TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2080 Baishakh

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

Subject: - Power Plant Equipment (*EE 703*)

- ✓ 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.*

Part A (Electrical Part)

1. a) What is pumped storage power plant? In which situation it will be economically feasible? [5]

   b) Explain the special characteristics of a hydraulic turbine and what is water starting time? [5]

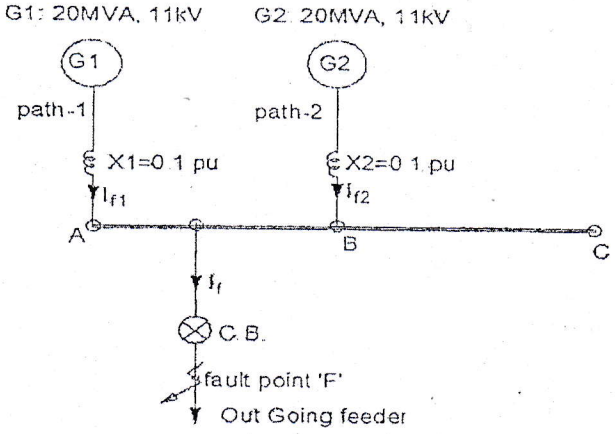
2. Two generators of 500 MW 11kV, 4% and 250 MW 11kV, 2% are supplying to a common load. When each generator is fully loaded, they operate at common frequency of 50 Hz. If the system load of 100 MW is reduced, what will be frequency deviation and find load shared by each unit? [10]

3. a) Describe the excitation system of a synchronous generator with stabilizing transformer. Derive mathematical model of the system in term of transfer function of each components. [6]

   b) Explain the SCADA system implemented in a power system. [4]

4. a) Describe the operation of an isochronous governor and explain why this type of governor is not suitable for parallel operation of two generating units. [4]

   b) Following figure shows two generators operating parallel [6]



   i) If a 3-phase to ground fault occurs on the outgoing feeder, calculate the fault current and fault level on the feeder.

   ii) If a 3rd generator (G3: 10MVA, 11kV, X3=0.2 pu) is added at point 'C', calculate the value of reactor to be added on the outgoing feeder so that the fault level remains same as before.

Part B (Mechanical Part)

1. What is diesel cycle and how the system is cooled during operation? Discuss the advantages and disadvantages of diesel power plant. [8]

2. During a 20 minutes trial of a single cylinder four stroke engine the following observations were recorded: [8]

   Bore = 0.2 m, Stroke = 0.28 m, Fuel consumption = 1.52 kg, Calorific value of fuel = 43900 kJ/kg, Indicated mean effective pressure = 3.1 bar, Net load on brakes = 640 N, r.p.m. = 350, brake drum diameter = 1 m

   Calculate: (i) Indicated power; (ii) Brake power; (iii) Mechanical efficiency; (iv) Indicated thermal efficiency.

3. Draw a sketch of a simple open cycle constant pressure gas turbine power plant with intercooling and describe the method to improve its thermal efficiency considering intercooling and T-s diagram. [8]

4. What are the ways by which efficiency of the Rankine cycle can be increased? Differentiate between impulse and reaction steam turbine. [4+4]

5. Draw the three popular designs of the combined steam and gas turbine cycle. Explain one of them with T-s diagram. [4+4]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2079 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
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Year / Part	IV / I	Time	3 hrs.

Subject: - Power Plant Equipment (*EE 703*)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
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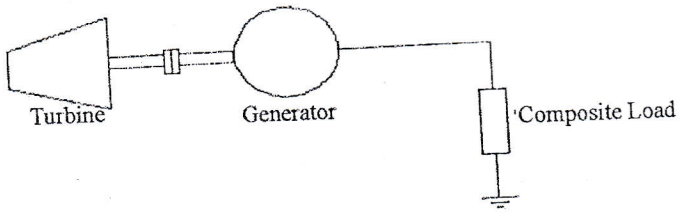
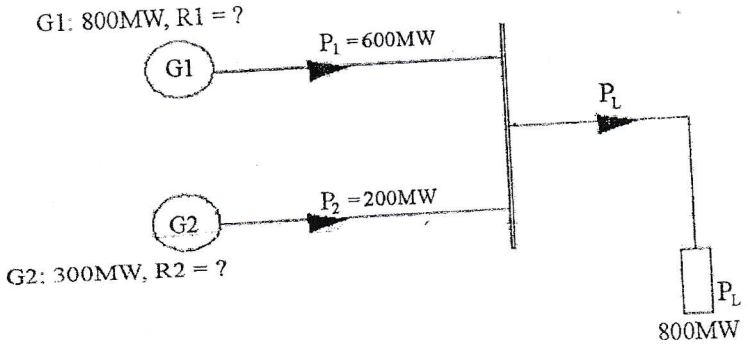
Part A (Electrical Part)

