MUZAFFARPUR INSTITUTE OF TECHNOLOGY, Muzaffarpur

COURSE FILE

OF

Power System II

(031508)

Faculty Name:

DR. Yagyanand Sharma

ASSOCIATE PROFESSOR, DEPARTMENT OF ELECTRICAL ENGINEERING

Content

VISION STATEMENT OF ELECTRICAL ENGINEERING DEPARTMENT

To produce cutting edge Electrical Engineers, innovators, researchers, and entrepreneurs with high human values to serve society, industry, nation and the world.

MISSION STATEMENT OF ELECTRICAL ENGINEERING DEPARTMENT

M1. To create state-of-the-art facilities for under-graduate, post- graduate and R&D work.

M2. To cater the needs of society with recent technologies, innovative ideas and inculcate ethical responsibilities.

M3. To develop strong collaborative links with premier industries, institutions and the government agencies.

Program Educational Objectives (PEOs) of Electrical Engineering Department:

PEO 1. Students will be able to engage in life-long learning and research including supportive and responsible roles on multi-disciplinary tasks.

PEO 2. Students will acquire, use and develop skills as required for effective professional and societal practices and leadership quality.

PEO 3. Students will be able to create a new dimension of innovation and entrepreneurship.

Program Outcomes (POs) based on Program Educational Objectives (PEOs) of Electrical Engineering Department:

PO 1. Students will be able to apply knowledge of applied mathematics & science in electrical engineering problems.

PO 2. Students will be able to identify, formulate and solve society and industries related problems.

PO 3. Students will be able to apply knowledge to design a system, component or process to meet desired needs within realistic constraints.

PO 4. Students will be able to conduct laboratory experiments and to critically analyze and interpret experimental data.

PO 5. Students will be able to use the recent techniques, skills, and modern tools necessary for engineering practices.

PO 6. Students will be able to understand the impact of engineering problems, solutions in a global and societal context.

PO 7. Students will be able to demonstrate professional and ethical responsibilities.

PO 8. Students will be able to apply leadership quality to work with team in the area of electrical engineering towards the solution of multi-disciplinary tasks.

PO 9. Students will be able to communicate effectively through verbally, technical writing, reports and presentation.

PO 10. Students will be able to develop confidence for self-education and ability to engage in life-long learning.

COURSE OBJECTIVE AND COURSE OUTCOMES:

Institute/college Name	Muzaffarpur Institute of Technology, Muzaffarpur
Program Name	B.E. Electrical (V semester)
Course Code/course credits	031508 (4)
Course Name	Power System II
Lecture/ Sessional (per week)	3/1
SEE duration	4 hours
Course Coordinator Name	Dr. Yagyanand Sharma

Course objective:

This course deals and enhance the knowledge in the area of power plant such as hydro power plant and thermal power plant, also deals the economy analysis of power system such as load factor, demand factor, diversity factor, etc., the symmetrical component of unbalanced phasor, faults analysis (LG, LL, LLG etc). Analysis of power system stability.

Course outcomes (CO):

CO1	Students are able to understand the basic concept of power generation, power plant economy, transmission line faults and its stability analysis.
CO2	Students are able to described the term related to power plant (hydropower plant, thermal power plant) also described the method of faults analysis and stability analysis.
CO3	Students are able to apply the concept for performance computation of power plant and its energy efficiency, load factor, diversity factor etc.
CO4	Students are able to apply the concept for computation of performance faulted transmission line such as Faults current, critical clearing angle, etc.
CO5	Students are able to analyse the operation and performance of power plant, also analyse the behaviour of faulted trans. line and its stability.

MAPPING OF COs AND POs

Sr. No.	Course Outcome	PO
1.	**CO1**: Students are able to understand the basic concept of power generation, power plant economy, transmission line faults and its stability analysis.	PO1, PO2, PO3, PO5, PO9
2.	**CO2**: Students are able to described the term related to power plant (hydropower plant, thermal power plant) also described the method of faults analysis and stability analysis.	PO3, PO4, PO7
3.	**CO3**: Students are able to apply the concept for performance	PO3, PO4, PO7, PO10

	computation of power plant and its energy efficiency, load factor, diversity factor etc.	
4.	**CO4**: Students are able to apply the concept for computation of performance faulted transmission line such as Faults current, critical clearing angle, etc.	PO3, PO4, PO7, PO8, PO9, PO10
5.	**CO5:** Students are able to analyse the operation and performance of power plant, also analyse the behaviour of faulted trans. line and its stability.	PO1, PO3, PO4, PO5, PO6, PO9, PO10

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	√	√	√	-	√	-	-	-	√	-
CO2	-	-	√	√	-	-	√	-	-	-
CO3	-	-	√	√	-	-	√	-	-	√
CO4	-	-	√	√	-	-	√	√	√	√
C05	√	-	√	√	√	√	-	-	√	√

Course syllabus of Power System-II

1. Power station and sub-station

Hydro and power station: Site selection, Layout, calculation of available power classification, Salient features, Pumped hydro plants.

