High Voltage Engineering (3 – 1 – 0)

Evaluation:

	Theory	Practical	Total
Sessional	30	20	50
Final	50	-	50
Total	80	20	100

Course Objectives:

To get familiarized with

- Generation, Measurement and Testing of High Voltages and Currents
- Power Cables and Protection used in High Voltages
- Over Voltage Phenomena and Insulation Co-ordination

Course Contents:

1. Generation of High Voltages and Currents **(10 hrs)**

1.1 Generation of High DC Voltages
- Rectifier and Voltage Doubler Circuits
- Voltage Multiplier Circuits: Cascaded Rectifier Unit with Pulse Generator, Cockroft-Walton-circuit

1.2 Generation of High AC Voltages
- Cascaded-Transformer Connection, Resonant Transformers
- High Frequency AC Voltages and Advantages of High-Frequency Transformers

1.3 Generation of Impulse Voltages
- Standard Impulse wave shapes
- Types of Impulse Generator Circuits and their analysis
- Effect of Circuit Parameters on Impulse Generator Circuits
- Wave shaping Circuit and Control
- Multistage Impulse Generator: Marx Circuit
- Vande-Graff Generator

1.4 Generation of Impulse Currents
- Impulse Current Waveforms
- Circuit for Producing Impulse Current Waves

2. Measurement of High Voltages and Currents **(8 hrs)**

2.1 Various Techniques for Measuring High Voltages and Currents

2.2 Direct Measurement
- Electrostatic Voltmeters
- Sphere Gaps and Rod-Gaps

2.3 Transformer and Potential Divider Methods
- Transformer ratio method
- Resistive and Capacitive Divider Method, Resistive Capacitive Divider Method

2.4 Measurement of Impulse Voltage and Currents

- Impulse Voltage Measurement: Cathode Ray Oscilloscope (CRO), Klydonograph and its application, Peak Voltmeters
- Impulse Current Measurement: Magnetic Potentiometers or Rogowski Coil, Magnetic Links

3. Introduction to High Voltage Testing **(8 hrs)**

3.1 Standard Testing Procedures, Type and Routine Tests

3.2 General Tests Carried Out on High Voltage Equipment:

- Sustained low-frequency Tests, High Voltage Direct Current Tests, High Frequency Tests, Surge or Impulse Tests, Flashover Tests

3.3 Testing of Cables, Line Insulators, Bushings, Isolators, Circuit Breakers and Surge Arrestors

3.4 Non-destructive Insulation Test Techniques

- Measurement of Dielectric Constant and loss factor, Partial Discharge Measurement and Test Circuits

4. High Voltage Power Cables **(7 hrs)**

4.1 Classication of Cables

4.2 Typical Construction and Cross-Sections of Cables

4.3 Dependence of Power Rating of Cable in Different Environments

4.4 Electrical Characteristics of EHV Cables

4.5 Belted Cables and its Capacitance Measurement

4.6 Super Tension Cables: H-type, Separate Lead (S.L) type and H.S.L type cables

4.7 Pressurized High Voltage Cables

- Oil-pressure cables, Gas-pressure cables(External and Internal Pressure cables)

4.8 Materials used for Insulation in HV cables: Oil filled, XLPE

4.9 Methods for Laying Underground Cables

5. Over Voltage Phenomena and Insulation Co-ordination **(6 hrs)**

5.1 Overvoltage due to Lighting and Switching Surges

5.2 Power Frequency Overvoltage

5.3 Insulation Co-ordination

- Necessity of Insulation Co-ordination
- Equipment Insulation level
- Insulation Co-ordination and volt-time characteristics
- Standards for Insulation Co-ordination: IEC 71
- Insulation Co-ordination in EHV and UHV systems
- Surge arrestor sizing

6. Protection Against High Voltage Surge **(6 hrs)**

6.1 Protection of Lines

- Application of Ground Rods and Counter Poise
- Ground Wire
- Lightning Arrestors and their characteristics: Gap type SiC Arrestors, Metal Oxide Arrestors, Thyrite type for EHV
- Protector Tube and Surge Absorber

6.2 Protection of Insulators: Arcing Horns, Corono and Grading Rings

Text Book:

1. S. K. Singh, *"Fundamentals of High Voltage Engineering"*, Dhantpat Rai & Co., 2012

Reference Books:

1. R. D. Begamudre, *Extra High Voltage AC Transmission Engineering*, New Age International Publishers, 2006.
2. M. S. Naidu and V. Kamaraju, *High Voltage Engineering*, Tata McGraw-Hill, 2009.
3. E. Kuffel, W. S. Zaengl and J. Kuffel, *High Voltage Engineering*, Newnes, 2000.
4. J. R. Lucas, *High Voltage Engineering*, 2001.