1. a) What do you mean by hammer effect in hydro power plant? Explain how it can be reduced. [5]

   b) Shows below figure the block diagram of water turbine driving an electric generator without speed governor. Explain how the inertia and load damping constant can control the speed of the system against small change in load. Derive the transfer function showing the effect of inertia and load damping constant. [5]



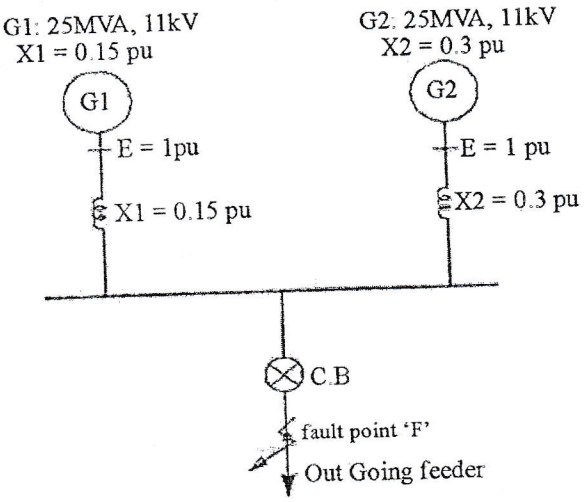
2. Shows figure below two generators operating in parallel and supplying a load of 800 MW. G1 is rated as 800 MW and G2 is rated as 300 MW. G1 supplies 600 MW and G2 supplies 200 MW and system frequency is 50 Hz. At no-load, they operate at a common frequency of 51 Hz. Calculate droop regulations R_1 an R_2 of G_1 and G_2 with respect their ratings. Assume base power = 1000 MW. When the load is decreased below 800 MW, the frequency increases to 50.2 Hz. Calculate the power supplied by each generator at reduced load. [10]



3. Describe the excitation system of a synchronous generator with stabilizing transformer. Derive mathematical model of the system in term of transfer function of each component of the system. [10]

4. a) What is the function of rector in Power system network? Explain the ring type bus bar rector scheme. [5]

b) For the system shown in figure below, calculate the fault level in MVA at out going feeder for a three phase to ground fault on this feeder. Calculate the value of reactance to be connected in the feeder in order to reduce the fault level by 50%. [5]



Part B (Mechanical Part)

1. Draw a complete sketch of a diesel power plant and mention its different systems. [8]
2. A diesel engine consumes fuel at the rate of 5.5 gm/sec and develops a power of 75 kW. The mechanical efficiency is 85%. The lower heating value of the fuel is 44 MJ.kg. Determine:
   a) Brake specific fuel consumption
   b) Indicated specific fuel consumption
   c) Brake thermal efficiency and
   d) Indicated thermal efficiency [4+4]
3. Explain how regenerator increases the output of the gas turbine power plant along with the neat sketch and show the cycle in p-v and T-s diagram. [6+2]
4. Steam at a pressure of 14 bar and temperature 300°C is expanded through a HP turbine to a pressure of 5 bar, it is then reheated at constant pressure to a temperature of 300°C and then it completes expansion through the LP turbine to an exhaust pressure of 0.2 bar. Calculate the ideal efficiency of the plant and work done: [8]
   a) Taking the reheating into account
   b) Without reheating
5. A gas turbine unit has a pressure ratio of 6:1 and maximum cycle temperature of 610°C. The isentropic efficiencies of the compressor and turbine are 80% and 82% respectively. Calculate the power output in kilowatts of an electric generator geared to the turbine when the air enters the compressor at 15°C at the rate of 16 kg/s. Find the thermal efficiency of the plant as well. Take Cp = 1.005 kJ/kg K and γ = 1.4 for the compression process, Cp = 1.11 kJ/kg and γ = 1.333 for the expression process and Cp = 1.11 kJ/kg K for the combustion process. [8]

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TRIBHUVAN UNIVERSITY
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Examination Control Division
2079 Baishakh

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Year / Part	IV / I	Time	3 hrs.

