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BSc. Engg. in EEE 7th Semester | Date: 03 October, 2023 (Afternoon)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid Semester Examination | **Winter Semester: 2022 – 2023**
Course Number: EEE 4731 | **Full Marks: 75**
Course Title: Power System III | **Time: 90 Minutes**

There are **3 (three)** questions. Answer **all** questions. The symbols have their usual meanings. Marks of each question and the corresponding CO and PO are written in brackets.

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1. a) Classify power system stability based on the balance between oppositely acting forces on the system under consideration. **05 (CO1, PO1)**

b) Consider the motion of the rotor of a synchronous generator working at an equilibrium state. If the load on the generator is suddenly changed, the equilibrium will be disturbed. With the help of swing equation, explain the impact of this change on i) rotor angular position, ii) rotor angular velocity, and iii) stored kinetic energy. **05 (CO1, PO1)**

c) A non-salient pole synchronous generator having terminal voltage (V_t) 1.02 p.u. is delivering 0.5 p.u. real power to a local load. The steady state stability limit of the generator is 2.5 p.u. and the synchronous reactance (X_s) is 0.6 p.u. Find out i) the value of rotor angle (δ) ii) the magnitude of the machine internal voltage (E) iii) the value of mechanical power (P_m) at equilibrium, and iv) the stability of the equilibrium operating point. **15 (CO2, PO2)**

2. a) Explain the reason behind unequal values of d-axis and q-axis reactance in a salient pole synchronous machine. **05 (CO2, PO1)**

b) Define reluctance power. Discuss why this will be available even when the machine excitation is reduced to zero. **05 (CO2, PO1)**

c) A salient pole synchronous machine is characterized by the following parameters: **15 (CO2, PO2)**

$$X_d = 1.1, \quad X_q = 0.8, \quad X_d^{/} = 0.35, \quad \text{and} \quad R_a = 0, \text{p.u.}$$

The machine is directly connected to an infinite bus of voltage 1.1 p.u. Determine the i) rotor angle, ii) voltage behind transient reactance, and iii) transient power angle equation. Sketch the power angle curve of the machine.

3. a) Write down the linearized swing equation without damping power. Discuss the impact of the polarity of synchronizing power coefficient on the small disturbance stability of the power system using s-plane plot. **07 (CO3, PO1)**

b) A 50-Hz synchronous generator have inertia constant H = 10 MJ/MVA, transient reactance $X_d^{/} = 0.45$ p.u. and damping power coefficient D = 0.2 p.u. The generator is connected to an infinite bus through a purely reactive circuit as shown in Figure 3(c). The generator is delivering real power of 0.75 p.u., 0.9 power factor lagging to the infinite bus at a voltage of V = 1.0 p.u. Consider a small disturbance of $\Delta\delta = 15^{\circ}$. Calculate: i) the synchronizing power coefficient, ii) the natural frequency of oscillation and damping ratio, and iii) the damped angular frequency of oscillation. Also, obtain equations describing the motion of the rotor angle and generator frequency.

18 (CO3, PO2)

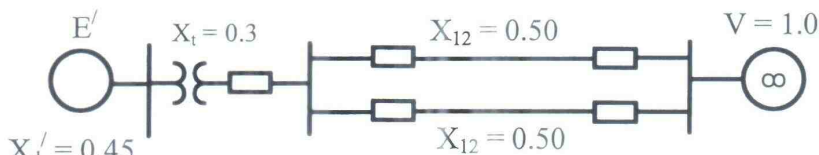

Figure 3(c)