ADVANCED POWER SYSTEM
(ELEC 4131)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) The unit of incremental transmission loss is
(a) MW^{-1} (b) MW (c) Unit less (d) Rs/MWh

(ii) What will be the penalty factor for a unit, if the generating station is located very close to load centre?
(a) 0 (b) 0.5 (c) 1 (d) 2

(iii) To determine the units that should operate for a particular load is the problem of
(a) unit commitment (b) optimal load scheduling
(c) economic load dispatch (d) optimal power flow

(iv) In an HVDC system
(a) both generation and distribution are dc
(b) generation is ac and distribution is dc
(c) generation is dc and distribution is ac
(d) both generation and distribution are ac

(v) Lightning arrester should be located
(a) near the circuit breaker (b) away from the circuit breaker
(c) near the transformer (d) away from the transformer

(vi) The reflection coefficient of a short-circuited line is
(a) -1 (b) +1 (c) 0.5 (d) 0

(vii) Which of the following is the primary purpose of installing capacitor banks in a power system?
(a) Minimize voltage fluctuations (b) Maintain a constant frequency
(c) Improve the power factor (d) Reduce the transmission line losses

(viii) What happens to the system frequency if the load demand exceeds the generation in an isolated power system?
(a) Frequency increases (b) Frequency decreases
(c) Frequency remains constant (d) Frequency fluctuates randomly

(ix) Full load compensation in a line requires
(a) shunt capacitors (b) series capacitors
(c) transformer (d) shunt reactor

(x) In Ferranti Effect the receiving end voltage
(a) Increases (b) Decreases
(c) Remains same (d) None of these

Fill in the blanks with the correct word

(xi) The unit of incremental fuel cost is _____.

(xii) The minimum value of penalty factor is _____.

(xiii) For economic load dispatch the generators of a power plant operate at equal ____.

(xiv) The converters and rectifiers are installed in the same station in case of _____ station.

(xv) HVDC Homo polar links uses conductors of usually _____ polarity.

Group - B

2. (a) Show that when a number of generating units are operating in parallel and supplying power into a transmission network, the most economic scheduling of loads, neglecting transmission losses, is obtained when their incremental costs of received power are equal. *[(CO1)(Apply/IOCQ)]*

(b) For a simple two unit system, the loss coefficients are: $B_{11} = 0.001\ MW^{-1}$, $B_{12} = -0.0005\ MW^{-1}$, $B_{22} = 0.0024\ MW^{-1}$. The incremental fuel costs of the two units are:

$\frac{dC_1}{dP_1} = 0.08P_1 + 16$ Rs/ MWh

$\frac{dC_2}{dP_2} = 0.08P_2 + 12$ Rs/ MWh

Find the generations P_1 and P_2 for $\lambda = 20$. Also compute the transmission loss, received power and efficiency of the transmission system. *[(CO1)(Evaluate/HOCQ)]*

5 + (3 + 2 + 1 + 1) = 12

3. (a) Develop 'Transmission Loss Coefficients'. *[(CO1)(Apply/IOCQ)]*

(b) Two units have the following cost curves:

$C_1 = 0.05P_{G1}^2 + 22P_{G1} + 120$ Rs/hr

$C_2 = 0.06P_{G2}^2 + 16P_{G2} + 120$ Rs/hr

Where PG is in MW. The limits of all the plants are as follows:

20 MW≤ PG≤ 100 MW

Determine how will a load of (a) 80 MW and (b) 120 MW and (c) 200MW be shared? *[(CO1)(Apply/IOCQ)]*

6 + 6 = 12

Group - C

4. (a) What do you mean by breakeven distance? With the help of breakeven distance explain when the HVDC transmission will be more economical than the HVAC transmission. *[(CO2)(Remember/LOCQ)]*
   (b) What is MTDC system? Mention the advantages and application of MTDC system. *[(CO2)(Remember/LOCQ)]*
   (c) Write short notes on harmonic filters. *[(CO2)(Remember/LOCQ)]*

