Name: **Enrolment No:**	UPES UNIVERSITY WITH A PURPOSE

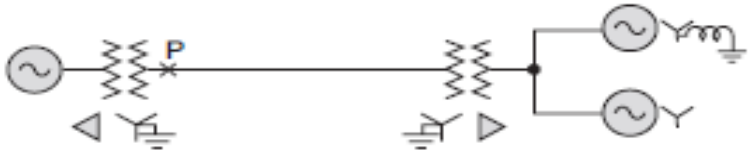
UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2019

Course: Power System Analysis & Stability **Semester: VI**
Program: B.Tech Electrical Engg. **Time : 03 hrs.**
Course Code: PSEG 317 **Max. Marks: 100**

Instructions: All questions are compulsory.

SECTION A

S. No.		Marks	CO
Q 1	Discuss the advantages of per-unit method over the absolute method of analysis.	**4**	**CO1**
Q 2	A system has 100 buses of which 20 buses are generator bus. Determine the number of load buses.	**4**	**CO1, CO4**
Q 3	Define running spare capacity constraint in case of economical load dispatch.	**4**	**CO2**
Q 4	Derive the relationship of active power in terms of symmetrical components.	**4**	**CO3**
Q 5	Discuss the importance of swing equation in case of steady state stability of the power system.	**4**	**CO4**
	SECTION B		
Q 6	Explain clearly with a flow chart the computational procedure for load flow solution using Gauss-Seidel method when the system contains all types of buses.	**10**	**CO1**
Q 7	Incremental fuel costs in Rs. per megawatt hour for two units in a plant are given by $dF_1/dP_1 = 0.2\ P_1 + 40$ $dF_2/dP_2 = 0.4\ P_2 + 32$ The minimum and maximum loads on each unit are to be 60 MW and 150 MW respectively. Determine the incremental fuel cost and the allocation of load between units for the minimum cost when loads is 120 MW. Assume both the units are operating. **OR** A system consists of two plants connected by a tie line and a load is located at plant 2. When 100 MW are transmitted from plant 1, a loss of 20 MW takes place on the tie-line. Determine the generation schedule at both the plants and the power received by the load when λ for the system is Rs. 50 per megawatt hour and the incremental fuel costs are given by the equation $dF_1/dP_1 = 0.4\ P_1 + 80$ $dF_2/dP_2 = 0.5\ P_2 + 60$	**10**	**CO2**
Q 8	A 40 MVA, 13.5 kV alternator with solidly grounded neutral has a sub-transient reactance of 0.20 p.u. The negative and zero sequence reactances are 0.15 and 0.1 p.u. respectively. A single line to ground fault occurs at the terminals of an unloaded alternator. Determine the fault current and the line-to-line voltages. Neglect resistance.	**10**	**CO3**
Q 9	A 50 Hz synchronous generator is connected to an infinite bus through a line. The p.u. reactances of generator and the line are $j0.6$ p.u. and $j0.4$ p.u. respectively. The generator no load voltage is 1.15 p.u. and that of infinite bus is 1.0 p.u. The inertia constant of the generator is 6	**10**	**CO4**

	MW-sec/MVA. Determine the frequency of natural oscillations if the generator is loaded to (*i*) 60% and (*ii*) 80% of its maximum power transfer capacity and small perturbation in power is given.		
	SECTION-C		
Q 10	a- Explain equal area criterion method applied in transient stability analysis of the power system. b- A 50 Hz four-pole turbo-generator rated 50 MVA, 12.5 kV has an inertia constant of H = 8.0 kW-sec/kVA. Determine the K.E. stored in the rotor at synchronous speed. Determine the acceleration if the input less the rotational losses is 50000 HP and the electric power developed is 30000 kW. If the acceleration computed for the generator is constant for a period of 15 cycles, determine the change in torque angle in that period and the r.p.m. at the end of 15 cycles. Assume that the generator is synchronized with a large system and has no accelerating torque before the 15 cycle period begins. **OR** a- Show that the maximum power can be transferred from sending end to receiving end when the reactance of the line is 1.732 times it's resistance. b- A 50 Hz generator is delivering 70% of the power that it is capable of delivering through a transmission line to an infinite bus. A fault occurs that increases the reactance between the generator and the infinite bus to 400% of the value before the fault. When the fault is isolated, the maximum power that can be delivered is 65% of the original maximum value. Determine the critical clearing angle for the condition described.	**20**	**CO4**
Q 11	A 50 MVA, 15 kV, 3-phase alternator has a sub-transient reactance of 25% and negative and zero sequence reactances of 25% and 15% respectively. The alternator supplies two motors over a transmission line having transformers at both ends as shown in figure 'A'. The motors have rated inputs of 30 MVA and 10 MVA both 7.5 kV with 20% sub-transient reactance and negative and zero sequence reactances are 20% and 15% respectively. Current limiting reactors of 5.0 ohms each are in the neutral of the alternator and the larger motor. The 3-phase transformers are both rated 40 MVA, 15 Δ / 150Y KV with leakage reactance of 10%. Series reactance of the line is 100 ohms. The zero sequence reactance of the line is 150 ohms. Determine the fault current when a line to line to ground fault takes place at point P.  Figure A	**20**	**CO3, CO4**

