Name: **Enrolment No:**	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2018

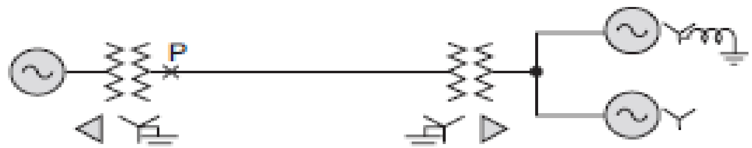
Course: Power System Analysis & Stability (PSEG 317) **Semester: VII**
Programme: B.Tech PSE **Max. Marks: 100**
No. of pages: 2 **Time: 03 hrs.**
Instructions: All questions are compulsory.

SECTION A

S. No.		**Marks**	**CO**
Q 1	In a 57 bus power system, there are 10 generators. In a particular iteration of Newton Raphson load flow technique (in polar coordinates), two of the PV buses are converted to PQ type. Determine the order of Jacobian matrices.	**5**	**CO1, CO4**
Q 2	Define incremental fuel rate and incremental efficiency in case of economic load dispatch problem of power system.	**5**	**CO2**
Q 3	Explain the significance of reactor in case of fault analysis in the power system.	**5**	**CO3**
Q 4	Define transient stability of the power system. Also, enumerate the factors affecting transient stability limit.	**5**	**CO4**

SECTION B

Q 5	A 3-bus power system network consists of 3 transmission lines. The bus admittance matrix of the uncompensated system is $\begin{bmatrix} -j6 & j3 & j4 \\ j3 & -j7 & j5 \\ j4 & j5 & -j8 \end{bmatrix}$ pu. If the shunt capacitance of all transmission line is 75% compensated then determine the new bus admittance matrics.	**10**	**CO1, CO4**
Q 6	Incremental fuel costs in Rs. per megawatt hour for two units in a plant are given by $dF/dP_1 = 0.1\ P1 + 20$ $dF/dP_2 = 0.12\ P2 + 16$ The minimum and maximum loads on each unit are to be 40 MW and 125 MW respectively. Determine the incremental fuel cost and the allocation of load between units for the minimum cost when loads is100 MW. Assume both the units are operating.	**10**	**CO2**
Q 7	A generating station having n section busbars each rated at Q kVA with x% reactance is connected on the tie-bars system through busbar reactances of b%. Determine the short-circuit kVA if a 3-phase fault takes place on one section. Determine the short-circuit kVA when n is very large. **OR** Explain Fortescue's theorem for three phase system. Also draw the zero sequence network of transformer under following cases: $\Delta / Y, Y / Y, \Delta / \Delta$.	**10**	**CO3**
Q 8	A three phase, 100 MVA, 25 kV generator has solidly grounded neutral. The positive,	**10**	**CO3**

	negative, and the zero sequence reactances of the generator are 0.2 pu, 0.2 pu, and 0.05 pu, respectively, at the machine base quantities. If a line to line fault occurs at the terminal of the unloaded generator, determine the fault current in amperes immediately after the fault. Also determine line to line voltages.		
SECTION-C			
Q 9	Analyze steady state stability of the power system by the linearization of swing equation. A 50 Hz generator is delivering 60% 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 300% of the value before the fault. When the fault is isolated, the maximum power that can be delivered is 80% of the original maximum value. Determine the critical clearing angle for the condition described. **OR** Derive the swing equation in power system dynamics. Determine the kinetic energy stored by a 50 MVA, 50 Hz two pole alternator with an inertia constant (*H*) of 5 kW sec. per KVA. If the machine is running steadily at synchronous speed with a shaft input (minus rotational losses) of 65000 HP when the electrical power developed suddenly changes from its normal value to a value of 40 MW, determine the acceleration or deceleration of the rotor. If the acceleration computed for the generator is constant for a period of 10 cycles, determine the change in torque angle in that period and the r.p.m. at the end of the 10 cycles.	**20**	**CO4**
Q 10	A 50 MVA, 25 kV, 3-phase alternator has a subtransient reactance of 10% and negative and zero sequence reactances of 10% and 5% 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 20 MVA and 10 MVA both 12.5 kV with 20% subtransient reactance and negative and zero sequence reactances are 20% and 5% respectively. Current limiting reactors of 2.0 ohms each are in the neutral of the alternator and the larger motor. The 3-phase transformers are both rated 50 MVA, 20 Δ / 120Y KV with leakage reactance of 10%. Series reactance of the line is 200 ohms. The zero sequence reactance of the line is 300 ohms. Determine the fault current when a single line to ground fault takes place at point *P*.  **Figure A**	**20**	**CO3**