Power Plant Design (3 – 1 – 0)

Evaluation:

	Theory	Practical	Total
Sessional	50		50
Final	50		50
Total	100		100

Course Objectives:
To study technical requirements and economic principals related to design of switchyards, power plant layout and plant design layout.

Course Contents:

1. **Energy Sources (Renewable and Nonrenewable)** **(11 hrs)**
   - 1.1 Hydro-power Plants
     - Selection of turbines for hydro power plants
     - Salient features of generators to be used in hydro power plants
   - 1.2 Steam Power Plants
     - Selection of turbines for steam power plants
     - Production of superheated steam using coal and using nuclear fuel(uranium)
     - Salient features of the generators to be used in steam power plant.
   - 1.3 Diesel Power Plants
     - Important features of IC engines used in Diesel power plants
     - Salient features of the generators to be used in Diesel power plants
   - 1.4 Energy production from solar, wind, geothermal and biomass power plants
   - 1.5 Cogeneration and total energy system
   - 1.6 Energy storage systems
     - Pumped storage plants
     - Compressed air storage
     - Battery storage

2. **Electric Power Generation** **(10 hrs)**
   - 2.1 Technical characteristics of various alternatives for electric power generation
   - 2.2 Comparative study of pollution and environmental hazards caused by different types of power plants
   - 2.3 Isolated versus Grid Connected Systems
   - 2.4 Generation costs: capital cost, operation cost, fuel cost and other costs
   - 2.5 Setting of generating facilities: choice of location and size of generating plants, numbers and size of units in the plants
   - 2.6 Balancing generation with load, Reserve planning, Benefits of interconnection with of Utility

3. **Some Major Components used in HV Switchyards and Power Plants** **(9 hrs)**
   - 3.1 HV Circuit Breakers
     - Purpose of CBs in HV switchyard and types of CBs

- Rated short circuit breaking of CB, rated short circuit breaking of CB, rated short operating of CB and rated short time current of CB.

3.2 Isolators or Disconnecting switches
- Purpose of Isolators in HV switchyard and types of Isolators in use

3.3 Lightning Arresters
- Lightning and voltage surges
- Method to suppress voltage surges
- Types of lightning arrestors(LAs) for outdoor applications

3.4 Instrument transformers (CTs & PTs)

3.4.1 Current transformers (CTs)
- Basic functions for Current Transformers
- Types of current transformers: Oil insulated current transformers, SF_6 insulated current transformers

3.4.2 Voltage/Potential transformers
- Basic functions for voltage Transformers
- Types of PT: Outdoor oil cooled PTs, Capacitor Voltage Transformers (CVTs)
- Main applications of CVTs in HV Networks

3.4.3 Location of current and voltage transformers in substations

4. Power Plant Design **(15 hrs)**

4.1 Symbols and IEC Standards

4.2 Busbar arrangements in switchyards and mechanical stress developed on busbars during short circuit

4.3 Earthing schemes in power plants and safety of operating personnel

4.4 Typical dc loads for a power plant

4.5 Importance of station service transformers for a power plant

4.6 Single line diagrams of power plants

4.7 Indoor and outdoor switchyards

Field Visit:
- Review and presentation on major components such as HV circuit brakers, turbines, generators, lightning arrestors, HV cables, battery and battery chargers, etc. used in power plants.
- Review and presentation on indoor and outdoor switchyards

Text Book:

1. Deshpande, *Elements of Electrical Power, Station Design,* pitman & Sons

Reference Books:

1. S. Rao, *Switchgear and Protection*, Khanna Publishers, New Delhi.
2. Stevenson, *Elements of Power System Analysis*, McGraw Hill
3. Willenbrock and Thomas, *Planning, Engineering and Construction of Electric Power generating Facilities*, John Wiley and Sons
4. Marsh, *Economics of Electric Utility Power Generations,* Clarendon Press

Professional Ethics in Engineering (2 – 0 – 0)

Evaluation:

	Theory	Practical	Total
Sessional	50	-	50
Final	50	-	50
Total	100	-	100

Course Objectives:

- To introduce Ethical and Legal Environment practiced in Engineering
- To address the contemporary issues in Engineering.

