TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2082 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV/ II	Time	3 hrs.

Subject: - Power Plant Design *(EE 753)*

- ✓ *Candidates are required to give their answers in their own words as far as practicable.*
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary charts are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. a) What are conventional and non-conventional energy sources? Describe with suitable sketches show electric power can be obtained from thermal power plant? [3+5]
   b) Describe the process of power generation from tidal energy. List out the advantages and disadvantages of tidal energy. [5+3]
2. a) What do you mean by system security? How can the system be made secure? Explain in brief the stages of system security. [8]
   b) Explain importance of load forecasting in power system. List out major steps followed during the forecasting process. [8]
3. a) Starting from the hydrograph, could you link the effects of mean monthly flow while selecting the hydro turbine? [8]
   b) Define Short Circuit Ratio (SCR) of synchronous generator. Prove that SCR is reciprocal of per unit value of synchronous reactance of generator. Explain significance of SCR in design of synchronous generator. [1+4+3]
4. a) List out the major elements that limits the alternators capability curve. Draw a typical capability curve of alternator and explain it. [2+6]
   b) Explain any two types of generator-transformer scheme with their features. [4+4]
5. A typical hydro power plant has following details. [16]

Month	Discharge (m^3/s)	Flow duration	
January	3.30	Q(max)	110.00 m^3/s
February	2.20	$Q_{25\%}$	16.42 m^3/s
March	1.40	$Q_{45\%}$	6.82 m^3/s
April	1.00	$Q_{65\%}$	3.7 m^3/s
May	3.50	$Q_{85\%}$	2.10 m^3/s
June	6.00	$Q_{95\%}$	1.17 m^3/s
July	14.00	Q(min)	0.64 m^3/s
August	35.00		
September	24.00		
October	12.00		
November	7.50		
December	5.00		

Turbine type	Head range
Kaplan	2<H<40
Francis	10<H<350
Pelton	50<H<1300

Gross Head	180 m
Turbine efficiency	90%
Generator efficiency	97%
Transformer efficiency	98%
Head loss	5%
Riparian release	10%
Generator sub transient reactance	21%
Transformer reactance	11%
Transmission line inductance	3 mH/km
Transmission line length	100 km
Transmission Voltage level	132 kV
Generation Voltage level	11 kV
Transmission circuit	Double circuit

Design a hydro power plant so as to obtain following parameters

a) Electrical power output taking design discharge as $Q_{60\%}$.
b) Select the numbers of unit and installed capacity.
c) Select the type of turbine.
d) Select the type of bus bar to be used.
e) Draw a single line diagram showing number of units, generator, power transformer, station transformer and diesel generator for black start.
f) Calculate the rating of generator circuit breaker in your design.

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2082 Shrawan

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - Power Plant Design *(EE 753)*

- ✓ *Candidates are required to give their answers in their own words as far as practicable.*
- ✓ *Attempt **All** questions.*
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- ✓ *Assume suitable data if necessary.*

1. a) What is cogeneration? Where would such plant seem appropriate? [4]
   b) Describe principally the power estimation formula from a wind power plant. [4]
   c) Compare the electric power from hydropower with solar photovoltaic based power generation on the basis of reliability, grid-connection, efficiency, operating range and maintainability. Also consider the scenario in Nepalese context during comparison. [8]
2. a) Discuss a suitable method for a short-term load forecasting. [4]
   b) Discuss transmission expansion planning considering suitable inputs to it and its outcome focusing on deregulated electricity market of a nation. [4]
   c) List down the various components of a medium head relatively higher discharge hydropower plant and mention their functions. [8]
3. a) Discuss major factors to be considered during selection of a suitable generator in a hydropower project. [6]
   b) Compare brushless excitation system with static excitation system for a synchronous generator on the basis of schematic diagram, operating range, accessories required, cost and so on. [6]
   c) How would you determine suitable rating of a neutral grounding transformer during grounding of generator neutral? [4]
4. a) What sort of generator circuit breaker would you recommend in a power plant and why? [6]
   b) List out the necessary protection schemes to be employed for a medium size generator in a power plant. [6]
5. A typical hydropower plant has the following details:

Month	Discharge (m^3/s)		
January	5.62	Q_{max} (Q_0)	210.00 m^3/s
February	4.80	$Q_{25\%}$	24.23 m^3/s
March	4.55	$Q_{45\%}$	9.82 m^3/s
April	4.8	$Q_{65\%}$	4.7 m^3/s
May	5.90	$Q_{85\%}$	3.1 m^3/s
June	12.70	$Q_{95\%}$	2.17 m^3/s
July	42.98	Q_{min}	0.64 m^3/s
August	100.26		
September	64.23		
October	24.00		
November	10.37		
December	6.80		

Turbine Type	Head range (m)
Kaplan	2<H<40
Francis	10<H<350
Pelton	50<H<1300

Gross Head	330 m
Turbine Efficiency	90%
Generator Efficiency	97%
Transformer Efficiency	99%
Head Loss	5%
Riparian Release	10%
Generator Sub transient Reactance	21%
Transformer Reactance	9.15%
Transmission Line Inductance	0.95 mH/km
Transmission Line Length	20 km
Generator Voltage Level	11 kV
Transmission Voltage	132 kV

Design a power plant so to obtain following parameters:

(i) Electrical power output or installed capacity taking design discharge as $Q_{45\%}$. [3]

(ii) Select numbers of units [3]

(iii) Select the type of turbine [3]

(iv) Show appropriate generator transformer scheme. [3]

(v) Draw single line diagram showing number of units, generator, power transformer, station transformer and diesel generator for black start. [4]

(vi) Calculate the rating of the transmission line side circuit breaker (HVCB) to be used in your design. [4]

A. Turbine Selection

Chart A. In round figure

Turbine Type	Head range (m)
Kaplan	2<H<40
Francis	10<H<350
Pelton	50<H<1300

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2081 Chaitra

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Year / Part	IV/ II	**Time**	3 hrs.

Subject: - Power Plant Design *(EE 753)*

- ✓ *Candidates are required to give their answers in their own words as far as practicable.*
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Is biomass renewable? How about our firewood in Nepalese villages? Justify your answer with necessary arguments. [4]
   b) What do you mean by captive power generation? Discuss its needs. [4]
   c) Compare the operational characteristics of thermal and hydropower plant on the basis of reliability, grid connection, efficiency, operating range, economics and maintainability. [8]
2. a) What is power system planning? Discuss in reference to deregulated electricity sectors of a nation. Also describe pros and cons of integration of two national or regional grids. [5+3]
   b) Make a sketch to show various components of medium head and relatively large discharge, medium size Pondage Run of Rive (PRoR) hydropower plant. Also, mention the functions of each component. [8]
3. a) What is capability curve of a generator? Describe briefly. [4]
   b) Discuss working of a brushless excitation with necessary schematic diagram. When would you recommend using such excitation system? [6]
   c) What is neutral grounding transformer (NGT)? Also describe the steps to find optimal size of NGT. [2+4]
4. a) Describe steps of grounding mat design in powerhouse or substation. [6]
   b) What is restricted earth fault protection? Illustrate its use with suitable diagram. [6]
5. A typical hydropower plant has the following details:

Month	Discharge (m^3/s)		
January	6.90	Q_{max} (Q_0)	218.00 m^3/s
February	5.86	$Q_{25\%}$	28.24 m^3/s
March	4.58	$Q_{45\%}$	9.80 m^3/s
April	3.55	$Q_{65\%}$	6.7 m^3/s
May	5.10	$Q_{85\%}$	4.1 m^3/s
June	17.70	$Q_{95\%}$	2.9 m^3/s
July	72.95	Q_{min}	1.64 m^3/s
August	120.26		
September	98.23		
October	25.05		
November	8.38		
December	7.85		

Gross Head	300 m
Turbine Efficiency	91%
Generator Efficiency	97%
Transformer Efficiency	99%
Head Loss	5%
Riparian Release	10%
Generator Sub transient Reactance	21%
Transformer Reactance	9.15%
Transmission Line Inductance	0.92 mH/km
Transmission Line Length	20 km
Generator Voltage Level	11 kV

Design a power plant so to obtain following parameters:

(i) Installed capacity in MW taking design discharge as $Q_{45\%}$ [3]

(ii) Select numbers of units [3]

(iii) Select the type of turbine [3]

(iv) Choose suitable generator transformer scheme. [3]

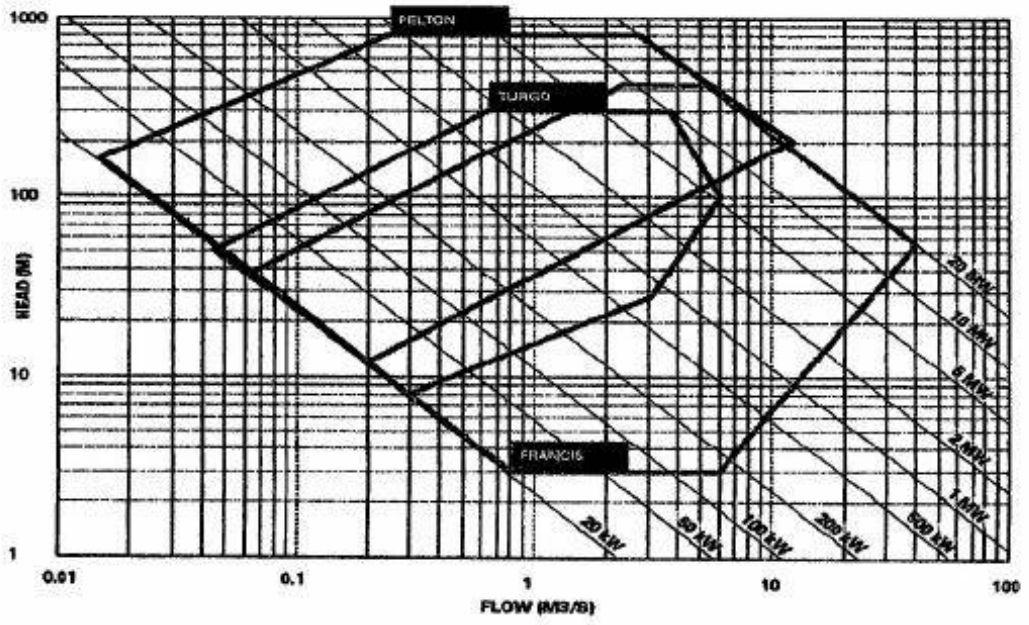
(v) Draw single line diagram showing number of units, generator, power transformer, station transformer and diesel generator for black start. [4]

