Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

V SEMESTER B.TECH (MECHATRONICS ENGINEERING)

END SEMESTER EXAMINATIONS, NOV/DEC 2015

SUBJECT: CONTROL SYSTEMS [ICE 337]

Time: 3 Hours MAX. MARKS:50

Instructions to Candidates:

- Answer **ANY FIVE FULL** the questions.
- Missing data may be suitably assumed.
- Normal graph sheet and semi log sheet will be provided.

1A. A dc motor develops 55 N-m of torque at a speed of 600 rad/s when 12 volts are applied. It stalls out this voltage with 100 N-m of torque. If the inertia and damping of the armature are 7 kg-m and 3 N-m-s/rad, respectively, find the transfer function, $G(s) = \theta_l(s)/Ea(s)$, of this motor if it drives an inertia load of 105 kg-m^2 through a gear train as shown in figure 1 **6**

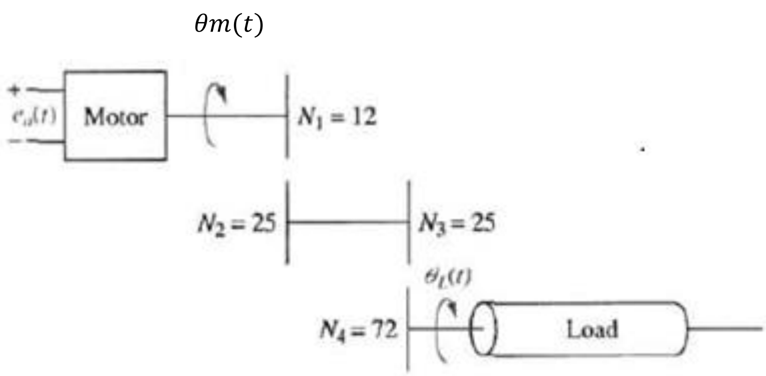

Figure 1

1B. Determine the transfer function C(s)/R(s) **4**

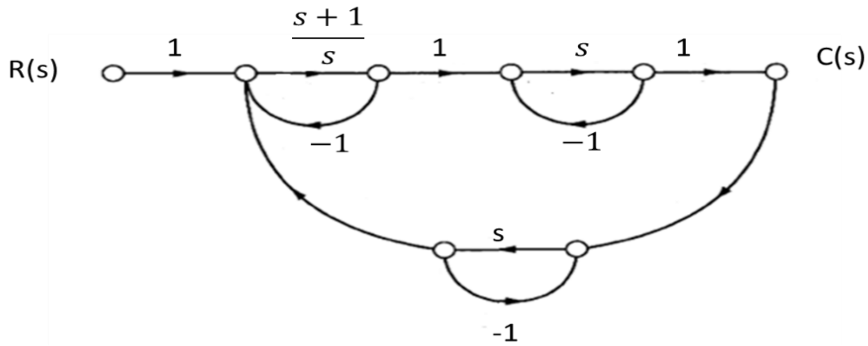

Figure 2

2A. For the system shown in Figure 3, find ω_n, ω_d, ε, $\%OS$, T_s, T_p **4**

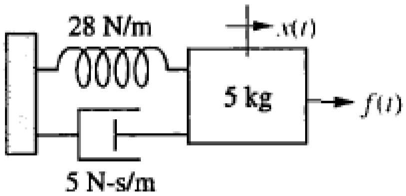

Figure 3

2B. A space station, shown in figure 4, will keep its solar arrays facing the Sun. If we assume that the simplified block diagram of figure 5 represents the solar tracking control system that will be used to rotate the array. Calculate steady-state error for step, ramp and parabolic commands **4**

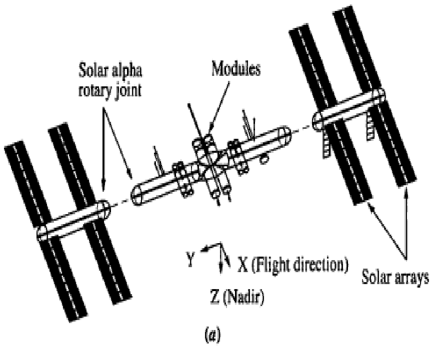

Figure 4

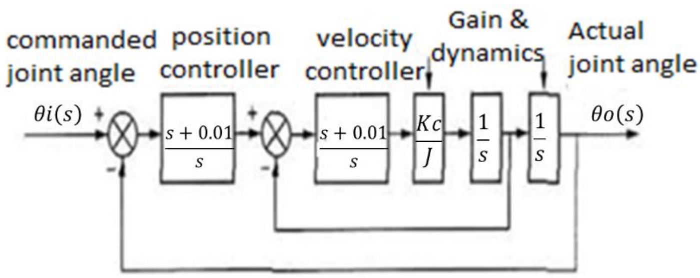

Figure 5

2C. Compare and contrast between open loop system and closed loop system **2**

3A. A model for an airplane's pitch loop is shown in Figure 6 of gain, K, that will keep the system stable. Design the value of K for the system to be stable. **3**

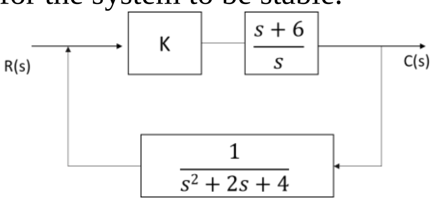

Figure 6

3B. Unit step response of a mechanical vibratory system (figure 7) is shown in the figure 8. Determine the values of M,K and B **3.5**