Subject: - Power Plant Equipment *(EE 703)*

- ✓ 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.*

Electrical Part

1. Explain the operation of pump storage hydropower plant with suitable scheme to reduce peak generation loss of steam power plant. [8

2. a) Explain with proper diagram of P-f and Q-V loop in hydro generating system. [8

   b) Two generators of 1000 MW, 2% and 500 MW, 4% are supplying to a common load. When each generator is fully loaded, they operate at common frequency of 49.5 Hz. Calculate the system load shared by each unit when frequency increased to 50 Hz. [6

3. For an excitation system with a stabilizing transformer, derive the transfer function. [8

4. a) A 100 MVA generator with 10% reactance and a 200 MVA generator with 8% reactance are connected to a common bus. The fault level on bus 1 is to be restricted to 1500 MVA. If a reactor is added in between these two generators in the bus bar, then on 100 MVA base Calculate the value of reactance added. [6]

   b) What are different parts of Power Transformer? Explain in brief. [4]

Mechanical Part

5. Draw a neat sketch of general layout of Diesel Power Plant with all major components. Explain the starting system and fuel supply system as well. [4+2+2]

6. List the common method used for the performance improvement of the steam turbine power plant. Explain how reheating increases efficiency of the plant. Draw the layout and show the cycle in T-S diagram. [2+4+2]

7. The gas turbine has an overall pressure ratio of 5:1 and the maximum cycle temperature of 550°C. The turbine drives the compressor and an electric generator. The mechanical efficiency of the drive being 0.97. The ambient temperature is 20° C and the isentropic efficiencies of the compressor and turbine are 0.8 and 0.83 respectively. Calculate the power output is kW for an air flow of 15 kg/s. Calculate also thermal efficiency and the work ratio. Neglect changes in kinetic energy and the loss of pressure in combustion chamber. [8]

8. Air is drawn in a gas turbine unit at 15°C, 100 kPa and pressure ratio is 7:1. The compressor is driven by the H.P turbine and L.P turbine drives a separate power shaft. The isentropic efficiencies of compressor and the H.P and L.P turbines are 0.82, 0.85 and 0.85 respectively. If the maximum cycle temperature is 610°C, Calculate

   a) The pressure and temperature of the gases entering the low pressure turbine.
   b) The net power developed by the unit per kg/sec mass flow.
   c) The thermal efficiency of the unit.

   (For compression process c_p = 1.005 kJ/kg.K and γ = 1.4 and for combustion and expansion process c_p = 1.15 kJ/kg.K and γ = 1.333) [12]

9. What are the possible combinations of combined cycle power plants? Point out the advantages of combined cycles. [2+2]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2078 Bhadra

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

Subject: - Power Plant Equipment *(EE 703)*

- ✓ 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.*

Part A (Electrical Part)

1. a) Explain the operation of pump storage hydropower plant and suggest the suitable scheme to reduce peak generation loss of power plant. [5]

   b) For change in load, explain how inertia and load damping constant can help to keep the speed constant which acceptable raise even in the absence of governor.

2. a) What do you mean by isochronous governor? What will be the problem if two hydropower plants with isochronous governor are operated in parallel to supply a common load? [5]

   b) Derive the transfer function of a water turbine and explain the response against unit step change in gate opening. [4]

3. a) What is excitation system? Draw a functional block diagram of a typical excitation control system and explain the role of each block and derive the complete transfer function of the system. [6]

   b) What is function reactor in power system. [8]

4. a) Two generators of capacities 40MVA, 11kV and 30MVA, 11kV having their sub transient reactance of 5% and 4% respectively operating in parallel and supplying to a common load by single feeder of reactance 2Ω. Calculate the value of reactor to be connected in series with feeder so as to reduce the fault label at the end of the feeder by 50%. [2]

   b) Three generators of 500MW, 2% drop, 250MW, 4% drop and 200MW, 3% drop are supplying to a common load. When each generator is fully loaded, they operate at common frequency of 49Hz. Calculate the system load shared by each unit when frequency increased to 50Hz. [5]

Part B (Mechanical Part)

5. Sketch the main components of diesel power plant. Write down the main function of lubricating system and cooling system in diesel engine power plant. [5]

