PROJECT ENGINEERING
CE …

Lecture : 3 **Year : IV**
Tutorial : 1 **Part : I**
Practical : 0

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,
- Cost Benefit analysis,
- Input analysis,
- Environmental analysis

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 Ishwar Adhikari and Santosh Kr. Shrestha, “A text of Project Engineering” 2011, Chandeshwori Publication, First Edition.

2 Dhurba P.Rizal, “Project Management” 2001, Ratna pustak bhandar, First Edition.

3 E.R. Yescombe, “Principles of Project Finance” 2002, Yescombe-Consulting Limited.

4 K. Nagarajan, “Project Management”, ISBN: 81-224-1340-4, New Age International (P) Limited, New Delhi, India, 2001.

5 Dr. Govinda Ram Agrawal, “Project Management in Nepal” Edition: 2006, 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 below.

Chapters	Hours	Marks Distribution*
1	6	10
2	8	12
3	12	24
4	7	12
5	7	12
6	5	10
Total	45	80

* There may be minor deviation in marks distribution.

ORGANIZATION AND MANAGEMENT
ME….

Lecture : 3 **Year : IV**
Tutorial : 1 **Part : I**
Practical : 0

Course Objectives:

1. Acquire knowledge in the field of organizational management and internal organization of companies required for managing an enterprise
2. Acquire knowledge in the field of personnel management, motivation and leadership for developing managerial skills
3. Gain knowledge for starting a small scale unit independently
4. Gain knowledge on case study and management information system.

Course Outlines:

1. Introduction

1.1 Organization (2 hours)

1.1.1 System approach applied to Organization
1.1.2 Necessity of Organization
1.1.3 Principles of Organization
1.1.4 Formal and Informal Organizations

1.2 Management (4 hours)

1.2.1 Functions of Management
1.2.2 Levels of Management
1.2.3 Managerial Skills
1.2.4 Importance of Management
1.2.5 Models of Management

1.3 Theory of Management (6 hours)

1.3.1 Scientific Management Approach
1.3.2 Administrative Management Approach
1.3.3 Behavioral Management Approach
1.3.4 Modern Management Theories

1.4 Forms of Ownership (2hours)

1.4.1 Single Ownership – Advantages and limitations
1.4.2 Partnership – Types of Partners – Advantages and limitations
1.4.3 Joint Stock Company – Formation of Joint Stock Company – Advantages and limitations
1.4.4 Co – operative Societies – Types of Co – operatives – Advantages and limitations
1.4.5 Public Corporations – Advantages and limitations

1.5 Organizational Structure (2 hours)

1.5.1 Line Organization – Advantages and dis – advantages
1.5.2 Functional Organization – Advantages and dis – advantages
1.5.3 Line and Staff Organization – Advantages and dis – advantages
1.5.4 Committee Organization – Advantages and dis – advantages

1.6 Purchasing and Marketing Management (4 hours)

1.6.1 Purchasing – Introduction
1.6.2 Functions of Purchasing Department
1.6.3 Methods of Purchasing
1.6.4 Marketing – Introduction
1.6.5 Functions of Marketing
1.6.6 Advertising

2. Personal Management (8 hours)

2.1 Introduction
2.2 Functions of Personal Management
2.3 Development of Personal Policy
2.4 Manpower Planning
2.5 Recruitment and Selection of manpower – Scientific selection
2.6 Training and Development of manpower
2.7 Job Analysis, Job Evaluation and Merit Rating
2.8 Wages and Incentives

