Ref. No.: Ex/EE/PE/B/T/421E/2024(S)

B.E. ELECTRICAL ENGINEERING
FOURTH YEAR
SECOND SEMESTER
SUPPLEMENTARY EXAM 2024

ADVANCED TOPICS IN POWER SYSTEMS

Time : Three hours

Full marks-100, marks in each part-50
(Use separate Answer script for each Part)
Part I

Answer any three questions

Two marks reserved for well organized answers

1. Discuss the role of an energy control centers in the operation of a present day Power system. With the help of a schematic diagram show the major facilities of an energy control center. Also name the important data received. (4+8+4 = 16)

2. Why Load flows are not considered to be suitable for performing the contingency analysis. Explain how linear sensitivity factors may be used for performing such analysis. (5+11 = 16)

3. Explain the importance of State estimation in power system. Derive the relevant expression for the weighted least square state estimation of power system. (5+11 = 16)

4. Establish the relationship between the harmonic order and phase sequence of power system quantities. How the induction motors may be modelled for harmonic analysis? (8+8 = 16)

5. i) Discuss the effect of supply harmonics on capacitors used for power factor correction.

   ii) Highlight the advantages of digital relaying over their conventional counterparts. (8+8 = 16)

[Turn over

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B. E. ELECTRICAL ENGG. 4th YEAR 2ND SEMESTER SUPPLEMENTARY EXAMINATION 2024

ADVANCED TOPICS IN POWER SYSTEM

Time: Three hours Full Marks 100 (50 marks for each part)

Use a separate Answer-Script for each part

Part II

Answer any two questions

1(a). A 12-pulse converter fed from a 230 kV, 50 Hz bus through a 220 kV/ 110 kV transformer, is drawing 500 MW from the a.c. bus at a p.f. of 0.85. If the effective commutating reactance is 5.9 ohm/ phase then calculate the value of the ignition delay angle and the commutation overlap angle with which the converter is operating. The transformer is operating at nominal turns ratio. Derive all the formulae used to solve the problem. 17

(b). Mentioning the proper reasons explain briefly how suitable operating characteristics are chosen for rectifier and inverter of an HVDC link. 8

2(a). Derive an expression for the voltage magnitude at the mid-point of a lossless transmission line when the voltage magnitudes at the two ends of the line are held equal and constant. 8

(b). Explain how an FC-TCR type SVC can maintain the voltage of a power system bus. Also discuss how the control range of an SVC with a given inductor can be enhanced with switched capacitors. 9

(c). A 3-phase, 50 Hz, 400KV, 900 km long line is operating with the voltage magnitudes at both ends maintained at 1.0 p.u. (at 400 KV base). An SVC with slope reactance X_{sl}=0.05 p.u.(at 300 ohm base) is connected at the midpoint of the line with its reference voltage set at 0.985 p.u. If the SVC operates at its capacitive limit when the line loading corresponds to δ=90° then calculate the capacitive susceptance of the SVC. Given: Z_c = 300 ohms, $\beta = 0.06^0$/km (the symbols have their usual significance). 8

3(a). Explain clearly how a TCR acts as a variable susceptance. 8

(b) For a lossless transmission line with the voltages at the two ends held equal and constant, with necessary derivation show the effect of SVC on the line power flow when the midpoint voltage of the line is regulated with the help of an SVC. 9

(c) With the loading of a lossless transmission line varying, plot the variation of reactive powers at the two ends of a lossless line to keep the voltages at the two ends equal and constant. Explain the nature of variation with necessary derivation. 8