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## MANIPAL INSTITUTE OF TECHNOLOGY (A Constituent Institute of Manipal University) Manipal – 576 104



**MAX. MARKS: 100** 

## VI SEMESTER B.Tech (BME) DEGREE END SEMESTER EXAMINATIONS MAY, 2016 SUBJECT: PHYSIOLOGICAL CONTROL SYSTEM (BME 322) (REVISED CREDIT SYSTEM) Friday, 6<sup>th</sup> May, 2016, 2 to 5 pm

## TIME: 3 HOURSNote: Answer any FIVE full questions

- Q1 (a) In a liquid level control system, a human operator observes the level of liquid in a tank with 7 the help of a float and regulates the inflow of liquid by adjusting a valve. Draw the component block diagram and identify the components.
  - (b) Obtain the response c(t) and plot, if a unit step voltage is applied to a second order system. 8
  - (c) A second order unity feedback control system is characterized by the following transfer 5 function.

 $\frac{C(s)}{R(s)} = \frac{100}{s^2 + 12s + 100}$  Assume the input is a unit step voltage, find,

(i) Damping ratio  $\zeta$ . (ii) Natural and damped frequencies.

(iii) Peak time  $t_{p.}$  (iv) Peak overshoot  $M_p$  (v) Settling time  $t_s$  for 5% of tolerance

Q2 a) For the mechanical system shown in Fig. Q2a, write the system differential equations. Also 10 obtain analogous force to current and force to voltage electrical circuit and write the corresponding equations.



- b) (i) Discuss the significance of Masons gain formula used for finding the transfer function of 2 feedback control system.
  - (ii) For the system shown in Fig. Q2b, Find C/R using
  - (a) Signal flow graph (b) Block diagram reduction technique.



Q3 (a) The characteristic equation for certain feed-back control system is given below. Using RH 6 criterion, determine the range of values of K for the system to stable. Also find the frequency of oscillation where the system just becomes unstable.

$$s^4 + 4s^3 + 13s^2 + 36s + K = 0$$

(b) A unity feedback control system has the characteristic equation

 $(s^2 + 2s + 2)(s^2 + 8s + 15) + K = 0$ 

Sketch the root locus diagram of the system for  $K \ge 0$  and determine the marginal value of K for stability. Also find the point of intersection of root locus on the  $j\omega$  axis.

Q4(a)(i) Discuss briefly, the gain margin and phase margin.3(ii) An unity feedback control system has the open loop transfer function12

$$GH(s) = \frac{10(s+1)}{s(1+0.5s)(1+0.02s)(1+0.1s)}$$

Construct the Bode plot, find the gain margin and the phase margin, and discuss the stability of the system.

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(b) For the Bode magnitude plot shown in fig. Q4b, find the open loop transfer function G(s) and 5 also find the frequency  $\omega_{a}$ .



- Q5 (a) With a suitable block diagram, explain the blood glucose regulation mechanism in human 8 body system.
  - (b) Draw a suitable model of transfer of substance between two compartments separated by a thin 8 membrane and obtain the differential equation.
  - (c) Draw the mechanical section of the human heart and label the each part of the system. 4
- Q6 a) With respect to visual control system of human Eye, explain accommodation mechanism.
  - (b) Draw the block diagram of Calcium ion regulation in the human body.
  - (c) Briefly discuss the heat production in associated with human body system.

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