3. Motivation, Leadership and Entrepreneurship (6 hours)

3.1 Motivation

3.1.1 Human needs
3.1.2 Maslow's Hierarchy of needs
3.1.3 Motivation – Introduction

3.1.4 Types of Motivation

3.1.5 Attitude Motivation; Group Motivation; Executive Motivation

3.1.6 Techniques of Motivation

3.1.7 Motivation Theories

3.1.7.1 McGregor's Theory X - Y

3.1.7.2 Fear and Punishment Theory

3.1.7.3 Alderfer's ERG Theory

3.1.7.4 MacClelland's Theory of learned needs

3.1.7.5 Herzberg's Hygiene Maintenance Theory

3.1.7.6 Vroom's Expectancy/ Valency Theory

3.2 Leadership - Introduction (2hours)

3.1.1 Qualities of a good Leader

3.1.2 Leadership Style

3.1.3 Blakes and Mouton's Managerial Grid

3.1.4 Leadership Approach

3.1.5 Leadership Theories

3.3 Entrepreneurship – Introduction (2 hours)

3.1.6 Entrepreneurship Development

3.1.7 Entrepreneurial Characteristics

3.1.8 Need for Promotion of Entrepreneurship

3.1.9 Steps for establishing small scale unit

4. Case Studies (2 hours)

4.1 Introduction

4.2 Objectives of case study

4.3 Phases of case study

4.4 Steps of case study

4.5 Types of case studies

5. Management Information System (5 hours)

5.1 Data and Information

5.2 Need, function and Importance of MIS

5.3 Evolution of MIS

5.4 Organizational Structure and MIS

5.5 Computers and MIS

5.6 Classification of Information Systems

5.7 Information Support for functional areas of management

5.8 Organizing Information Systems

Note: Students have to submit a case study report after visiting an industrial organization outside or inside the Kathmandu valley.

Reference:

1. H. B. Maynard, "*Industrial Engineering Handbook*" , Editor – in – Chief, 4th Edition, McGraw Hill, 19xx

2. E. S. Buffa and R. K. Sarin "*Modern Production / Operations Management",* 8th Edition, Wiley, 1987

3. H. J. Arnold and D. C. Feldman "*Organizational Behavior" ,* McGraw – Hill, 1986

4. J. A. Senn, "*Information Systems in Management "* , 4th Edition, Wadsworth Inc., 1990

5. P. Hershey and K. H. Blanchard, "*Management of Organizational Behavior – Utilizing Human Resources "*, 4th Edition, Prentice – Hall Inc., 1982

6. M. Mahajan, "*Industrial Engineering and production Management*" ,Dhanpat Rai and Co. (P) Ltd. , Delhi, 2002

7. S. Sadagopan, "*Management Information System",* Prentice Hall of India Pvt Ltd, 1997

8. C. B. Mamoria "*Personnel Management*", Himalaya Publishing House – 1989

9. O. P. Khanna, "*Industrial Engineering and Management*" , Dhanpat Rai Publications (P) Ltd., 2007

Evaluation Scheme:

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

Chapters	**Hours**	**Marks distribution***
1& 1.2	6	8 or 16
1.3	6	8
1.4 & 1.5	4	8
1.6	4	8
2	8	16
3.1	6	8
3.2 & 3.3	4	8
4 & 5	7	8 or 16
Total	45	80

* There may be minor deviation in marks distribution.

TECHNOLOGY ENVIRONMENT AND SOCIETY

CE ..

Lecture : 2 **Year : IV**
Tutorial : 0 **Part : I**
Practical : 0

Course Objectives:

The course has been devised to provide knowledge of environment, technology and its impact on society. It would be helpful to the students to understand the global, national and local environmental issues and challenges of the information society.

1. Technology (8hours)
- 1.1. Definition,
- 1.2. Impact of technology on environment & society,
- 1.3. Benefits of technology due to new inventions,
- 1.4. Conflict of technology, technology creates opportunity for society to change
- 1.5. Appropriate technology,
- 1.6. Intermediate technology, labor based and labor intensive technology,
- 1.7. Shifts in employment due to technological advancement,
- 1.8. Role of technology to unmask old social problems, society's control of technology,
- 1.9. Impact of technology on culture, tradition and social values,
- 1.10. Technology is irreversible,
- 1.11. Agricultural age, industrial age and information age,
- 1.12. Characteristics of information society,
- 1.13. Information as power and wealth

2. Development approach: (6 hours)
- 2.1. LEP (labor based, environment friendly and participatory),
- 2.2. Community management, engineers role as facilitator,
- 2.3. Key features of infrastructure development policies of Nepal,
- 2.4. Ethnographic approach to collect information ,
- 2.5. Participatory approach as community empowerment ,
- 2.6. Participatory tools, focus group discussions, key informants interview,
- 2.7. Participatory observation, structured questionnaire,
- 2.8. Resource mapping, wealth ranking, poverty definition

3. Brief history of human civilization (4 hours)
- 3.1. Early civilization,
- 3.2. Great renaissance of Europe,
- 3.3. Early part of industrial revolution,
- 3.4. Transformation of industrial society into information society,
- 3.5. Impact of world war 1 & 2, Population explosion,
- 3.6. Rise of environmental issues,
- 3.7. Climate change as a threat to human civilization

