ROLL NO. _____

Code: DE120 **Subject: CONTROL ENGINEERING**

DipIETE – ET (New Scheme)

Time: 3 Hours **June 2018** **Max. Marks: 100**

PLEASE WRITE YOUR ROLL NO. AT THE SPACE PROVIDED ON EACH PAGE IMMEDIATELY AFTER RECEIVING THE QUESTION PAPER.

NOTE: There are 9 Questions in all.

- **Question 1 is compulsory and carries 20 marks. Answer to Q.1 must be written in the space provided for it in the answer book supplied and nowhere else.**
- **The answer sheet for the Q.1 will be collected by the invigilator after 45 minutes of the commencement of the examination.**
- **Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

Q.1 Choose the correct answer or the best alternative in the following: (2×10)

a. Which unit is adopted for magnitude measurement in Bode plots?
(A) Degree **(B)** Decimal
(C) Decibel **(D)** Deviation

b. For which systems are the signal flow graphs applicable?
(A) Causal **(B)** Invertible
(C) Linear time invariant system **(D)** Dynamic

c. If the system is specified by open loop transfer function G(s) H(s) = k / s(s+3) (s +2) how many root loci proceed to end at infinity?
(A) 2 **(B)** 3
(C) 5 **(D)** 6

d. Which plots in frequency domain represent the two separate plots of magnitude and phase against frequency in logarithmic value?
(A) Polar plot **(B)** Bode plots
(C) Nyquist plots **(D)** All of these

e. Consider the equation $s^3 + 3s^2 + 5s + 2 = 0$. How many roots are located in left half of s-plane?
(A) Zero **(B)** Two
(C) Three **(D)** Four

f. If poles are added to the system, where will the system tend to shift the root locus?
(A) To the left of an imaginary axis
(B) To the right of an imaginary axis
(C) At the center
(D) No shifting takes place

g. At which frequency does the magnitude of the system becomes zero dB?
(A) Resonant frequency **(B)** Cut-off frequency
(C) Gain crossover frequency **(D)** Phase crossover frequency

h. For a stable system
(A) Gain margin and phase margin both are positive
(B) Gain margin and phase margin both are negative
(C) Gain margin is positive and phase margin is negative.
(D) Gain margin is negative and phase margin is positive

i. The location of the closed loop conjugate pair of pole on jω axis indicates that the system is
(A) stable **(B)** unstable
(C) marginal stable **(D)** critical stable

j. The stability of a system
(A) decreases as the type of system increases
(B) increases as the type of the system increases
(C) does not change as the type of system increases
(D) none of these

Answer any FIVE Questions out of EIGHT Questions.
Each question carries 16 marks

Q.2 a. Determine the equations of the system shown in Fig. 1 using force-current analogy. Obtain an analogous electrical circuit based on it. **(8)**

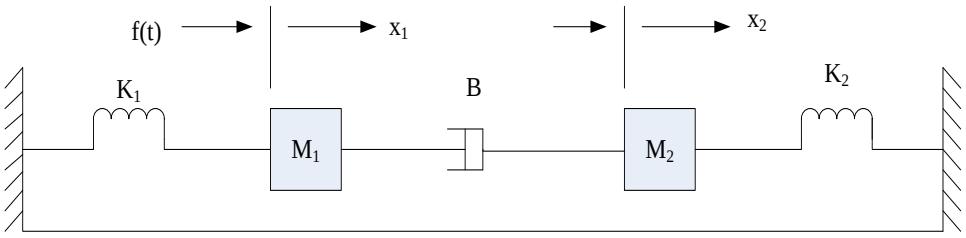

Fig. 1 Figure for Q.2 (a)

b. Explain the transfer function of the function and its relationship with impulse response. **(4)**

c. Determine the transfer function of the network shown in Fig. 2 relating $V_o(s)$ and $V_i(s)$. **(4)**

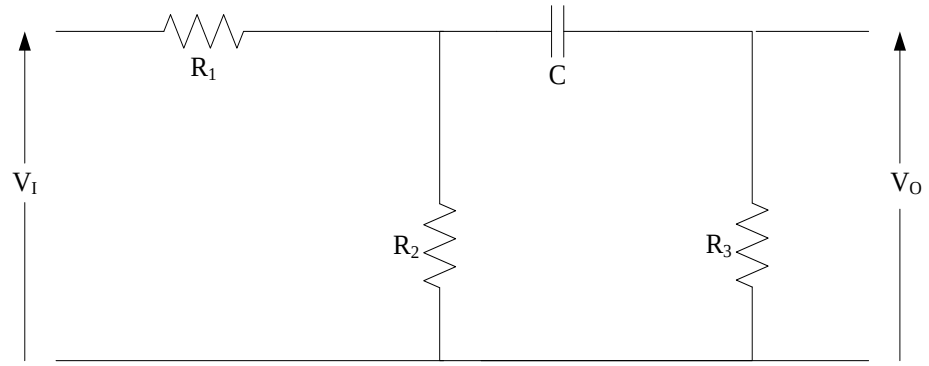

Fig. 2 Figure for Q.2 (c)