(vi) Calculate the rating of the generator circuit breaker (GCB) to be used in your design. [4]

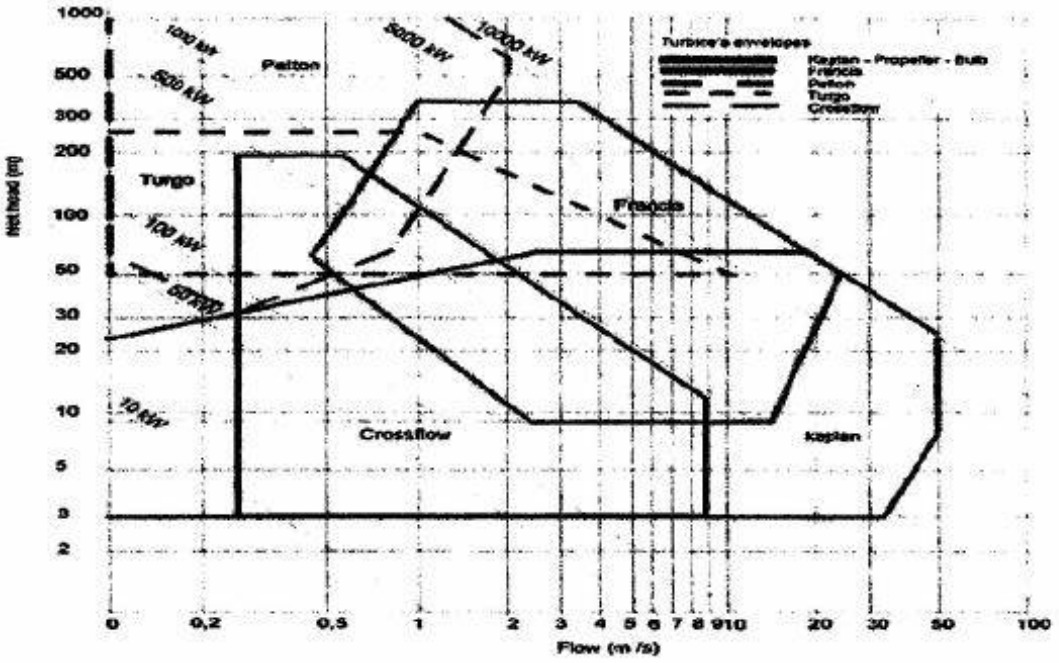
a) Turbine selection

Turbine Type	Head range (m)
Kaplan	2<H<40
Francis	10<H<350
Pelton	50<H<1300

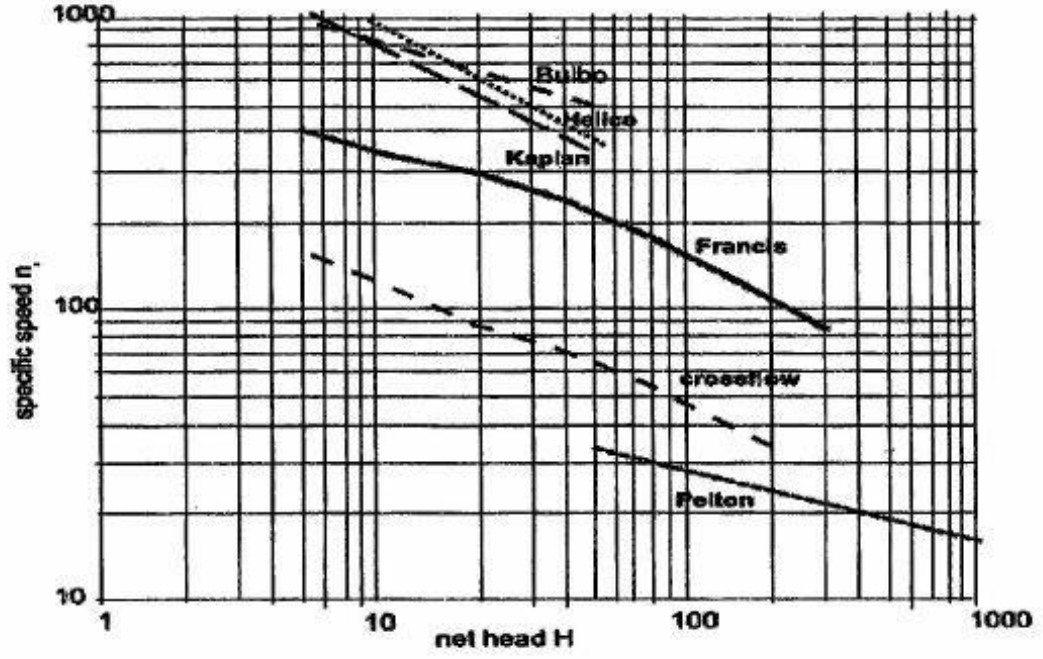
b) For higher Head



c) For lower head.



d) Specific speed method



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TRIBHUVAN UNIVERSITY
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Examination Control Division
2081 Shrawan

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - Power Plant Design *(EE 753)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Necessary charts are attached herewith.*
- ✓ *Assume suitable data if necessary.*

1. a) Present in brief the world scenario of renewable energy sector of the recent decade. [6]
   b) What is cogeneration? Why is it seemed useful in biomass-based power plant? [4]
   c) Compare thermal power plant with nuclear power plant on the basis of availability, grid connectivity, easiness to control, environmental effect, cost factors and so on. [6]
2. a) A house is using in average the following electrical appliances [6]
   - Two 10 W lamp for 4 hours per day
   - One 60 W fan for 2 hours per day
   - One 75 W television used for 4 hours per day

   The system has to be powered by isolated PV System with 12 V battery.
   Determine Size of the PV Panel, Inverter and Battery.
   (Consider wiring losses 20%, assume inverter efficiency 95% & for battery: efficiency is 90%, depth of discharge factor 0.6 and days of autonomy as 3. Make our smart assumption if further required)
   b) Assume that you have identified a suitable hydropower site in Nepal for electricity generation. Discuss the steps/stages how would you proceed to own, build the project and finally sell power to Nepal Electricity Authority. [6]
   c) What is power system security? Also describe about reserve requirement in a power system. [4]
3. a) Discuss major components of a high dam type hydropower project with suitable schematic diagram. [6]
   b) Mention major factors governing during appropriate turbine selection. [4]
   c) Explain static excitation system. Also highlight its pros and cons in comparison to its best possible alternative. [6]
4. a) Describe the major steps that to be followed for design of earthing (grounding) mat in power station and its switchyard. [8]
   b) Discuss the consequences of choosing higher or lower Short Circuit Ratio (SCR) of a generator. [4]
   c) What does "black start capability" of a generating unit mean? How would it have been made so? [4]

5. A typical hydro power plant has the following details.

Month	Discharge (m^3/s)			
Jan	4.68533	Q_{max}(Q0)	207.0024	m^3/s
Feb	3.867942	$Q_{25\%}$	18.2424	m^3/s
Mar	3.584017	$Q_{45\%}$	6.87999	m^3/s
Apr	4.553517	$Q_{65\%}$	4.706992	m^3/s
May	3.22678	$Q_{85\%}$	3.106132	m^3/s
Jun	12.77418	$Q_{95\%}$	2.17348	m^3/s
July	32.95867	Q_{min}	0.648732	m^3/s
Aug	40.26243			
Sept	31.23782			
Oct	15.05586			
Nov	7.380238			
Dec	4.858522			

Gross Head	220 m
Turbine efficiency	90%
Generator efficiency	97%
Transformer efficiency	98%
Head loss	5.00%
Riparian release	10%
Generator sub transient reactance	21%
Transformer reactance	9%
Transmission line inductance	0.95 mh/kM
Transmission line length	25 kM
Transmission voltage Level and no. of circuits	Use optimal one
Generator voltage level	11 kV

Design a hydro power plant so as to obtain the following parameters.

a) Installed capacity taking design discharge as $Q_{45\%}$. [2]

b) Select the number of unit and turbine type. [3]

c) Select the type of turbine. [3]

d) Draw the single line diagram showing number of units, generator, power transformer and station transformer. [4]

e) Calculate the rating of generator circuit breaker to be used in your design. [4]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
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2080 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - Power Plant Design *(EE 753)*

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- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary charts are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. a) Present scenario of Nepalese electricity sector for this decade. [6]
   b) What is captive power plant? List out its significance. [4]
   c) Compare grid tied solar PV with hydropower plant on the basis of availability, grid connectivity, easiness to control and investment cost. [6]
2. a) Assume that we live in an area slightly above sea level that has an air density of 1.225 Kg/m^3 and we have installed a 45% efficient wind turbine which has a rotor blade radius of 12 m. Calculate the output power from the turbine at a wind speed of 18 m/s. [4]
   b) What is biomass energy? Is it renewable? What about the firewood being used in Nepal? [6]
   c) What is power system expansion planning? Discuss its applicability in context of a national electric utility organization. [6]
3. a) Draw schematic diagram of a hydropower plant and explain the basic civil, mechanical and electrical components used. [8]
   b) What is flow duration curve? Also discuss about its applicability. [4]
   c) Discuss about suitability of Kaplan turbine in context of Nepalese hydropower sector. [4]
4. a) List out the most essential protection schemes required for Alternator and Generator Step Up transformer in a mega size power project. [6]
   b) Discuss brushless excitation system. Also mention its pros and cons in comparison to its best possible alternative. [6]
   c) Discuss briefly about requirements of DC supply system in a power generating station. [4]
5. A typical hydro power plant has the following details.

