Ref No: EX/EE/T/423E/2017

BACHELOR OF ELECTRICAL ENGINEERING EXAMINATION, 2017

4th year, 2nd Semester (Old)

SUBJECT: - ADVANCED TOPICS IN POWER SYSTEM

Full Marks: 100

Time: Three hours (**50** marks for this part)

Use a separate Answer-Script for each part

		PART - I Answer any Three Questions (Two marks reserved for well organized answers)	**Marks**
1)	a)	Discuss the role of Energy Control Centre in the operation and control of Power Systems.	(4)
	b)	Name the functions generally performed in an Energy Control Centre. Also mention the time frame of the execution of these functions.	(3 + 3)
	c)	In what ways digital relaying may be considered to be superior to the conventional relaying techniques?	(6)
			(3)
2)	a)	Derive expression for the static State estimation of linear systems on the basis of minimization of the sum of the weighted square of errors.	(8)
	b)	Using the above derivation, develop an expression for the state estimation of power system.	(8)
3)	a)	Give a brief outline of the steps to be followed for security monitoring of power system.	(4)
	b)	Why is AC load flow generally not suitable for contingency analysis?	(4)
	c)	How the method based on contingency ranking may be used for contingency analysis?	(8)
4)	a)	With the help of suitable expressions, establish the relation between Phase Sequence and harmonics in Power System.	
	b)	A 3-phase, 50 Hz, 11 kV, 2.5 MW, 2970 rpm, 2-pole induction motor has the following data:	(8)
		$R_s = 0.2\ \Omega$, $X_s = 3.2\ \Omega$, $R_r' = 0.3\ \Omega$, $X_r' = 5.1\ \Omega$, $R_m = 6500\ \Omega$, and $X_m = 155\Omega$, where the symbols have their usual meanings.	(8)
		Calculate the impedances for 7^{th} and 11^{th} harmonic models of the motor.	
5)	a)	Discuss the effects of harmonics on the following: (i) Transformer (ii) Capacitor	(8)
	b)	Give a brief account of the sources of harmonics in power system.	(6)

[Turn over

Ref.: EX/EE/T/423E/2017

B. E. ELECTRICAL ENGG. 4TH YEAR 2ND SEMESTER (OLD) EXAMINATION 2017

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 six pulse converter supplied from a 3-phase sinusoidal voltage source is operating with no firing delay and no commutation overlap. With a neat sketch show the d.c. output voltage waveform alongwith the 3-phase a.c. input voltage waveform when no smoothing reactor is present at the output. Also show the conduction periods of the thyristors and the a.c. current waveform of any one of the phases. (8+3+3=14)

Deduce an expression for the steady d.c. output voltage of the converter in terms of a.c. input voltage with the converter operating at the above condition.

Also establish a relation between the d.c. current and RMS value of the fundamental a.c. current.

(b) Deduce an expression for the steady d.c. output voltage when the converter mentioned in question 1(a) is operating with firing angle α and a commutation overlap angle of μ. Also derive an expression for the fundamental a.c. power factor. (7+4=11)

2.(a) With necessary diagram show how two 6-pulse converters can be used to derive a 12-pulse converter. What will be the effect of this connection on the expressions of the output d.c. voltage, d.c. current, voltage drop due to commutation overlap and the a.c. input current? (5)

(b) A 12-pulse converter is fed from a 230kV bus through a transformer having nominal voltage rating of 220/110kV. Calculate the effective turns-ratio required to develop a d.c. voltage of 300kV with a delay angle of 18^0 and an overlap angle of 15^0. If the d.c. power delivered by the converter is 550MW then calculate the fundamental a.c. current and power factor at the H.T. side of the transformer. (8)

(c) Explain clearly why rectifier side of an HVDC link should have a combined CIA and CC characteristics whereas the inverter side is required to have a combined CEA and CC characteristics for proper operation of the link. How can the power flow through the link be reversed? (12)

3.(a) The voltages at the two ends of a loss-less line are equal and constant. With derivation of the required expressions show the variation of the reactive power at the two ends of the line with the line loading, and clearly explain the nature of variation. (13)

(b) Derive the expressions for the midpoint voltage and current for the line mentioned in question 3(a). If the midpoint voltage is maintained at a value equal to that of the end voltages then show how power transfer capacity is increased. (12)

4.(a) Explain why a TCR can act as a variable susceptance. Discuss how an FC-TCR type SVC maintains the voltage of a power system bus to which it is connected. Also explain how the control range of an SVC with a given range of inductor can be enhanced with the help of switched capacitors. (15)

(b) A 3-phase, 50Hz, 400kV, 800km long loss-less line with $Z_c = 350\ \Omega$ and $\beta = 0.07^0$ / km is operating with $V_S = V_R = 1$ p.u.. If an SVC with a slope reactance of 0.05 p.u. is connected at the midpoint with $V_{ref} = 0.985$ p.u. calculate the midpoint voltage and the current drawn by the SVC when the loading corresponds to (i) $\delta = 30^0$,(ii) $\delta = 60^0$ (iii) $\delta = 90^0$. (10)
Symbols have their usual significance.