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UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, May 2018

Program/course: B.Tech Electrical Engg. **Semester – VI**
Subject: Power System Analysis & Stability **Max. Marks : 100**
Code :PSEG 317 **Duration : 3 Hrs**
No. of page/s:2

SECTION A (20 MARKS)

Attempt all questions. Each question carries 5 marks.

Q1- [CO1] The reactance of a generator designated X " is given as 0.25 p.u. based on the generator's nameplate rating of 1.8 KV, 500 MVA. The base for calculations is 20 KV, 100 MVA. Find X" on the new base.

Q2- [CO2] Explain the significance of reactive power limit for a generator bus in case of load flow analysis.

Q3- [CO4] How the rating of circuit breaker is selected in power system network explain?

Q4- [CO1] Discuss Fortescue's theorem for analysis of unbalanced system.

SECTION B (40 MARKS)

Attempt all questions. Each question carries 10 marks.

Q5- [CO3] A two-bus system is shown in Figure A. If a load of 125 MW is transmitted from plant 1 to the load, a loss of 15.625 MW is incurred. Determine the generation schedule and the load demand if the cost of received power is Rs. 24/MWhr. Solve the problem using the penalty factor method approach. The incremental production costs of the plants are

$$dF_1/dP_1 = 0.025P_1 + 15$$

$$dF_2/dP_2 = 0.025P_2 + 20.$$

Figure A

Q6- [CO1] A 25 MVA, 13.2 kV alternator with solidly grounded neutral has a subtransient reactance of 0.25 p.u. The negative and zero sequence reactances are 0.35 and 0.1 p.u.respectively. A double line to ground fault occurs at the terminals of an unloaded alternator. Determine the fault current and the line-to-line voltages. Neglect resistance.

Q7- [CO4] 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 400% 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.

Q8- [CO2] Explain the flow chart of fast decoupled load flow method applied for load flow analysis.

SECTION C (40 MARKS)

Attempt both questions. Each question carries 20 marks.

Q9. (a)- [CO4] Derive the swing equation in power system dynamics. Also analyze steady state stability of the power system by the linearization of swing equation.

(b)- [CO4] A 50 Hz synchronous generator is connected to an infinite bus through a line. The p.u. reactances of generator and the line are $j0.3$ p.u. and $j0.2$ p.u. respectively. The generator no load voltage is 1.1 p.u. and that of infinite bus is 1.0 p.u. The inertia constant of the generator is 3 MW-sec/MVA. Determine the frequency of natural oscillations if the generator is loaded to 50% of its maximum power transfer capacity and small perturbation in power is given.

OR

A 50 Hz four-pole turbo-generator rated 20 MVA, 13.5 KV has an inertia constant of H = 9.0 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 25000 HP and the electric power developed is 15000 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.

Q10- [CO1] A 30 MVA, 13.8 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 B. 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 35 MVA, 13.2 Δ / 115Y kV with leakage reactance of 10%. Series reactance of the line is 80 ohms. The zero sequence reactance of the line is 200 ohms. Determine the fault current when a line to line fault takes place at point P.

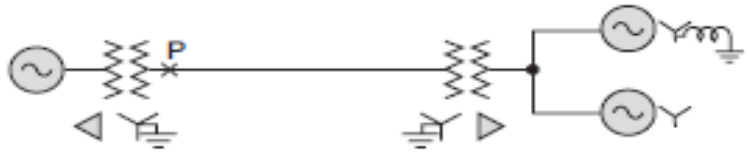

Figure B

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UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

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Program/course: B.Tech Electrical Engg **Semester – V**
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SECTION A (20 MARKS)

Attempt all questions. Each question carries 5 marks.

Q1- [CO1] Explain the significance of slack bus in a power system.
Q2- [CO2] Derive the relationship for base changing for a per unit impedance in terms of new base MVA and new base voltage (KV)
Q3- [CO4] Differentiate steady state stability and transient stability in case of power system.
Q4- [CO1] Explain the concept of infinite bus in a power system. Also show that per unit impedance of infinite bus is zero.

SECTION B (40 MARKS)

Attempt all questions. Each question carries 10 marks.

Q5- [CO1] A 50 MVA, 13.5 kV alternator with solidly grounded neutral has a subtransient reactance of 0.50 p.u. The negative and zero sequence reactances are 0.35 and 0.1 p.u. respectively. A single line to line fault occurs at the terminals of an unloaded alternator. Determine the fault current and the line-to-line voltages. Neglect resistance.

Q6- [CO3] The fuel inputs per hour of plants 1 and 2 are given as

$$F1 = 0.8\ P_1^2 + 60\ P1 + 160 \text{ Rs. per hr}$$
$$F2 = 0.6\ P_2^2 + 90\ P2 + 150 \text{ Rs. per hr}$$

Determine the economic operating schedule and the corresponding cost of generation if the maximum and minimum loading on each unit is 250 MW and 100 MW, the demand is 360 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.

Q7- [CO4] 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*0.5 p.u. and *j*0.4 p.u. respectively. The generator no load voltage is 1.09 p.u. and that of infinite bus is 1.0 p.u. The inertia constant of the generator is 6 MW-sec/MVA. Determine the frequency of natural oscillations if the generator is loaded to (a) 30% and (b) 60% of its maximum power transfer capacity and small perturbation in power is given.

Q8- [CO2] Explain the flow chart of Gauss Seidel load flow method applied for load flow analysis.

SECTION C (40 MARKS)

Attempt both questions. Each question carries 20 marks.

Q9- (a)- [CO4] Explain equal area criterion method applied in transient stability analysis of the power system.

(b)- [CO4]A 50 Hz generator is delivering 55% 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 70% of the original maximum value. Determine the critical clearing angle for the condition described.

OR

A 50 Hz four-pole turbo-generator rated 60 MVA, 15 kV has an inertia constant of H = 8 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 40000 HP and the electric power developed is 20000 kW. If the acceleration computed for the generator is constant for a period of 20 cycles, determine the change in torque angle in that period and the r.p.m. at the end of 20 cycles. Assume that the generator is synchronized with a large system and has no accelerating torque before the 10 cycle period begins.

Q10- [CO1] A 50 MVA, 13.2 kV, 3-phase alternator has a subtransient reactance of 20% and negative and zero sequence reactances of 20% 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 30 MVA and 10 MVA both 12.5 kV with 30% subtransient reactance and negative and zero sequence reactances are 30% and 5% respectively. Current limiting reactors of 4.0 ohms each are in the neutral of the alternator and the larger motor. The 3-phase transformers are both rated 40 MVA, 13.5 Δ / 120Y KV with leakage reactance of 15%. Series reactance of the line is 100 ohms. The zero sequence reactance of the line is 250 ohms. Determine the fault current when a single line to ground fault takes place at point P.

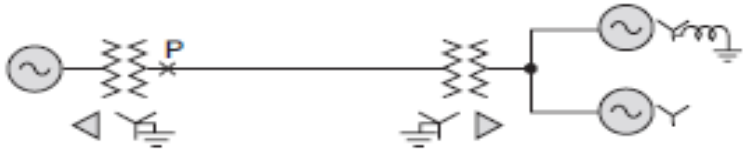

Figure A