6. In a diesel power plant engine is coupled with an alternator. The engine has compression ratio 15:1. The compression begins at 0.1MPa and 40°C. The heat added at the end of compression is 1675MJ/kg. Consider air constant, R = 287 kJ/kgK and Find: [4+2+2]

   (i) The maximum temperature and pressure in the cycle
   (ii) The cut off ratio of the engine
   (iii)Net work done per kg of air
   (iv)Thermal efficiency of the engine
   (v) Mean effective pressure of the cycle. [8]

7. Explain the methods of efficiency improvement in gas turbine power plant. [6]

8. In a test for four-cylinders, four stroke engine has a engine has a diameter of 100mm, stroke = 120mm, speed of engine = 1800 rpm, fuel consumption of 0.2 kg/min, calorific value of fuel is 44000 kJ/Kg. Difference in tension on either side of brake pulley = 40 kg, Brake circumference is 300cm and the radius of the pulley rope is 25mm. If the mechanical efficiency is 90%. Determine :

   (i) Brake-thermal efficiency,
   (ii) Indicated thermal efficiency,
   (iii)Indicated mean effective pressure, and
   (iv)Brake specific fuel consumption. [10]

9. What is combined Power plant? Sketch the layout with necessary labels, for various types of combined power plant. Discuss the performance and economics of combined power plants. [2+4+2]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2076 Chaitra

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

Subject: - Power Plant Equipment *(EE 703)*

- ✓ 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.*

Part A (Electrical Part)

1. a) What do you mean by water hammer in context of hydro power plant? How it can be minimized? [5]

   b) For hydro dominated integrated system like Nepal, is pump storage hydro power plant economical? Justify your answer with its operation. [5]

2. a) Explain the importance of speed droop in sharing common load by two alternator operating in parallel with suitable block diagram and derivation. [5]

   b) What are the special characteristics of hydraulic turbine? Explain in brief. [5]

3. a) Explain the dynamic response of excitation system with stabilizing transformer with suitable mathematical deduction. [8]

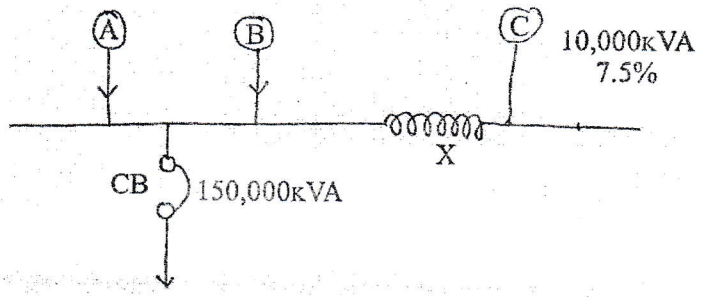
   b) What is main function of reactor in power system network? [2]

4. a) Two generating units has following rating and droop characteristics

Unit-1	600MVA	R_1=4%
Unit-2	500MVA	R_2=6%

   These two units are operating in parallel and sharing a total load of 900MW at nominal frequency of 60Hz. Unit-1 supplies 500MW and unit-2 supplies 400MW. If the load increases by 90MW, calculate the new frequency and new generation of each generator. [5]

   b) A small generating station has two alternators of 2500KVA and 500KVA with percentage reactance of 8 & 6 percentage respectively. The circuit breakers are rated at 150,000kVA. Due to increase in system load it is intended to add a third generator of 10,000kVA rating and 7.5% reactance. If the system voltage is 3300volts, find the reactance X necessary to protect the C.B. [5]



Part B (Mechanical Part)

5. Explain the closed cooling system with its advantages and disadvantages. [8]

6. A diesel engine power plant operated by a two stroke desel engine was motored when the meter reading was 4.5 KW. Then the test on the engine was carried out for one hour run and the following observations were recorded: (i) Brake torque = 250Nm; (ii) Speed=1500rpm; (iii) Fuel consumed = 5 kg and (iv) Calorific value of fuel = 40MJ/kg. Determine:

   a) Mechanical efficiency
   b) Indicated thermal efficiency
   c) Brake thermal efficiency [8]

7. Explain how regeneration increases the output of the stream turbine power plant along with the neat sketch and show the cycle in P-V and T-S diagram. [6+2]

8. Air enters the compressor of an ideal gas turbine power plant at 100kPa, 300K. The pressure ratio is 10. The turbine inlet temperature is 1400K. Determine the efficiency of the plant. Also determine the increment in efficiency if a regenerator with effectiveness 80% is used in the plant. [Take C_p=1.005 kJ/kgK and γ=1.4] [12]