4. Environment (3 hours)
- 4.1. Definition,
- 4.2. Importance, ecology & ecosystem,
- 4.3. Conservation of environment,
- 4.4. Optimum utilization of natural resources,
- 4.5. Renewable and non renewable resources,
- 4.6. Conflict of resources,
- 4.7. Global environmental issues,
- 4.8. Environmental issues of Nepal

5. Water and air pollution (6 hours)
- 5.1. Fecal -oral infection transmission route
- 5.2. Preventive measures,
- 5.3. On site sanitation(including eco -sanitation),
- 5.4. Importance of health education,
- 5.5. Organic pollution,
- 5.6. Inorganic pollution(nitrate, fluoride, iron, manganese, calcium arsenic, heavy metals), water pollution due to insecticides and pesticides
- 5.7. Sources, causes & impacts of airpolution
- 5.8. Mitigation measures,
- 5.9. Indoor air pollution,
- 5.10. Severity of its problems in Nepal

6. Climate change (3 hours)
- 6.1. Definition, causes, impacts,
- 6.2. Mitigation measures,
- 6.3. International efforts to mitigate its problems,
- 6.4. Bio –gas, organic farming,
- 6.5. Deforestation and its consequences,
- 6.6. Importance of national parks, conservation areas and forestation programs in Nepal

References:

1. B. C. Punmia, Ashok Kumar Jain and Arun Kumar Jain, "Environmental Engineering", Laxmi Publications (P) Ltd., New Delhi, 1998
2. H.G. Wells, "Brief History of Civilization"
3. J. Neharu, "Glimps of World History"

Examination scheme

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

Chapters	Hours	Marks Distribution*
1	8	10
2	6	8
3	4	4
4	3	4
5	6	10
6	3	4
Total	30	40

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

POWER ELECTRONICS
EE …

Theory : 3 **Year : IV**
Tutorial : 1 **Part : I**
Practical : 1.5

Course Objective:
To introduce various power electronics based circuits and their use in power system

1. Characteristics and specification of power electronics device (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 Off mechanism, switching characteristics, protection scheme,
  - 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 (4 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" Dhanpat Rai and Sons
2. B.R Gupta and V.Singhal " Power Electronics" Kataria and Sons

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	16
2	6	8
3	4	8
4	6	8
5	8	16
6	6	16
7	5	8
Total	44	80

* There may be minor deviation in marks distribution.

UTILIZATION OF ELECTRICAL ENERGY
EE …

Theory : 3 **Year : IV**
Tutorial : 1 **Part : I**
Practical : 3/2

Course Objectives:
To present the basic concepts on 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 [12 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

Reference:

1. A course in Utilization of Electrical Energy, *G. Garg*
2. A course in Electrical Drives, *S. K. Pillai*
3. Utilization of electrical energy, *Taylor*

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.	4	8
2.	8	16
3.	12	16
4.	8	16
5.	6	8
6.	8	16
Total	46	80

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

POWER PLANT EQUIPMENT
EE …

Lecture : 4 **Year : IV**
Tutorial : 0 **Part : I**
Practical : 1.5

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 (6 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 (10 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 hydrogenerating systems (6 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 (8 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 (10 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 (7 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 (7 hours)
- 7.1. Rankine 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 (6 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. P.Kundur “Power System Stability and Control” Mc Graw Hill Inc
2. D.P. Kothari “Power System Engineering”
3. Hadi Sadat “Power System ”
4. S.C. Arora, S. Domkundwar “ A course in power plant Engineering”
5. P.C. Sharma “Power Plant Engineering”

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	6	8
2	10	16
3	6	8
4	8	8
5	10	16
6	7	8
7	7	8
8	6	8
Total	60	80

* There may be minor deviation in marks distribution.

PROJECT - I

Lecturer : 0 **Year : IV**
Tutorial : 0 **Part : I**
Practical : 3

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. End semester defense

Elective I

ELECTRICAL ENERGY SYSTEM MANAGEMENT
Elective-I

Lecture : 3 **Year : IV**
Tutorial : 1 **Part : I**
Practical : 3/2

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
2. Allen J Wood and Bruce W Woolenberg: Power Generation Operation and Control
3. C. L. Wadhwa: Electrical Power Systems, Willey Eastern Limited
4. V. N. A. Naikan: Reliability Engineering and Life Testing, Printice Hall of India Ltd.
5. S. Makridakis, S.C. Wheelwright, V.E. Mc Gee: Forecasting Methods and Applications
6. I.G. Nagarath and D.P. Kothari: Power System Engineering, Tata Mc Grawhill Publishing Company

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 Distributions*
1	9	16
2	9	16
3	9	16
4	9	16
5	9	16
Total	45	80

* There may be minor deviation in marks distribution.