3 + 6 + 3 = 12

5. (a) Compare the merits and demerits of HVDC transmission over EHV-AC transmission. *[(CO2)(Remember/LOCQ)]*
   (b) Give short notes on back to back HVDC system. *[(CO2)(Apply/IOCQ)]*
   (c) Discuss the problems of DC circuit breaking. *[(CO2)(Apply/IOCQ)]*

4 + 4 + 4 = 12

Group - D

6. (a) Sketch the block diagram representation of ALFC. *[(CO4)(Apply/IOCQ)]*
   (b) Modify ALFC to obtain the block diagram representation of AGC. *[(CO4)(Create/HOCQ)]*
   (c) What is the purpose of AGC? *[(CO4)(Remember/LOCQ)]*
   (d) A 200 MVA synchronous generator has a regulation of 4% and the no load operating frequency is 50 Hz. The load on the generator is suddenly reduced by 30 MW. Due to time lag in the governor system, the steam valve begins to close after 0.5 second. Determine the change in frequency during this time. Inertia constant of the generator is 5 MWs/MVA. *[(CO4)(Evaluate/HOCQ)]*
   (e) Define composite load. *[(CO4)(Remember/IOCQ)]*

2 + 2 + 2 + 4 + 2 = 12

7. (a) Prove that in case of two generators connected in parallel their output is shared in the inverse ratio of their speed regulation. *[(CO4)(Evaluate/HOCQ)]*
   (b) Sketch the block diagram representation of AVR. *[(CO4)(Remember/LOCQ)]*
   (c) What are the types of Exciters of an alternator? *[(CO4)(Remember/LOCQ)]*
   (d) Why do the AVR loop and ALFC loop work independently? *[(CO4)(Understand/LOCQ)]*
   (e) Two generators rated 200 MW and 400 MW are operating in parallel. The droop characteristics of their governors are 4 % and 5%, respectively from no-load to full load. Assuming that the generators are operating at 50 Hz at no-load, how would a load of 600 MW be shared between them? Find the system frequency at this load? Assume free governor operation. *[(CO4)(Evaluate/HOCQ)]*

3 + 2 + 1 + 2 + 4 = 12

Group - E

8. (a) Why does a series capacitor require special protection whereas a shunt compensation does not require such special protection? *[(CO5)(Analyse/IOCQ)]*

(b) A balanced 3-phase load consumes 120 kW at 0.75 lagging on a 400 V line. It is required to improve the p.f. to 0.98 lagging. Find the (i) reactive power of capacitor required (ii) what is the capacitance required per phase in μf if the capacitors are connected in star? *[(CO5)(Evaluate/HOCQ)]*

(c) Classify the FACTS controllers. *[(CO5)(Analyse/IOCQ)]*

(d) A 3 phase 200 kW industrial load operates at a power factor of 0.6 lagging. The power company requires the consumer to maintain a minimum p.f. of 0.9 lagging. Determine the (i) KVAR rating of the capacitor bank to be installed (ii) reduction in kVA demand after p.f. correction. *[(CO5)(Evaluate/HOCQ)]*

2 + 4 + 2 + 4 = 12

9. (a) Deduce the expression of surge impedance of a transmission line. *[(CO5)(Analyse/IOCQ)]*

(b) Sketch the nature of variation voltage along a transmission line when it is loaded above and below the natural loading. *[(CO5)(Apply/IOCQ)]*

(c) Compare any two features of series and shunt compensation. *[(CO5)(Analyse/IOCQ)]*

(d) Sketch the circuit diagram and VI characteristics of FC-TCR. *[(CO5)(Remember/LOCQ)]*

(e) An inductive load draws power of (2+j1) MVA at a receiving end bus of a radial three phase line. The receiving end bus voltage is 11 kV at 50 Hz and the system reactance is 0.5 Ω/phase. Determine receiving end current. *[(CO5)(Evaluate/HOCQ)]*

2 + 2 + 2 + 4 + 2 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	28.13	40.62	31.25