Thermal power Station: Site selection, Layout, calculation of coal requirements, cooling water

tower efficiency, co-ordination of hydro and thermal power stations.

2. Economy of power system

Load curves, Load duration curves, Diversity Factor, Base and peak Load station, Cost allocation of power station-fixed cost, Two par Tariff and Evaluation

3. Symmetrical three phase faults on synchronous machines

Short circuit current and reactance of synchronous machines, Internal voltage of loaded machines under transient conditions.

4. Symmetrical components

Synthesis of unsymmetrical phases from their symmetrical components operators, The symmetrical components of unsymmetrical phase, phase shift in transformer bank:

power in terms of symmetrical components; unsymmetrical series impedances; sequence impedances and sequence networks; sequence networks of unbalanced generators; sequence impedance of circuit elements positive and negative sequence networks; zero sequence network.

5. Unsymmetrical Faults

Signal line to ground fault, line to line fault, double line to ground fault on unloaded generator and power systems, Interpretation of inter guidance sequence networks.

6. Power System Stability

Steady state power limit of cylindrical rotor and salient pole machines without saturation, Maximum power transmitted to a transmitting network, series capacitor, Transient stability power angel curve,

Inertia clearance angel, equal swing equation, equal area criterion and its application.

Books:

- **'Elements of Power System Analysis ' by Stevenson (McGraw Hill)**
- **'Modern Power System Analysis' by D P Kothari & I J Nagarath(TMH)**
- **'Elective Power System' by Soni, Bhatnagar &Gupta**

GATE Syllabus of Power System II:

Section: Power Systems

Power generation concepts, ac and dc transmission concepts, Models and performance of transmission lines and cables, Series and shunt compensation, Electric field distribution and insulators, Distribution systems, Per-unit quantities, Bus admittance matrix, Gauss-Seidel and Newton-Raphson load flow methods, **Voltage and Frequency control, Power factor correction, Symmetrical components, Symmetrical and unsymmetrical fault analysis,** Principles of over-current, differential and distance protection; Circuit breakers, **System stability concepts.**

ELECTRICAL 5TH SEM.

ROOM NO.: 15

DAY/TIME	9:00-10:00	10:0-11:00	11:00-12:00	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00
MONDAY	NT (SA)	SS (AKS)	AE (SR)	EMFT (T2) FA		WEEKLY TESTS (30 MIN. EACH PAPER) PS II, SS, EMFT, NT, AE, IS		
TUESDAY	EMFT (T4) (FA)	NT (SA)	SS (AKS)	PS-II (T1) (YNS)/ SS (T2) (AKS) 50		EMFT (T3) (FA)		
WEDNESDAY	AE (SR)	PS-II (YNS)	SS (AKS)	IS (SS)	L U N C H	AE LAB (SR+AK)/NT LAB (SA+RKM)		
THURSDAY	PS-II (T2) (YNS)/ SS (T1)(AKS) 50	AE (SR)	PS-II (YNS)	EMFT (FA)		EMFT (T1) (FA)		
FRIDAY	IS (SS)	PS-II (YNS)	EMFT (FA)	PS-II (T3) (YNS)/ SS (T4) (AKS) 50		AE LAB (SR+AK)/NT LAB (SA+RKM)		
SATURDAY	IS (SS)	EMFT (FA)	NT (SA)			PS-II (T4) (YNS)/ SS (T3)(AKS) 50		

ROLL NO. [16E02 -- 16E21 (T1) 16E22 -- 16E41 (T2) 16E42 -- 16E61 (T3) 16E62 -- 17(LE)E10 (T4)]

SUBJECT NAME		FACULTY NAME	
NT	NETWORK THEORY	**SA**	PROF. SHAHZAD AHSAN
SS	SIGNALS AND SYSTEMS	**AKS**	PROF. ANKIT KUMAR SINGH
EMFT	ELECTROMAGNTIC FIELD THEORY	**SR**	PROF. SHADAB RABBANI
AE	ANALOG ELECTRONICS	**FA**	PROF. FAIZ AHMAD
PS-II	POWER SYSTEM-II	**YNS**	DR. Y.N. SHARMA
IS	INFORMATION SECURITY	**SS**	PROF. SAVYASACHI

STUDENT LIST:

S.NO.	***Roll No***	***Name***
1	16EE01	NANDAN KUMAR
2	16EE02	ANJALI KUMARI
3	16EE03	KAUSTUBHA
4	16EE04	RISHABH KUMAR
5	16EE05	AMRITA KUMARI
6	16EE06	SUMIT KUMAR
7	16EE07	RITESH RAJ
8	16EE08	VIPUL MISHRA
9	16EE09	SAMEER KUMAR
10	16EE10	MD SAIFULLAH SADIQUE
11	16EE11	PREETI KUMARI
12	16EE12	KULDEEP THAKUR
13	16EE13	SHANTANU KUMAR SINGH
14	16EE14	SEEMA KUMARI
15	16EE15	PRIYAM KUMARI
16	16EE16	VANDANA BIHARI
17	16EE17	RAJNANDANI
18	16EE18	SANJAY KUMAR YADAV
19	16EE19	PRAVEEN DIVAKAR
20	16EE20	AMIT KUMAR PANDIT
21	16EE21	CHANDAN KUMAR THAKUR
22	16EE22	ALOK KUMAR
23	16EE23	DEVENDRA KUMAR
24	16EE24	ARVIND KUMAR
25	16EE25	AMITESH KUMAR
26	16EE26	VIVEK KUMAR
27	16EE27	VIKASH KUMAR RAY
28	16EE28	ROHIT KUMAR
29	16EE29	OM PRAKASH KUMAR

30	16EE30	RAVI KUMAR
31	16EE31	SANDEEP KUMAR
32	16EE32	DEO ALOK
33	16EE33	BAJRANGI KUMAR
34	16EE34	MANOJ KUMAR SONI
35	16EE35	SANJEEV KUMAR
36	16EE36	NEERAJ KUMAR
37	16EE37	SATYAM KUMAR
38	16EE38	PRASHANT GAURAV
39	16EE39	NITISH KUMAR RAJAK
40	16EE40	UJJAWAL KUMAR
41	16EE41	PRABHAT KUMAR
42	16EE42	MD HASIM JILANI
43	16EE43	SHIV CHARAN KUMAR
44	16EE44	ANISH BHARTI
45	16EE45	RAHUL KUMAR
46	16EE46	RAJEEV RANJAN PRASAD
47	16EE47	SHUBHAM KUMAR
48	16EE48	TAHIR QAMAR
49	16EE49	PRASHANT KUMAR
50	16EE50	NAMAN KUMAR
51	16EE51	KESHAV CHANDRA
52	16EE52	SWETA BHARTI
53	16EE53	PRATIK ANAND
54	16EE54	SHAGUFTA ANJUM
55	16EE55	GOLDEN KUMAR
56	16EE56	MURLI MANOHAR
57	16EE57	ARPIT ANAND
58	16EE58	AKSHAT RAJ
59	16EE59	ANJAN KUMAR
60	16EE60	SUMAN KUMAR BHARTIYA
62	16EE61	SAKET

63	16EE62	RISHABH KUMAR
64	16EE63	SUMAN KUMAR
65	16EE64	SUNITA KUMARI
66	16EE65	NISHANT RAJ
67	16EE66	VIPIN SINGH
68	16EE67	ANKIT RAJ
69	16EE68	GUNJAN KUMAR
70	16EE69	PRATAP CHANDRA CHOUDHARY
71	17(LE)EE01	VIVEK KUMAR
72	17(LE)EE02	RITIK KUMAR
73	17(LE)EE03	ANAND RANJAN
74	17(LE)EE04	ABHISHEK KUMAR
75	17(LE)EE05	POONAM KUMARI
76	17(LE)EE06	SAURABH KUMAR JHA
77	17(LE)EE07	PARMANAND KUMAR
78	17(LE)EE08	ROHAN RAJ
79	17(LE)EE09	ANAND KUMAR
80	17(LE)EE10	MANISH

Course Handout

1. Scope and Objectives of the Course

This course deals and enhance the knowledge in the area of power plant such as hydro power plant and thermal power plant, also deals the economy analysis of power system such as load factor, demand factor, diversity factor, etc., the symmetrical component of unbalanced phasor, faults analysis (LG, LL, LLG etc).Analysis of power system stability.

2. Textbooks

TB1: Elements of Power System Analysis 3rd Edition by Stevenson, McGraw Hill
TB2 : A Course of Electrical Power by Soni Bhatnagar and Gupta, Dhanpat Rai & Sons. **TB3:** Modern Power System Analysis by Nagrath and Kothari, Tata McGraw Hill.

3. Reference Books

RB1: Electrical Power System by C.L.Adhwa, Wiley Eastern.