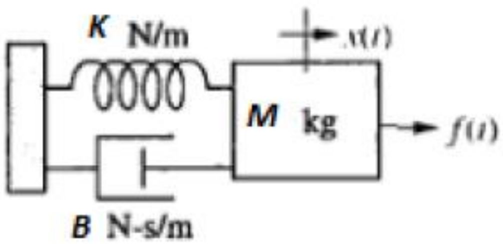

Figure 7

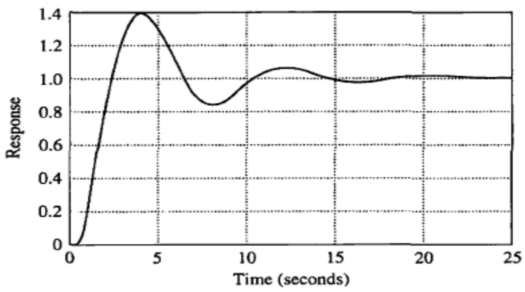

Figure 8

3C. For the system $G(s) = 60(s+5)$,find the error using dynamic error coefficient method for input of $6+5t+\frac{6t^2}{2}$ at t=10s **3.5**

4A. A robot arm is given by the OLTF, $G(s) = \frac{K(s+2)}{s^2+4}$.Construct root locus diagram of a negative unity feedback system. **5**

4B. Determine the value of K for stable undamped oscillations for the system described in **Qn 4A**. **1**

4C. Design a passive compensator to yield a closed-loop step response with 4.34% overshoot with 2 fold reduction in settling time for the system described in **Qn 4A**. **4**

5A. Draw the Bode log-magnitude and phase plots for the position control system where $G(s)=\frac{K}{(s+5)(s+20)(s+50)}$ **6**

5B. Determine the range of K for stability from bode plot **1**

5C. Evaluate gain margin, phase margin, gain cross over frequency, phase cross over frequency from Bode plot for K=10,000 **3**

6A. For the rotational mechanical systems shown in Figure 9, write, but do not solve, the equations of motion. **3**

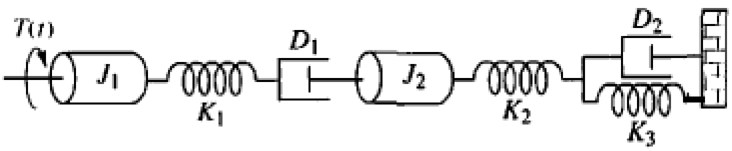

Figure 9

6B. Sketch the electrical equivalent for the system shown in the figure 9 **3**

6C. Design a passive compensator for a level controller of nuclear power plant with OLTF as **4**

$G(s) = \frac{K(s+2)}{(s+1)(s+3)(s+4)}$ to improve the steady-state error by a factor of 10 if the system is operating with 17.8%overshoot. (The root locus of the plant is given in the figure 10). Verify the design.

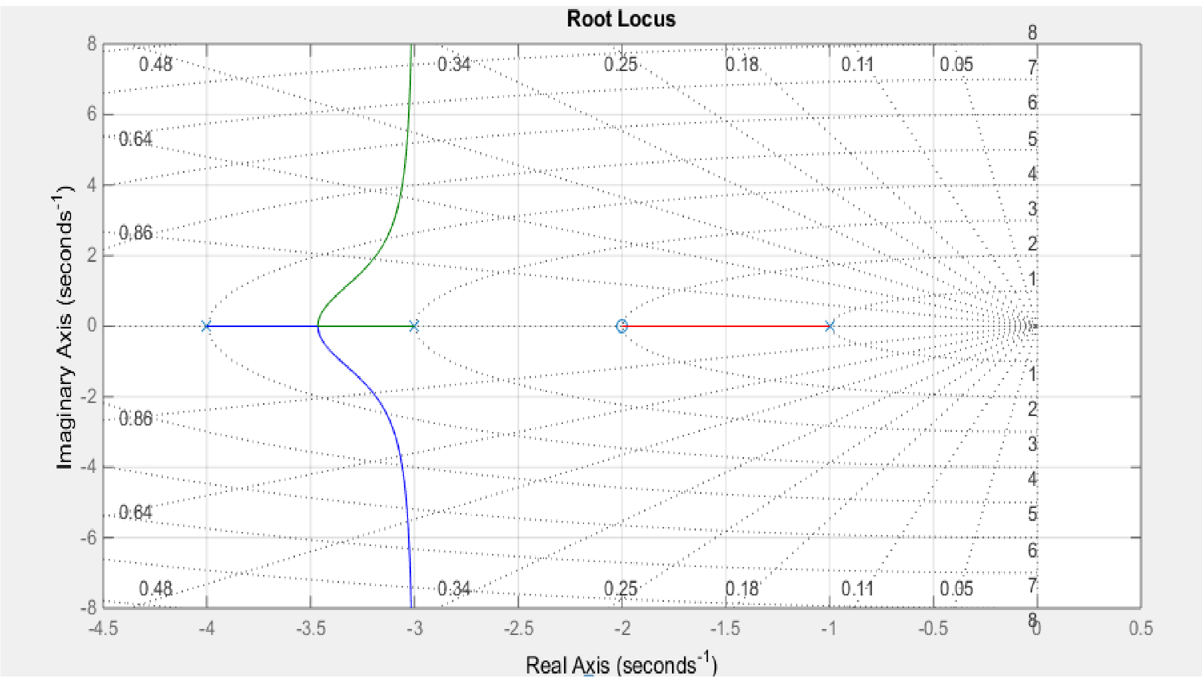

Figure 10