Month	Discharge(m^3/s)		
January	13.5	Q_{max} (Q_o)	149.00 m^3/s
February	8.6	$Q_{25\%}$	72.5 m^3/s
March	6.58	$Q_{45\%}$	22.87 m^3/s
April	7.5	$Q_{65\%}$	12.7 m^3/s
May	12.8	$Q_{85\%}$	8.70 m^3/s
June	25.7	$Q_{95\%}$	7:1 m^3/s
July	72.5	Q_{min}	5.05 m^3/s
August	101.2		
September	81.3		
October	27.05		
November	21.38		

Gross Head	310 m
Turbine efficiency	91%
Generator efficiency	97%
Transformer efficiency	99%
Head loss	5%
Raparian release	10%
Generator sub transient reactance	21%
Transformer reactance	9.15%
Transmission line inductance	0.95mH/km
Transmission line length	30 kM
Transmission voltage level	As required
Generator voltage level	11kV
Transmission circuit (single or double)	Choose appropriately as required

(Please make your own smart assumption if needed beside given data above)
Design a power plant project so as to obtain following,

a) Installed capacity with design discharge as Q45% and appropriate number of units. [3]

b) Choose the appropriate type of Generator lead. [2]

c) Choose your generator transformer scheme mentioning the reasons. [3]

d) Make single line diagram for the project choosing earthing system, excitation system and bus bar system. [4]

e) Find Rating of high voltage circuit breaker of the project. [4]

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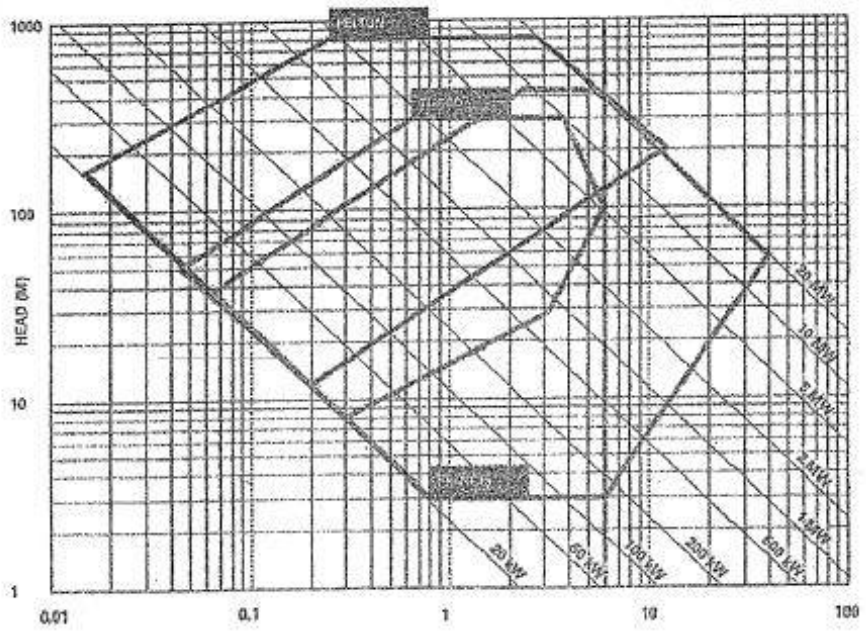
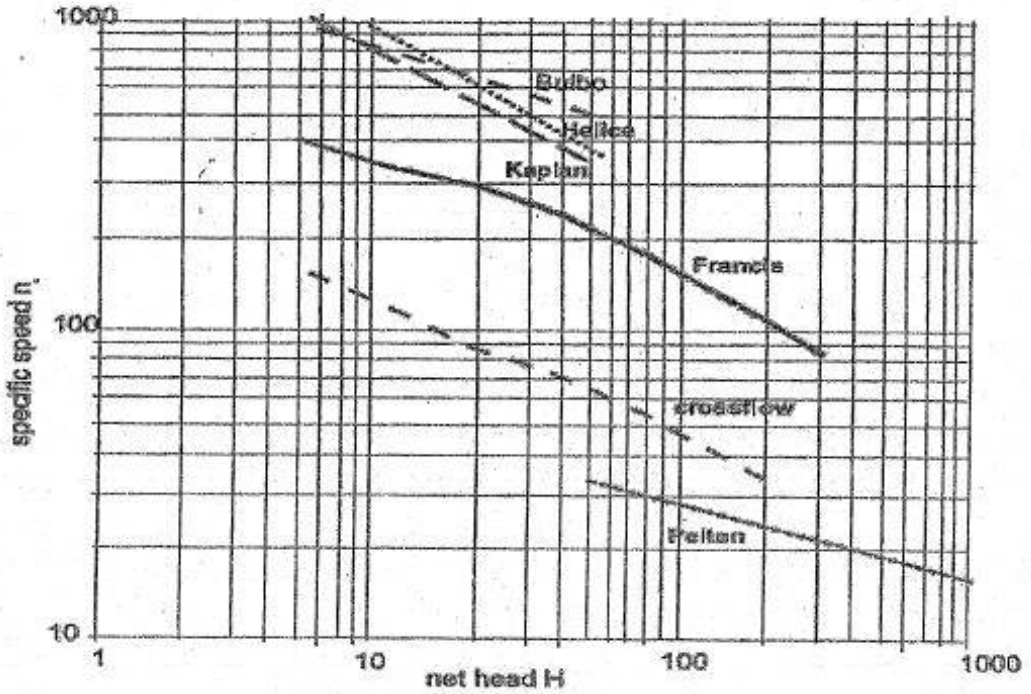
Turbine Selection Table and Charts

Turbine type	Head range in metres
Kaplan and Propeller	2 < H < 40
Francis	10 < H < 350
Pelton	50 < H <1300
Michell-Banki	3 < H < 250
Turgo	50 < H < 250





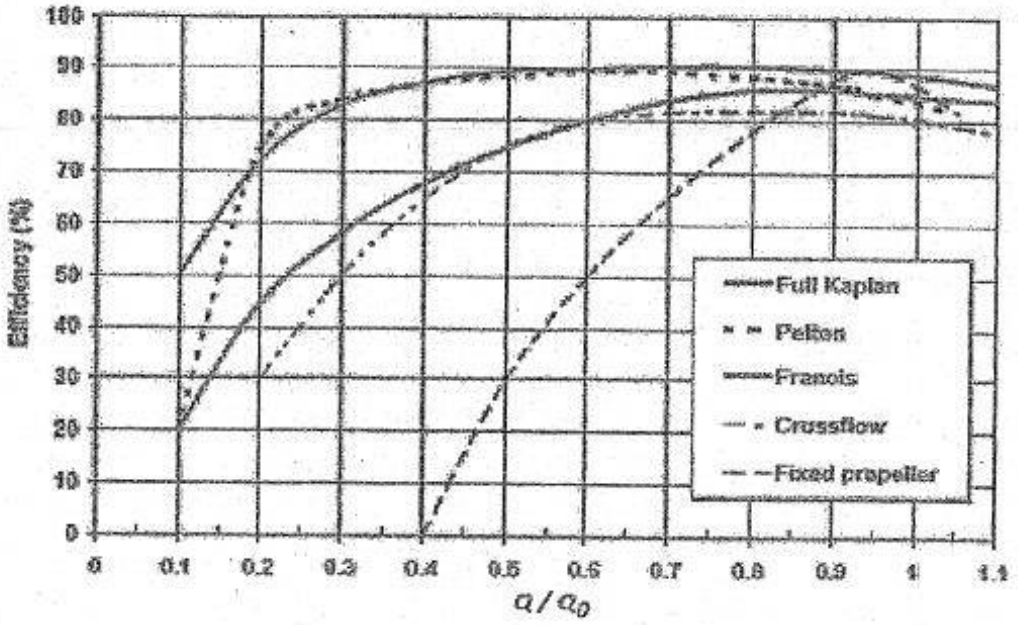


Fig. Trubine Efficiency

TRIBHUVAN UNIVERSITY
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Examination Control Division
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Exam.	Regular		
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Year / Part	IV / II	Time	3 hrs.

Subject: - Power Plant Design *(EE 753)*

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- ✓ *Attempt **All** questions.*
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1. a) Discuss the development of hydro power plant in the context of Nepal. [6]
   b) Compare the operational characteristics of Solar Power plant with hydro power plant on the basis of reliability, grid connection, efficiency, operating range, maintainability and economics. [6]
   c) Explain how bio-mass source of energy can maintain sustainable carbon neutral cycle? [4]
2. a) How would the interconnection of regional utilities help in integrated system planning in design approach? Does it solve the issue of reserve bottling? [6]
   b) What is the difference between spinning reserve and reserve power? [4]
   c) Show that the power output of wind power plant is cube of the velocity of air. What are the other factors that may guide the possible output of wind power project? [3+3]
3. a) Draw a schematic diagram of reservoir type hydro-power plant and describe necessary civil, mechanical and electrical components. [8]
   b) Describe the working principle of electronic based automatic voltage regulator with suitable diagrams. [8]
4. a) Discuss logics behind recommending brushless excitation system over static excitation system. [6]
   b) Compare grounded and ungrounded power system. [6]
   c) List out the possible protection scheme that to be employed for a medium size hydropower generator. [4]
5. A typical hydropower plant has the following details.