9. Sketch the basic components of a combine power plant. Also sketch the corresponding process on T-S diagram. [4]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2076 Ashwin

Exam.	Back		
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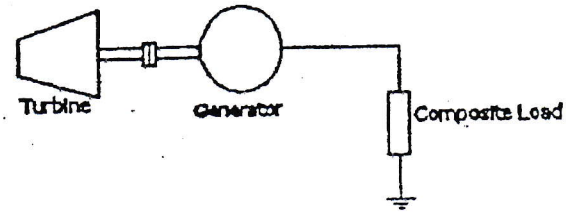
Programme	BEL	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Power Plant Equipment *(EE 703)*

- ✓ 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 tables are attached herewith.*
- ✓ *Assume suitable data if necessary.*

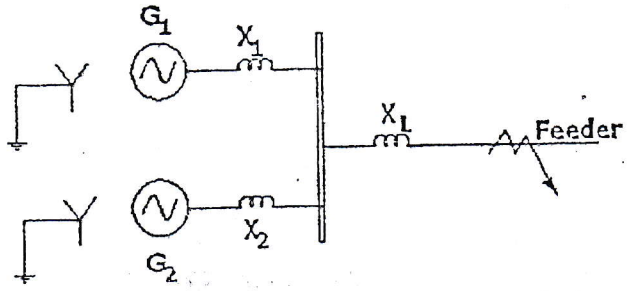
Electrical Part

1. Explain the operation of pump storage type hydro power plant with neat diagram. [8]
2. Below figure shows the block diagram of water turbine driving an electric generator without speed governor. Explain how the inertia and load damping constant can control the speed of the system against small change in load. Derive the transfer function showing the effect of inertia and load damping constant. [8]



3. Two generating units of 500MW and 250MW capacities respectively are operating in parallel and supplying power to a common load. When each generator is half loaded, they operate at a common frequency of 50Hz. The droop regulations are 5% and 6% respectively based on their respective ratings. If the load is increased by 100 MW, Calculate:
   a) New frequency at which they operates
   b) Power supplied by each generator [8]
4. Describe the excitation system of a synchronous generator with stabilizing transformer. Derive mathematical model of the system in term of transfer function of each component of the system. [8]
5. Below figure show the single line diagram of parallel operated generators. Their ratings are: [8]

   G_1: capacity = 50 MW, 11kV, X_1 = 0.16 pu based on its rating
   G_2: capacity = 40 MW, 11kV, X_2 = 0.12 pu based on its rating
   XL = 2 ohms



   a) If a three-phase to ground fault occurs at outgoing feeder, calculate the fault current and fault power at the outgoing feeder and fault current supplied by each generator.
   b) Calculate the value of inductor (in mH) of the reactor to be connected in series with X_2 so that both generators delivers equal amp of fault current during 3 phase to ground fault on the feeder.

Mechanical Part

6. Explain the working of combined gas-steam power plant with neat figure and also show the process on T-S diagram. [10]
7. Explain the different types of water cooling system with their advantages and disadvantages. [6]
8. Explain the closed and open Brayton cycle. [6]
9. Steam is generated in a boiler at 50 bar and 450°C. For the purpose of governing, the steam is throttle to 30 bar before it enters the high pressure state of turbine. after expansion in high pressure stage, the steam emerges just dry saturated and then reheated at the same pressure to 300°C before it expanded in the low pressure stage to a pressure of 0.06 bar, when it emerges again just dry and saturated. If the intermediate pressure is 3 bar, what are the states efficiencies? Also calculate the overall cycle efficiency and work ratio shared by HP stage to that of work shared by LP stage. [10]
10. A 4-stroke diesel engine develops 5 kW at 2000 RPM when its mean effective pressure is 7.5 bar. If for engine, L = 1.25 D, find their dimensions. [8]