RB2: principal of power system by V.K.mehta

Other readings and relevant websites

S.No.	**Link of Journals, Magazines, websites and Research Papers**
1.	https://www.journals.elsevier.com/international-journal-of-electrical-power-and-energy-systems
2.	http://www.imanagerpublications.com/journalsfulldetails/20/JournalonPowerSystemsEngineering https://www.ieee-pes.org/ieee-transactions-on-power-systems https://www.sciencedirect.com/journal/electric-power-systems-research/vol/115
3.	https://onlinecourses.nptel.ac.in

Lecture Number	Topics	Web Links for video lectures	Text Book / Reference Book / Other reading material	Page numbers of Text Book(s)
1	**1. Power station and sub-station**		RB2	9-40
	Hydro and power station: Site selection, Layout, calculation of available power classification, Salient features, Pumped hydro plants. **Thermal power Station:** Site selection, Layout, calculation of coal requirements, cooling water tower efficiency, co-ordination of hydro and thermal power stations.	https://www.youtube.com/watch?v=0tmFtC54O70 https://www.youtube.com/watch?v=JBrdUoU2uTE https://www.youtube.com/watch?v=JBrdUoU2uTE https://www.youtube.com/watch?v=D0i1E_lE_TE	TB2,TB3	
10-18	**2. Economy of power system**		RB2	42-86
	Load curves, Load duration curves, Diversity Factor, Base and peak Load station, Cost allocation of power station-fixed cost, Two par Tariff and Evaluation	https://www.youtube.com/watch?v=w0VvAQJz6UI https://www.youtube.com/watch?v=qZcv5pAW2lA	TB2,TB3	
19-26	**3. Symmetrical three phase faults on synchronous machines**		TB1	191-208
	Short circuit current and reactance of synchronous machines, Internal voltage of loaded machines under transient conditions.	https://www.youtube.com/watch?v=HcMh7ahJxfo https://www.youtube.com/watch?v=dyK_t3NneQc	RB1, TB3	
27-34	**4. Symmetrical components**		TB1	210-270
	Synthesis of unsymmetrical phases from their symmetrical components operators, The symmetrical components of unsymmetrical phase, phase shift in transformer bank: power in terms of symmetrical components; unsymmetrical series impedances; sequence impedances and sequence networks; sequence networks of unbalanced generators; sequence impedance of circuit elements positive and negative sequence networks; zero sequence network.	https://www.youtube.com/watch?v=24X4znh4nl0 https://www.youtube.com/watch?v=oYj7j5QBlY0 https://www.youtube.com/watch?v=taWP9FvE0NE	RB1,TB3	
35-42	**5. Unsymmetrical Faults**		TB1	272-293
	Signal line to ground fault, line to line fault, double line to ground fault on unloaded generator and power systems, Interpretation of inter guidance sequence networks.	https://www.youtube.com/watch?v=0k_N5mPZuNY https://www.youtube.com/watch?v=-Lmw6UE9rNo https://www.youtube.com/watch?v=67aBucrRbWc	RB1,TB3	
	6. Power System Stability		TB1	319-348

	Steady state power limit of cylindrical rotor and salient pole machines without saturation, Maximum power transmitted to a transmitting network, series capacitor, Transient stability power angel curve, Inertia clearance angel, equal swing equation, equal area criterion and its application.	https://www.youtube.com/watch?v=2VTQv7bBpCU https://www.youtube.com/watch?v=vQvjwyjVH_c https://www.youtube.com/watch?v=rfmi9S3lTwc https://www.youtube.com/watch?v=5z7d4g3dZn8	**RB1,TB3**	

	LACTURE PLAN	
SL. No.	**Topic Name**	**Period**
1	**Power station and sub-station**	
	Hydro and power station: Site selection, Layout	2
	Calculation of available power classification	1
	Salient features,	1
	Pumped hydro plants.	1
	Thermal power Station :Site selection, Layout	2
	Calculation of coal requirements	1
	Cooling water tower efficiency	1
	Co-ordination of hydro and thermal power stations.	1
2	**Economy of power system :**	
	Load curves,	2
	Load duration curves,	2
	Diversity Factor	1
	Base and peak Load station	2
	Cost allocation of power station-fixed cost	2
	Two par Tariff and Evaluation	1
3	**Symmetrical three phase faults on synchronous machines**	
	Short circuit current and reactance of synchronous machines	2
	Internal voltage of loaded machines under transient conditions.	2

