Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

(A constituent unit of MAHE, Manipal 576104)

V SEMESTER B.Tech (BME) DEGREE END SEM EXAMINATIONS NOVEMBER 2019

SUBJECT: PHYSIOLOGICAL CONTROL SYSTEMS (BME 4009)

(REVISED CREDIT SYSTEM)

Friday, 22nd November 2019: 2 PM to 5 PM

TIME: 3 HOURS **MAX. MARKS: 50**

Instructions to Candidates:

1. **Answer all the questions.**
2. **Draw labeled diagrams wherever necessary.**

1. (a) Describe with necessary blocks, the operation of the biological control system consisting of human being reaching out for an object to be picked up. 03

(b) The system shown in Fig.Q1b, shows a block diagram representation of a feedback control system. Draw the SFG of this system and find the transfer function, $\frac{C(s)}{R(s)}$. 04

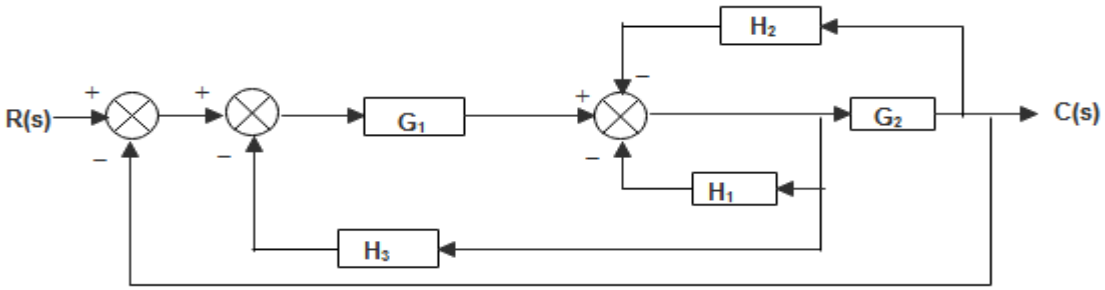

Fig.Q1b

(c) Discuss the effect of negative feedback in control systems on, 03

(i) Sensitivity. (ii) External noise.

2. (a) For the mechanical system shown in Fig. Q2a, write the system differential equations. Also construct the analogous electrical circuit based on force to current analogy and write the corresponding equations. 04

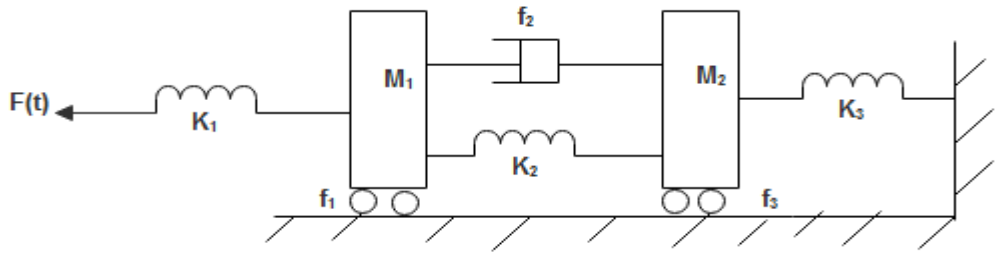

Fig.Q2a

(b) Obtain $c(t)$ due to unit step response to a first order feedback control system. Also determine the steady state error e_{SS}. 03

(c) The open loop transfer function of a unity feed-back control system is given by 03

$$G(s) = \frac{36}{s(s+8)}$$

Find the natural frequency and damping ratio of the system. Also find the rise time, peak time, maximum overshoot and the 2% criterion settling time for a unit step input.

3. (a) Consider the characteristic equation of a unity feed-back control system is given by 03

$s^5 + 2s^4 + 24s^3 + 48s^2 - 25s - 50 = 0$.

Apply RH criterion to locate the roots of the characteristics equation.

(b) The open loop transfer function of a feed-back control system is given by, 07

$$GH(s) = \frac{K}{s^3 + 6s^2 + 34s}$$

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

4. (a) A unity feedback control system has the open loop transfer function 07

$$G(s) = \frac{1000(s+1)}{s(s+2)(s+5)(s+10)}$$

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

(b) For the resultant BODE magnitude plot shown in Fig. Q4b, find its open loop transfer function $GH(s)$. 03

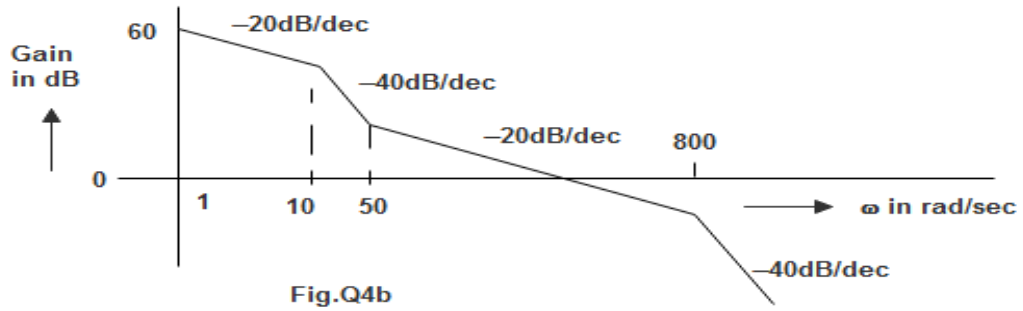

Fig.Q4b

5 (a) Physiological system has neither a reference input nor an error detector. Discuss this with a suitable example. 02

(b) Explain the transfer of substances between two physiological compartments separated by a thin membrane and obtain the necessary differential equation. 04

(c) With the help of necessary block diagrams, explain the regulation of extracellular Na^+ concentration in human body system 04