

**ADVANCED POWER SYSTEM
(ELEC 4131)**

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

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

**Group - A
(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) If the penalty factor of a plant is unity, the incremental transmission loss is
(a) 1.0 (b) -1.0 (c) zero (d) 2
 - (ii) To determine the units that should operate for a particular load is the problem of
(a) Unit commitment (b) Optimal load scheduling
(c) Economic dispatch (d) Optimal power flow
 - (iii) In the case of an HVDC system, there is
(a) charging current but no skin effect
(b) skin effect but no charging current
(c) neither charging current nor skin effect
(d) both charging current and skin effect.
 - (iv) Reactive power to HVDC system may be supplied from
(a) ac filters (b) shunt capacitors
(c) SVS (d) all of the above
 - (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) Kinetic Energy (K.E.) and frequency (f) of a synchronous machine are related as:
(a) $K.E. \propto f$ (b) $K.E. \propto 1/f$ (c) $K.E. \propto f^2$ (d) $K.E. \propto 1/f^2$
 - (vii) In an Automatic load frequency control (ALFC) loop, Δf can be reduced by using controller
(a) Differential (b) Integral
(c) Proportional (d) None of these
 - (viii) In fly ball speed governor, the decrease in speed results
(a) when Fly ball moves outward (b) when Fly ball moves inward
(c) when Fly ball moves downward (d) when Fly ball moves upward

- (ix) TCSC is
(a) shunt controller (b) series controller
(c) both (a) and (b) (d) none of these.
- (x) Series compensation in transmission lines
(a) increases stability limit (b) decreases stability limit
(c) has no effect on stability limit (d) none of these.

Group- B

2. (a) What is the penalty factor and incremental transmission loss for a thermal generating unit. [(CO1) (Remember/LOCQ)]
- (b) Develop the condition for economic load scheduling of thermal power plants considering transmission losses. [(CO1) (Apply/IOCQ)]
- (c) The fuel costs of two generators in a power plant are given by:
$$C_1 = 100 + 2P_1 + 0.005P_1^2 \text{ Rs/hr}$$
$$C_2 = 200 + 2P_2 + 0.01P_2^2 \text{ Rs/hr}$$
where P1 and P2 are in MW. The plant supplies a load of 450 MW. Neglecting transmission loss, determine
(i) the economic load scheduling of the two generators and
(ii) the incremental fuel cost. [(CO1)(Evaluate/HOCQ)]
(2 + 2) + 5 + 3 = 12

3. (a) Define spinning reserve. [(CO1) (Remember/LOCQ)]
- (b) Develop the expression of the transmission loss in terms of transmission loss coefficients for a power system consisting of two generating plants. [(CO1) (Apply/IOCQ)]
- (c) A power system has two generating plants and the power is being dispatched economically with
 $P_1 = 150 \text{ MW}$ and $P_2 = 275 \text{ MW}$. The loss coefficients are:
 $B_{11} = 0.10 \times 10^{-2} \text{ MW}^{-1}$
 $B_{12} = -0.01 \times 10^{-2} \text{ MW}^{-1}$
 $B_{22} = 0.13 \times 10^{-2} \text{ MW}^{-1}$ To raise the total load on the system by 1 MW will cost an additional Rs 200 per hour. Determine
(i) the penalty factor for plant 1, and
(ii) the additional cost per hour to increase the output of plant 1 by 1 MW.
[(CO1)(Evaluate/HOCQ)]
2 + 5 + (3 + 2) = 12

Group - C

4. (a) Explain the following as a shortnote:
(i) Back to back HVDC station. [(CO2) (Understand/LOCQ)]

- (b) Examine the effect of travelling wave on a terminal inductor. [(CO3) (Analyse/IOCQ)]
- (c) A surge of 100kV travelling in a line of natural impedance 600 Ω arrives at a junction of two lines of impedances 800 Ω and 200 Ω respectively. Determine the surge voltages and currents transmitted into each of the branch lines. [(CO3) (Evaluate/HOCQ)]
3 + 5 + 4 = 12

