

	Ref: Ex/EE/PE/B/T/421E/2025 B.E. ELECTRICAL ENGINEERING FOURTH YEAR SECOND SEMESTER EXAM 2025 SUBJECT: 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 Answer any Three (Two marks reserved for well-organised answers)	
1.	Briefly explain the contingency analysis procedure. Why is AC load flow generally not used for contingency analysis? In this regard, define the generation shift factor and line outage distribution factors. Explain how these factors are used in contingency analysis.	(16)
2.	Discuss the importance of energy control centres in the operation of the present day power systems. Describe the computing and related facilities required in an energy control centre.	(16)
3.	Differentiate between state estimation and load flow. With the help of a complete flowchart, explain the Weighted Least Square Estimation (WLSE) for power system state estimation.	(16)
4.	Give a brief account of the sources of harmonics in a power system. Discuss the steps to be followed for harmonic analysis.	(16)
5.	Discuss the basic components of a digital protection scheme. In what ways can digital relaying be considered to be superior to conventional relaying techniques?	(16)

[Turn over

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B. E. ELECTRICAL ENGG. 4th YEAR 2ND SEMESTER EXAM 2025

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

Answer any two questions. All symbols used have their usual meaning.

1(a). A 6-pulse converter is being fed from a 3-ph a.c. bus of a power system through a transformer with an effective turns ratio 1:T. If E_{LL} is the line to line voltage of the bus then deduce an expression for the ideal no load d.c. output voltage V_{d0} of the converter in terms of E_{LL} and T. If it is given that the d.c. output voltage V_d of the converter is given by $V_{d0} (\cos\alpha + \cos\delta)/2$ when the converter is operating with a delay angle α and extinction angle δ then derive an expression for the fundamental power factor at which the power is drawn from the a.c. bus. 17

(b) A 12-pulse converter, fed from a 230 kV bus through two 220/110KV 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. If the equivalent commutating resistance of each converter is 5.65 ohms then calculate the values of the delay angle and the overlap angle of the converter. Derivation of formulae (if you use any) is not necessary. 8

2.(a) Explain briefly the operating characteristics required for the two converters of an HVDC link for proper control of the link. Discuss how reversal of power flow through the link is achieved. Also explain the importance of current margin in this context. 15

(b) For a loss less transmission line operating with $P_R < P_0$, which of the following conditions is to be satisfied to maintain $V_S = V_R$? Justify your answer with necessary derivation. 5

i) $Q_R > 0$ and $Q_S < 0$ ii) $Q_R < 0$ and $Q_S > 0$ iii) both > 0 iv) both < 0 v) both $= 0$

(c) 'The midpoint voltage of a loss less transmission line will be less than V when operating with $V_S = V_R = V$ and $P_R > P_0$ '. ---- With proper explanation and necessary derivation mention whether the statement is correct or incorrect. 5

3.(a) Explain how an FC-TCR type SVC can maintain the voltage of a power system bus. Also discuss how its operating range can be extended with the help of switched capacitors. 10

(b) A 3-phase, 50 Hz, 400KV, 900 km long loss-less 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 $X_{sl} = 0.025$ p.u. (at 300 ohm base) is connected at the midpoint of the line with its reference voltage set at 0.99 p.u. If the SVC operates at its capacitive limit when the line loading corresponds to $\delta = 90^\circ$ then calculate the value of the capacitance used in the SVC. Given: $Z_c = 300$ ohms, $\beta = 0.06^\circ/\text{km}$. 8

(c) Explain clearly how a TCR can act as a variable susceptance'. 7