Month	Discharge (m^3/s)	Flow duration	
January	3.30	Q_{max}	110.00 m^3/s
February	2.20	$Q_{25\%}$	16.42 m^3/s
March	1.40	$Q_{45\%}$	6.82 m^3/s
April	1.00	$Q_{65\%}$	3.7 m^3/s
May	3.50	$Q_{85\%}$	2.10 m^3/s
June	6.00	$Q_{95\%}$	1.17 m^3/s
July	14.00	Q_{min}	0.64 m^3/s
August	35.00		
September	24.00		
October	12.00		
November	7.50		
December	5.00		

Turbine type	Head range
Kaplan	$2 < H < 40$
Francis	$10 < H < 350$
Pelton	$50 < H < 1300$

Gross Head	95 m
Turbine efficiency	90 %
Generator efficiency	97 %
Transformer efficiency	98 %
Head loss	5 %
Riparian release	10 %
Generator sub transient reactance	20 %
Transformer reactance	11 %
Transmission line inductance	0.77 mH/km
Transmission line length	80 km
Transmission Voltage level	66 kV
Generator Voltage level	11 kV
Transmission circuit	Single circuit

Design a hydro power plant so as to obtain following parameters

a) Electrical power output taking design discharge as $Q_{65\%}$. [1]
b) Select the numbers of unit and installed capacity. [2]
c) Select the type of turbine. [3]
d) Select the type of bus bar to be used. [2]
e) Draw the single line diagram showing number of units, generator, power transformer, station transformer and diesel generator for black start. [4]
f) Calculate the rating of generator circuit breaker and high voltage circuit breaker in your design. [4]

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Subject: - Power Plant Design (*EE 753*)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
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- ✓ *Necessary Charts are attached herewith.*
- ✓ *Assume suitable data if necessary.*

1. a) Discuss recent trends or changes of scenario of "world's electricity generation from renewable resources" in general. Is it impacting power generation trend in Nepalese Power Sector as well? [6]
   b) Compare Combined Cycle Gas Turbine power plant with hydro power project considering various possible aspects. [6]
   c) Assume that we live in an area slightly above sea level that has an air density of 1.225 kg/m^3 and we have installed a 35% efficient wind turbine which has a rotor blade radius of six 6.5 m. Calculate the output power from the turbine at a wind speed of 9 m/s and again at double the velocity of 18 m/s. [4]
2. a) Write down the appropriate use of geo-thermal energy found in different parts of Nepal. Write down the types of plant if we geo-thermal energy to produce electricity. Draw figures if necessary. [6]
   b) What is transmission expansion planning? Discuss its applicability. [4]
   c) Assume that you have identified a suitable hydropower site for electricity generation. Discuss the steps/stages how would you proceed to own, build that project and finally sell power to Nepal Electricity Authority. [6]
3. a) Stating environmental impact of P-ROR type hydro-power plant, draw a schematic diagram showing all the necessary components and describe each of them. [8]
   b) What is scientific method of turbine selection? [4]
   c) Discuss briefly the concept of power system security. [4]
4. a) Write down the different types of high voltage bus bar with appropriate line diagram. Write the advantages and disadvantages of main and transfer bus bar. [8]
   b) Make a tentative an example type quotation of a high voltage side "circuit breaker" for power evacuation purpose at switch yard of a hydropower project that has installed capacity about 48 MW and line length to grid point substation is about 15 km. [4]
   c) Discuss major steps of Grounding Mat design in a power project area. [4]

5. A typical hydro power plant has the following details

Month	Discharge (m^3/s)		
Baishakh	6.26	Q_{max} (Q_o)	157.00 m^3/s
Jestha	12.45	$Q_{25\%}$	18.24 m^3/s
Ashad	32.12	$Q_{40\%}$	12.85 m^3/s
Shrawan	49.08	$Q_{65\%}$	10.7 m^3/s
Bhadra	44.47	$Q_{85\%}$	6.40 m^3/s
Ashoj	23.88	$Q_{95\%}$	4.91 m^3/s
Kartik	11.57	Q_{min}	3.35 m^3/s
Mangsir	7.2		
Poush	5.06		
Magh	4.1		
Falgun	3.69		
Chaitra	4.25		

Gross Head	589 m
Turbine efficiency	91%
Generator efficiency	97%
Transformer efficiency	99%
Head loss	4%
Raparian release	10% of driest flow
Generator sub transient reactance	18%
Transformer reactance	7.15%
Transmission line inductance	0.95 mH/km
Transmission line length	12 kM
Transmission voltage level	132 kV
Generator voltage level	11 kV
Transmission circuit	Double circuit

(please make your own smart assumption if needed beside given data above)

Design a power plant project so as to obtain following

a) Electrical power output taking design discharge as Q40%. [3]
b) Select the numbers of units and installed capacity. [2]
c) Recommend the appropriate type of Generator-transformer scheme. [3]
d) Make single line diagram for the project choosing your generator transformer scheme and bus bar system. [4]
e) Find MVA rating of a generator circuit breaker of the project. [4]

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Turbine Selection Table and Charts

Turbine type	Head range in meters
Kaplan and Propeller	$2 < H < 40$
Francis	$10 < H < 350$
Pelton	$50 < H < 1300$
Michell –Banki	$3 < H < 250$
Turgo	$50 < H < 250$

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2079 Jestha

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - Power Plant Design (*EE 753*)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt <u>All</u> questions.*
- ✓ *The figures in the margin indicate <u>Full Marks</u>.*
- ✓ *Assume suitable data if necessary.*
- ✓ ***Necessary Graph is attached herewith.***

1. a) What are the conventional and no-conventional energy sources in Nepal? Describe the possibility and scope of wind energy in the context of Nepal. [8]
   b) Explain about mechanical and thermal energy storages technologies. [8]
2. a) Define the following terms. [3×2]
      i) Load uncertainties
      ii) System security
      iii) Reserve power
   b) Sketch a typical layout of a medium head hydropower station fitted with Francis turbine. Briefly describe the main elements. [10]
3. a) Describe the characteristics of various types of turbines used in hydro electric power stations. [8]
   b) Compare the brushless excitation system with static excitation system on the basis of schematic diagram. [8]
   c) Discuss the different types of busbar layout used in substation with suitable circuit diagram. [8]
4. a) Develop a typical specification while procuring a power transformer to be used in power plant design. [8]

b) A typical hydro power plant has the following details. [16]

Month	Discharge(m^3/s)		
Jan	11.95	Q_{max} (Q_o)	674.19 m^3/s
Feb	9.94	Q25%	48.90 m^3/s
Mar	9.20	Q45%	16.75 m^3/s
Apr	11.93	Q65%	9.34 m^3/s
May	8.48	Q85%	6.21 m^3/s
Jun	42.28	Q95%	4.38 m^3/s
July	120.98	Qmin	1.40 m^3/s
Aug	143.00		
Sep	110.27		
Oct	50.95		
Nov	24.66		
Dec	16.17		

TURBINE TYPE	HEAD RANGE IN METERS
Kaplan	2 < H < 40
Francis	10 < H < 350
Pelton	50 < H < 1300
Gross Head	120 m
Turbine efficiency	90%
Generator efficiency	97%
Transformer efficiency	98%
Head loss	5%
Raparian release	10%
Generator sub-transient reactance	15%
Transformer reactance	12%
Transmission line inductance	0.96 mH/km
Transmission line length	20 km
Transmission Voltage level	33 kv
Generator Voltage level	11 kv
Transmission circuit	Single circuit

Design a power plant so as to obtain the following parameters

i) Electrical power output taking design discharge as Q45%
ii) Select the numbers of units and installed capacity with suitable reasons
iii) Draw the single line diagram showing numbers of units, generators, power transformer, station transformer and diesel generator for black start
iv) Select the type of turbine
v) Select the type of busbar with suitable reasons
vi) Calculate the MVA level of LV bus, MV bus and HV bus
vii) Calculate the rating of CB to be used in your design.
(Assume suitable data if required)

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2078 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - Power Plant Design *(EE 753)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary charts are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. a) Discuss trends or changes of scenario of "Nepalese electricity generation and consumption" that of before FIVE years and that may come up after FIVE years from today's date. [6]
   b) Write down the strength, weakness, opportunity and threats (SWOT) analysis for installing wind turbine for generating electricity in Nepal. [6]
   c) Assume that there is barrage of size 3 km × 5.5 km for tidal power project. Average number of tides per day is 2 and the tide height is 10m. Considering power conversion efficiency of 60%, determine power output capacity of the tidal project. The density of sea water is 1023 kg/m^3. [4]
2. a) What do you understand by generation expansion planning? How does load forecasting effects generation expansion planning? [6]
   b) What is flow duration curve? Discuss its applicability. [4]
   c) What are the factors to be considered during selection of appropriate site for hydropower? Also mentions the factors that govern discharge of a hydropower project. [4+2]
3. a) Discuss major components of a Daily Pondage Run off the River type hydropower project with tentative head 150 m and discharge 10 m^3/s per unit. Illustrate with suitable schematic diagram. [8]
   b) Differentiate applicability of Francis and Kaplan Turbine in reference to hydropower project. [4]
   c) How would flow duration curve affect while designing unit sizes of power plant? [4]
4. a) Discuss the capability curve of a generator. [6]
   b) How are the concepts of STEP POTENTIAL and TOUCH POTENTIAL utilized during grounding mat design of a power project area? Why and how these potentials are appropriately set? [6]
   c) Discuss advantages of solidly grounded system of generator grounding. [4]

5. A typical hydro power plant has the following details

Month	Discharge (m^3/s)		
January	7.50	Q_{max} (Q_o)	207.00 m^3/s
February	6.60	$Q_{25\%}$	28.24 m^3/s
March	5.58	$Q_{45\%}$	18.87 m^3/s
April	6.55	$Q_{65\%}$	13.7 m^3/s
May	8.8	$Q_{85\%}$	8.90 m^3/s
June	17.77	$Q_{95\%}$	7.91 m^3/s
July	56.95	Q_{min}	5.05 m^3/s
August	134.26		
September	103.27		
October	29.05		
November	19.38		
December	12.35		

Gross Head	360 m
Turbine efficiency	90%
Generator efficiency	97%
Transformer efficiency	98%
Head loss	5%
Raparian release	10%
Generator sub transient reactance	19%
Transformer reactance	8.15%
Transmission line inductance	0.95 mH/km
Transmission line length	22 kM
Transmission voltage level	132 kV
Generator voltage level	11 kV
Transmission circuit	Double circuit

(Please make your own smart assumption if needed beside given data above)