5. (a) What do you mean by a 1.2/50 μs lightning surge? Sketch the waveform. [(CO3) (Remember/LOCQ)]
- (b) Compare the performance of HVAC interconnections with HVDC interconnections. [(CO2) (Analyze/IOCQ)]
- (c) An existing three-phase, double-circuit AC line is to be converted to three circuit DC line. Assuming the same insulation level and unity power factor in the ac systems, prove that
- (i) the ratio of power transmitted by DC to that by AC is equal to $\sqrt{2}$ and
- (ii) the ratio of percentage loss by DC to that by AC is equal to $1/\sqrt{2}$. [(CO2) Evaluate/HOCQ]
3 + 4 + 5 = 12

Group - D

6. (a) Explain the basic working principle of Speed Governing System for a steam turbine with proper constructional diagram. [(CO4) (Understand/LOCQ)]
- (b) Develop the mathematical model and block diagram of the Speed Governing System for steam turbine. [(CO4) (Apply/IOCQ)]
6 + 6 = 12

7. (a) From the following block diagram of load frequency control, develop the expressions for steady-state response of speed governing system.

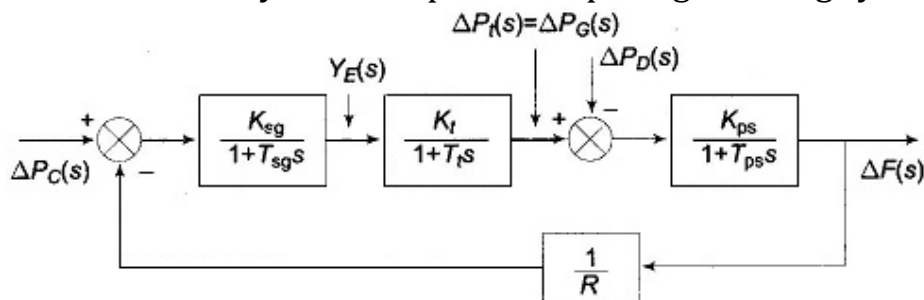


Fig.-1

[(CO4) (Apply/IOCQ)]

- (b) A 125 MVA turbo-alternator operates on full load at 50 Hz frequency. The load is suddenly reduced to 60 MW. The steam valves to the turbine commence to close after 0.5 seconds due to the time lag in the governor system. Assume the inertia constant, H= 5 kW-sec per kVA of generator capacity. Determine the change in frequency that occurs in this time. [(CO4) (Evaluate/HOCQ)]

7 + 5 = 12

Group - E

8. (a) What is STATCOM? [(CO5) (Remember/LOCQ)]
 (b) Compare the performance and operation of SVC with that of STATCOM. [(CO5) (Analyze/IOCQ)]
 (c) 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 $0.5 \Omega/\text{phase}$. Determine (i) receiving end current, (ii) voltage regulation, (iii) sending end voltage and (iv) Maximum power transfer capability of the system. Assume lossless system. [(CO5) (Evaluate/HOCQ)]
2 + 5 + 5 = 12
9. (a) What is the definition of FACTS? [(CO5) (Remember/LOCQ)]
 (b) Compare the performance of series and shunt capacitors in a power system. [(CO5) (Analyze/IOCQ)]
 (c) Prove that voltage regulation in a transmission line mainly depends on reactive power. [(CO5) (Evaluate/HOCQ)]
2 + 6 + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	23%	44.8%	32.2%

Course Outcome (CO):

After the completion of the course students will be able to

CO1: understand the Economic Operation of Power Generation Systems

CO2: learn about the components and operation of HVDC transmission system.

CO3: learn about the power system transients and protection against overvoltage.

CO4: understand and analyze the frequency Control in Power System.

CO5: know about the basic principle of voltage control and operation of FACTS devices.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question

Department & Section	Submission Link
EE	https://classroom.google.com/c/Mjk5MzYwNzcyMDIw/a/NDYzMDI1Mzc3MTI5/details