Course Contents:

1. Background (5 hrs)

1.1 History of Engineering practice
1.2 Cultural, Political, Societal motivations and limitations
1.3 Impacts and consequences of technology on society
1.4 Education and training of technologists, scientists and engineers

2. Profession and Ethics (3 hrs)

2.1 Definition and Characteristics
2.2 Codes of ethics and guidelines for professional engineering practice
2.3 Relationship of engineering profession to other professions (e.g. fellow engineers, clients and contractors)
2.4 Moral dilemma on ethical decision making
2.5 Negligence and Liabilities

3. Professional Practices in Nepal (4 hrs)

3.1 General job description of an engineer in public and private sector
3.2 Public and Private sector practices
3.3 Roles of Professional Associations

4. Legal Aspects and Regulatory Environment of Professional Engineering in Nepal (8 hrs)

4.1 Nepal Engineering Council Act
4.2 Labor Law
4.3 Contract Law
4.4 Cyber Law
4.5 Public Procurement Act
4.6 Intellectual Property Right
4.7 Company Registration Procedures
4.8 Relationship to foreign firms working in Nepal

5. Contemporary and Emerging Issues in Engineering (6 hrs)

5.1 Globalization and cross cultural issues

5.2 WTO perspectives
5.3 Public Private Partnership (PPP)
5.4 Development versus Environmental Degradation
5.5 Addressing the Climate Change issues
5.6 Conflicts and Dispute management

6. Case Studies Involving Professional Ethical Issues (4 hrs)

6.1 Copyrights and Patent Protection
6.2 Personal Data Privacy
6.3 Industrialization and Environmental protection
6.4 Risk/Benefit considerations in public transportation
6.5 Engineers and the military
6.6 Science and technology for medicine
6.7 Engineers in international development
6.8 Arbitration

Reference Materials

1. Carson Morrison and Philip Hughes, "Professional Engineering Practice – Ethical Aspects", McGraw-Hill Ryerson Ltd., Toranto, 1982.
2. Rajendra Adhikari, " Engineering Professional Practice – Nepalese and International Perspectives", Pashupati Publishing House, Kathmandu, Nepal
3. Engineering Council Act
4. Public Contract Act
5. Labor Act
6. Company Act
7. Public Procurement Act
8. Other relevant Acts, Rules and Regulation of Nepal

Utilization of Electrical Power (3 – 1 – 0)

Evaluation:

	Theory	Practical	Total
Sessional	50		50
Final	50		50
Total	100		100

Course Objectives:

- To familiarize with utilization of electrical power in applications like electrical drives, tractions, lighting systems, heating and welding

Course Contents:

1. **Illumination and Lighting** **(8 hrs)**
   - 1.1 Lighting basics and Photometry
   - 1.2 Units of illumination, reflectors , beam angle , illumination levels , standards , luminous efficiency, luminous efficacy and color rendering index
   - 1.3 Different type of lamps: fluorescent versus incandescent lights, arc and neon lights and ultra violet lamps
   - 1.4 Polar curves and their uses, lighting schemes, Lighting calculations, Evaluation of light requirements for specific tasks
   - 1.5 Building and Industrial lighting, Flood lighting and Street lighting

2. **Electric Heating and Welding** **(6 hrs)**
   - 2.1 Methods of electric heating equipment, Resistance ovens
   - 2.2 Induction heating and its types
   - 2.3 Dielectric heating, arc furnace, Heating of buildings
   - 2.4 Electric welding, resistance welding and arc welding

3. **Industrial Drives** **(8 hrs)**
   - 3.1 Introduction and classification of electric drives, Functional block diagram
   - 3.2 Types of loads, speed-torque characteristics
   - 3.3 Motor Sizing and Power-Torque Calculation
   - 3.4 Thermal Loading, Motor Duty Cycle types
   - 3.5 Steady state and transient Characteristics
   - 3.6 Load Equalization and Fly wheel sizing
   - 3.7 Electric drives for different applications

4. **Starting of Electric Motors** **(7 hrs)**
   - 4.1 Effects of starting on power supply
   - 4.2 Starting Dynamics of DC drives :Separately excited and DC Shunt motor
   - 4.3 Starting Dynamics Induction Motor

4.4 Acceleration time, energy relation during starting of DC shunt motor, DC series motor and 3 phase induction motors
4.5 Energy losses during transient operation of DC motor and three phase induction motor
4.6 Methods of reducing energy losses during starting

5. Electric Braking **(8 hrs)**

5.1 Types of Braking
5.2 Regenerative braking for DC shunt motor and Induction Machine, Braking of Synchronous Machine
5.3 Energy losses and stopping time calculation during dynamic braking of DC shunt motor
5.4 Energy losses and stopping time calculation during dynamic braking and plugging of 3-ph induction motor

6. Electric Traction **(8 hrs)**

6.1 System of traction and their Significant features
6.2 Transmission of drive, train movement, speed time and speed distance curves, simplified speed –time curves
6.3 Mechanical considerations, control and auxiliary equipments
6.4 Factors influencing energy consumption of traction
6.5 Introduction to Hybrid Vehicles and topologies

Text Books:

1. E. O. Taylor, "Utilization of Electric Energy, Orient Longman Private Limited", 2006.
2. G. K. Dubey, "Fundamentals of Electrical Drives", Alpha Science International Ltd, 2001.
3. R. K. Rajput, "Utilization of Electrical Power", Firewall Media, 2006.