Ref. No.: Ex/EE/PE/B/T/421E/2023

B.E. ELECTRICAL ENGINEERING
FOURTH YEAR SECOND SEMESTER EXAM 2023

ADVANCED TOPICS IN POWER SYSTEMS

Time : Three hours Full Marks : 100

(50 Marks for each Part)
Use separate answer script for each Part

PART I (50 Marks)

Answer all the three questions

1. Answer any two of the following questions: CO-6
   a) i)Discuss the importance of Energy Control Centres in the operation of present day Power Systems. (4)
   (ii)Identify the online and offline functions performed in an Energy control centres. (4)
   iii)What type of data are generally collected at the Energy control centres? (4)

   b) (i)Mention the practices to be followed to ensure secure operation of power system.(3)

   (ii)Why AC load flow can not be used for contingency analysis ? (4)
   (iii)How active power contingencies may be ranked? (5)

   © (i)How State estimation is different from load flow? (4)

   (ii)Identify the data which are needed for both Load flow and State estimation. Also identify the data not used in load flow but used in State estimation. (4)
   (iii) Why state estimation in power system requires iterative solution? (4)

2. Answer any two of the following questions: CO-5
   i) Show that harmonics in the power supply may be related with phase sequence. How this relation may be utilized in deriving the harmonic model of Induction motor? (5+4)
   iii) How the presence of Power factor correcting capacitors may form resonances in a distribution system having distorted power supply? A 3-phase 13.8 kV, 5 MVA capacitor bank causes a bus voltage rise of 400 V when switched to a bus. Determine the harmonic order at which resonance would take place. (5+4)
   iv)Identify the data needed for the harmonic analysis of power system. How the required data may be obtained for a Power Grid? (4+5)

3. Answer any one of the following questions CO-1
   i) Explain how digital relays may be considered to be flexible, adaptable and having self-checking as well as mathematical capability. (8)
   ii)How transmission line model may be utilized in the development of a digital distance relay? Comment on the possible errors of this relay. (8)

[Turn over

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B. E. ELECTRICAL ENGG. 4th YEAR 2ND SEMESTER EXAM 2023

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 (50 Marks)

1(a) A 6-pulse converter is supplied with a balanced 3-phase sinusoidal voltage. If the converter operates with an ignition delay angle α and a commutation overlap angle μ, then show that the d.c. current delivered by the converter is given approximately by $I_d = (\pi/\sqrt{6})I$ where, I is the RMS value of the fundamental component of line current delivered by the a.c. source. Also derive the expression for the fundamental power factor in terms of α and μ. 20

(b) With necessary diagram show how two 6-pulse converter can be connected to form a 12-pulse converter. 5

OR

1(a) Showing the necessary operating characteristics explain briefly the principle of control of the converters in an HVDC link. Discuss how reversal of roles of the converters are achieved, and also explain the importance of current margin in this context. 15

(b) A 12-pulse converter, fed from a 230 kV bus through two 220/110 kV transformers both operating at nominal turns ratio , is drawing a fundamental R.M.S. line current of 1.56 kA and a total 3-phase reactive power of 300 MVAr from the h.t. bus. Calculate the values of the delay angle, the overlap angle, and the equivalent commutation resistance of the converter. Derivation of formulae is not necessary. 10

2(a) For a lossless transmission line with the voltages at the two ends held equal and constant, derive an expression for the mid-point voltage. Explain how the steady state power transfer capacity is enhanced by midpoint shunt compensation. Also show that uniformly distributed shunt compensation results in infinite steady state power transfer limit. 10

(b) 'A TCR acts as a variable susceptance'- explain clearly. 7

(c) A 900 km long, 50 Hz, lossless transmission line having $\beta = 0.05°$/km is operating with $V_S = V_R = 1.0$ p.u. If an SVC having $X_{SL} = 0.05$ p.u. (with Z_c as base) is connected at the mid-point of the above line with its reference voltage set at 1.0 p.u. then find V_m at operating $\delta = 90°$. Also calculate the current drawn by the SVC and comment on its nature. Assume that the SVC is operating within its control range. What is the value of susceptance at this condition ? Derivation of formulae is not required. The symbols have their usual meaning. 8

OR

2(a) Explain how an SVC can maintain the voltage of a power system bus. Also discuss how the operating range of an SVC can be extended with the application of switched capacitors. 9

(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 is regulated with the help of an SVC. 10

(c) With necessary derivation, plot the variation of reactive powers at the two ends of a lossless line so that the voltages at the two ends can be held equal and constant with varying line load. 6