B.Sc. in EEE, 6th Semester

(13)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid-Semester Examination
Course No.: EEE 4631
Course Title: Power System III

Summer Semester, A. Y. 2022-2023
Time: 90 Minutes
Full Marks: 75

There are 3 **(three)** questions. Answer all 3 **(three)** questions. The symbols have their usual meanings. Programmable calculators are not allowed. Marks of each question and corresponding COs and POs are written in the brackets.

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1. a) Figure 1 represents the cross-sectional view of a synchronous machine under loaded condition. i) Locate the various mmf axes by providing appropriate dot and cross signs as per your choice. ii) Locate and explain the concept of θ_m. iii) Calculate the corresponding electrical angle of θ_m. iv) Sketch the corresponding phasor diagram considering zero armature resistance. **15 (CO1, PO1)**

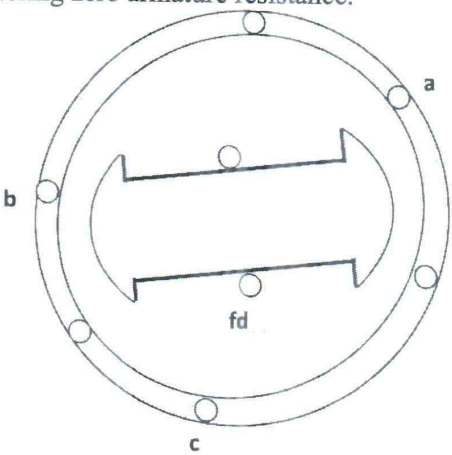

Figure 1

b) Explain the necessity of representing the rotor position with respect to a rotating reference frame with a neat diagram. **5 (CO1, PO1)**

c) Mention the range of rotor angle for generation mode of operation. Justify your answer. **5 (CO2, PO2)**

2. a) The fuel-cost functions for two thermal plants in Tk./h are given by **18 (CO3, PO2)**

$$C_1(P_1) = 561 + 7.92P_1 + 0.001562P_1^2$$

$$C_2(P_2) = 310 + 7.85P_2 + 0.00194P_2^2$$

and the line loss is represented as $P_{loss} = 0.00003P_1^2 + 0.00009P_2^2$ where P_1 and P_2 are in kW. The total demand is 850 kW. Neglecting the generator limits, find the optimal dispatch and the total power loss. (Maximum three iterations).

b) The swing equation is given by $\frac{d^2\delta}{dt^2} = \frac{\omega_s}{2H}\left(P_m - P_{\max}\sin\delta\right)$. Derive the linearized swing equation without incorporating the damping power. **7 (CO1, PO1)**

3. Assume the rotor position, of the system shown in Figure 3, with respect to a stationary frame of reference after 1 second is 55 radians. The angular velocity of a synchronously rotating reference frame is α rpm. A 50 Hz two pole synchronous generator having inertia constant H=9.94 MJ/MVA is connected to an infinite bus through a purely reactive circuit as shown in Figure 3. Reactances are marked on the diagram on a common system base. Assume per unit damping power coefficient is equal to β. Find the values of a) damping ratio, b) natural frequency of oscillation and c) determine the stability of the system by calculating the roots of the system when **25 (CO2, PO2)**

i. $\alpha = 500$ rpm, $\beta = 0.14$

ii. $\alpha = 520$ rpm, $\beta = 0.14$

iii. $\alpha = 520$ rpm, $\beta = -0.14$

[NB: Formula for converting RPM to radian is given by $\omega_{(rad/s)} = \frac{2\pi \times RPM}{60}$]

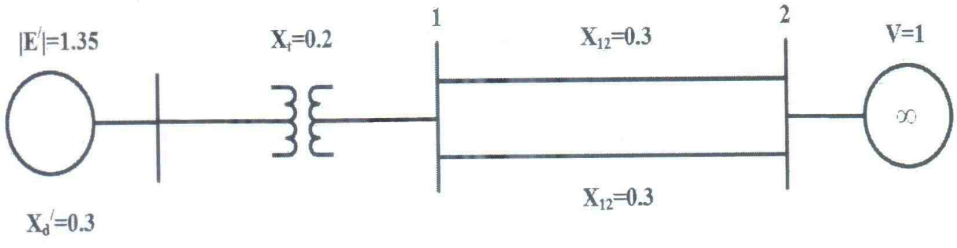

Figure 3