenue generation
. Operating expenses
. Capital Investment
. Profitability of the scheme
. Social Aspects o Energy based Enterprise development
. Energy based Income Generation activities introduced
. Impact on social life – Health, education, security, communication

• A report to be produced by each student on case study

References:

1. AS Pabla, "Electric Power Distribution", TATA McGRAW HILL
2. Bhjendra Aryal, "Cultural and human factors in Rural development", Dikshant Prakashan
3. AEPC/ESAP Guideline for detailed feasibility study for projects from 100 kW to 1000 kW
4. Electricity regulation 2050, Nepal
5. Samudayik Bidyut bitran niyamawali 2060, NEA