Design a power plant project so as to obtain following

a) Electrical power output taking design discharge as $Q_{45\%}$. [3]
b) Select the numbers of units and installed capacity. [2]
c) Recommend the appropriate type of Generator-transformer scheme. [3]
d) Make single line diagram for the project choosing your generator transformer scheme and bus bar system. [4]
e) Find MVA Rating of a generator circuit breaker of the project. [4]

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Turbine Selection Table and Charts

Turbine type	Head range in meters
Kaplan and Propeller	$2 < H < 40$
Francis	$10 < H < 350$
Pelton	$50 < H < 1300$
Michell-Banki	$3 < H < 250$
Turgo	$50 < H < 250$

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2078 Kartik

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - Power Plant Design *(EE 753)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt <u>All</u> questions.*
- ✓ *The figures in the margin indicate <u>Full Marks</u>.*
- ✓ *<u>Necessary figures are attached herewith.</u>*
- ✓ *Assume suitable data if necessary.*

1. A typical hydro power plant has the following details

Month	Discharge (m^3/s)		
January	5.5	Q_{max} (Q_0)	207.00 m^3/s
February	4.6	$Q_{25\%}$	28.24 m^3/s
March	3.58	$Q_{45\%}$	8.87 m^3/s
April	4.55	$Q_{65\%}$	5.7 m^3/s
May	4.8	$Q_{85\%}$	4.10 m^3/s
June	12.77	$Q_{95\%}$	2.91 m^3/s
July	39.95	Q_{min}	1.05 m^3/s
August	50.26		
September	41.23		
October	23.05		
November	9.38		
December	6.35		

Gross Head	260 m
Turbine efficiency	90%
Generator efficiency	97%
Transformer efficiency	98%
Head loss	5%
Raparian release	10%
Generator sub transient reactance	21%
Transformer reactance	9.15%
Transformer line inductance	0.95mH/km
Transformer line length	30 kM
Transformer voltage level	66 kV
Generator voltage level	11 kV
Transmission circuit	Double circuit

(Please make your own smart assumption if needed beside given data above)
Design a power plant project so as to obtain following

a) Electrical power output taking design discharge as Q45%. [3]
b) Select the numbers of units and installed capacity. [3]
c) Choose the appropriate type of Generator lead. [2]
d) Make single line diagram for the project choosing your generator transformer scheme and bus bar system. [4]
e) Find Rating of generator circuit breaker of the project. [4]

2. a) Discuss current Nepalese electricity scenario of demand and supply and its trend in near future. [6]

b) Compare Thermal Power Project with Nuclear Power Project considering various possible aspects. [6]

c) Assume that we live in an area slightly above sea level that has an air density of 1.225 kg/m^3 and we have installed a 40% efficient wind turbine which has a rotor blade radius of 6m. Calculate the output power from the turbine at a wind speed of 8m/s and again at double the velocity of 16m/s. [4]

3. a) Discuss why choosing appropriate Short circuit ratio (SCR) of a generator is crucial from the perspective of stability of the system? [4]

b) Make a tentative an example type quotation of a "Power Transformer" for power evacuation purpose from switch yard of a general medium size hydropower project situated in hilly region. [6]

c) Discuss major steps of Grounding Mat design in a power project area. [6]

4. a) Discuss major components of a Daily Pondage Run off the River type hydropower project with suitable schematic diagram. [8]

b) What is scientific method of turbine selection? Mention major factors governing turbine during selection of appropriate turbine type. [4+4]

5. a) Why are biomass considered renewable source of Energy? [4]

b) What are hydrograph and flow duration curve? Discuss its applicability. [6]

c) Assume that you have identified a suitable hydropower site for electricity generation. Discuss the steps/stages how would you proceed to own, build that project and finally sell power to Nepal Electricity Authority. [6]

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Turbine Selection Table and Charts

Turbine type	Head range in metres
Kaplan and Propeller	$2 < H < 40$
Francis	$10 < H < 350$
Pelton	$50 < H < 1300$
Michell-Banki	$3 < H < 250$
Turgo	$50 < H < 250$

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2077 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - Power Plant Design *(EE 753)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary charts are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. a) What are the non-conventional energy sources in Nepal? Describe the technology, possibility and scope of wind energy in the context of Nepal. [6]
   b) Hydropower brings holistic development for the region. How could it be possible? [4]
   c) Compare Geothermal power plant with conventional thermal power plant considering various aspects. [6]
2. a) What is Transmission Expansion Planning? Discuss its brief procedure. [6]
   b) Find size of a solar panel and inverter system for a home in an isolated remote area, that has loads as in following table. [6]

Load Type	No.	Watt	Average Operating hours
Lamps	3	10	4
TV	1	85	6
Laptop	1	65	8

   Note: Make your own necessary assumptions.
   c) What is scientific method of turbine selection? [4]
3. a) Draw a schematic diagram of PROR type hydropower plant showing all the necessary components and describe each of them. [8]
   b) Write down the types of generator neutral grounding. Specify the types to be used in accordance to the size of power plant with their advantages and disadvantages. [8]
4. a) What are the factors affecting the system expansion planning? [4]
   b) List out major methods/requirements you may recommend for protection of generator in a medium size power project. [4]
5. A typical hydro power plant has the following details

Month	Discharge (m^3/s)		
January	4.15	Q_{max} (Q_o)	120.00 m^3/s
February	3.60	$Q_{25\%}$	43.24 m^3/s
March	3.44	$Q_{45\%}$	16.17 m^3/s
April	3.89	$Q_{65\%}$	5.99 m^3/s
May	5.54	$Q_{85\%}$	4.40 m^3/s
June	16.67	$Q_{95\%}$	3.71 m^3/s
July	43.36	Q_{min}	2.65 m^3/s
August	53.29		
September	37.84		
October	16.56		
November	8.15		
December	5.53		

Gross Head	550 m
Turbine efficiency	91%
Generator efficiency	97%
Transformer efficiency	99%
Head loss	4.5%
Raparian release	10%
Generator sub transient reactance	21%
Transformer reactance	9.15%
Transmission line inductance	0.95 mH/km
Transmission line length	25 kM
Transmission voltage level	132kV
Generator voltage level	11kV
Transmission circuit	Single circuit

(Please make your own smart assumption if needed beside given data above)

Design a power plant project so as to obtain following

a) Electrical power output taking design discharge as Q45%. [3]
b) Select the numbers of units and Turbine Type. [3]
c) What kind of Generator lead do you choose and why? [3]
d) Make single line diagram for the project choosing your generator transformer scheme and bus bar system. [5]
e) Find Rating of generator circuit breaker of the project. [4]
f) Make a tentative quotation for purchasing suitable "Generator Transformer" as per the requirement of the project. [6]

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13 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - Power Plant Design *(EE753)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Necessary charts are attached herewith.*
- ✓ *Assume suitable data if necessary.*

1. a) What are the conventional and non conventional energy sources? How the fossil fuel can be replaced by non-conventional energy in Nepal? [6]
   b) Compare the operational characteristics of solar photovoltaic power plant with hydropower plant on the basis of reliability, grid connection, efficiency, operating range, maintenance perspectives and so on. Also, discuss the beauty of combination of such to kind of power project for an electric system. [7+3]
2. a) Derive the formula to estimate electric power output from a wind power system. [4]
   b) Discuss Cogeneration Technology. Recommend the places where such system is more attractive. [6]
   c) Discuss briefly the Generation expansion planning procedure. [6]
3. a) Discuss the various components of PROR hydropower plant with suitable schematic diagram. [6]
   b) Discuss the tentative steps/phases for developing a hydropower plant in relevance to such project in Nepal. [4]
   c) The design exceedance of hydropower plant $Q_{45\%}$, what does that mean? Compare $Q_{45\%}$ with $Q_{65\%}$ while designing hydropower plant from the perspective of power producer (seller). [6]
4. a) Compare brushless and static excitation system according to operation and use. [6]
   b) List out the major elements that limits the alternator's capability curve. Draw a typical capability curve of alternator and explain it. [6]
   c) Describe the major steps that to be followed for design of Earthing (Grounding) mat in power station. [4]
5. A typical hydro power plant has the following details.

Month	Discharge (m^3/s)		
January	5.2	Q_{max} (Q_0)	211.00m3/s
February	3.86	$Q_{25\%}$	18.24m3/s
March	3.58	$Q_{45\%}$	7.00m3/s
April	4.55	$Q_{65\%}$	4.70m3/s
May	3.20	$Q_{85\%}$	3.10m3/s
June	12.77	$Q_{95\%}$	2.17m3/s
July	32.95	Q_{min}	0.64m3/s
August	40.26		
September	31.23		
October	15.05		
November	7.38		
December	4.85		

