Ref.: EX/EE/T/422E/2019

B. E. ELECTRICAL ENGG. 4TH YEAR 2nd SEMESTER EXAMINATION 2019

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
Figures in the margin indicate full marks

1. Answer any two questions from (a), (b) and (c) 12 X 2=24

(a) Discuss the infrastructural facilities available in Energy control centres. Indicate the online and offline functions of Energy control centres.

(b).Explain the necessity of security monitoring in power system. How ranking method is useful in security monitoring? Discuss the method used for active power contingency ranking.

© Derive expression for weighted least squared state estimation. How the method is applied for state estimation of Power System?

2. Answer any two questions from (a), (b) and (c) 9 X2=18

(a)Show that negative and zero sequence components may exist in a symmetrical supply system when the waveforms are distorted.

(b)Discuss the effects of supply harmonics on transformers.

© Explain, how a power grid may be modeled for harmonic analysis on the basis of short circuit equivalent.

3. Answer one question out of (a) and (b) 8

(a) Discuss the basic components of a digital protection scheme.

(b) Discuss an algorithm useful for distance protection. Mention the benefits and shortcomings of the algorithm.

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PART II
Answer **all** questions.
Figures in the margin indicate full marks

1.(a) A 6-pulse converter, operating as a rectifier, is being supplied from a balanced 3-ϕ sinusoidal voltage source and operating with a delay angle α and an overlap angle μ. Deduce an expression for the voltage drop due to commutation overlap as well as the dc output voltage. Also derive the relation between the r.m.s value of fundamental a.c. current drawn by the converter with the d.c. current delivered by it. (12)

Or,

With proper explanation discuss the different contrl modes and related operating characteristics of the converters in an HVDC link for proper operation of the link.

(b) A 12-pulse converter fed from a 3-phase, 220 kV, 50 Hz bus through a transformer with a nomial voltage rating of 220 kV/110 kV, is drawing 500 MW from the bus at a fundamental power factor of 0.85 (lag). If the delay angle is 15^0, calculate the value of d.c. current and equivalent commutating reactance per phase. (8)

2.(a) Show that a TCR can behave as a variable susceptance. (7)

Or,

A loss-less transmission line is operating with the voltages at the two ends held equal and constant. With necessary derivation show the variation of reactive power at the two ends with increasing loading of the line.

(b) Explain clearly how an FC-TCR type SVC maintains the voltage of a power system bus. (8)

3. A 3-phase, 50 Hz, 400 kV, 800 km long transmission line having parameter value $Z_c = 300\Omega$ and $\beta = 0.07^0$ / km (the symbols have their usual significance) is operating with $V_S = V_R = 1.0$ p.u. and transferring a power of 1.04 p.u. With necessary derivation calculate the midpoint voltage. If an SVC with a slope reactance 0.05 p.u. is connected at the midpoint of the line with its reference voltage set at 0.98 p.u. then calculate the power transferred at a load angle of 90^0 and the corresponding value of the SVC susceptance. Also calculate the amount of increase in power transfer achieved at the load angle of 90^0 due to the connection of SVC. (15)