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Superheated steam table

P	T	v	u	h	s
kPa	°C	m³/kg	kJ/kg	kJ/kg	kJ/kg.K
300	(133.56)	(0.6059)	(2543.5)	(2725.3)	(6.9921)
	150	0.6339	2570.7	2760.9	7.0779
	200	0.7163	2650.2	2865.1	7.3108
	250	0.7963	2728.2	2967.1	7.5157
	300	0.8753	2806.3	3068.9	7.7015
	350	0.9536	2885.3	3171.3	7.8729
	400	1.0315	2965.4	3274.9	8.0327
	450	1.1092	3047.0	3379.7	8.1830
	500	1.1867	3130.1	3486.1	8.3252
	550	1.2641	3214.7	3594.0	8.4604
	600	1.3414	3301.1	3703.5	8.5895
	650	1.4186	3389.1	3814.7	8.7134
	700	1.4958	3478.9	3927.7	8.8325
	750	1.5729	3570.5	4042.3	8.9475

P	T	v	u	h	s
kPa	°C	m³/kg	kJ/kg	kJ/kg	kJ/kg.K
5000	(263.98)	(0.03944)	(2596.5)	(2793.7)	(5.9725)
	300	0.04530	2697.0	2923.5	6.2067
	350	0.05193	2808.0	3067.7	6.4482
	400	0.05781	2906.5	3195.5	6.6456
	450	0.06330	2999.8	3316.3	6.8187
	500	0.06856	3091.1	3433.9	6.9760
	550	0.07367	3181.8	3550.2	7.1218
	600	0.07869	3272.8	3666.2	7.2586
	650	0.08362	3364.5	3782.6	7.3882
	700	0.08850	3457.1	3899.7	7.5117
	750	0.09334	3551.0	4017.7	7.6300
	800	0.09815	3646.3	4137.0	7.7438
	850	0.1029	3742.9	4257.5	7.8536

Table A2.1: Properties of SATURATED WATER – Pressure Table

P	T	v_f	v_{fg}	v_g	u_f	u_{fg}	u_g	h_f	h_{fg}	h_g	s_f	s_{fg}	s_g
kPa	°C	m³/kg	m³/kg	m³/kg	kJ/kg	kJ/kg	kJ/kg	kJ/kg	kJ/kg	kJ/kg	kJ/kg.K	kJ/kg.K	kJ/kg.K
6.0	36.167	0.001006	23.737	23.738	151.46	2272.5	2424.0	151.47	2415.0	2566.5	0.5208	7.8075	8.3283
300	133.56	0.001073	0.6048	0.6059	561.29	1982.2	2543.5	561.61	2163.7	2725.3	1.6721	5.3200	6.9921

TRIBHUVAN UNIVERSITY
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Examination Control Division
2075 Chaitra

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Subject: - Power Plant Equipment *(EE 703)*

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- ✓ *Attempt **All** questions.*
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- ✓ *Assume suitable data if necessary.*

Electrical Part

1. Explain the use of Fransis turbine in pumped storage plant. Is this type of power plant feasible to install in Nepal's power system? Give reasons. [8]

2. a) Explain the speed response of turbine generator coupled system with change in load as determined by inertia and damping constant. [6]

   b) Two generators of 600MW, 2% and 300 MW, 4% are supplying to a common load. When each generator is fully loaded, they operate at common frequency of 49 Hz. Calculate the system load shared by each unit when frequency increased to 50Hz. [8]

3. Obtain the transfer function of excitation system with stabilizing transferred. [8]

4. Two generators each of capacities 40Mva, 11kv having their sub transient reactance of 5% and 4% respectively operating in parallel and supplying to a common load by single feeder of reactance 2 ohm. Calculate the fault level when there is 3-phase to ground fault on the outgoing feeder. Also calculate the value of reactor to be connected in series with 2 ohm reactor to reduce the fault level by 40%. [5+5]

Mechanical Part

5. Make a layout of a diesel power plant showing the following systems and briefly discuss about them:

   (i) Air intake system
   (ii) Cooling system
   (iii)Fuel supply system
   (iv)Lubrication system
   (v) Exhaust system [10]

6. A gas turbine unit has a pressure ratio of 6:1 and maximum cycle temperature of 610°C. The isentropic efficiencies of the compressor and turbine are 0.80 and 0.82 respectively. Calculate the power output in kilowatts of an electric generator geared to the turbine when the air enters the compressor at 15°C at the rate of 16 kg/s.
   Take c_p = 1.005kJ/kgK and γ = 1.4 for the compression process, and take cp=1.11kJ/kg K and γ = 1.333 for the expansion process. [10]

7. a) Differentiate between the operation of impulse and reaction turbines? [5]

   b) What are the essential requirements of steam power station design? [5]