Turbine	Head range (m)
Kaplan	2<H<40
Francis	10<H<350
Pelton	50<H<1300

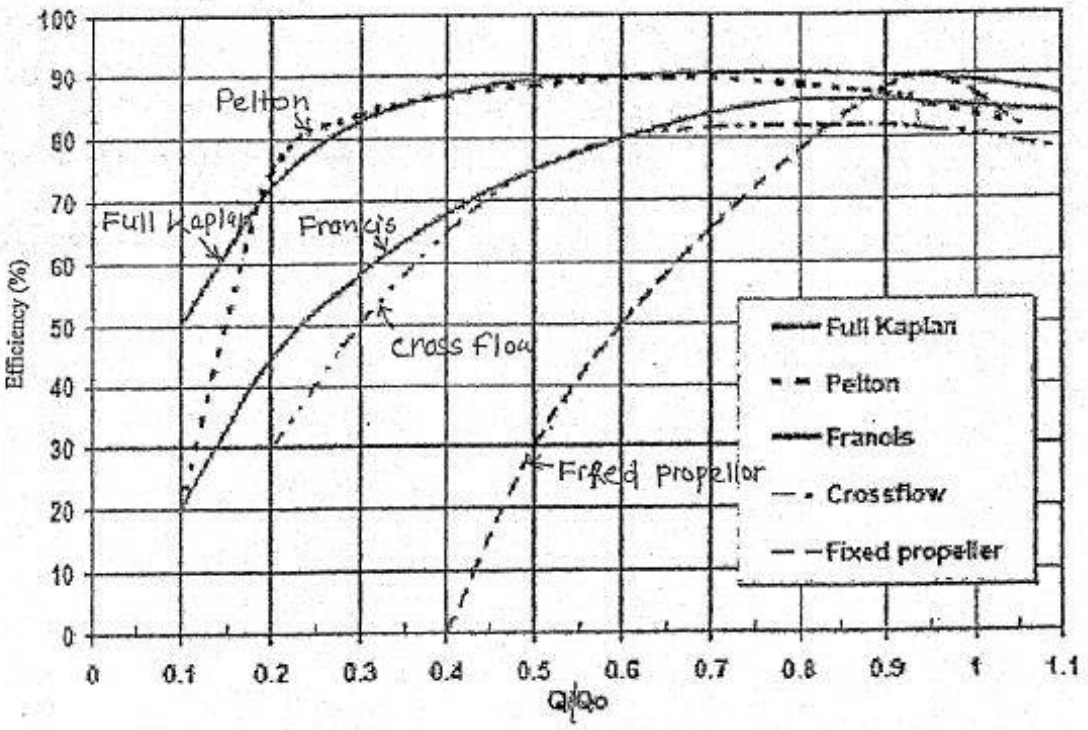
Gross Head	280 m
Turbine efficiency	91%
Generator efficiency	97%
Transformer efficiency	99%
Head loss	5%
Riparian release	10%
Generator sub transient reactance	21%
Transformer reactance	9.15%
Transmission line inductance	0.92 mH/km
Transmission line length	30kM
Transmission voltage level	66kV
Generator voltage level	11kV
Transmission circuit	Double circuit

Design a power plant so as to obtain following parameters

a) Electrical power output taking design discharge as Q45% [2]
b) Select the numbers of units and installed capacity [2]
c) Select and Recommend suitable turbine [4]
d) Draw the single line diagram showing generators, power transformers, station transformer and diesel generator for black start [4]
e) Calculate the rating of generator circuit breaker to be used in your design [4]

(Assume suitable data if necessary and necessary graph is attached herewith)

Turbine Selection Chart



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24 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 Magh

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - Power Plant Design *(EE753)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) How do you claim that biomass is renewable sources of energy? [4]
   b) What do you mean by captive power generation and discuss its needs. [4]
   c) Compare the operational characteristics of thermal and hydropower plant on the basis of reliability, grid connection, efficiency, operating range, economics and maintainability. [8]
2. a) Explain how the electricity can be generated from solar with suitable sketch. Explain the characteristics of wind power on the basis of turbine efficiency, energy cost, capacity and annual energy output. [6]
   b) Explain the importance of power system planning? Discuss briefly the generation expansion and distribution planning procedure. [6]
   c) What are the benefits of accurate load forecasting? Explain in brief about power system security? [4]
3. a) Discuss the various components of hydropower plant focusing on medium head high discharge project? Also mention their functions. [3+5]
   b) Explain any two scheme of unit generator transformer combination used in power plant on the basis of fault level, maintenance outage and efficiency. Also draw the single line diagram for both of the scheme. [5+3]
4. a) What is the significance of short circuit ratio (SCR) in design of synchronous generator? Show analytically its impact on stability of the power system. [3+5]
   b) What particular precaution should be taken while using vacuum circuit breaker (VCB) as a generator circuit breaker (CB)? [3]
   c) Discuss electrical characteristics of unit transformer that to be considered during its selection. [5]

Transmission Line length	35Km
Transmission Voltage Level	66kV
Generator Voltage Level	11kV
Transmission Circuit	Double Circuit

Design a power plant so as to obtain the following parameters.

a) Electrical power output taking design discharge as $Q_{45\%}$.

b) Select the number of units and installed capacity.

c) Select the type of turbine.

d) Draw the single line diagram showing number of units, generator, power transformer, station transformer and diesel generator for black start.

e) Suggest the type of bus bar to be used.

f) Calculate the rating of the generator circuit breaker to be used in your design.

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24 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - Power Plant Design *(EE753)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) What is Cogeneration? [5]

   b) Biogas plant of Nepal are registered as Clean Development Mechanism because of its contribution for reducing greenhouse gas emission. How would you argue that the biogas plants are contributing to reduce greenhouse gas emission? [5]

   c) Compare the operational characteristics of the thermal power plant and hydropower plant regarding daily load curve, stability, grid connection and operational characteristics and so on. [8]

2. You have planned to electrify a house with electric load as below in table. Make a suitable selection for Solar Panel and battery size (of 12 V systems) for the house. [10]

Load type	Numbers	Wattage	Operating hours (per day)
Lamps	5	Each 10 W	4
TV	1	60 W	5
Computer	1	65 W	3

Assume equal efficiency for both inverter and battery as 80%. Consider sun shining duration 6 hours a day.

3. a) Discuss the functions and importance of various components of hydropower plant with proper schematic diagram of ROR hydropower plant. [8]

   b) Describe the criterion for selection turbine in hydroelectric power plant. [5]

   c) Why riparian release is considered during the design of hydropower plant? What are the criteria of design discharge selection? [5]

4. a) Discuss the various factors which should be considered for the choice of generator during the design of a power plant. [6]

   b) Clarify analytically that lower the short circuit ratio (SCR), lower be the stability of the system. [6]

   c) Compare Brushless Excitation System with Static Excitation System for a synchronous generator on the basic of schematic diagram, operating range, accessories required cost and so on. [6]

5. A typical hydro power plant has following details. [16]

Month	Discharge (m^3/s)		
January	4.92	$Q_{max}(Q_o)$	211.00 m^3/s
February	3.86	$Q_{25\%}$	18.24 m^3/s
March	3.58	$Q_{45\%}$	6.80 m^3/s
April	4.55	$Q_{65\%}$	4.70 m^3/s
May	3.0	$Q_{85\%}$	3.10 m^3/s
June	12.77	$Q_{95\%}$	2.17 m^3/s
July	32.95	Q_{min}	0.64 m^3/s
August	40.26		
September	31.23		
October	15.02		
November	7.38		
December	4.85		

Turbine Type	Head range (m)
Kaplan	2<H<40
Francis	10<H<350
Pelton	50<H<1300

Gross Head	250m
Turbine Efficiency	91%
Generator Efficiency	97%
Transformer Efficiency	98%
Head Loss	5%
Riparian release	10%
Generator Sub-transient reactance	21%
Transformer reactance	9.15%
Transmission Line inductance	0.95mH/km

24 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - Power Plant Design *(EE 753)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary figures are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. a) Discuss the situation of electrical energy among total energy need of Nepal. [4]
   b) Firewood, a common biomass used as a major energy resource in context of Nepal, can or cannot be renewable. Comment on this statement. [6]
   c) Compare the operational characteristics of thermal power with hydropower plant on the basis of reliability, grid connection, efficiency, operating range and so on. [6]
2. a) List out the advantages and disadvantages of wind power. Estimate electric power output from a wind turbine that has turbine blade length of 1.25 m and wind speed of 16 m/sec. Assume that air density is 1.23 kg/m^3 and power coefficient is 0.3. [2+4]
   b) What do you mean by power system planning? Explain in detail Transmission expansion and distribution planning procedure. [6]
   c) Why load forecasting is important in system planning? Explain the need for accurate load forecasting. [4]
3. a) Make a sketch to show various components of medium head, medium size Pondage Run of River (PROR) hydropower plant? Also mention functions of the components. [4+4]
   b) Draw the unit protection scheme of a power transformer. Mention the selection criteria for the power transformer. What reflects the Vector group of a power transformer? [8]
4. a) How the 'specific speed' is defined for a turbine? Discuss its purpose. [6]
   b) What is DOD of a battery? Draw the typical schemes of service station. [6]
   c) What could be the consequences of using higher or lower short circuit ratio (SCR) for a synchronous generator? [4]
5. A typical hydro power plant has the following details. [16]

Month	Discharge (m^3/s)		
Jan	6.13	$Q_{max}(Q_o)$	449.46 m^3/s
Feb	5.10	Q25%	32.60 m^3/s
Mar	4.72	Q45%	11.17 m^3/s
Apr	6.12	Q65%	6.23 m^3/s
May	4.35	Q85%	4.14 m^3/s
Jun	21.68	Q95%	2.92 m^3/s

July	62.04	Qmin	0.93 m^3/s
Aug	73.37		
Sep	56.55		
Oct	26.13		
Nov	12.65		
Dec	8.24		

TURBINE TYPE	HEAD RANGE IN METERS
Kaplan	2 < H < 40
Francis	10 < H < 350
Pelton	50 < H < 1300

Gross head	120 m
Turbine efficiency	90%
Generator efficiency	97%
Transformer efficiency	98%
Head loss	5%
Raparian release	10%
Generator sub-transient reactance	20%
Transformer reactance	15%
Transmission line inductance	0.95mH/km
Transmission line length	35km
Transmission voltage level	66kv
Generator voltage level	11kv
Transmission circuit	**Single circuit**

Design a power plant so as to obtain the following parameters

a. Electrical power output taking design discharge as Q45%
b. Select the numbers of units and installed capacity with suitable reasons
c. Draw the single line diagram showing numbers of units, generators, power transformer, station transformer and diesel generator for black start
d. Select the type of turbine
e. Select the type of busbar with suitable reasons
f. Calculate the MVA level of LV bus, MV bus and HV bus
g. Calculate the rating of CB to be used in your design.