RELIABILITY ENGINEERING
ELECTIVE I

Lecture : 3
Tutorial : 1
Practical : 1.5

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 (4 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.

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 Distributions*
1	4	16
2	4	
3	4	
4	8	16
5	4	16
6	4	
7	4	16
8	4	
9	8	16
Total	44	80

* There may be minor deviation in marks distribution.

RURAL ELECTRIFICATION
ELECTIVE I

Lecture : 3
Tutorial : 1
Practical : 3/2

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 (4 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 stations
  - 3.2.1. Micro Hydro components (Civil, Mechanical and Electrical components including T&D network)
- 3.3. Electrification through alternative energy sources
  - 3.3.1. Solar (Components of Solar Home system)
  - 3.3.2. Wind (Components of Wind Power)

4. Environmental concerns, safety considerations and reliability indices in RE (8 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

1. Case studies in rural electrification
- Technical Aspects
  - 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
  - Revenue generation
  - Operating expenses
  - Capital Investment
  - Profitability of the scheme
- Social Aspects
  - 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. National water Plan, Nepal
6. Samudayik Bidyut bitran niyamawali 2060, NEA
7. ISO 9001 standard
8. AEPC status/progress reports on renewable energy

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 Distributions*
1	4	8
2	4	8
3	8	16
4	8	16
5	10	16
6	10	16
Total	44	80

* There may be minor deviation in marks distribution.

ENGINEERING PROFESSIONAL PRACTICE
CE ……

Lecture : 2 **Year : IV**
Tutorial : 0 **Part : II**
Practical : 0

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
   - 4.4. Contract agreement

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
   - 6.3. 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 1982
2. Dr Rajendra Adhikari, “Engineering Professional Practice – Nepalese and international Perspectives” Pashupati Publishing House, Kathmandu Nepal 2010
3. M. Govindarajan; S Natarajan and V.S. Senthikumar., “ Engineering Ethics” – PHI Learning Pvt. Ltd. New Delhi 2009
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 below.

Chapter	Hours	Marks distribution*
1	3	4
2	6	8
3	3	4
4	6	8
5	5	6
6	3	4
7	4	6
Total	30	40

* There may be minor deviation in marks distribution.

HIGH VOLTAGE ENGINEERING

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Lecture : 3 **Year : IV**
Tutorial : 1 **Part : II**
Practical : 0

Course Objective:
After the completion of this course the student will get through knowledge for

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

1. Evolution of power system [6]
- 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. Electric shocks [6]
- 2.1. Physiological effects of electric shock, ventricular fibrillation
- 2.2. First aid for electric shock
- 2.3. Safety precautions and regulations
- 2.4. Earthing and shielding techniques for personnel and equipment protection
- 2.5. Measurements of earth resistivity and earth resistance

3. Over voltages in power system [8]
- 3.1. Classification of over voltages; temporary and transient over voltages, internal and external over voltages
- 3.2. Temporary Over Voltage ; Unsymmetrical faults in the system, High capacitance of long EHV lines, Ferro-resonance, Load rejection, effective grounding, shunt compensations
- 3.3. 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
- 3.4. 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. Insulation coordination: [4]
- 4.1. Basic Insulation level and basic switching level
- 4.2. insulation coordination to different equipments; transformers, bus structures, bushings, transmission lines;
- 4.3. insulation protection level for temporary, switching and lightning over voltages
- 4.4. surge protection: lighting and switching surge characteristics, horn gaps, grading rings, lighting arrestors

5. High stress electric fields [8]
- 5.1. review of electromagnetic field theory : electrostatic potential difference, potential gradient, conducting and dielectric materials in electric fields, polarization, leakage conductance of dielectrics
- 5.2. electromagnetic fields near transmission lines; electromagnetic induction in neighboring facilities such as communication circuits, pipelines or railway tracks
- 5.3. evaluation of electric field distributions, manual and computer flux mapping and field calculations
- 5.4. corona and radio interference

