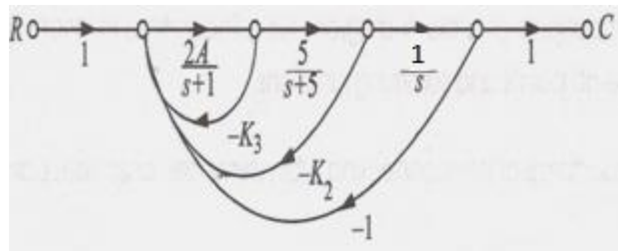
Birla Institute of Technology and Science, Pilani

First Semester 2010-2011

AAOC C321: Control Systems
Comprehensive Examination (Closed Book)

Date: December1st, 2010(FN) **Time: 3 Hrs** **MM: 120**

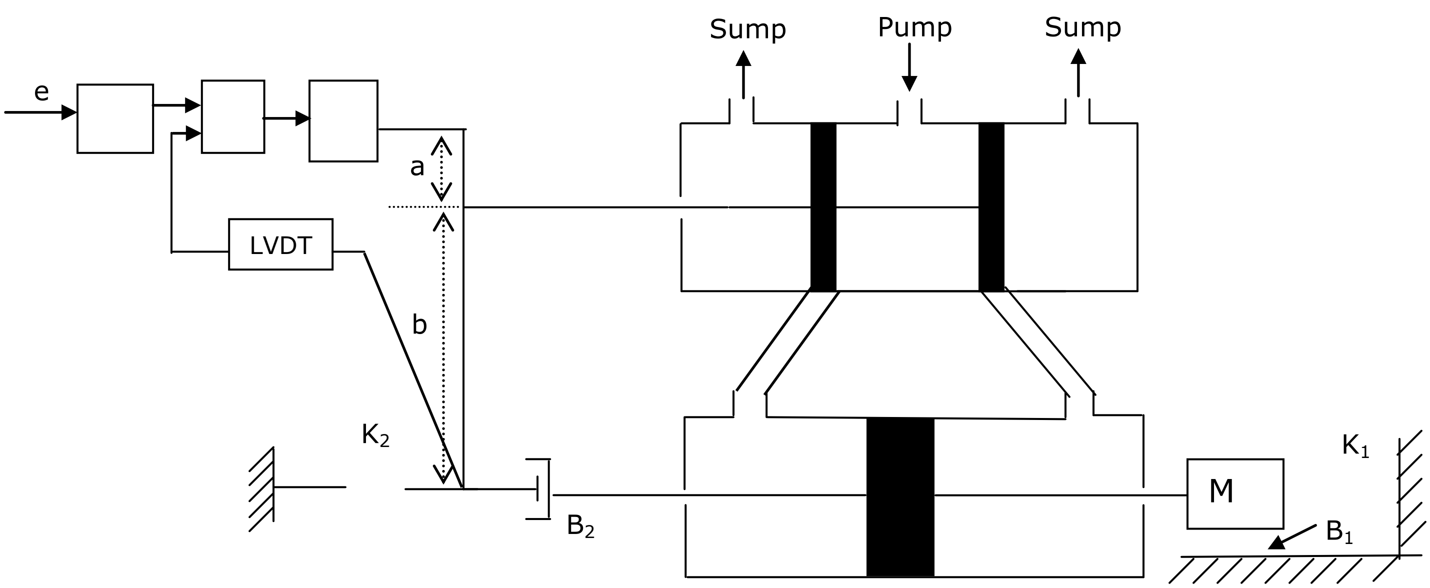
Q1(a). Signal flow graph of a system is shown in figure. Determine the value of A, K_2, K_3 so that the poles of the system lie at: -100 and - 0.708 ±j 0.7064. Reduce the system to second order using dominant pole pair concept and then determine the value of rise time.