(Assume suitable data if required and the necessary graph is attached herewith)

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24 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Magh

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - Power Plant Design *(EE 753)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Necessary figures are attached herewith.*
- ✓ *Assume suitable data if necessary.*

1. a) What do you mean by conventional and non-conventional energy sources? Discuss bio-mass energy suitable examples. [8]
   b) Compare the operational characteristics of thermal, geothermal and nuclear plant on the basis of reliability, grid-connection, efficiency, operating range and maintainability. [8]
2. a) How electricity is generated from Wind-turbine system? What are the merits of wind energy? Estimate the power output from the wind turbine that has blade length of 5.5m and wind speed of 25m/sec. Assume that air density is 1.23 kg/m^3 and power coefficient is 0.4. [6]
   b) Discuss briefly the Generation expansion planning procedure. [6]
   c) Discuss the scenario of tie up between two national level electric utilities. [4]
3. a) What are the disadvantages of a very low specific speed reaction turbine? What are its advantages? How does the efficiency of the pelton wheel vary with its speed? [8]
   b) Describe brushless excitation system with suitable diagram. When would you find it better than static excitation system? [3+2]
   c) Which circuit breaker would you think suitable as generator circuit breaker (GCB) in hydropower station, and why? [3]
4. a) What are the major factors that should be considered while choosing the generator during the design of a power plant? [5]
   b) Make a specification for purchasing a power transformer. [6]
   c) Discuss the working of Brushless excitation system and static excitation system with proper schematic diagram. [5]
5. A typical hydro power plant has the following details. [16]

Month	Discharge (m^3 / s)		
January	4.9	Q_{max} (Q_0)	211.00 m^3/s
February	3.86	$Q_{25\%}$	18.24m^3/s
March	3.58	$Q_{45\%}$	7.20 m^3/s
April	4.55	$Q_{65\%}$	4.70 m^3/s
May	3.00	$Q_{85\%}$	3.10 m^3/s
June	12.77	$Q_{95\%}$	2.17 m^3/s
July	32.95	Q_{min}	0.64 m^3/s
August	40.26		
September	31.23		
October	15.05		
November	7.38		
December	4.85		

Gross Head	245 m
Turbine efficiency	91%
Generator efficiency	98%
Transformer efficiency	98%
Head loss	5%
Reparian release	10%
Generator sub transient reactance	21%
Transformer reactance	9.15%
Transmission line inductance	0.9mH/km
Transmission line length	50 kM
Transmission voltage level	66 kV
Generator voltage level	11kV
Transmission circuit	Double circuit

Design a power plant so as to obtain following parameters

a) Electrical power output taking design discharge as Q45%
b) Select the numbers of units and installed capacity
c) Select the type of turbine
d) Draw the single line diagram showing generators, power transformers, station transformer and a stand by generator for black start
e) Calculate the rating of generator circuit breaker to be used in your design. (Assume suitable data if necessary and necessary graph is attached herewith)

Turbine Selection Table and Charts

Turbine Type	Head range (m)
Kaplan	2<H<40
Francis	10<H<350
Pelton	50<H<1300

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6. Write three important properties or Normal distribution. A certain type of storage battery lasts, on average, 3.0 years with a standard deviation of 0.5 year. Assuming that battery life is normaliy distributed, find the probability that a given battery will last less than 2.3 years. [5]

7. write the difference between sample and population. Write three important of central limit theorem. [5]

8. A manufacturer of sports equipment has developed a new synthetic fishing line that the company claims has a mean breaking strength of 8 kilograms with a standard deviation of 0.5 kilogram. Test the hypothesis that $\mu = 8$ kilograms against the alternative that $\mu \neq 8$ kilograms if a random sample of 50 lines is tested and found to have a mean breaking strength of 7.8 kilograms. Use a 0.01 level of significance. [5]

9. Distinguish between z- test and t-test of hypothesis for test of single population mean? [5]

OR

Discuss errors of testing of hypothesis. Write the procedure of testing of single mean for small sample.

10. At what condition pair test should be use. Write the procedure of testing of pair test. [5]

11. A random sample of size n1 = 25, taken from a normal population with a standard deviation σ1 = 5.2, has a mean = 81. A second random sample of size n2 = 36, taken from a different normal population with a standard deviation σ2 = 3.4, has a mean = 76. Test the hypothesis that μ1 = μ2 against the alternative, μ1 ≠ μ2. Use 5 % level of significance [5]

12. A real estate agent claims that 60% of all private residences being built today are 3-bedroom homes. To test this claim, a large sample of new residences is inspected; the proportion of these homes with 3 bedrooms is recorded and used as the test statistic. State the null and alternative hypotheses to be used in this test and determine the location of the critical region. [5]

OR

Three testing machines are used to determine the breaking load in tension of wire which is believed to be uniform. Nine pieces of wire are cut off, one after another. They are numbered consecutively, and three are assigned to each machine using random numbers. Random numbers are used also to determine the order in which specimens are tested on each machine. The breaking loads (in Newtons) found on each machine are shown in the table below.

Machin 1	1570	1750	1680
Machin 2	1890	1860	2390
Machin 1	1640	1760	2020

Do the data indicate (at the 5% level of significance) that one or two of the machines give higher readings than others? (*value of* $F_{2,6} = 5.1433$)

13. The thrust of an engine (y) is a function of exhaust temperature (x) in F when other important variables are held constant. Consider the following data. [5]

Thrust	4300	4650	3200	3150	4950	4010		3810	4500	3008
Temperature	1760	1652	1445	1390	1820	1665		1550	1700	1270

(a) Plot the data.

(b) Fit a simple linear regression to the data and plot the line through the data.

14. Distinguish between correlation and regression. Write importance of coefficient of determination. [5]

15. A container of car antifreeze is supposed to hold 3785 mL of the liquid. Realizing that fluctuations are inevitable, the quality-control manager wants to be quite sure that the standard deviation is less than 30 mL. Otherwise, some containers would overflow while others would not have enough of the coolant. She selects a simple random sample, with the results given here. Use these sample results to construct the 99% confidence interval for the true value of s. [8]

3761	3861	3769	3772	3675	3861	3888	3819	3788	3800	3720	3748
3787	3753	3821	3811	3740	3740	3839	3445	3351	3332	323	3423
3312	3452										

Using your calculator

a) Calculate the sample mean
b) Calculate the sample standard deviation
c) Does this confidence interval suggest that the fluctuations are at an acceptable level?
d) Observing your result draw your conclusion

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24 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2072 Ashwin

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - Power Plant Design *(EE753)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks***
- ✓ ***Necessary figures are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. a) What is bio-energy? Describe with a suitable example. [6]
   b) Bio-gas plants of Nepal are registered as Clean Development Mechanism project because of its contribution for reducing greenhouse gas emission. How would you argue that the biogas plants are contributing to reduce greenhouse gas emission? [6]
2. a) What do you mean by 'power system security'? What are the vital components of security assessment? [6]
   b) Explain the benefits of inter connection of regional utilities. [6]
3. a) Discuss the effect of the following factors in selecting of a turbine for a hydroelectric plant? (i) head (ii) speed and specific speed (iii) part load operation. [8]
   b) Sketch a typical layout of a medium head hydroelectric power station fitted with Francis turbine. Briefly describe the main elements. [8]
4. a) Discuss working of a brushless excitation with necessary schematic diagram. When would you recommend using such excitation system? [4]
   b) Describe speed governing system of hydro generator. [4]
5. A typical hydro power plant has the following details. [32]

Month	Discharge(m^3/s)		
Jan	6.13	$Q_{max}(Q_o)$	449.46m^3/s
Feb	5.10	Q25%	32.60 m^3/s
Mar	4.72	Q45%	11.17 m^3/s
Apr	6.12	Q65%	6.23 m^3/s
May	4.35	Q85%	4.14m^3/s
Jun	21.68	Q95%	2.92 m^3/s
July	62.04	Qmin	0.93 m^3/s
Aug	73.37		
Sep	56.55		
Oct	26.13		
Nov	12.65		
Dec	8.24		

TURBINE TYPE	HEAD RANGE IN METERS
Kaplan	$2 < H < 40$
Francis	$10 < H < 350$
Pelton	$50 < H < 1300$
Gross head	150 m
Turbine efficiency	90%
Generator efficiency	97%
Transformer efficiency	98%
Head loss	5%
Raparian release	10%
Generator sub-transient reactance	15%
Transformer reactance	12%
Transmission line inductance	0.97mH/km
Transmission line length	35km
Transmission voltage level	66kv
Generator voltage level	11kv
Transmission circuit	Single circuit

Design a power plant so as to obtain the following parameters

a. Electrical power output taking design discharge as Q45%
b. Select the numbers of units and installed capacity with suitable reasons
c. Draw the single line diagram showing numbers of units, generators, power transformer, station transformer and diesel generator for black start
d. Select the type of turbine
e. Select the type of busbar with suitable reasons
f. Calculate the MVA level of LV bus, MV bus and HV bus
g. Calculate the rating of CB to be used in your design.
(Assume suitable data if required and the necessary graph is attached herewith)

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24 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2072 Magh

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - Power Plant Design *(EE753)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt <u>All</u> questions.*
- ✓ *The figures in the margin indicate <u>Full Marks</u>.*
- ✓ ***<u>Necessary figures are attached herewith.</u>***
- ✓ *Assume suitable data if necessary.*

1. a) What are the conventional and non-conventional energy sources? Describe with suitable sketches how electric power can be obtained from solar? [8]
   b) Compare the operational characteristics of the hydroelectric power plant and thermal power plant considering factors such as techno-economic, environmental and so on. [8]
2. What is Reserve Planning? Study the benefits of interconnection of utilities on power system? [8]
3. a) Draw the schematic diagram of hydropower plant showing different structural components. State the role of surge tank in hydropower plant construction. [8]
   b) What do you mean by discharge exceedance? Describe the criterion for selecting turbine in hydro-electric power plant. [8]
4. Make a comparison between vacuum circuit breaker with SF6 circuit breaker in a power system. [8]
5. A typical hydro power plant has the following details. [32]

Month	Discharge(m^3/s)		
January	4.62	Q_{max} (Q_o)	210.00 m3/s
February	3.80	$Q_{25\%}$	18.24 m3/s
March	3.55	$Q_{45\%}$	7.82 m3/s
April	4.55	$Q_{65\%}$	4.7 m3/s
May	3.5	$Q_{85\%}$	3.10 m3/s
June	12.70	$Q_{95\%}$	2.17 m3/s
July	32.98	Q_{min}	0.64 m3/s
August	40.26		
September	31.23		
October	15.00		
November	7.37		
December	4.80		