Q.3 a. Determine the transfer function of the control system shown in Fig. 3 using block reduction technique. **(8)**

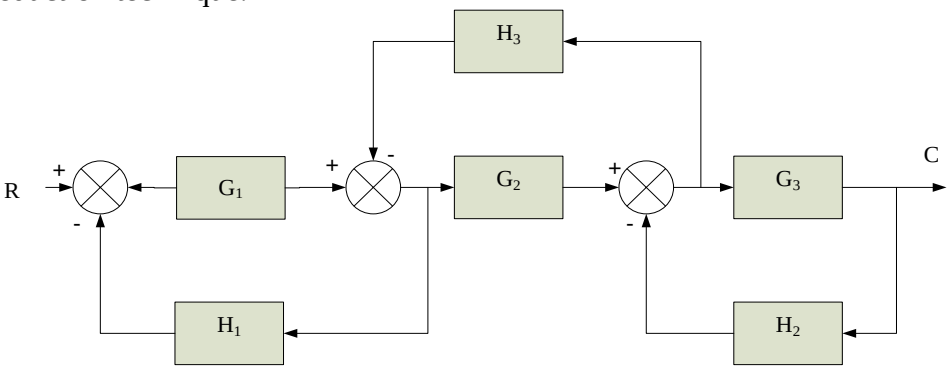

Fig. 3 Block diagram for Q.3 (a)

b. Draw the signal flow graph for a system whose block diagram is shown in Fig. 4. Identify the forward paths, individual loops and determine the relation C/R. **(8)**

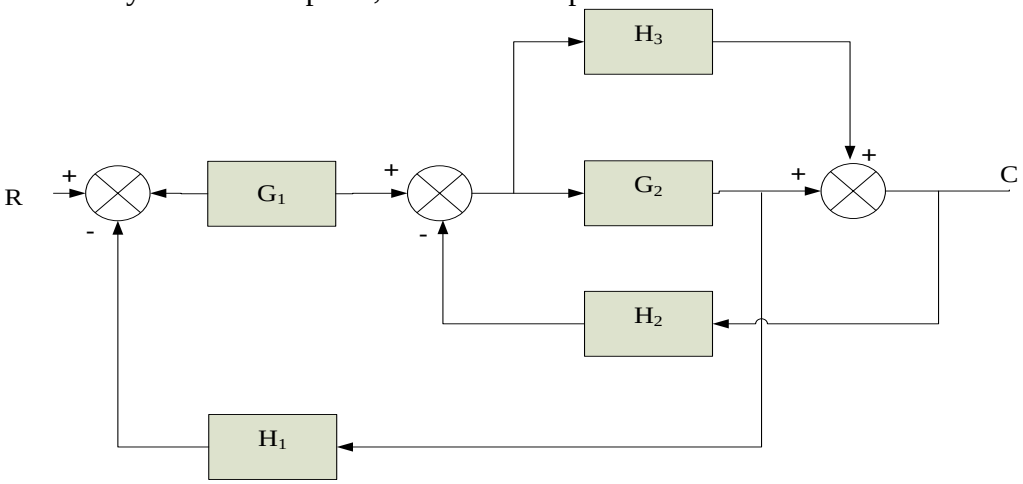

Fig. 4 Block diagram for Q.3 (b)

Q.4 a**.** Define the sensitivity and derive the expression for the closed loop sensitivity with respect to the feedback path transfer function. **(8)**

b. What is the Hydraulic system? Draw its schematic and explain its working. Also explain its application. **(8)**

Q.5 a. For a system G(s) H(s) = $\frac{k}{s^2(s+2)(s+3)}$ find the value of k to limit the steady state error to 10 when input to system is 1+10t. **(5)**

b. Define the steady state error and obtain the steady state error for type 1 system with unit step input. **(5)**

c. By applying Routh-Hurwitz criterion determine the stability of a closed loop control system whose characteristics equation is **(6)**

$$s^5 + s^4 + 2s^3 + 2s^2 + 11s + 10 = 0$$

Q.6 Sketch the root locus of a system having open loop transfer function as **(16)**

$$G(s) = \frac{k(s+2)}{s(s+1)(s+4)} \text{ where } k>0$$

Q.7 a. Sketch the bode plot for the open loop transfer function for the unity feedback system given below and asses stability **(10)**

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

b. Explain the following terms **(2×3)**
(i) Minimum phase system
(ii) Non-minimum phase system
(iii) All pass system

Q.8 a. For a unity feedback control system having open loop transfer function as $G(s)\,H(s) = \frac{100}{s(s+5)(s+15)}$, obtain the stability using Nyquist criteria. **(8)**

b. Explain the gain margin and phase margin. Determine the gain margin and phase margin of a unity feedback system having an open-loop transfer function. **(8)**

$$G(j\omega) = \frac{10}{j\omega(J0.1\omega + 1)(J0.05\omega + 1)}$$

Q.9 a. Define phase lag and lead compensating network with its diagram and also find the transfer function of both networks. **(8)**

b. Derive the value of the maximum phase lead angle and also find the value of maximum lead angle of the network $G(s) = \frac{1+0.2s}{1+0.1s}$. **(8)**