Ref.: EX/EE/T/422E/2018

B. ELE. ENGG. 4TH YEAR 2ND SEMESTER EXAMINATION 2018

ADVANCED TOPICS IN POWER SYSTEM

Time: Three hours Full Marks: 100

(50 marks for each part)
Use separate answer script for each part.
PART I
Answer **any three** questions.
Figures in the margin indicate full marks
Two marks reserved for well organized answers

1.(a) Discuss the importance of Energy Control Centres in the operation and control of Power System. (4)

(b) Show the computer configuration of an Energy Control Centre. (8)

(c) Indicate the data generally collected at the Energy Control Centre. (4)

2.(a) Explain the importance of State Estimation in Power System. How is State Estimation different from load flow? (3+3)

(b) Without going into the details of mathematical derivations, explain the method of linear sensitivity factors for contingency analysis in Power System. (10)

3.(a) Discuss the steps involved in harmonic analysis of Power System. (4)

(b) How the following components can be modeled for harmonic analysis? (6+6)

(i) High Voltage Grid (ii) Induction Motor

4.(a) Explain, how the power factor correcting capacitors may cause resonance problem in Power System in presence of harmonics distortions. (10)

(b) A three phase, 13.8 kV, 5MVA 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. (6)

5.(a) Why harmonic distortion is a problem at the distribution voltage level? Identify five sources of harmonics in Power System. (4+4)

(b) Mention the special features of digital relaying that are not available in their conventional counterparts. (8)

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B. E. ELECTRICAL ENGG. 4TH YEAR 2ND SEMESTER EXAMINATION 2018

ADVANCED TOPICS IN POWER SYSTEMS

Time: Three hours | Full Marks: 100

(50 marks for each part)
Use separate answer script for each part.
PART II
Answer **any two** questions.
Figures in the margin indicate full marks

1.(a) A balanced 3-phase source having line to line voltage E_{LL} is supplying a 6-pulse converter through a transformer having turns ratio T:1 with the secondary side connected to the converter. If the converter operates with no ignition delay and no commutation overlap, then, with necessary derivation, show (i) how the r.m.s. value of the fundamental a.c. current drawn from the source is related to the d.c. current delivered by the converter (ii) how the average d.c. voltage is affected when a delay angle α is introduced. (6+6)

(b) Explain how an SVC can maintain the voltage of a power system bus. (7)

(c) 'A TCR acts as a variable susceptance'- explain clearly. (6)

2.(a) Deduce an expression for the voltage drop due to commutation overlap in a 6-pulse converter operating with a delay angle α and overlap angle μ. Also derive the expression for the fundamental power factor at such operating condition. (10+3)

(b) Derive an expression for voltage magnitude at the mid-point of a lossless line when the voltage magnitudes at the two ends are held equal and constant. (6+6)
If the midpoint voltage is regulated with the help of an SVC, then deduce the expression for the line power flow to show the effect of SVC on it.

3.(a) 'Under normal operating condition of an HVDC link, the rectifier side controls the current through the link while the inverter side is responsible for controlling the link voltage'- explain clearly. (10)

(b) A 12-pulse converter, fed from a 230KV bus through a 220/110 kV transformer, is delivering 515 MW at a d.c. voltage of 257.5 kV. If the equivalent commutating resistance of the converter is 11.3 ohm then calculate the firing angle and the overlap angle. Also calculate the r.m.s. value of the fundamental current and the reactive power drawn from the 230KV bus. The transformer is operating at nominal turns ratio. (8)

(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 0.98 p.u. If the SVC operates at its capacitive limit when the line loading corresponds to $\delta=90°$ then calculate the capacitive susceptance of the SVC. Also calculate the increase in the amount of power transfer achieved by connecting the SVC. Given: Z_c = 300 ohms, $\beta = 0.06^0$/km (the symbols having their usual significance). (7)