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MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
A Constituent Institution of Manipal University

V SEMESTER B.Tech (BME) DEGREE MAKE-UP EXAMINATIONS DECEMBER 2017

SUBJECT: PHYSIOLOGICAL CONTROL SYSTEM (BME 4009)
(REVISED CREDIT SYSTEM)
Wednesday, 27th December 2017: 2 PM to 5 PM

TIME: 3 HOURS **Note: Answer ALL questions** **MAX. MARKS: 100**

Q1 **(a)** In a liquid level control system, a human operator observes the level of liquid in a tank with the help of a float and regulates the inflow of liquid by adjusting a valve. Draw the component block diagram and identify the components. **5**

(b) The system shown in **Fig.Q1b**, find the expression $\frac{C(s)}{R(s)}$ using, **8+7**

(i) Block diagram reduction technique. (ii) Signal flow graph technique.

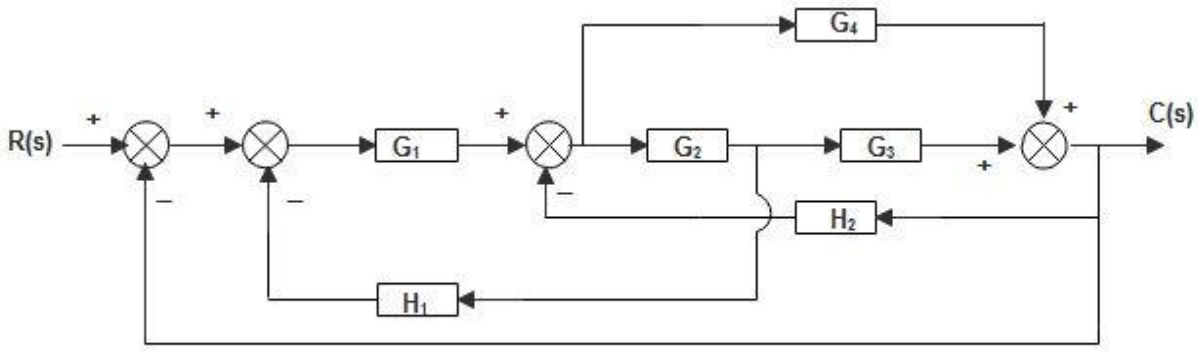

Fig.Q1b

Q2 **(a)** For the rotational system shown in **Fig. Q2a**, write the system differential equations. Also construct the analogous electrical circuit based on Torque to current analogy and write the corresponding equations. **8**

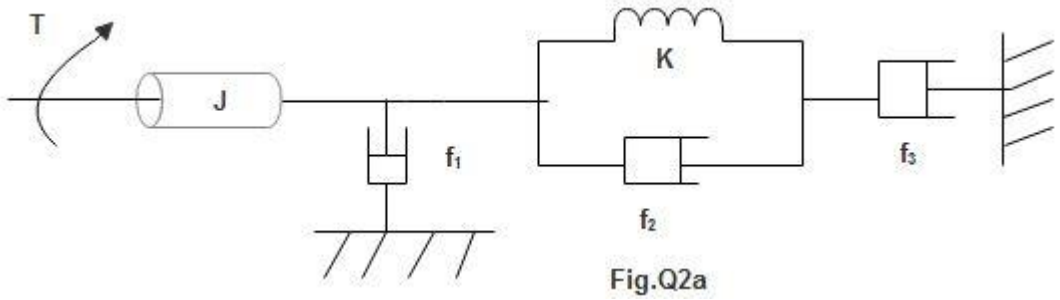

Fig.Q2a

(b) Derive the time response and steady state error pertaining to a unit parabolic response of a first order feed-back control system. **6**

(c) A second order unity feedback control system is characterized by the following transfer function. **6**

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

(i) Damping ratio ζ. (ii) Natural and damped frequencies.

(iii) Peak time t_p. (iv) Rise time t_r. (v) Peak overshoot M_p (vi) Settling time t_s for 5% of tolerance.

Q3 **(a)** A unity feed-back control system is characterized by the open loop transfer function **6**

$$G(s) = \frac{K}{s^4 + 4s^3 + 8s^2 + 2s}$$

Using Routh criterion find the range of the value of K for which the system is stable. Also determine value of K for which the system response is oscillatory and the value of frequency of oscillations at this value of K.

(b) A unity feedback control system is characterized by the open loop transfer function given by, **14**

$$G(s) = \frac{K(s+1)(s+3)}{s^3}$$

Sketch the root locus diagram of the system for K ≥0 and determine the marginal value of K for stability.

Q4 **(a)** (i) Discuss briefly, the concept of gain margin and phase margin. **3**

(ii) A unity feedback control system has the open loop transfer function **12**

$$G(s) = \frac{10(s+1)}{s(1+\frac{s}{2})(1+\frac{s}{10})(1+\frac{s}{50})}$$

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

(b) For the Bode magnitude plot shown in **Fig.Q4b**, find the open loop transfer function G(s). Also find the gain crossover frequency ω_g. **5**

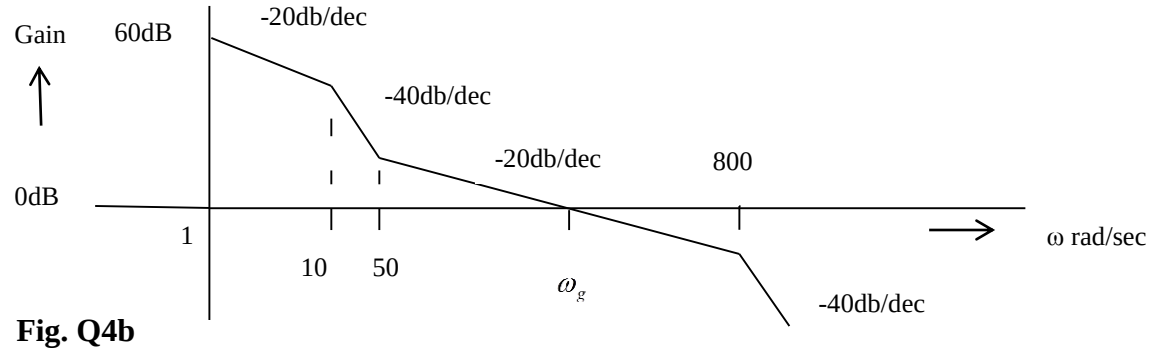

Fig. Q4b

Q5 **(a)** Explain with example, the differences of physiological and technological control systems. **7**

(b) Since Calcium ions comprise one of the important portion of the extracellular fluid. With the help of the block diagram, explain how the extracellular Calcium ion concentration is regulated in human body. **6**

(c) Discuss briefly, how the heat is produced in human body system. **7**