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SECTION A

S. No.		Marks	CO
Q 1	Derive the equation for converting the per unit impedance expressed in one base to another.	**4**	**CO1**
Q 2	A system has 150 buses of which 100 buses are load bus. Determine the number of generator buses.	**4**	**CO1,CO4**
Q 3	Define generator constraint in case of economical load dispatch.	**4**	**CO2**
Q 4	Derive the equation for converting unbalanced phasors in terms of symmetrical components.	**4**	**CO3**
Q 5	Define steady state stability and transient stability in case of power system.	**4**	**CO4**
	SECTION B		
Q 6	Explain clearly with a flow chart the computational procedure for load flow solution using Newton-Raphson method when the system contains all types of buses.	**10**	**CO1**
Q 7	The fuel inputs per hour of plants 1 and 2 are given as $F_1 = 0.25\ P^2_1 + 30\ P_1 + 150$ $F_2 = 0.25P^2_2 + 40\ P_2 + 120$ Determine the economic operating schedule and the corresponding cost of generation if the maximum and minimum loading on each unit is 100 MW and 25 MW, the demand is 180 MW, and transmission losses are neglected. If the load is equally shared by both the units, determine the saving obtained by loading the units as per equal incremental production cost.	**10**	**CO2**
Q 8	Draw the zero sequence network of transformer under the following cases of windings (Primary / Secondary) a- Delta / Star with grounded b- Star / Star c- Delta / Delta d- Star / Star with grounded e- Star with grounded / Star with grounded **OR** The line currents in a 3-phase supply to an unbalanced load are respectively $I_a = 10 + j20$, $I_b = 12 - j10$ and $I_c = -3 - j5$ amperes. The phase sequence is abc. Determine the sequence components of currents.	**10**	**CO3**
Q 9	A 50 Hz generating unit has H-constant of 2 MJ/MVA. The machine is initially operating in	**10**	**CO4**

	steady state at synchronous speed, and producing 1 pu of real power. The initial value of the rotor angle δ is 6º, when a bolted three phase to ground short circuit fault occurs at the terminal of the generator. Assuming the input mechanical power to remain at 1 pu, determine the value of δ in degrees, after 0.02 second of the fault.		
	SECTION-C		
Q 10	a- Explain the concept of infinite bus in a power system. Also show that per unit impedance of infinite bus is zero. b- A 50 Hz synchronous generator is connected to an infinite bus through a line. The p.u. reactances of generator and the line are *j*0.35p.u. and *j*0.5p.u. respectively. The generator no load voltage is 1.05 p.u. and that of infinite bus is 1.0 p.u. The inertia constant of the generator is 8 MW-sec/MVA. Determine the frequency of natural oscillations if the generator is loaded to (*i*) 40% and (*ii*) 90% of its maximum power transfer capacity and small perturbation in power is given. **OR** a- How the rating of circuit breaker is selected in power system network explain? b- A 50 Hz generator is delivering 80% of the power that it is capable of delivering through a transmission line to an infinite bus. A fault occurs that increases the reactance between the generator and the infinite bus to 600% of the value before the fault. When the fault is isolated, the maximum power that can be delivered is 55% of the original maximum value. Determine the critical clearing angle for the condition described.	**20**	**CO3,CO4**
Q 11	a- A small generating station has a busbar divided into three sections. Each section is connected to a tie-bar with reactors each rated at 5 MVA, 0.1 p.u. reactance. A generator of 8 MVA rating and 0.15 p.u. reactance is connected to each section of the busbar. Determine the short-circuit capacity of the breaker if a 3-phase fault takes place on one of the sections of busbar. b- Two generating stations having short circuit capacities of 1500 MVA and 1000 MVA respectively and operating at 11 kV are linked by an interconnected cable having a reactance of 0.6 ohm per phase, determine the short circuit capacity of each station.	**20**	**CO3,CO4**