

BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI (RAJASTHAN)
FIRST SEMESTER 2007-2008

AAOC C321 Control Systems
Comprehensive Examination (Closed Book)
Part- A and B

Date 08-12-2007

Total Time: 3 Hrs

Max Marks: 120

Part- A

Time: 1 Hr.

Maximum Marks: 30

- NOTE: (i) Number of questions: 22
(ii) Number of blanks : 30
(iii) Each blank carries one mark.

Name: _____ ID No: _____ Sec. No. _____

- Q.1 Lumped parameters are characterized by _____ (differential eqs. / partial differential eqs.)
- Q.2 System described by equation $Y = \frac{d^2x}{dt^2} + \frac{dx}{dt} + 7\sqrt{x}$, where X is input and Y is output is a _____ system (Non linear/linear and Time variant/invariant).
- Q.3 In an ideal position control servo mechanism, back emf constant is numerically equal to _____ constant.
- Q.4 For a unity negative feedback system, forward path gain is $K/(s+9)$. Sensitivity of the system, in case of open loop and closed loop to small changes in K ($K = 0.4$) at $\omega = 1$ rad/s is _____ and _____ respectively.
- Q.5 In Q.4, if required time constant for closed loop system is 10 ms then the value of K and corresponding steady state gain is _____ and _____ respectively.
- Q.6 If a first order system works in open loop mode, its steady state gain and the speed of response is _____ and _____ respectively, as compared to closed loop mode.
- Q.7 A 6-stack stepper motor has _____ numbers of teeth if the angular displacement between stacks of stator teeth is 4° (assuming, stack rotor teeth aligns with its stator).
- Q.8 In Synchro transmitter, at some position of its rotor, the voltage in one coil is maximum while across other two is zero, this position of the rotor is known as _____ and the same name is given to the control transformer rotor position if the rotors of synchro pair are at _____.
- Q.9 The Hydraulic actuator will work as an ideal integrator if leakage and _____ flow are negligible. (compressible/turbulent)
- Q.10 For the same horse power, hydraulic actuators are _____ than electrical motors. (lighter/heavier)

PTO

Q.11 Out of Pneumatic and hydraulic systems, which one has shorter response time?
_____.

Q.12 The _____damped step response of a second order system oscillates with constant frequency and magnitude.

Q.13 The response of a system for step input of 4 unit is $(1 - e^{-4t})u(t)$. If this system is excited by a input of $e^{-5t}u(t)$, the steady state value of the response is_____.

Q.14 The addition of only a zero in the closed loop transfer function results in _____rise time and _____peak over shoot.

Q.15 For the system shown in Fig Q. 15, value of position error coefficient is _____ and acceleration error coefficient is _____.

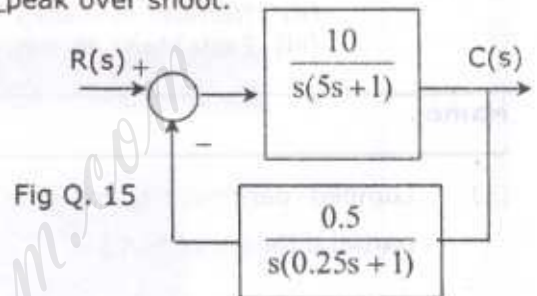


Fig Q. 15

Q.16 The open loop transfer function of a negative feedback system is $K / [(s+1)(s+3)]$. The range of K for which system exhibits the overdamped response, is_____.

Q.17 The characteristic equation of a negative feedback system is $s^3 + 4s^2 + 5s + K = 0$. The range of K for system to be stable is_____.

Q.18 For a system to be stable, the gain at phase cross-over frequency should be less than _____db.

Q.19 The transfer function of a compensation network is $(s+5)/(s+0.5)$, this represents a _____network. (lead/lag)

Q.20 The maximum phase lead required from a lead network is 30° . The value of α (or a) is _____.

Q.21 The frequency plot of a system is given in Fig Q.21. The gain margin is _____ db and phase margin is_____.