6. Dielectric breakdowns [8]
- 6.1. 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
- 6.2. electrical breakdown in insulating liquids: chemical breakdown of liquids, presence of impurities, polar molecules and dielectric heating in ac field
- 6.3. 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

7. Introduction to high voltage testing: [4]
- 7.1. breakdown testing using high voltage ac and dc voltages and impulse voltages,
- 7.2. measurement of high AC, DC and Impulse voltages, standardization of testing procedures
- 7.3. 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. High voltage engineering, KamaRaju & Naidu
2. Extra High voltage AC Transmission, Rakosh Das Begmudre
3. Power System Analysis by W.D. Stevension, Tata McGraw Hill Publications
4. Power System Stability and Control by P. Kundur

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	6	8
2	6	8
3	8	16
4	4	8
5	8	16
6	8	16
7	4	8

*There could be a minor deviation in Marks distribution

POWER PLANT DESIGN
EE …

Theory : 3 **Year : IV**
Tutorial : 0 **Part : I**
Practical : 3

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, biothermal, 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 (4 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. 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
1. Design of a hydro power plant – civil and mechanical components
   - 1.1. Analysis of hydrological data, topology, determination of discharge and head, site selection
   - 1.2. Selection of plant and unit size, selection and layout of hydraulic structures and approximate sizing
   - 1.3. Turbine selection
2. Design of a hydro power plant – electrical system design
   - 2.1. Generator and transformer selection, specification for procurement
   - 2.2. Fault level calculation for switchgear
   - 2.3. Earthing system – grid size and conductor size calculation, earth resistance calculation
   - 2.4. Protection system – connection diagram of generator protection, settings of generator over-current, differential, reverse power, loss of excitation, stator and rotor earth-fault relays
   - 2.5. Switchyard scheme design and layout design
   - 2.6. Auxillary and Ancillary System

References:

1. Engineering and Design of Hydro electric Power Plants – US Army Corps of Engineers
2. Technical Manual – Electrical Power Plant Design – Department of the US Army.
3. Guide for Control of Hydroelectric Power plants – IEEE No. 1010-1987

4. Guide for safety in AC substation grounding – IEEE No. 80-2000.
5. Wilenbrock and Thomas 'Planning Engineering and Construction of electric Power Generating Facilities" John Wiley and Sons
6. Marsh 'Economics of Electric Utility power Generation "Clarendon Press
7. Dr.P.C. Sharma "Power Plant Engineering" S.K. kataria and Sons
8. Generation and Economic Considerations – J.B. Gupta
9. Power Plant Engineering – AK Raja, Amit Prakash Srivastava, Manish Dwivedi

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	8	16
2	4	8
3	8	16
4	24	40
Total	44	80

* There may be minor deviation in marks distribution.

TRANSMISSION AND DISTRIBUTION DESIGN
EE

Lecturer : 3 **Year : IV**
Tutorial : 0 **Part : II**
Practical : 3

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. Introduction [4 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: ampacities, towers, sire 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. 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. Overhead line insulator design [8 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. Conductor & support 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 [7 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, protecton

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:

Chapter	Hours	Marks Distributions*
1	4	8
2	4	8
3	8	16
4	10	16
5	4	8
6	7	16
7	5	8

*There could be a minor deviation in Marks distribution

Project-II

Lecturer : 0
Tutorial : 0
Practical : 6

Year : IV
Part : II

Course Objective:
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

EE …….

Lecture : 3 **Year : IV**
Tutorial : 1 **Part : II**
Practical : 1.5

Course Objective:

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. 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. 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. Switfhing 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. 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 Siedal method, Newton-Raphson method and Fast-Decoupled method.
- 4.5. Rotor Angle Stability
- 4.6. Voltage Stability

Practical: Exercised on computer simulation

References

1. Jhon J. Grainger and William D. Stevenson Jr., "Power system Analysis", Mc Graw Hill int.
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.

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 Distributions*
1	5	8
2	8	16
3	20	32
4	12	24
Total	45	80

* There may be minor deviation in marks distribution.

Biomedical Instrumentation

Lecture : 3 **Year : IV**
Tutorial : 1 **Part : II**
Practical : 1.5

Course Objectives:

To provide specific engineering and instrumentation methods and principles to the task of obtaining basic knowledge of design, application and maintenance of different biomedical instruments.

