Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH(EE)/SEM-7/EE-704D/2011-12

2011

POWER PLANT INSTRUMENTATION AND CONTROL

Time Allotted : 3 Hours *Full Marks :* 70

The figures in the margin indicate full marks.

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

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

   i) Combustion control in a thermal power plant is an example of

      a) feed forward control b) fuzzy control

      c) ratio control d) simple PID control.

   ii) Cold junction compensation is necessary for temperature measurement using a

      a) Thermocouple b) Thermistor

      c) RTD d) IC based sensors.

   iii) An RVDT is used for measurement of

      a) vibration

      b) rotational displacement

      c) acceleration

      d) linear velocity.

iv) The flame temperature of coal-fired boiler furnace is measured by

a) Thermocouple

b) RTD

c) Optical Radiation Pyrometer

d) None of these.

v) The sensing element used for measurement of main steam flow is

a) Orifice plate b) Flow nozzle

c) Pitot tube d) Ultrasonic flowmeter.

vi) Bourdon pressure gauges have a near elliptical cross-section and the tube is generally bent into a C-shape or arc length of about

a) 270 degrees b) 60 degrees

c) 120 degrees d) 90 degrees.

vii) Boiler following turbine mode of operation is best suited for

a) small load changes

b) large load changes

c) both small and large changes

d) none of these.

viii) A temperature transmitter of range 0 to 100 degree Celsius uses a 4-20mA loop terminated by a 250Ω resistance. An output of 1V corresponds to

a) 0 degree b) 10 degrees

c) 20 degrees d) irrational signal.

ix) Shrink and swell are associated with

a) single element drum level control

b) three-element drum level control

c) de-aerator level control

d) none of these.

x) The analyzer used for measurement of oxygen content in flue gas is

a) IR gas analyzer

b) thermal conductivity based

c) zirconia probe

d) absorption type.

xi) Flow nozzles are generally made of

a) Phosphor bronze b) Nickel

c) Cast iron d) Stainless steel.

xii) Sliding pressure control increases efficiency at

a) part load b) full load

c) near full load d) none of these.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. State the Law of Intermediate Metals and the Law of Intermediate Junctions for a Thermocouple. 2 + 3

3. What are the different configurations in which a piezo-resistive sensing element can be used ? Sketch these configurations. 2 + 3

4. Define master control signal for a thermal power plant. Schematically represent the turbine following boiler (AG) mode of operation. 2 + 3

5. The emitted radiation from a piece of metal is measured and the temperature is found to be 1065 degree Celsius, assuming an emissivity of 0·82. It was letter found out that the emissivity was 0·85. Calculate the error in temperature measurement.

6. Describe the working principle of a pH meter.

7. Why is analysis of flue-gas necessary ? Briefly describe the working principle of an IR CO analyzer.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

8. A thermocouple circuit uses a Chromel-Alumel thermocouple which produces an emf of 40 mV when measuring a temperature of 800 degree Celsius with a reference of 0 degree. The resistance of the meter coils R_m is 50Ω and a current of 0·1 mA gives a full-scale deflection. The resistance of the junctions and lead is 12Ω. Calculate—
   a) series resistance if the thermocouple is used to measure a temperature in the range of 0 to 800 degree Celsius.
   b) The approximate error in measurement due to a rise of 20 degrees in the copper coil of the meter if the temperature coefficient of the resistance is 0·000426/degrees Celsius. 5 + 10

9. A capacitive transducer is used to measure a displacement Δd produced by an applied force. Devise a mechanism to obtain a linear output from the transducer for the displacement and deduce the expression for the voltage sensitivity of the transducer.

10. Explain how temperature can be measured using a 3-wire RTD.

11. Why is cascaded control used in mainstream temperature control ? With the help of a neat schematic, explain the cascaded control scheme used for MS (mainstream) temperature control in a thermal power plant. 5 + 10

12. Explain swell and shrink phenomena. With the help of a neat schematic explain the operation of the three element drum level controller. Can it be used during plant startup ? 8 +7

13. With the help of a neat schematic explain how the air-fuel ratio is maintained in a coal-fired thermal power plant. How and why is the temperature of the air-fuel mixture controlled ? 8 + 7

14. Schematically represent a Data Acquisition System used in power plant and state the functions of its various blocks. What is the advantage of a 4-20mA loop ? 12 +3