(b). An electro hydraulic system with lever feedback is shown in figure below. Assume that valve orifice coefficient is K_1 and the area of piston is A. The rate of oil flow to the piston is $Q = K_1x - K_2P$, where x is the valve opening, P is the supply pressure and K_2 is a constant. The sensitivity of LVDT is K_L V/m, input device gain is K_i V/m, amplifier gain is K_a V/V and transducer gain is K_t m/V. For this system

(i) Draw the block diagram and

(ii) Obtain the transfer function Y(s)/E(s), where y is the displacement of mass M. [12+18]



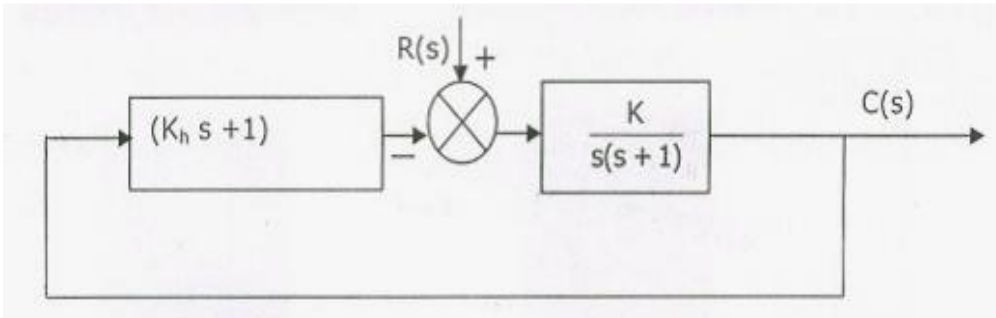
Q2(a). The open loop transfer function of a unity negative feedback system is given by:

$$\frac{K(s+2)}{s(s^2+2s+16)}$$

Draw the Bode's magnitude (asymptotic) and phase plots on the Semi-log graph sheet provided, so that steady state error of the system is 10%. From the plots, determine the gain margin & phase margin and comment on system stability.

(b). The open loop transfer function of a unity negative feedback system is $\frac{15}{s(s+4)}$. Design a lead compensator so that the system has a Phase margin of 70°. Take safety of margin as 5°. (Without using Semi-log graph sheet) [20+10]

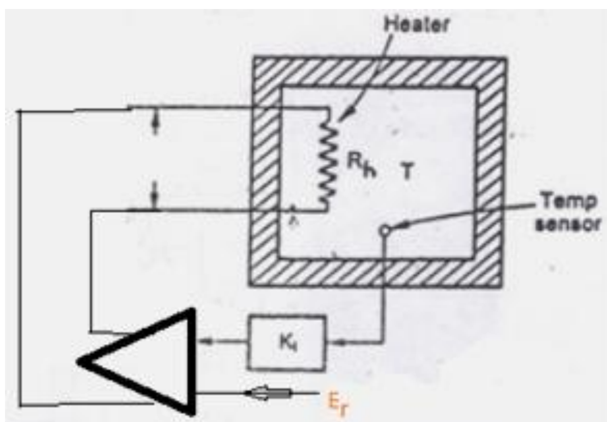
Q3(a). The block diagram of a control system is given below. Sketch the neat root contours showing all necesssary steps for K>1 (Take any two values) and therefrom determine the time at peak overshoot correspondingly.



(b). A temperature control system is shown in figure below. The various parameters of this system are as follows:

Amplifier gain is K_a V/V; Thermal resistance of tank is R °C/W; Thermal capacitance of the mass in tank is C J/°C; Temperature sensor constant is K_t V/ °C. J is Joule's coefficient. E_r is the reference voltage source. For this system

i. Draw the labeled signal flow graph
ii. Obtain the incremental transfer function, $\Delta T(s)/\ \Delta E_r(s)$
iii. Derive the expression for sensitivity of the system for changes in K_a in open loop & closed loop mode and reduce this for DC conditions. [15+15]



Q4(a). Characteristic equation of a system is $s^3+5s^2+4s+Ks+20=0$. Draw a neat sketch of root locus of the system, on your answer sheet showing all necesssary steps for 0< K <∞.

(b). Sketch the Nyquist plot for a system whose open loop transfer function is $\dfrac{2.5K}{s(1+0.4s)(0.2s+1)}$, choosing the appropriate Nyquist contour and therefrom determine the range of K (K>0) for which the closed loop system is stable. Also determine the Gain Margin for K=3. [10+20]