1. Fundamental of Medical Instrumentation: (4 hours)
- 1.1. Biomedical Engineering and Areas of Engineering Contribution
- 1.2. Biometrics and Design Consideration Factors for Medical Instruments
- 1.3. Man Instrument System and their Objectives
- 1.4. Components of Man Instrument System

2. Bioelectric Signals and Electrodes: (4 hours)
- 2.1. Body System and Bioelectric Phenomenon
- 2.2. Sources of Bioelectric Signals
- 2.3. Resting and Action Potentials
- 2.4. Electrode Theory and their Equivalent Circuits
- 2.5. Types of Biopotential Electrodes
- 2.6. Application of electrodes in medical instrumentation

3. Physiological Transducers: (4 hours)
- 3.1. Classification of Transducers
- 3.2. Performance Characteristics of Transducers
- 3.3. Active Transducers and their Application in Medical Instruments
- 3.4. Passive Transducers and their Types used in Medical Instruments

4. Bioelectric Signals Measurement and Recording System (10 hours)
- 4.1. Aspects of Bioelectric Signals
- 4.2. Electrocardiography (ECG)
  - 4.2.1. Normal Characteristics of Electrocardiogram
  - 4.2.2. ECG Lead Configuration and Recording Techniques
  - 4.2.3. Computer –Aided Electrocardiograph Analysis
- 4.3. Electroencephalography (EEG)
  - 4.3.1. Electroencephalogram and Evoked Potential
  - 4.3.2. EEG Pre amplifier Design
  - 4.3.3. EEG Electrode Configuration and Recording Techniques
  - 4.3.4. Practical Details of EEG
- 4.4. Electromyography (EMG)
  - 4.4.1. Electromyography Recording Technique
  - 4.4.2. Applications of EMG

5. Non- Invasive Diagnostic Instruments (12 hours)
- 5.1. Blood Flow Measurement
  - 5.1.1. Magnetic Blood Flow meter
  - 5.1.2. Ultrasonic Blood Flow meter
  - 5.1.3. Blood Flow Measurement by Thermal Convection
  - 5.1.4. Blood Flow Measurement by Radiographic Method
- 5.2. Diagnostic Medical Imaging System
  - 5.2.1. Radiographic Imaging System
    - 5.2.1.1. Principle of generation of X-rays and its medical properties
    - 5.2.1.2. Functional X-ray Machine
    - 5.2.1.3. Biological Effects of X-rays
  - 5.2.2. Ultrasonography Imaging System
  - 5.2.3. Computer Tomography (CT-Scan) System
  - 5.2.4. Magnetic Resonance Imaging System (MRI)
  - 5.2.5. Nuclear Medicine Machine

6. Therapeutic Instruments (4 hours)
- **6.1.** Function of Kidneys
- **6.2.** Principle of Artificial Kidneys
- **6.3.** Heamodialysis Machine
- **6.4.** Types of Dialyzers
- **6.5.** Lithotripsy and its principle
- **6.6.** Lithotripter Machine
- **6.7.** Defibrillator Machine

7. Biomedical Telemetry and Telemedicine (3 hours)
- **7.1.** Wireless Telemetry
- **7.2.** Single Channel Telemetry System
- **7.3.** Multi channel Telemetry
- 7.4. Telemedicine Using Mobile Communication Equipments

8. Electrical Safety of Medical Equipment (4 hours)
- **8.1.** Physiological Effects of Electricity
- **8.2.** Leakage Currents and Methods of Accident Prevention
- **8.3.** Micro shocks and Macro shocks Hazards
- **8.4.** Electrical Safety Codes and Standards
- **8.5.** Special Safety Measures for Electrical Susceptible Patients

8.6. Power Distribution and Protection System of the Hospital

Practicals:

Three practical exercises based on availability of the portable medical instruments, clinical based equipment and Field Visit to Medical Institution and related Field Visit Report and Viva Voce.