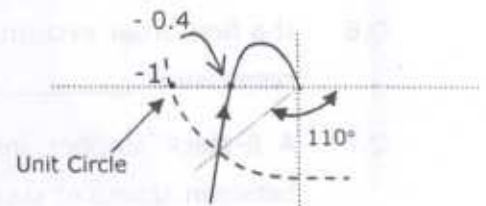


Fig Q.21

Q.22 In a compensation network, the zero location is at -0.5 and at dc frequency the network provides an attenuation of 14 db. The location of compensatory pole is _____and the frequency, at which it provides maximum phase lead is_____ rad/s.

Birla Institute of Technology and Science, Pilani

First Semester 2007-2008

AAOC C321: Control Systems
Comprehensive Examination (Part B)

Date: 08.12.2007

Time: 2 Hrs

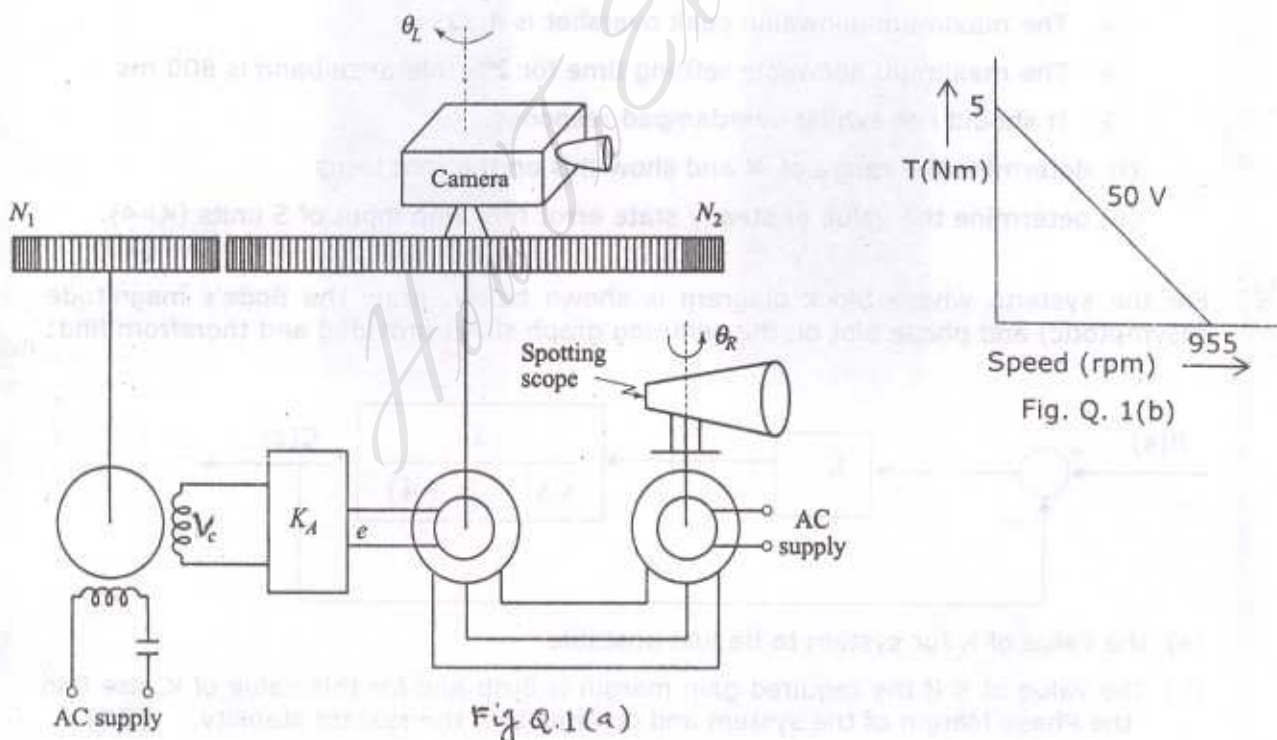
MM: 90

Q.1 Position of a camera is to be controlled as shown in Fig Q.1 (a). The camera is driven by an ac servo motor through a gear train and is designed to follow the movement of the spotting scope. The two phase servo motor develops a torque in accordance with the equation $T_m = K_1 V_c - K_2 \omega_m$ and its torque-speed characteristic is shown in Fig Q.1 (b). The various parameters of this system are given below:

- Sensitivity of the synchro error detector (K_s) is 30 V/rad, Amplifier gain (K_A) is 20 V/V, $N_1/ N_2 = 1/2$, Moment of inertia of camera (J_L) = 1 kg-m²;
- Friction coefficient of camera (B_L) = 4 Nm/rad/s. Moment of inertia and friction coefficient of motor are negligible.

For this system:

- (i) Draw the block diagram
- (ii) Determine the transfer function $\theta_L(s)/ \theta_R(s)$.
- (iii) Determine the magnitude of sudden input that is required to achieve a final position of 5° of the camera. [20]

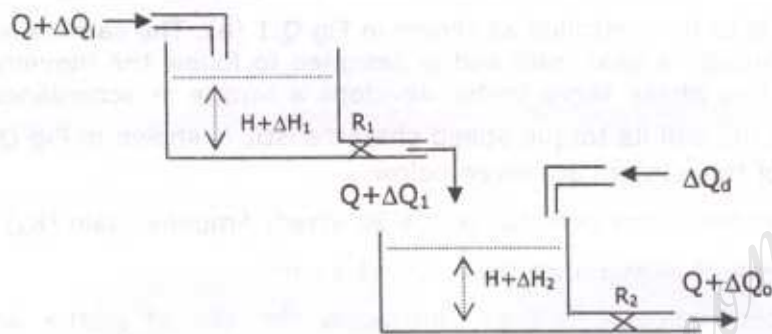


Q.2 Sketch the Nyquist plot for a system whose open loop transfer function is $\frac{K(1 + 0.5s)(s + 1)}{(1 + 10s)(s - 1)}$, choosing the appropriate Nyquist contour. Determine the range of K for which the closed loop system is stable. [20]

Q.3 For the system shown below

- write the governing differential equations
- draw the signal flow graph and therefrom determine the transfer function $\frac{\Delta Q_o(s)}{\Delta Q_d(s)}$ using Mason's gain formula. Capacity of tanks are C_1 and C_2 respectively.

[10]

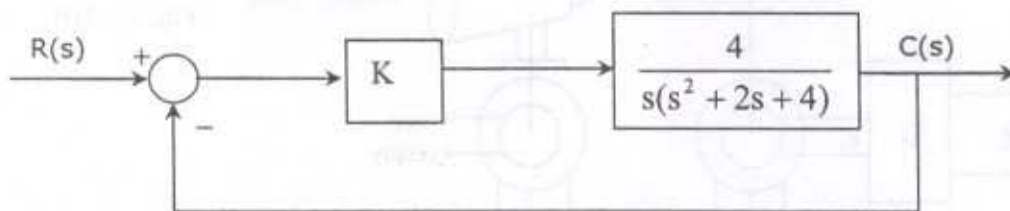


Q.4 For a unity negative feedback system, the open loop transfer function is $\frac{K(s+15)}{s(s+2)}$.

- draw the neat sketch of root locus for this system, on the answer sheet, showing all the necessary steps.
- time domain specifications for this system are given below:
 - > The maximum allowable peak overshoot is 4.32%
 - > The maximum allowable settling time for 2% tolerance band is 800 ms
 - > It should not exhibit overdamped response.
- (i) determine the range of K and show this on the root locus
- (ii) determine the value of steady state error for ramp input of 5 units ($K=4$).

[20]

Q.5 For the system, whose block diagram is shown below, draw the Bode's magnitude (asymptotic) and phase plot on the semi-log graph sheet provided and therefrom find:



- the value of K for system to be just unstable
- the value of K if the required gain margin is 6 db and for this value of K also find the Phase Margin of the system and comment on the system stability. [20]