[Total No. of Questions: *12*]   [Total No. of Printed Pages: *4*]

UNIVERSITY OF PUNE
[4363]-119
T. E. (*Mechanical*) Semester-II
Examination – 2013
Mechatronics (2008 Course)

[Time: *3* Hours]   [Max. Marks: 100]

Instructions:

1 *Answer any three questions from each section.*
2 *Answers to the* **two sections** *should be written in* **separate answer-books**.
3 *Neat diagrams must be drawn wherever necessary.*
4 *Assume suitable data, if necessary.*
5 *Use of Scientific calculator is allowed.*

SECTION –I

Q.1 A Explain in brief Sensitivity, Accuracy and Precision with suitable example for each.   **10**

B An RTD $\alpha_0 = 0.0037$ at $T_0 = 50°C$; $R(50°C) = 350\ Ohm.$ find $R(75°C)$ **6**

OR

Q.2 A Explain with a neat sketch the load cells along with its applications.   **6**

B A strain gauge and bridge circuit are used to measure the tension force in a steel bar. The steel bar has a cross sectional area of 50mm^2. The strain gauge has a nominal resistance of 120Ω and GF of 2. The bridge is supplied with 10V. when the bar is unloaded, the bridge is balanced so the output is 0 V. then force is applied to the bar, and the bridge voltage goes to 0.0005 V. find the force on the bar.(Young's Modulus of steel is 2.1×10^5 N/mm^2, assume Poisson's ratio=0.3)   **10**

Q. 3 A Calculate the capacitance of an air gap parallel plate capacitor with plates (25mm $\times$ 25mm) & a plate separation of 1mm. Calculate the change in capacitance when movable plate is displaced 0.4 mm farther from fixed plate. (Given: $\epsilon_0 = 8.854 \times 10^{-12}$)   **8**

B Explain in brief the DC motor as an electro mechanical system.   **10**

OR

Q. 4 A An LVDT with a secondary voltage of 5 V has a range of $\pm$ 1 inch. Find   **10**

(i) Linear Range
(ii) The output voltage when the core is -0.75 inch from the centre.
(iii) Calculate the core movement from the centre when output voltage is +3V DC.

B Explain capacitive and inductive principles used in position sensing.   **8**

Q. 5   A Derive the model equation of a rotational mechanical system with   6
           torsional stiffness, damping and mass moment of inertia
        B Use block diagram reduction to simplify the block diagram shown in   10
           figure Q 5 (b) below into a single block relating Y(s) to R(s)
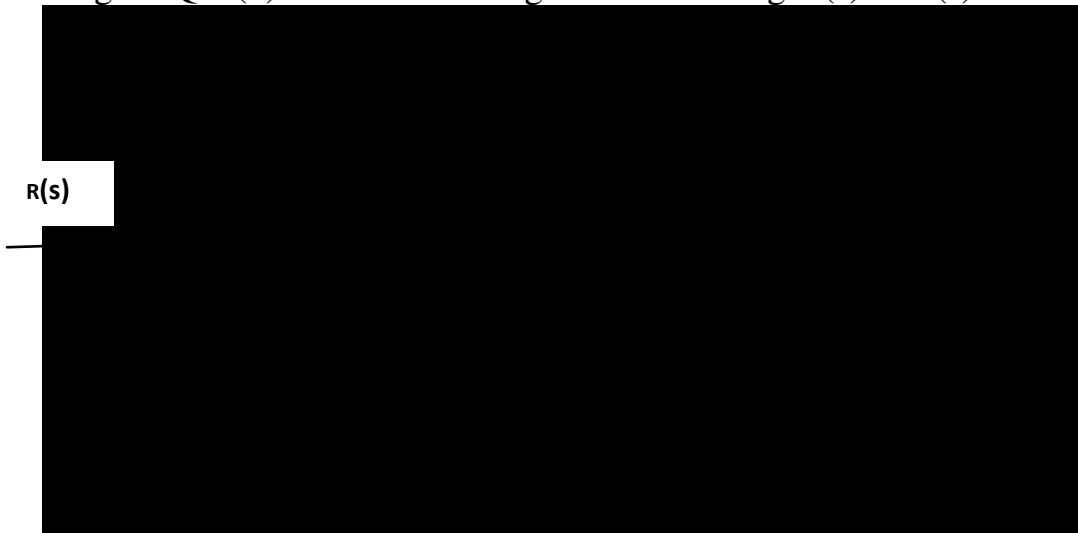
OR

Q. 6   A Explain in brief ADC and DAC   8
        B Use block diagram algebra to reduce the block diagram shown if fig Q   8
   6 (b)
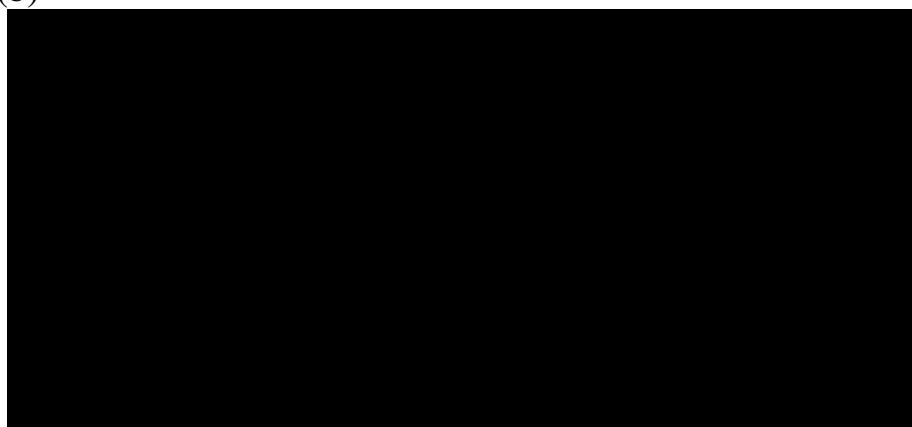
SECTION II

