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

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

ADVANCED TOPICS IN POWER SYSTEMS

Full marks-100, marks in each part-50

Part I

Group A

Answer any two questions

1. Give a brief outline of the infrastructural facilities needed in an energy control centre. Mention the online and offline functions and data collected. (6+2+2=10)
2. Why redundant measurements are needed for state estimation? Explain how iterative process may be employed for State estimation of Power System. (3+7=10)
3. Why approximate analysis is preferred for contingency analysis? Explain how active power contingencies may be ranked. Why the ranking method followed for active power contingency is not applicable to reactive power contingency ranking? (3+4+3=10)

Group B

Answer any two questions

4. Discuss the process to be followed for harmonic analysis of power system. How the high voltage grid may be modelled? (5+5=10)
5. Discuss the effect of supply harmonics on (a) transformer and (b) Shunt capacitors installed for power factor correction. (5+5=10)
6. Why harmonics problem is a concern at distribution level only? Why weak systems are more affected by system harmonics? Why power factor correcting capacitors should preferably be connected with the help of a short length cable? (4+3+3=10)

Group C

7. Explain an algorithm for digital protection of transmission line and highlight its shortcomings. (6+4=10)

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

ADVANCED TOPICS IN POWER SYSTEM

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

Use separate answer script for each part

Part II

1(a) A 6-pulse converter is supplied from a balanced 3-phase sinusoidal voltage source. If the converter operates as a rectifier with an ignition delay angle α and an extinction angle δ, then derive an expression for the output d.c. voltage in terms of α and δ. 18

(b) With necessary diagram show how two 6-pulse converters can be properly connected to form a 12-pulse converter. What is the advantage of 12-pulse converter over 6-pulse converter? 7

OR

1(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. Discuss how reversal of operating modes 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 230KV bus through a 220/110KV transformer, is delivering 515 MW at a d.c. voltage of 257.5KV. 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. Derivation of formula is not required. 10

2(a) Explain how an SVC can maintain the voltage of a power system bus to which it is connected. 9

(b)Explain clearly how a TCR can act as a variable susceptance. 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 δ=90° then calculate the capacitive susceptance of the SVC. Given: Z_c=300 ohms, β=0.06^0/km (the symbols have their usual significance). 8

OR

2(a) For a lossless transmission line derive an expression for the mid-point voltage when the voltages at

the two ends are held equal and constant. 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) If the voltages at the two ends of a lossless transmission line are held constant at equal magnitudes then show, with necessary derivation, the effect of SVC on the line power flow when the midpoint voltage is regulated with the help of an SVC. 8

(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. 7