4	**Symmetrical components**	
	Synthesis of unsymmetrical phases from their symmetrical components operators , The symmetrical components of unsymmetrical phase	1
	Phase shift in transformer bank: power in terms of symmetrical components , Unsymmetrical series impedance	2
	Sequence impedances and sequence networks ,Sequence networks of unbalanced generators	2
	Sequence impedance of circuit elements positive and negative sequence networks, Zero sequence networks.	1
5	**Unsymmetrical Faults**	
	Signal line to ground fault	2
	line to line fault	1
	double line to ground fault on unloaded generator and power system	2
	Interpretation of inter guidance sequence networks.	1
6	**Power System Stability**	
	Steady state power limit of cylindrical rotor and salient pole machines without saturation	2
	Maximum power transmitted to a transmitting network	1
	series capacitor, Transient stability power angel curve	1
	Inertia clearance angel, equal swing equation	1
	equal area criterion and its application	1
	Total	42

Govt. of Bihar

MUZAFFARPUR INSTITUTE OF TECHNOLOGY, MUZAFFARPUR-842003

(Under the Department of Science & Technology Govt. of Bihar, Patna)

Department of Electrical Engineering
Power System -II

Assignment I

1. Draw the systemic diagram of Hydro power plant and define the following. (i) Head (ii) Reservoir (iii) Surge tank (iv) water hammering (v) Spill-way (vi) Fore-bay
2. Explain the factors are taken into account to select the site of steam power station?
3. Explain the factors are taken into account to select the site of Hydro power station?
4. Draw the systemic diagram of a steam power station and define the following terms

(i) Economiser (ii) Super heater (iii) Condenser (iv) cooling tower (v) Boiler (vi) Turbine (vii) ESP

Assignment II

1. What do you understand from the load curve and what information are converged by a load curve.
2. Discuss the important points to be taken into consideration while selecting then size and number of unit's generation.
3. Explain the terms, connected load, load factor, plant use factor, diversity factor

Assignment III

1. Draw the zero sequence networks for Y-Δ transformer bank with grounded Y-neutral.

2. Draw the sequence network for star connected Synchronous generator with solidly grounded.

3. Explain the LL faults and draw sequence network.

4. Explain the LLG faults and draw sequence network.

Assignment IV

1. What is swing equation?

2. Explain the steady state stability.

3. Explain the Equal area criterion.

Govt. of Bihar

MUZAFFARPUR INSTITUTE OF TECHNOLOGY, MUZAFFARPUR-842003

(Under the Department of Science & Technology Govt. of Bihar, Patna)

TUTORIAL-I

1. Water for a hydro-electric station is obtained from a reservoir with a head of 100 metres. Calculate the electrical energy generated per hour per cubic meter of water if the hydraulic efficiency be 0·86 and electrical efficiency 0·92.

2. A hydro-electric station has an average available head of 100 metres and reservoir capacity of 50 million cubic metres. Calculate the total energy in kWh that can be generated, assuming hydraulic efficiency of 85% and electrical efficiency of 90%.

3. It has been estimated that a minimum run off of approximately 94 m3/sec will be available at a hydraulic project with a head of 39 m. Determine (i) firm capacity (ii) yearly gross output. Assume the efficiency of the plant to be 80%.

TUTORIAL -II

1. A power station is to supply three loads. The daily cycle of loads are given below:

Time in hours	0 - 6	6 - 10	10 - 12	12 - 18	18 - 22	22 - 24
Loads A in MW	10	15	20	30	15	5

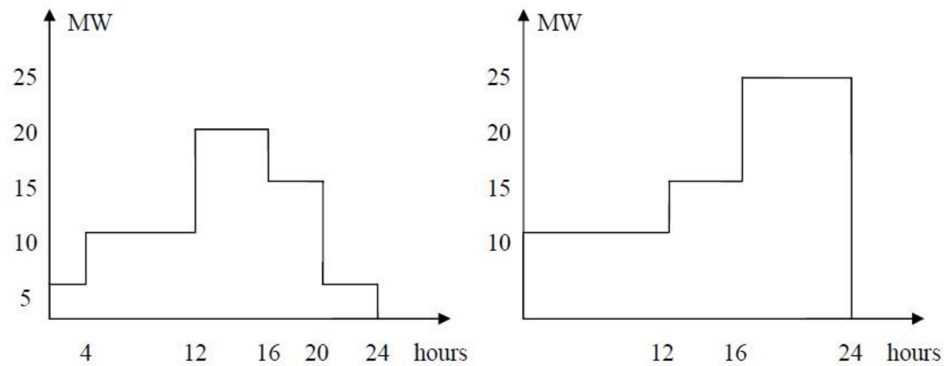
Time in hours	0 - 10	10 - 20	20 - 24
Loads B in MW	0	15	0

Time in hours	0 - 4	4 - 10	10 - 14	14 - 16	16 - 20	20 - 24
Loads C in MW	5	15	50	10	20	10

1. Draw

(i) The load and duration curves of power station.
(ii). Calculate: (a)- load factor of each load.
(b)- Load factor of the power station.
(c)- Diversity factor of the power station.
(d)- The capacity factor when the station is having reserve set 20% of the max. demand.