8. What are the advantages and disadvantages of gas and steam combined cycle? Briefly discuss the popular designs of the combination cycles. [10]

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INSTITUTE OF ENGINEERING
Examination Control Division
2074 Chaitra

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

Subject: - Power Plant Equipment *(EE703)*

- ✓ 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.*

Group A
(Electrical Part)

1. Explain with example how pump storage hydropower plant can be installed together with base load plant for efficient operation and to reduce peak generation loss. [10]

2. a) What do you mean by Isochroanous generator? Describe its transient response for a step increase in load. [4]

   b) A power system consist of two generators operating in parallel and supplying a load of 1200 MW. Generator G_1 is rated as 900 MW with 2% drop regulation and generator G2 is related as 450MW with 3% drop regulation. G1 supplied 750 MW and G2 supplies 450 MW and frequency is 60 Hz. When the load is increased by 150 MW, Calculate the new operating frequency and additional power generated by each generator. [8]

3. Explain the dynamic response of excitation system with suitable mathematical deduction. [8]

4. a) Two generators of capacities 40Mva, 11kv and 30 Mva, 11kv having their sub transient reactance of 5% and 4% respectively operating in parallel and supplying to a common load by single feeder of reactance 2 ohm. Calculate the value of reactor to be connected in series with feeder so as to reduce the fault label at the end of the feeder by 40%. [6]

   b) Describe how a SCADA can be implemented in a power system. [4]

Group B
(Mechanical Part)

5. a) Briefly illustrate the main components of a diesel power plant. [6]

   b) A single cylinder engine running at 1800 rpm develops a torque of 8 Nm. The indicated power of the engine 1.8 kW. Find the loss due to friction power as the percentage of indicated power. [4]

6. Discuss the methods to improve thermal efficiency of Gas Turbine Plant. [10]

7. a) What is the fundamental difference between the operation of impluse and reaction turbines? [5]

   b) What are the advantages and disadvantages of steam power plant? [5]

8. What are the advantgaes of gas and stream combined cycle? Briefly explain the three popular designs of the combination cycles. [10]

17 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 Ashwin

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

Subject: - Power Plant Equipment *(EE703)*

- ✓ 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 Tables are attached herewith.***
- ✓ *Assume suitable data if necessary.*

Electrical Part

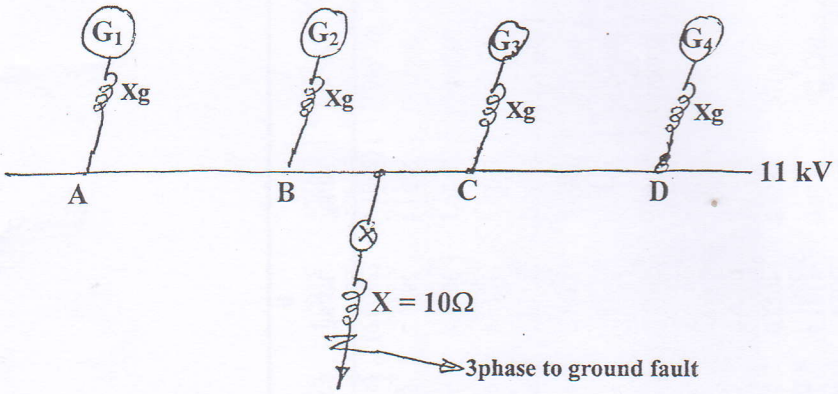
1. a) Explain the response of frequency during transient period in a turbine-generator couple system with Governor. [8]

   b) Describe the phenomena of sharing common load by two alternators operating in parallel with individual speed-drop setting. [8]

2. Two generating units of capacity 600Mva and 500Mva having droop of 4% and 6% are supplying 500Mva and 400Mva respectively to a common load of 900Mva at 60Hz. Calculate the new frequency and the new generation on each unit if load is increased to 100Mva. [8]

3. What is the function of excitation system in generating station? Derive the transfer function of an excitation system with stabilizing transformer. [2+6]

4. Below figure shows 4 Nos of identical generators operating in parallel.



Each generator is rated as 1600 kVA, 11kV, Xg = 0.2 pa.

(i) Calculate fault current in outgoing feeder and fault current supplied by each generator.