Turbine Type	Head range (m)
Kaplan	2<H<40
Francis	10<H<350
Pelton	50<H<1300

Gross Head	250 m
Turbine efficiency	90%
Generator efficiency	97%
Transformer efficiency	98%
Head loss	5%
Raparian release	10%
Generator sub transient reactance	21%
Transformer reactance	9.15%
Transmission line inductance	0.95mH/km
Transmission line length	55 Km
Transmission voltage level	33kV
Generator voltage level	11kV
Transmission circuit	Double circuit

Design a power plant so as to obtain following parameters

a) Electrical power output taking design discharge as Q25%

b) Select the numbers of units and installed capacity

c) Select the type of turbine

d) Draw the single line diagram showing number of units, generator, power transformer, station transformer and diesel generator for black start

e) Suggest the type of bus bar to be used

f) Calculate the rating of the generator circuit breaker (GCB) to be used in your design (Assume suitable data if necessary and necessary graph is attached herewith)

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24 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Bhadra

Exam.	Regular / Back		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - Power Plant Design *(EE753)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Necessary charts are attached herewith.*
- ✓ *Assume suitable data if necessary.*

1. a) Discuss about operational characteristic of combined cycle gas turbine plant for power generation. [4]
   b) How does a geothermal power plant operate? Describe briefly. [4]
   c) Compare the operational characteristics of thermal, wind and PV plant on the basis of reliability, grid connection, efficiency, operating range and maintainability. [8]
2. a) How electric power is generated from a Tidal Power Project? Estimate the power output from a tidal project that has tidal range of approximately 10 m. The surface area of tidal harnessing plant is 3 kM × 3 kM. Consider that there are two high tides every day. Assume power conversion efficiency as 30%. Density of sea water is about 1025 Kg/m^3. [4+4]
   b) You have planned to electrify a house with electric load as below in table. Make a suitable selection for Solar Panel and battery size (of 12 V system) for the house. [8]

Load type	Numbers	Wattage	Operating hours (per day)
Lamps	5	Each 10 W	4
TV	1	80 W	5
Computer	1	85 W	3

   Assume equal efficiency for both inverter and battery as 80%. Consider sun shining duration 7 hours a day.
3. a) List down the various components of hydropower plant and mention their functions. [2+6]
   b) Discuss the benefits from interconnection of regional electric utilities. [4]
   c) Discuss the need for accurate load forecasting in system planning. [4]
4. a) Discuss the various factors which should be considered for the choice of generator during the design of a power plant. Also clarify analytically that lower the short circuit ratio (SCR), lower be the stability of the system. [5+5]
   b) Compare with necessary schematic diagrams Brushless Excitation System with Static Excitation System used in a synchronous generator on the basis of operating range, accessories required and cost. [6]

5. A typical hydro power plant has the following details. [16]

Month	Discharge(m^3/s)		
January	4.62	Q_{max} (Q_0)	210.00 m3/s
February	3.80	$Q_{25\%}$	18.24 m3/s
March	3.55	$Q_{45\%}$	7.82 m3/s
April	4.55	$Q_{65\%}$	4.7 m3/s
May	3.5	$Q_{85\%}$	3.10 m3/s
June	12.70	$Q_{95\%}$	2.17 m3/s
July	32.98	Q_{min}	0.64 m3/s
August	40.26		
September	31.23		
October	15.00		
November	7.37		
December	4.80		

Turbine Type	Head range (m)
Kaplan	2<H<40
Francis	10<H<350
Pelton	50<H<1300

Gross Head	230 m
Turbine efficiency	90%
Generator efficiency	97%
Transformer efficiency	98%
Head loss	5%
Raparian release	10%
Generator sub transient reactance	21%
Transformer reactance	9.15%
Transmission line inductance	0.95mH/km
Transmission line length	45 Km
Transmission voltage level	33kv
Generator voltage level	11kv
Transmission circuit	Double circuit

Design a power plant so as to obtain following parameters.

a) Electrical power output taking design discharge as Q45%.
b) Select the numbers of units and installed capacity.
c) Select the type of turbine.
d) Draw the single line diagram showing number of units, generator, power transformer, station transformer and diesel generator for black start.
e) Suggest the type of bus bar to be used.
f) Calculate the rating of the generator circuit breaker (GCB) to be used in your design.

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24 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Magh

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - Power Plant Design *(EE753)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt <u>All</u> questions.*
- ✓ *The figures in the margin indicate <u>Full Marks</u>.*
- ✓ ***<u>Necessary figures are attached herewith.</u>***
- ✓ *Assume suitable data if necessary.*

1. a) Can firewood be regarded as renewable energy source? Justify your answer in the context of Nepal. [6]

   (b) Compare the operational characteristics of thermal, geothermal and PV plant on the basis of reliability, grid connection, efficiency, operating range and maintainability. [10]

2. (a) List out the advantages and disadvantages of wind power. Estimate electric power output from a wind turbine that has turbine blade length of 1.5 m and wind speed of 14 m/sec. Assume that air density is 1.23 kg/m^3 and power coefficient is 0.35. [2+4]

   (b) Discuss briefly the Generation expansion planning procedure. [6]

   (c) Discuss the relevance of intelligent methods for power system load forecasting. [4]

3. (a) Discuss the various components of Run of River (ROR) hydropower plant? Also mention their functions. (3+5)

   (b) Explain any two schemes of unit generator transformer combination used in power plant on the basis of fault level, maintenance outage and efficiency. Also draw the single line diagram for both of the schemes. [5+3]

4. (a) How the 'specific speed' is defined for a turbine? Discuss its purpose. [6]

   (b) Discuss electrical characteristics of a power transformer for a power project. [6]

   (c) What could be the consequences of using higher or lower short circuit ratio (SCR) for a synchronous generator? [4]

5. A typical hydro power plant has the following details [16]

Month	Discharge(m^3/s)		
January	4.9	Q_{max} (Q_o)	211.00 m^3/s
February	3.86	$Q_{25\%}$	18.24 m^3/s
March	3.58	$Q_{45\%}$	6.80 m^3/s
April	4.55	$Q_{65\%}$	4.70 m^3/s
May	3.00	$Q_{85\%}$	3.10 m^3/s
June	12.77	$Q_{95\%}$	2.17 m^3/s
July	32.95	Q_{min}	0.64 m^3/s
August	40.26		
September	31.23		
October	15.05		
November	7.38		
December	4.85		

Turbine Type	Head range (m)
Kaplan	2<H<40
Francis	10<H<350
Pelton	50<H<1300

Gross Head	250 m
Turbine efficiency	91%
Generator efficiency	97%
Transformer efficiency	98%
Head loss	5%
Raparian release	10%
Generator sub transient reactance	21%
Transformer reactance	9.15%
Transmission line inductance	0.92mH/km
Transmission line length	35 km
Transmission voltage level	66kV
Generator voltage level	11kV
Transmission circuit	Double circuit

Design a power plant so as to obtain following parameters

a) Electrical power output taking design discharge as $Q_{45\%}$

b) Select the numbers of units and installed capacity

c) Select the type of turbine

d) Draw the single line diagram showing generators, power transformers, station transformer and diesel generator for black start

e) Calculate the rating of generator circuit breaker to be used in your design

f) Suggest the type of bus bar to be used

(Assume suitable data if necessary and necessary graph is attached herewith)

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24 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 Magh

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - Power Plant Design *(EE753)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Assume suitable data if necessary.*

1. a) What is bio energy? Discuss the advantages and disadvantages of biomass in comparison with geothermal energy. [2+6]

   b) Compare the operation characteristics of the tidal power and wind power plant regarding daily curve, stability, grid connection and operating range. [8]

2. a) Define the following terms on the basis of integrated system planning approach. [2×4]

   i) Load uncertainties
   ii) System security

   b) Discuss the various factors which should be considered for the choice of generator during the design of a power plant. Also mention the significance of short circuit ratio in the selection of generator. [5+3]

3. a) What are the criteria for selection of a hydropower project? If the water in the river is known to carry high sediments and debris, what would be your particular recommendation in its design? [5+3]

   b) Compare the components, operation and characteristics of run of river (ROR) type hydropower plant with pondage run of river (PROR). [8]

4. a) Develop a typical specification while procuring a power transformer to be in power plant design. [8]

   b) Name the auxillary and ancillary systems with their function in a hydropower plant with Francis turbine of 100 MW. [8]

5. A typical hydro power plant has the following details: [16]

Month	Discharge(m^3/s)		
January	4.62	Q_{max} (Q_o)	207.00 m3/s
February	3.80	$Q_{25\%}$	18.24 m3/s
March	3.55	$Q_{45\%}$	6.82 m3/s
April	4.55	$Q_{65\%}$	4.7 m3/s
May	3.22	$Q_{85\%}$	3.10 m3/s
June	12.70	$Q_{95\%}$	2.17 m3/s
July	32.98	Q_{min}	0.64 m3/s
August	40.26		
September	31.23		
October	15.00		
November	7.37		
December	4.80		

Turbine Type	Head range (m)
Kaplan	2<H<40
Francis	10<H<350
Pelton	50<H<1300

Gross Head	200 m
Turbine efficiency	90%
Generator efficiency	97%
Transformer efficiency	98%
Head loss	5%
Raparian release	10%
Generator sub transient reactance	21%
Transformer reactance	9.15%
Transmission line inductance	0.95mH/km
Transmission line length	25 Km
Transmission voltage level	33kv
Generator voltage level	11kv
Transmission circuit	Double circuit

Design a power plant so as to obtain the following parameters:

a) Electrical power output taking design discharge as Q45%
b) Select the numbers of units and installed capacity
c) Draw the single diagram showing number of units, generator, power transformer, station transformer and diesel generator for black start
d) Select the type of turbine
e) Suggest the type of bus bar to be used
f) Calculate the MVA level of LV bus, MV bus and HV bus
g) Calculate the rating of circuit breaker to be used in your design
(Assume suitable data if required and the necessary graph is attached herewith)

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