B.TECH. IN AEROSPACE ENGINEERING (BTAE)

Term-End Examination 01509

June, 2012

BAS-020 : BASIC CONTROL THEORY

Time : 3 hours *Maximum Marks : 70*

Note : *Attempt **Any seven** questions. **All** questions carry equal marks.*

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1. (a) Consider the mechanical system of Fig. (1). **5**

Obtain the transfer function $G(s) = \dfrac{x(s)}{F(s)}$,

Assuming zero initial conditions. Draw the corresponding electric network using the force voltage analogy.

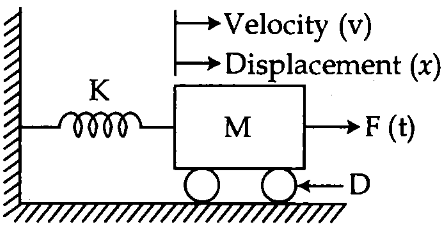

Fig. (1)

(b) Obtain the transfer function model as the overall block diagram for the electrical network of Fig (2) and also it's mechanical equivalent. 5

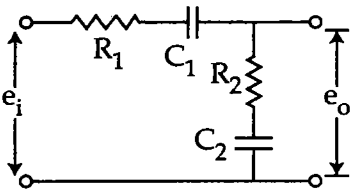

Fig. (2)

2. (a) Consider the closedloop system given by : 5

$$\frac{C(s)}{R(s)} = \frac{w_n^2}{\left(s^2+2\,\xi\, w_n s+w_n^2\right)}.$$

Determine the value of ξ and Wn so that the system responds to step input with Approximately 5% overshoot and with a settling time of 2 seconds. (use the 2% criterion)

(b) Determine the Range of K for stability of a unity-feedback contral system whose open loop transfer function is : 5

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

3. Sketch the Root loci for the system with 10

$$G(s) = \frac{K}{s\,(s+0.5)\left(s^2+0.6\,s+10\right)}, \; H(s)=1.$$

4. Consider the system shown in Fig. (3). Draw the Bode diagram of the openloop transfer function G(s) with K = 1. Determine the phase margin and gain margin. Find the value of K to Reduce the phase margin by 10°. **10**

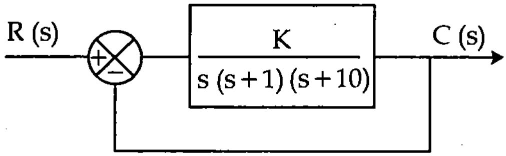

Fig. (3)

5. For the system whose signal flow graph is shown by Fig. (4). find $\frac{Y(s)}{R(s)}$ **10**

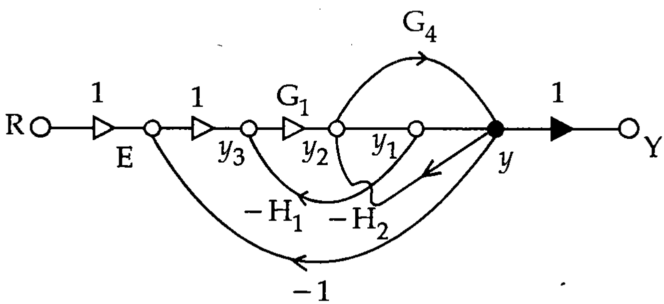

Fig. (4)

6. The forward path transfer function of a unity-feedback control system is given as : **10**

$$G(s) = \left[\frac{K}{s(1+0.1s)(1+0.5s)}\right.$$

Draw the Bode plot of G (s) and find the value of K so that the gain margin of the system is 20 dB.

7. Derive the transfer function of the OP Amp. circuit shown Fig. (5). Also prove that the circuit processes the input signal by proportional + derivative + integral Action. 10

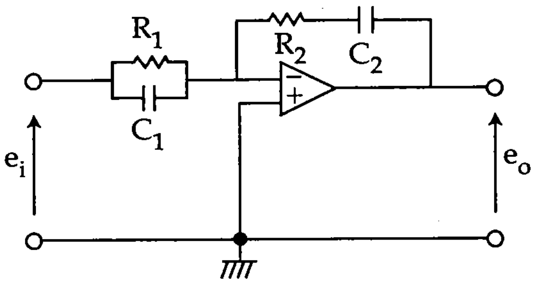

Fig. (5)

8. The electro hydraulic position control system shown in Fig. (6) positions a mass (M) with negligible friction. Assume that the rate of oil flow in the power cylinder is $q = K_1 x - K_2 \Delta P$ where x is displacement of the spool any ΔP is the differential pressure across the power piston. Draw a block diagram of the system and obtain them from the transfer function $\frac{Y(s)}{R(s)}$. The system constant's are given below. Mass $M = 1000$ kg ; constant's of the hydraulic actuator. 10

$K_1 = 200\ cm^2/sec$ per cm of spool displacement

$K_2 = 0.5\ cm^2/sec$ per gm - wt/cm^2

Potentiometer sensitivity $KP = 1 volt/cm$

Power Amplifier gain KA = 500 mA/volt. Linear transducer constant K = 0.1 cm/mA Piston area A = 100 cm^2

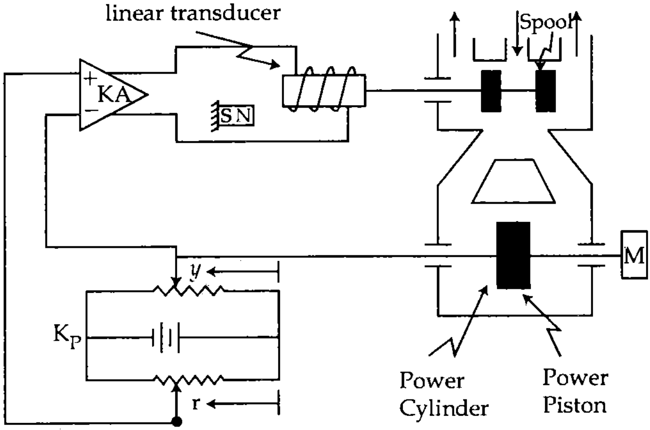

Fig. (6)

9. Determine the value of K > 0 and a > 0 so that the system shown in Fig. (7). Oscillates at a frequency of 2 rad/sec. **10**

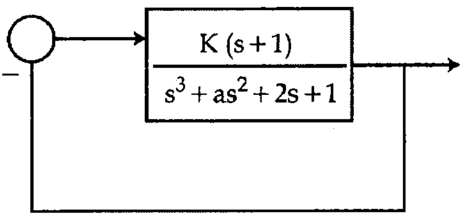

Fig. (7)