2. A power station is to supply two loads . The daily load curves of two loads are shown in figures below :



Load curve A   Load curve B

(i) - Plot the load and duration curves of power station .
(ii) - Find :
(a)- Load factor of each load.
(b)- Load factor and Diversity factor of power station.
(c)- The reserve capacity and Capacity factor of the power station .If the power station consists of three units , the installed capacity of each unit is 20 MW.

TUTORIAL –III

1. The voltages across a 3-phase unbalanced load are $V_a = 300 \angle 0°$ V , $V_b = 300 \angle -90°$ V and $V_c = 800 \angle 143.1°$ V respectively. Determine the sequence components of voltages. Phase sequence is *abc*

2. Three 6.6 kV, 12 MVA, 3-phase alternators are connected to a common set of busbars. The positive, negative and zero sequence impedances of each alternator are 15%, 12% and 4.5% respectively. If an earth fault occurs on one busbar, determine the fault current:

(i) if all the alternator neutrals are solidly grounded;
(ii) if one only of the alternator neutrals is solidly earthed and the others are isolated;
(iii) if one of the alternator neutrals is earthed through a reactance of 0.5 ohm and the others are isolated.

3. A 3-phase, 5 MVA, 6.6 kV alternator with a reactance of 8% is connected to a transmission line of series impedance (0.12 + *j*0.48) ohm per km. The transformer is rated at 3 MVA, 6.6 kV/33 kV and reactance 5%. Determine the fault current supplied by the generator operating under no load with voltage 6.9 kV when a 3-phase delta connected fault occurs 15 km along the line with fault impedance between each line being (12 + *j*48) ohms.

TUTORIAL -IV

1. A two-pole, 50 Hz, 11 kv turbo alternator has a rating of 100 Mw, Power factor 0.85 lagging. The rotor has a moment of inertia of a 10,000 kg-m^2. Calculate H and M.

2. Two turbo alternators with ratings given below are interconnected via a short transmission line.

Machine 1: 4 poIe, 50 Hz, 60 MW, power factor 0.80 lagging, moment of inertia 30,000 kg-m^2,
Machine 2: 2 pole, 50 Hz, 80 MW, power factor 0.85 lagging, moment of inertia 10,000 kg-$m^{2.'}$ Calculate the inertia constant of the single equivalent machine on a base of 200 MVA.

3. A power deficient area receives 50 MW over a tie line from another area. The maximum steady state capacity of the tie line is 100 MW. Find the allowable sudden load that can be switched on without loss of stability.

University Question of PS-II 2017

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Code : 031508

B.Tech 5th Semester Exam., 2017

POWER SYSTEM—II

Time : 3 hours *Full Marks* : 70

Instructions :

(i) *The marks are indicated in the right-hand margin.*

(ii) *There are* **NINE** *questions in this paper.*

(iii) *Attempt* **FIVE** *questions in all.*

(iv) *Question No.* **1** *is compulsory.*

(v) *Assume appropriately where data is missing.*

1. Choose the correct option (any *seven*) : 2×7=14

(a) Which of the following power stations is mainly used to cover peak load on the system?

(i) Coal-based thermal plant

(ii) Nuclear plant

(iii) Gas-based thermal plant

(iv) Pumped storage hydropower plant

(b) For the hydroelectric power plants

(i) operating cost is high and initial cost is high

(ii) operating cost is low and initial cost is high

(iii) operating cost is low and initial cost is low

(iv) operating cost is high and initial cost is low

(c) On what factor, the fixed charge is dependent in a two-part tariff?

(i) Energy consumed

(ii) Peak load demand

(iii) Maximum demand

(iv) All of the above

(d) Fault calculations using computer are usually done by

(i) Y_{bus} method

(ii) Z_{bus} method

(iii) All of the above

(iv) None of the above

(e) What is the value of zero sequence current?

(i) Three times the current in neutral wire

(ii) 1/3 time the current in neutral wire

(iii) $\sqrt{3}$ times the current in neutral wire

(iv) Equal to the current in neutral wire

(f) The following sequence currents were recorded in a power system under a fault condition :

$I_{positive} = j1.753$ p.u.

$I_{negative} = -j0 \cdot 6$ p.u.

$I_{zero} = -j1 \cdot 153$ p.u.

