ROLL NO. ________________

Code: AE61/AE109 Subject: CONTROL ENGINEERING

AMIETE – ET (Current & New Scheme)

Time: 3 Hours **June 2019** 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 or the best alternative in the following: (2×10)

a. In pneumatic systems we assume pneumatic flow also as
(A) Compressible **(B)** Incompressible
(C) Expandable **(D)** Undependable

b. If we are picking up a pencil placed on a table in front of us. This system is
(A) Open loop **(B)** Closed loop
(C) None of these **(D)** Both **(A)** & **(B)**

c. In case of D C servomotor the armature is slotted with
(A) AC winding **(B)** No winding
(C) D.C. winding **(D)** Both AC and DC winding

d. Steady state error for type-1system for unit ramp I/P is
(A) ∞ **(B)** 1/(1+Kp)
(C) 0 **(D)** 1/Kv

e. When all the elements in any one row of the Routh's array are zero this condition indicates that there are
(A) Symmetrically located roots in s-plane
(B) Asymmetrically located roots in s-plane
(C) The roots are not in s-plane
(D) None of these

f. The angle of departure from an open loop pole is given by
(A) $\phi_p = \pm 180°(2q+1) + \phi$ **(B)** $\phi_p = \pm 90°(2q+1) + \phi$
(C) $\phi_p = \pm 180°(q+1) + \phi$ **(D)** $\phi_p = \pm 90°(q+1) + \phi$

g. Second order system of the form has $\frac{C(s)}{R(s)} = \frac{\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}$.

The steady state output of the system for a sinusoidal input of unit magnitude and variable frequency ω is given by

(A) $C(t)=\frac{1}{\sqrt{[(1-u^2)^2+(2\zeta u)^2]}}\sin\left(\omega t-\tan^{-1}\frac{(2\zeta u)}{1-u^2}\right)$

(B) $C(t)=\frac{1}{\sqrt{(2\zeta u)^2}}\cos^{-1}\left(\omega t-\tan^{-1}\frac{1}{2\zeta u}\right)$

(C) $C(t)=\frac{1}{\sqrt{[(1-u^2)^2+(2\zeta u)^2]}}\sin^{-1}\omega t$

(D) None of these

h. Consider an open loop unstable system G(s) H(S) = (s+2)/(s+1)(s-1). If we consider that feedback path is closed, then whether the system is stable or unstable?
(A) Stable **(B)** Unstable
(C) Conditionally Stable **(D)** None of these

i. The function of a prefilter circuit is to
(A) Cancel out a closed loop pole **(B)** Introduce a closed loop pole
(C) Cancel out a closed loop zero **(D)** Introduce a closed loop zero

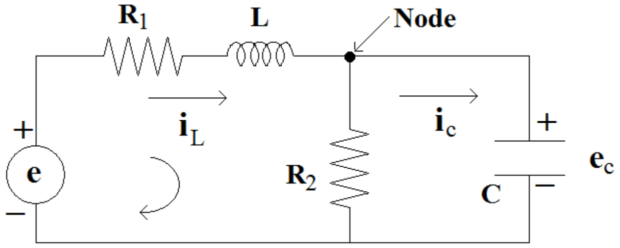
j. In a canonical variable or normal form representation of system, the matrix A turns out to be a
(A) Square matrix **(B)** Diagonal matrix
(C) Skew matrix **(D)** Symmetric matrix

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

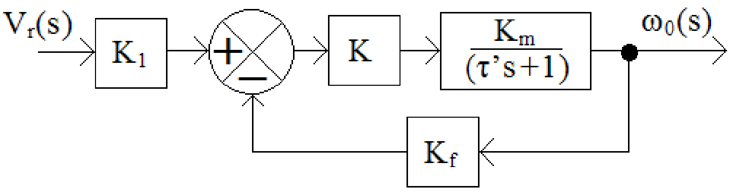
Q.2 a. What is accelerometer? Draw its model and derive its various parameters. **(8)**

b. What is a transfer function? What are its various types and explain the procedure for deriving it for various systems. **(8)**

Q.3 Consider the circuit of fig. blow **(4x4)**
(a) Identify a set of variables (Physical)
(b) Draw the signal flow graph of the circuit in terms of the state variable identified as in part (a)
(c) From the signal flow graph, write the state variable equations of the circuit
(d) From the signal flow graph, determine the transfer function $\varepsilon_c(s)/\varepsilon(s)$



Q.4 The transfer function of an armature-controlled is employed to control the speed of J,f load in closed-loop with tachometer feedback as shown in fig. below. The motor-load transfer function is $G(s)=\frac{K_m}{(\tau' s+1)}$



Determine the time constant τ" of the overall transfer function T(l) = $\omega_o(s)/V_r(s)$. What would be the value of gain K for τ" = τ'/10? Calculate its numerical value for τ' = 0.1, K_m = 1.25, K_t = 0.2. Find $S_{K_t}^{T}$ and its limiting value for low frequencies. **(16)**

Q.5 a. Explain the response of second order system to the unit step. **(8)**

b. Explain the terms (i) Rise time (ii) settling time (iii) Peak time (iv) Peak overshoot in brief. **(2x4)**

Q.6 a. Consider a sixth order system with characteristic equation. **(8)**
$S^6+2s^5+8s^4+12s^3+20s^2+16s+16=0$. Find the stability.

b. Consider the feedback system with characteristic eqn. $1+k\dfrac{1}{s(s+1)(s+2)}=0$
Draw its root locus and analyse the feedback system. **(8)**

Q.7 a. Consider a feedback system whose open loop transfer function in given by
G(s) H(s) = $\dfrac{k}{s(Ts+1)}$. Draw its intended Nyquist plot. **(8)**

b. Sketch the magnitude Bode plot for the system having **(8)**
$G(s)=\dfrac{(1+100s)(1+s)}{(1+10s)(1+0.1s)}$

Q.8 a. Enumerate the preliminary conditions required for classical design. **(8)**

b. Explain the concept of realization of basic compensators. **(8)**

Q.9 For the control flow system shown in fig below, prepare a signal flow graph. Identify suitable state variables and write down the state variable model. **(16)**
Given:
$K\alpha = 25$, $K_p = 1$, $K_d = 0.005$, $K_m = 5$, $J = 0.05$, $R_\alpha = 1\alpha$ (motor)
$q_i = Kq\theta$, $Kq = 8$, tank Area $A = 50m^2$, $q_0 = k_h h$, $k_h = 225$ $k_f = 0.25$