(ii) If reactors of 5 ohm each are connected between point A and B, point C and D respectively. Calculate fault current in outgoing feederal fault current supplied by each generator. [4+4]

Mechanical Part

5. Explain the fuel supply system of a diesel power plant with neat diagram. [8]

6. A two stroke diesel engine was motored when the meter reading was 2.2 kW. Then the test on the engine was carried out for one hour and the following observations were recorded: Brake torque = 150 Nm; Speed = 800 rpm; Fuel used = 2.5 kg; calorific value of fuel = 40 MJ/kg;

   Determine:

   (a) Brake power
   (b) Indicated power,
   (c) Mechanical efficiency and
   (d) Indicated thermal efficiency. [8]

7. List the common methods used for the performance improvement of the gas turbine power plants. Explain how inter-cooling increases efficiency of the plant. [8]

8. On a regenerative cycle, steam leaves the boiler and enters the turbine at 4 MPa, 400°C. After expansion to 400 kPa, some of the steam is extracted from the turbine to heat the feed water in an open feed water heater. The pressure in the feed water heater is 400 kPa, and the water leaving it is saturated liquid at 400 kPa. The steam not extracted expands to 10kPa. Determine the cycle efficiency.[Refer the attached table for the properties of stream] [12]

9. Sketch the basic components of a combine power plant with corresponding processes on T-S diagram. [4]

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16 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Shrawan

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

Subject: - Power Plant Equipment *(EE703)*

- ✓ 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.*

Group A
(Electrical Part)

1. a) Describe the steady state and transient behavior of a turbine generator coupled system with governor. [6]

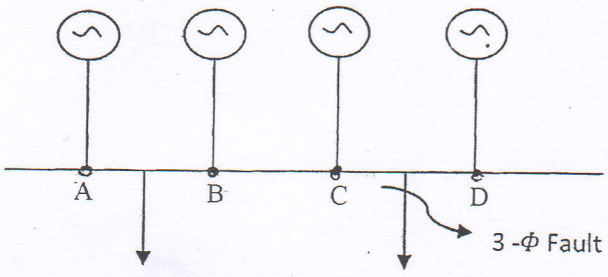
   b) Draw and explain the P-F and Q-V control loop of a hydrogenating system. [4]

2. a) Two generators are supplying power to a system. Their rating are 250 MW and 500 MW respectively. Each generator is half loaded and operating at a frequency of 60 Hz. If the system load is increased by 100 MW, the frequency drops to 59.5 Hz. What must be the individual droop of these generators so that they share the load according to their capacity? [5]

   b) What do you mean by isochronous governor? Write down its disadvantages when operated in parallel to supply a common load. [3]

3. a) Derive the transfer function of an excitation system with stabilizing transformer. [7]

   b) The figure below shows four identical generators, each rated 11 kV, 25 MVA and each having sub-transient reactance of 16% on its own rating. Find 3-ϕ fault level at one of the outgoing feeder. Also calculate the value of reactance to be connected in the bus bar between "B" and "C" so that fault level reduces by 40%. [5]



4. a) Why is rector used in power system? Explain different types of reactor. [5]

   b) Describe the fire fighting system used in power station with necessary diagram. [5]

Group B
(Mechanical Part)

1. Explain fuel storage and supply system of a diesel power plant with a neat sketch. Also write down application of diesel power plants. [8]
2. The following observations were recorded during a trial of a four stroke engine with rope dynamometer. Engine speed = 650 rpm, Dia. of brake drum = 600 mm, Dia. of rope = 50 mm, Dead load on the brake drum = 32 kg, spring balance reading = 4.75 kg, Mechanical efficiency = 80%. Calculate the brake power and indicated power. [8]
3. An open cycle gas turbine plant uses heavy oil as fuel. The maximum pressure and temperature in the cycle are 500kPa and 650°C. The pressure and temperature of air entering into the compressor are 10^5Pa and 27°C. The exit pressure of the turbine is also 10^5Pa. Assuming isentropic efficiencies of compressor and turbine to be 80% and 85% respectively, find the thermal efficiency of the cycle. Take C_p (for air and gas) = 1kJ/kg°C and γ (for air and gases) = 1.4. If the plant consumes 5 kg of fuel per sec, find the power generating capacity of the plant. [10]
4. Explain how reheater increases the output of the stream turbine power plant along with neat sketch. Draw the layout and show the cycle in T-S diagram. [8]
5. Enumerate the advantages of a combined cycle plant. With the help of a neat diagram, explain the principle of working of a combined cycle plant to enhance the efficiency of electricity generation. [6]

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