

**M.Sc.(Instrumentation) Examination 2017**  
**1<sup>st</sup> year 2<sup>nd</sup> semester**

**Subject: Industrial Measurement and Process Control**  
**Full marks:100**

**Paper: VIII(T-203)**  
**Time: 4 hours**

**Group: A**

**Section-I, Answer any two questions**

1. Discuss how a bimetallic strip (open ended) can be used as a sensor for temperature measurement. Derive the working principle for the radius of curvature of a bimetallic strip in the form of cantilever and how temperature can be measured. Discuss a bimetallic instrument is used in thermostat. A bimetallic element of stainless steel and invar is heated from 20°C to 180°C. Each strip is of equal thickness of 1 mm each. Calculate radius of curvature and vertical displacement.  
 ( $\alpha_{\text{steel}} = 1.6 \times 10^{-5} / ^\circ\text{C}$  and  $\alpha_{\text{invar}} = 1.7 \times 10^{-6} / ^\circ\text{C}$ ). 2+4+4
2. What is solar constant and find its dependence on altitude. Describe thermoelectric pyrometer and show how solar temperature can be measured ( $r = \text{solar radius} = 6.93 \times 10^5 \text{ km}$ ,  $R = \text{mean distance between Sun and Earth} = 14.8 \times 10^7 \text{ km}$ ,  $\sigma = 1.37 \times 10^{-12} \text{ cal/cm}^2/\text{sec}$ ,  $\rho = 1.94 \text{ cal/cm}^2/\text{min}$ ). Find the expression of solar constant in terms of instrument parameter. 2+5+3
3. (a) State weins displacement law of radiation and obtain Stefan's law.  
 (b) Write notes on vapour pressure thermometer. 5+5

**Section –II, answer any three questions**

4. Describe the working principle of Bourdon tube and capacitive pressure transducer. Write a short note on bellow type pressure gauge and differential pressure gauge. (2.5 x 2) + (2.5 x 2) = 10
5. Draw the schematic diagram of dipstick and bubbler tube. Why level measurement is important? Write a short note on capacitive level measurement and float. 3 + 2 + (2.5 x 2) = 10
6. (a) Explain basic Principle of working of an ultrasonic Flowmeter with necessary diagram. State its merits and demerits. 4+2  
 (b) What is Psychrometer? Describe an Industrial Psychrometer and explain its operation. 1+3
7. Write the phenomena on the basis of which Viscosity measurement are carried out.  
 Explain the procedure with neat diagram for measuring Viscosity for a process fluid in Industry using capillary flow based Viscometer.  
 What is Redwood Viscometer ? 2+6+2
8. Answer all short questions:
  - (i) Define Relative Humidity and Absolute Humidity.
  - (ii) Differentiate Laminar flow and turbulent flow on the basis of Renolds number.
  - (iii) State application of electromagnetic flowmeter (any four).
  - (iv) Newtonian fluid and Non-Newtonian fluid.
  - (v) Write the working Principle of Piezoelectric Hygrometer. 2 X 5

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Group B

Answer any five questions

- 1 (a) Write the transfer function of a PID controller and briefly state the responses of such a controller in different modes like P, I, PI, PD and PID with special stress on peak deviation, settling time and offset when individual parameters are adjusted.  
 (b) Define proportional band as is accepted in industrial practice. 7 + 3
2. Define the terms deviation reduction factor, proportional control factor and subsidence ratio. Discuss how are these useful in determining controllability of a process. 10
3. (a) Name three different methods of study of stability of control systems. How are these related with the characteristic equation?  
 (b) Briefly outline the Bode plot technique for stability studies. 3 + 7
4. How may an offset develop in a process control system? How is it defined for its analytical evaluation? In a process of transfer function  $2.2/(1 + 0.4s)$  when a proportional control action is only applied with its gain 4. If measurement system and actuator-control valve have unit transfer functions what would be the offsets with unit step changes of the set point and load. Deduce relations. 10
- 5.State the principles of the methods of choosing PID parameters. Take one method of your choice and tabulate the parameters for different control modes.  
 A single loop unit feedback system uses only a proportional action controller of gain  $K_c$  and actuator-control valve has unit transfer function. If the transfer function of the process is  $4/[s(s+1)(s+3)]$ , what would be the PID parameters when a PID controller is used in the system? 6 + 4
6. In what type of processes can we use on-off controllers? Define differential gap and time cycle in such a control scheme.  
 Draw the circuit scheme of an on-off controller where provision is there to change the dead zone using a simple potentiometer. Explain the circuit. 4 + 6
7. Draw the circuit scheme of a PID controller where (a) derivative over-run is prevented, (b) anti-reset control or smooth start-up is provided, and (c) the output magnitude is constrained to a maximum specified value. Explain the circuit operation.  
 Show that the circuit you propose is a standard PID controller circuit. 7 + 3
8. How would you demonstrate that a cascade control scheme is better than a single loop control scheme? Discuss in steps with appropriate diagrams. 10
9. Write notes on any two of the following:  
 (a) PLC, (b) State controllability, (c) Feed-forward control, (d) Nyquist criteria. 10