References:

1. Biomedical Instrumentation and Measurements - Leslie Cromwell, et Al, Prentice Hall, India

2. A Hand Book of Biomedical Instrumentation, R S Khandpur, Tata Mc Graw Hill

Evaluation Scheme

chapters	hours	Marks distribution*
1	4	6
2	4	8
3	4	10
4	10	16
5	12	24
6	4	8
7	3	4
8	4	4
Total	45	80

Applied Photovoltaic Engineering

Lecture : 3 **Year : IV**
Tutorial : 1 **Part : II**
Practical : 1.5

Course Objectives:

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 photovoltaics **(4 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 **(8 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
- 5.4. Water pumping

6. Grid Connected PV system **(8 hours)**
- 6.1. Phase, frequency and voltage matching
  - 6.1.1.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)

1. 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
2. Design and simulation of stand-alone photovoltaic system: use suitable numerical tools (such as Maltlab Simulink, PSCAD)
3. Design and simulation of grid connected PV system: use suitable numerical tools (such as Maltlab Simulink, PSCAD)
4. Case study: Study of large scale PV system (one from *world and Nepal* each)
5. Field visit

Reference

1. Photovoltaic system analysis and design, AK Mukharji, PHI 2011.
2. Kalogirou, S. A. Solar Energy Engineering: Processes and Systems, Academic Press, 2009, ISBN-10: 0123745012
3. Renewable and Efficient Electric Power Systems, G Masters, Wiley Publication 2004.
4. Messenger, R. A., Ventre, J., Photovoltaic Systems Engineering, 2nd ed., CRC Press, 2003, ISBN-10: 0849317932
5. Foster, R.; Ghassemi, M.; Cota, A.; Solar Energy: Renewable Energy and the Environment, CRC Press, 2009, ISBN-10: 1420075667

Evaluation Scheme

SN	Chapter	Hours	Marks
1	1	4	8
2	2	6	8
3	3	4	8
4	4	8	16
5	5	6	8
6	6	8	16
7	7	4	8
8	8	4	8

* There may be minor deviation in marks distribution.

Elective III

MICRO-HYDRO POWER
EE

Lecture : 3 **Year : IV**
Tutorial : 1 **Part : II**
Practical : 1.5

Course Objective:
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 (7hours)

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, Printice Hall of India Ltd.

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 Distributions*
1	2	16
2	7	
3	9	16
4	9	16
5	4	16
6	5	
7	9	16
Total	45	80

* There may be minor deviation in marks distribution.

ARTIFICIAL NEURAL NETWORK

EE….

Lecture : 3 **Year : IV**
Tutorial : 1 **Part : II**
Practical : 1.5

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

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. **Introducton of Artifical Neural Network (ANN): Biological Analogy, Historical development; ANN terminology; network structure; basis functions; activation functions; advantages of ANN; application areas of ANN. (6 hours)**

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.

4. **Supervised network (8 hours)**
   - 4.1. McCullotch and Pitt Neuron; LTUs, simple perceptron and perceptorn learning. Limitation of simple percepron.
   - 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

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

7. **Application of ANN in Electrical Engineering (8 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.

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 Distributions*
1	4	8
2	6	8
3	10	16
4	8	16
5	4	8
6	4	8
7	8	16
Total	44	80

WIND ENERGY CONVERSION SYSTEM
EE …

Lecture : 3 **Year : IV**
Tutorial : 1 **Part : II**
Practical : 1.5

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

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. Economics
  - 1.6.1. 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. 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 Wind
  - 2.3.1. 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 Calcualtions: aerodynamics, power curve and Weibull statistics
- 2.8. Wind Turbine Economics 371
  - 2.8.1.Capital Costs and
  - 2.8.2.Annual Costa 371
  - 2.8.3.Annualized ost of Electricity from Wind Turbines

3. Technology of wind energy conversion system (8 hours)
- 3.1. Wind Turbines
- 3.2. Generators
- 3.3. Power Electronics Interfaces
- 3.4. Classification of WECS
  - 3.4.1.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 (8 hours)
- 4.1. Interconnection issues
- 4.2. Operation of off-grid mode:hybrid system
- 4.3. Operation in grid connected mode
- 4.4. Fault ride through

5. Wind power and electricity markets (8 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 partid\cular 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. Wind Power in Power Systems, edited by Thomas Ackermann, Wiley publication, 2nd edition, 2004
2. Renewable and efficient power system
3. Wind Energy: Fundamentals, Resource analysis and Economics, Mathew Sathyajith, 2006
4. Wind Energy Explained: theory, Design and Application, James F. Manwell, Jon G. McGowan, Anthony L. Rogers, 2010.

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	8	16
2	8	16
3	10	16
4	8	16
5	8	16
Total	40	80

* There may be minor deviation in marks distribution.