Power Plant Design

**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. Renewable and non-renewable energy sources – Technology of geothermal, tidal, wind, solar thermal, solar photovoltaic, thermal, combustion, biothermal, combined cycle, gas turbine and hydro
   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
   3. Environmental aspects of each of the technologies, scope and feasibility in Nepalese context
   4. Co-generation, captive generation, distributed generation

1. **Integrated System Planning in design approach (4 hours)**
   1. Load forecast, system expansion planning, load uncertainties, system security, balancing load, reserve capacity, spinning reserve,
   2. Different technologies for stable system operation, benefits of interconnection of regional utilities

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

1. **Electric system design of a power plant (24 hours)**
   1. Electrical Single Line diagram, device symbols and numbers, generator and transformer schemes, scheme selection
   2. Generator and transformer specification, operation and maintenance viewpoint
   3. Governor and Excitation system, mode of operation, brushless and static excitation
   4. Protection systems for generator and transformer in different types of plants, generator neutral grounding, protection standards
   5. LV switchgear and station service, battery characteristics and battery charger operation, fire-fighting
   6. HV and MV Switchgear in power plants, HV switchyard, Switchyard scheme, bus layout, auxiliary and ancillary systems
   7. Fault level calculation
   8. Earthing system design of power station and sub-station
   9. Protection system design of generator
   10. Switchyard and synchronizing scheme
   11. Power evacuation & transmission line selection

**Power Plant Design Laboratory**

1. Design of a hydro power plant – civil and mechanical components
   1. Analysis of hydrological data, topology, determination of discharge and head, site selection
   2. Selection of plant and unit size, selection and layout of hydraulic structures and approximate sizing
   3. Turbine selection
2. Design of a hydro power plant – electrical system design
   1. Generator and transformer selection, specification for procurement
   2. Fault level calculation for switchgear
   3. Earthing system – grid size and conductor size calculation, earth resistance calculation
   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
   5. Switchyard scheme design and layout design
   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:**

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| **Chapters** | **Hours** | **Marks distribution\*** |
| 1 | 8 | 16 |
| 2 | 4 | 8 |
| 3 | 8 | 16 |
| 4 | 24 | 40 |
| **Total** | **44** | **80** |

**\*Note: There may be minor deviation in marks distribution.**