Q. 7   A Explain open loop and closed loop control system with suitable   8
           example each showing input and output
        B Construct the block diagram for resistance, capacitance and inductance 8
           arranged in series with voltage E applied across them. Comment
           whether it is open loop or closed loop.

OR

Q. 8   A Explain the terms process load and process equation.   8
        B A controller outputs 0 to 5 V DC to control the heater from 10 W to 100 8
           W with linear dependence. Calculate
           i)   The voltage corresponding to 55 W

ii) This value of voltage expressed as % of controller output

Q. 9   A   Define proportional plus Derivative (PD) controller along with   6
mathematical equation. Explain the reason why derivative controller is
added to proportional.

      B   Figure Q 9 (b) shows an error time graph. Sketch the PD controller   10
output w.r.t time Kp = 5%/%, KD = 0.5 %/s and m(0) = 30%
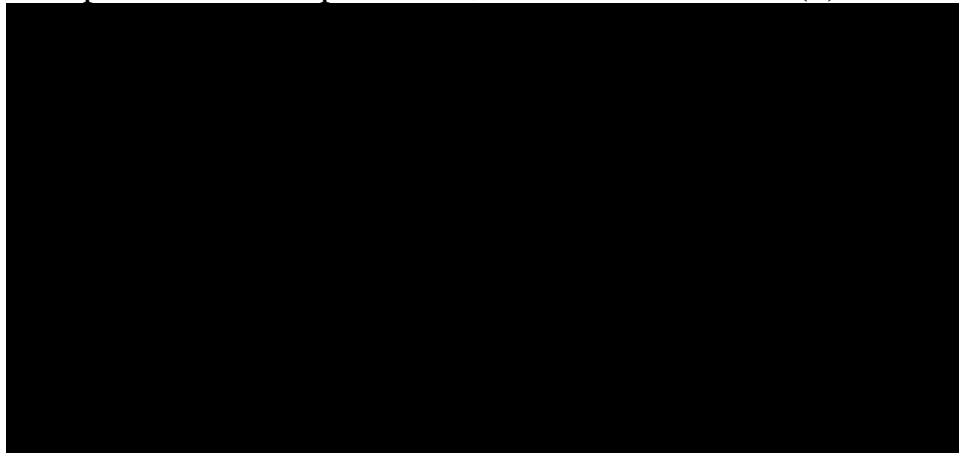
OR

Q. 10   A   Define Proportional Band, Integral action time derivative action time.   8

       B   Explain the term Offset error in proportional control. Which mode of   8
controller is used to minimize the offset error and why?

Q. 11   A   Explain the difference in Timers and Counters used in PLC   6
programming with a suitable example each.

       B   Consider a washing machine with in-flow valve (Q1), drain-flow valve   12
(Q2), switch for door used to input cloths (I3), load switch to sense
cloths in machine (I4), and washing motor (Q3). Develop a plc ladder
program for following objectives.

     i)   The cycle is ON when START (push-to-ON) (I1) button is
pushed and will continue ON till STOP (push-to-OFF) (I2)
button is pushed.

    ii)   The cycle shall be stopped as where it is when door is opened
(Door switch is OFF)

   iii)   When door is closed (Door switch is on) and cloths are fed
(Load switch is ON) in-flow is started for 1 minute.

   iv)   When in-flow is stopped, and door is closed washing motor is
ON and will continue to be on for 5 minutes.

    v)   When washing motor is stopped, drain-flow opens and
continues to be open for 3 minutes

Mention the input and outputs and which input is connected to
which PLC input terminal

Write the Boolean equation of each rung.
Draw ladder diagram with Ex ON, Ex OFF and PLC output symbol
(Do not show switches in the ladder program)

OR

Q. 12   A   Explain advantages of PLC ladder program over ladder program   6

   B   Consider a tank with inflow valve V1 and outflow valve V2 connected   12
   to a tank at top and bottom respectively. The level high (LH) and level
   low (LL) floats switches mounted at top and bottom to indicate the
   level. Develop a PLC ladder program for the following objectives
   i)   When LL is OFF and LH is OFF, the V1 should be ON
   ii)   V1 shall continue to be ON till LH is ON
   iii)   When LL and LH is ON, V1 should be OFF and V2 should be
           ON
   iv)   V2 should continue to be ON till LL is OFF.
Mention the input and outputs and which input is connected to which
PLC input terminal
Write the Boolean equation of each rung.
Draw ladder diagram with Ex ON, Ex OFF and PLC output symbols
(Do not show switches in ladder program)