The fault is

(i) line to ground

(ii) three-phase

(iii) line to line to ground

(iv) line to line

(g) If all the sequence voltages at the fault point in a power system are equal, then the fault is a

(i) line to line to ground fault

(ii) three-phase fault

(iii) double-line fault

(iv) single-line to ground fault

(h) Which of the following networks gets affected by the method of neutral grounding?

(i) Zero sequence network

(ii) Positive sequence network

(iii) Negative sequence network

(iv) All of the above

(i) For 800 MJ stored energy in the rotor at synchronous speed, what is the inertia constant (H) for a 50-Hz, 4-pole turbo-generator rated 100 MVA, 11 kV?

(i) 2 MJ/MVA

(ii) 4 MJ/MVA

(iii) 6 MJ/MVA

(iv) 8 MJ/MVA

(j) Which of the following cannot be determined from equal area criterion?

(i) Critical clearing angle

(ii) Critical clearing time

(iii) Transient stability limit

(iv) Both (i) and (ii)

2. (a) What are the factors to be considered for selection of site for a thermal power station?

(b) Draw the schematic layout of a typical coal fired power station.

(c) Explain the role of economizer and superheater in a thermal power plant. 4+5+5=14

3. (a) Define load factor and diversity factor. What is the impact of diversity factor?

(b) An electric supply undertaking has to cater to a demand of two consumers A and B, each having a maximum demand of 5 kW. Variation of loads for these consumers are given below :

Consumer A :

From midnight to 7 AM	200 W
From 6 PM to 7 PM	1500 W
From 7 PM to 9 PM	5000 W
From 9 PM to midnight	800 W

Consumer B :

From midnight to 6 AM	400 W
From 6 AM to 12 Noon	1600 W
From 12 Noon to 2 PM	5000 W
From 2 PM to 7 PM	600 W
From 7 PM to 11 PM	3600 W
From 11 PM to midnight	600 W

Draw the separate load curve for each consumer and the system load curve. Find the maximum demand on the system. Also, calculate the load factor and the diversity factor. 6+8=14

4. *(a)* What are different types of reactance of an unloaded synchronous machine under short-circuit condition? Discuss them briefly using approximate circuit model.

(b) A synchronous generator rated 500 kVA, 440 V, 0·1 p.u. subtransient reactance is supplying a passive load of 400 kW at 0·8 lagging power factor. Calculate the initial symmetrical r.m.s. current for a three-phase fault at generator terminal. 8+6=14

5. *(a)* Define positive, negative and zero-sequence components.

(b) Write the equation to transform phase voltage into sequence voltage.

(c) The voltages across a three-phase unbalanced load are $V_a = 200$ V, $V_b = 200\angle -90^\circ$ V, $V_c = 600\angle 140^\circ$ V respectively. Determine the sequence component of voltages. Phase sequence is *abc*. 6+2+6=14

6. *(a)* Calculate the sequence component of three-phase star-connected balanced supply voltages.

(b) Derive the sequence component of a transmission line having X_s (self-reactance of each line) and X_m (mutual reactance of any line pair). The series resistance of the line may be ignored. 4+10=14

7. *(a)* For a three-phase unloaded alternator with neutral grounded through impedance Z_n and fault impedance Z_f, draw the phase and sequence network for an *L-L* fault. Also derive the expression for the sequence component of the current in a three-phase unloaded alternator for *L-L* fault.

(b) A 20 MVA, 33 kV, three-phase alternator is subjected to different types of short-circuit tests. The fault currents were

three-phase fault current—300 A

line to line fault current—400 A

single-line to ground fault current—600 A

The alternator is solidly grounded. Find the per unit value of three-sequence reactance of the alternator. Neglect resistance. 7+7=14

8. (a) Derive an expression for the maximum power transfer between two nodes. Show that this power is maximum when $X = \sqrt{3}R$, where X and R are reactance and resistance of the system respectively.

(b) A motor is receiving 30% of the power that it is capable of receiving from an infinite bus. If the load on the motor is doubled, calculate the maximum value of δ during the swing of the rotor around the equilibrium position. 8+6=14

9. Write short notes on any *two* of the following : 7×2=14

(a) Transient stability

(b) Equal area criterion

(c) Hydrothermal scheduling

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Question Bank of Power System-II

1. What is a power generating station?
2. What is a steam power station? Discuss its advantages and disadvantages.
3. Draw the schematic diagram of a modern steam power station and explain its operation.
4. Explain the important components of a steam power station.
5. What factors are taken into account while selecting the site for a steam power station?
6. Discuss the merits and demerits of a hydro-electric plant.
7. Draw a neat schematic diagram of a hydro-electric plant and explain the functions of various components.
8. Explain the essential factors which influence the choice of site for a hydro-electric plant.
9. Explain the functions of the following:

   (i) Dam (*ii*) spillways (*iii*) surge tank (*iv*) headwork's (*v*) draft tube.
10. Give the comparison of steam power plant, hydro-electric power plant.
11. Why is the overall efficiency of a steam power station very low?
12. Why is a condenser used in a steam power station?
13. Why hydro-electric stations have high transmission and distribution costs?
14. Why is the load on a power station variable? What are the effects of variable load on the operation of the power station?
15. What do you understand by the load curve? What information's are conveyed by a load curve?
16. Define and explain the importance of the following terms in generation:

    (i) Connected load (*ii*) maximum demand (*iii*) demand factor (*iv*) average load.
17. Explain the terms load factor and diversity factor. How do these factors influence the cost of generation?
18. Explain how load curves help in the selection of size and number of generating units.

19. Discuss the important points to be taken into consideration while selecting the size and number of units.

20. What do you understand by (*i*) base load and (*ii*) peak load of a power station?

21. Discuss the method of meeting the peak load of an electrified area.

22. Discuss the advantages of interconnected grid system.

23. Write short notes on the following :

    (i) load curves,

    (ii) load division on hydro-steam system,

    (iii) load factor,

    (iv) plant capacity factor,

24. What do you understand by a short-circuit? Discuss the possible causes of short-circuit in the power system.

25. Explain the harmful effects of short-circuit fault on the power system.

26. What is the importance of short-circuit calculations?

27. Discuss the possible faults on overhead lines.

28. What do you understand by percentage reactance? Why do we prefer to express the reactances of various elements in percentage values for short-circuit calculations?

29. What is the importance of base kVA in short-circuit calculations?

30. Why do we use reactors in the power system? Discuss their advantages.

31. Explain the various methods of connecting short-circuit current limiting reactors in the power system.

32. Why do we choose a base kVA in short-circuit calculations?

33. What is the advantage of expressing reactance's in percentage values?

34. Why do we decide the rating of a circuit breaker on the basis of symmetrical short-circuit currents?

35. Will the value of short-circuit current change if we take different base kVAs' ? Explain your answer.

36. Can feeder reactors permit the use of circuit breakers of lower ratings?

37. What is a 3-φ unsymmetrical fault? Discuss the different types of unsymmetrical faults that can occur on a 3-φ system.

38. Discuss the 'symmetrical components method' to analyze an unbalanced 3-φ system.

39. Express unbalanced phase currents in a 3-φ system in terms of symmetrical components.

40. What do you understand by positive, negative and zero sequence impedances? Discuss them with reference to synchronous generators, transformers and transmission lines.

41. Derive an expression for fault current for single line-to-ground fault by symmetrical components method.

42. Derive an expression for fault current for line-to-line fault by symmetrical components method.

43. Derive an expression for fault current for double line-to-ground fault by symmetrical components method.

44. What do you understand by sequence networks? What is their importance in unsymmetrical fault calculations?

45. Write short notes on the following:

    (i) Positive sequence network

    (ii) Negative sequence network

    (iii) Zero sequence networks

46. Why is 3-φ symmetrical fault more severe than a 3-φ unsymmetrical fault?

47. In a 3-φ system, it has been found that negative sequence components and zero sequence components are absent. What do you conclude from it ?

48. Do the sequence components physically exist in a 3-φ system?

49. Why do we prefer to analyze unsymmetrical faults by symmetrical components method?

50. The positive sequence network of a power system is similar to the negative sequence network. What do you infer from it ?

51. Explain steady state stability.

52. Explain transient stability.
53. Described Equal area criterion method.
54. What is swing equation?
55. What is critical clearing angle?
56. What are the factors affecting transient stability?

Reference materials

1. **Textbooks**

TB1: Elements of Power System Analysis 3rdEdition by Stevenson, McGraw Hill

TB2 : A Course of Electrical Power by Soni Bhatnagar and Gupta, Dhanpat Rai & Sons.

TB3: Modern Power System Analysis by Nagrath and Kothari, Tata McGraw Hill.

2. **Reference Books**

RB1: Electrical Power System by C.L.Adhwa, Wiley Eastern.

RB2: principal of power system by V.K.mehta

Other readings and relevant websites

S.No.	**Link of Journals, Magazines, websites and Research Papers**
4.	https://www.journals.elsevier.com/international-journal-of-electrical-power-and-energy-systems
5.	http://www.imanagerpublications.com/journalsfulldetails/20/JournalonPowerSystemsEngineering https://www.ieee-pes.org/ieee-transactions-on-power-systems https://www.sciencedirect.com/journal/electric-power-systems-research/vol/115
6.	https://onlinecourses.nptel.ac.in