### POWER PLANT INSTRUMENTATION (AEIE 4231)

**Time Allotted : 3 hrs** 

Full Marks: 70

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and <u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> 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 follows
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 $10 \times 1 = 10$ 

- (i) Primary air is that air which is used to
  - (a) Reduce the flame length
  - (b) Increase the flame length
  - (c) Transport the dry coal into the furnace
  - (d) Provide air round the burners for getting optimum combustion.

(ii) Match the followings (cause-effect)

- 1. Boiler A. Reversible adiabatic expansion of steam
- 2. Turbine B. Constant pressure heat addition
- 3. Condenser C. Reversible adiabatic compression
- 4. Pump D. Constant pressure heat rejection
- (a) 1-C, 2-D, 3-B, 4-A (c) 1-B, 2-A, 3-D, 4-C
- (b) 1-C, 2-A, 3-D, 4-B (d) 1-B, 2-C, 3-D, 4-A.
- (iii) Fire tube boilers are (a) Externally fired
  - (a) Externally fired(b) Internally fired(c) Both internally and externally fired(d) None of the mentioned.
- (iv) What is the actual turbine inlet temperature in Rankine cycle?
  (a) 540 °C
  (b) 700 °C
  (c) 250 °C
  - (c) 850 °C (d) 900 °C.
- (v) Increase in turbine speed indicate that load demand
   (a) Increases
   (b) Decreases
   (c) Remain same
   (d) None of these.
- (vi) The purpose of deaeration is to(a) remove the dissolved gases in the feed water(b) heat the feed water
  - (c) heat the air in the water
  - (d) add minerals.

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(vii)	Reflector in nuclear power plant	neutron leakage.	
	(a) has no effect	(b) decreases	
	(c) increases	(d) all of the mentioned	
(viii)	The modern steam turbines are		
	(a) Impulse turbines	(b) Reaction turbines	
	(c) Impulse-reaction turbines	(d) None of the above.	
(ix)	Water-tube boilers are preferred for		
	(a) high pressure and high output	(b) high pressure and low output	
	(c) low pressure and high output	(d) low pressure and low output.	
(x)	Which of the following is the cheapest plant in operation and maintenance?		
	(a) Coal fired power plant	(b) Nuclear power plant	
	(c) Hydro power plant	(d) All of the above.	

## Group - B

2. (a) With the necessary schematic diagram, describe air and flue gas circuit.

- (b) Using a block diagram, describe the activities that are performed on raw coal to convert it to a furnace-acceptable condition. [(CO1)(Understand/LOCQ)]
- (c) Why is it necessary to pre-heat the air that enters the furnace?

[(CO1)(Analyse/IOCQ)]4 + 5 + 3 = 12

- 3. (a) Explain operation of water tube boiler with a net sketch. [(C01)(Remember/LOCQ]
   (b) State the stages of the turbine commonly used in power plant. How are they installed to neutralise the axial thrust? [(C01)(Analyse/IOCQ)]
  - (c) Lowering of condenser pressure increases the efficiency of the reheat Rankin cycle. Explain using a T-S diagram. State the drawbacks of this technique.

[(CO2)(Analyse/IOCQ)]4 + (1 + 2) + (4 + 1) = 12

## Group – C

4. (a) Why is it required to purge the burner before turning it on? Describe the operational circumstances that the burner management system monitors.

[(CO3)(Analyse/IOCQ, Understand/LOCQ)]

(b) Compute the expression for water level of the steam drum using suitable schematic diagram. [(CO3)(Analyse/IOCQ)]

(2+6)+4=12

5. (a) Explain how 2/3 logic works? [(CO3)(Understand/LOCQ)]
 (b) Analyse the furnace draft control scheme with necessary P&I diagram. [(CO3)(Analyse/IOCQ)]
 (c) Explain 3-element drum level control scheme with necessary P&I diagram. [(CO3)(Analyse/IOCQ)]

3 + 4 + 5 = 12

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## Group - D

- 6. (a) List the fundamental minimum conditions that must be met before steam is charged into the turbine. [(CO4)(Understand/LOCQ)] The starting sequence of various boiler auxiliaries is configured as follows: (b) (i) Regenerative air heaters, (ii) Induced draft (ID) fans, (iii) Forced draft (FD) fans, (iv) Primary air (PA) fans, (v) Pulverisers and (vi) Coal feeders. Design start interlock system using logic gates. [(CO4)(Create/HOCQ)] important parameters monitored Turbine Supervisory (c) State six by Instrumentation (TSI) system. [(CO5)(Remember/LOCQ)] 3 + 6 + 3 = 12
- 7. (a) Describe the turbine speed control scheme with necessary diagram.
  - (b) What do you mean by differential expansion for turbine? Why it may occur in turbine.
     (CO5)(Understand/LOCQ)]
  - (c) Draw and explain a schematic for detecting turbine differential expansion.

[(CO5)(Understand/LOCQ)]

5 + 4 + 3 = 12

# Group - E

- 8. (a) What do you mean by scaling? How do scale formation cause issues with the running of a thermal power plant. *[(CO6)(Remember/LOCQ, Analyse/IOCQ)]* 
  - (b) What do you understand about process of blow down? [(CO6)(Understand/LOCQ)]
  - (c) How do NOx emission contribute to the air pollution? [(CO6)(Understand/LOCQ)]

(2+4) + 3 + 3 = 12

- 9. (a) Explain one method of combustion control techniques that prevents the formation of  $NO_x$  during combustion. [(CO6)(Analyse/IOCQ)]
  - (b) What do you mean by water hammer? Describe how water hammer can be avoided by using a good diagram. [(C01)(Analyse/IOCQ)]
  - (c) Describe the qualities of the moderator element in a nuclear power plant. [(C01)(Remember/LOCQ)]

4 + 4 + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	48.96	44.79	6.25

#### Course Outcome (CO):

After the completion of the course students will be able to

- 1. Describe the main equipment of a power plant.
- 2. Explain the thermodynamic cycles used thermal power plant.
- 3. Give details of instrumentation and control loops in thermal power plant.'

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- 4. Include safety interlocks necessary for safe operation of thermal power plant.
- 5. Describe the turbine supervisory instrumentation system.
- 6. Gain knowledge about water treatment system and Pollution measurement and regulation of NOx, SOx and COx.

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