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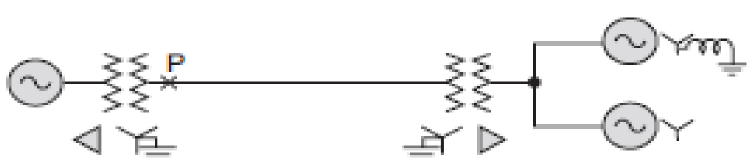
SECTION A

S. No.		Marks	CO
Q 1	What is load flow solution? Explain its significance in power system analysis.	5	CO1, CO4
Q 2	Define Running Spare Capacity Constraints in case of economic load dispatch problem of power system.	5	CO2
Q 3	Derive the expression of active power in terms of symmetrical components.	5	CO3
Q 4	Define steady state stability of the power system. Also enumerate the factors affecting steady state stability limit.	5	CO4

SECTION B

S. No.		Marks	CO
Q 5	For the Y-bus matrix of a 4-bus system given in per unit as shown below. Determine the shunt elements of the buses. $$\mathbf{Y}_{\mathbf{BUS}} = j\begin{bmatrix} -5 & 2 & 2.5 & 0 \\ 2 & -10 & 2.5 & 4 \\ 2.5 & 2.5 & -9 & 4 \\ 0 & 4 & 4 & -8 \end{bmatrix}$$	10	CO1,CO4
Q 6	A three phase, 100 MVA, 25 kV generator has solidly grounded neutral. The positive, negative, and the zero sequence reactances of the generator are 0.2 pu, 0.2 pu, and 0.05 pu, respectively, at the machine base quantities. If a bolted single phase to ground fault occurs at the terminal of the unloaded generator, determine the fault current in amperes immediately after the fault. Also, determine line-to-line voltages.	10	CO3
Q 7	A turbo-alternator with 4-pole, 50 Hz, 80 MW, p.f. 0.8 lag and moment of inertia 40,000 kgm^2 is inter-connected via a short transmission line to another alternator with 2-pole, 50 Hz, 100 MW, p.f. 0.8 lag and moment of inertia 10,000 kgm^2. Determine the inertia constant of the single equivalent machine on a base of 100 MVA. **OR** A generator operating at 50 Hz delivers 1 p.u. power to an infinite bus when a fault occurs which reduces the maximum power transferable to 0.4 p.u. whereas the maximum power transferable before the fault was 1.75 p.u. and is 1.25 p.u. after the fault is cleared. Determine the critical clearing angle.	10	CO4
Q 8	A 50 Hz generating unit has H-constant of 2 MJ/MVA. The machine is initially operating in steady state at synchronous speed, and producing 1 pu of real power. The initial value of the	10	CO4

	rotor angle δ is 5º, 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 9	The fuel inputs to two plants are given by $F_1 = 0.015\, P_1^2 + 16\, P_1 + 50$ $P2 = 0.025\, P_2^2 + 12\, P_2 + 30$ The loss coefficients of the system are given by $B_{11} = 0.005$, $B_{12} = -0.0012$ and $B_{22} = 0.002$. The load to be met is 200 MW, determine the economic operating schedule and the corresponding cost of generation if (*i*) the transmission line losses are coordinated, (*ii*) the losses are included but not coordinated. **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 10 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. 25 per megawatt hour and the incremental fuel costs are given by the equation $dF/dP_1 = 0.03\, P_1 + 17$ Rs./MWhr $dF/dP_2 = 0.06\, P_2 + 19$ Rs./MWhr	**20**	**CO2**
Q 10	A 50 MVA, 12.5 kV, 3-phase alternator has a subtransient reactance of 15% and negative and zero sequence reactances of 15% and 5% 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 25 MVA and 10 MVA both 7.5 kV with 10% subtransient reactance and negative and zero sequence reactances are 10% and 5% respectively. Current limiting reactors of 3.0 ohms each are in the neutral of the alternator and the larger motor. The 3-phase transformers are both rated 40 MVA, 15 Δ / 150*Y* 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**