Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

V SEMESTER B.TECH (MECHATRONICS ENGINEERING)

END SEMESTER EXAMINATIONS, DEC 2015/JAN 2016

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 battery charging system is shown in the Figure 1, find the values of R_2 and C to yield 8% overshoot with a settling time of 1 ms for the voltage across the capacitor, with $v_i(t)$ as a step input. **5**

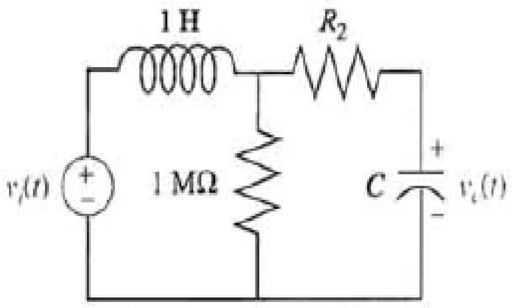

Figure 1

1B. A boat is circling a ship that is using a tracking radar. The speed of the boat is 36km/hour, and it is circling the ship at a distance of 1000m, figure 2. A simplified model of the tracking system is shown in figure 3. Find The limits of the gain K for keeping the boat in the track **2**

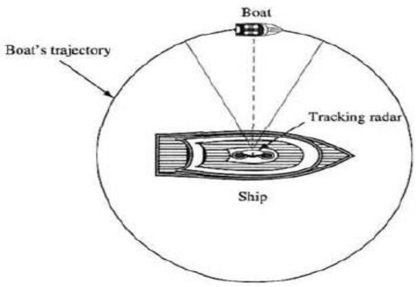

Figure 2

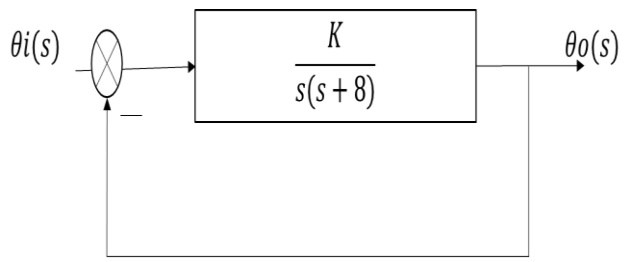

Figure 3

1C. Find the value of K (**Qn 1 B**) so that the boat is kept in the center of the radar beam with no more than 0.1 degree error. **3**

2A. Find the transfer function, $G(s)=\Theta_2(s)/T(s)$, for the system shown in figure 4 **4**

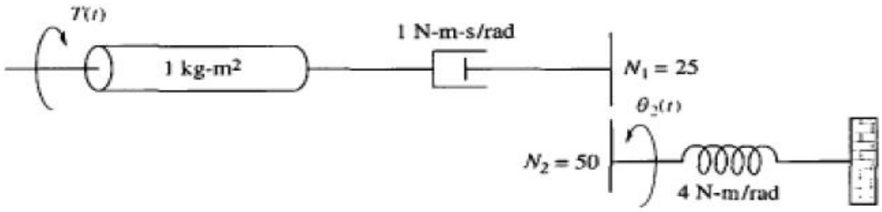

Figure 4

2B. Find the transfer function Y_2/Y_1 of the system shown in the figure 5 using Mason's gain formula **6**

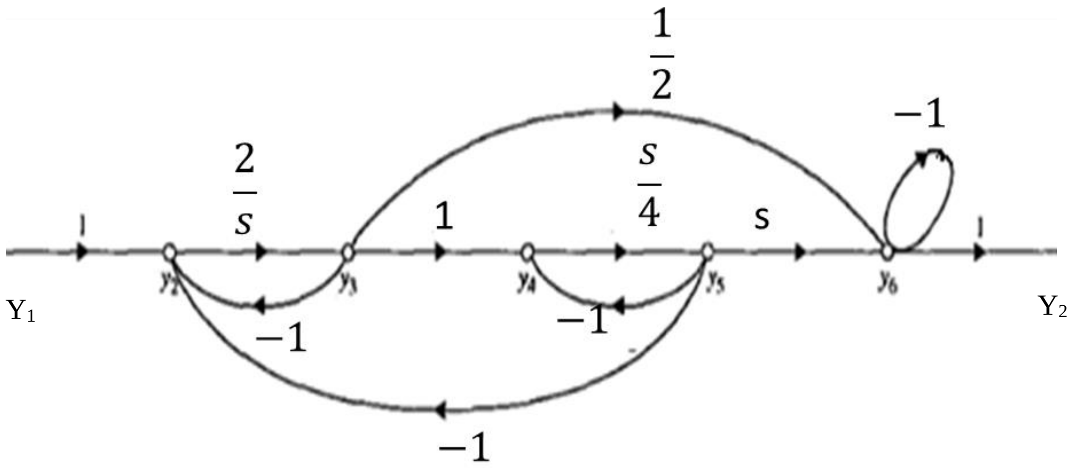

Figure 5

3A. Estimate the number of poles in the left half plane, the right half plane and on the jωaxis for the system given in the figure 6 **4**

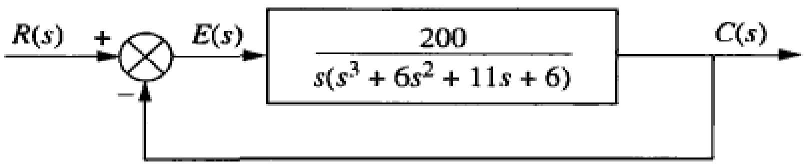

Figure 6

3B. Also comment on the stability of the system shown in **Qn 3A** **1**

3C. For the system $G(s) = 10(s+7)$,find the error using dynamic error coefficient method for input of $6+5t+\frac{6t^2}{2}$ at t=15s **5**

4A. Determine the frequency domain specifications(resonance peak, resonance frequency, BW, cut-off frequency)for the closed loop system with negative unity feedback if OLTF $G(s)=\frac{225}{s(s+6)}$ **3**

4B. Draw the Bode log-magnitude and phase plots for the system where $G(s)=\frac{5K}{(1+0.2s)(1+0.1s)(1+0.02s)}$ **5**

4C. Determine the system gain K for the gain cross over frequency to be 20 rad/s **2**

5A. Design a lag compensator for a plant with OLTF as G(s) = $\frac{1}{(s+1)(s+3)}$ to improve the steady-state error by a factor of 10 if the system is operating with 1.51 %overshoot. (The root locus of the plant is given in the figure 7). Verify the design. **5**

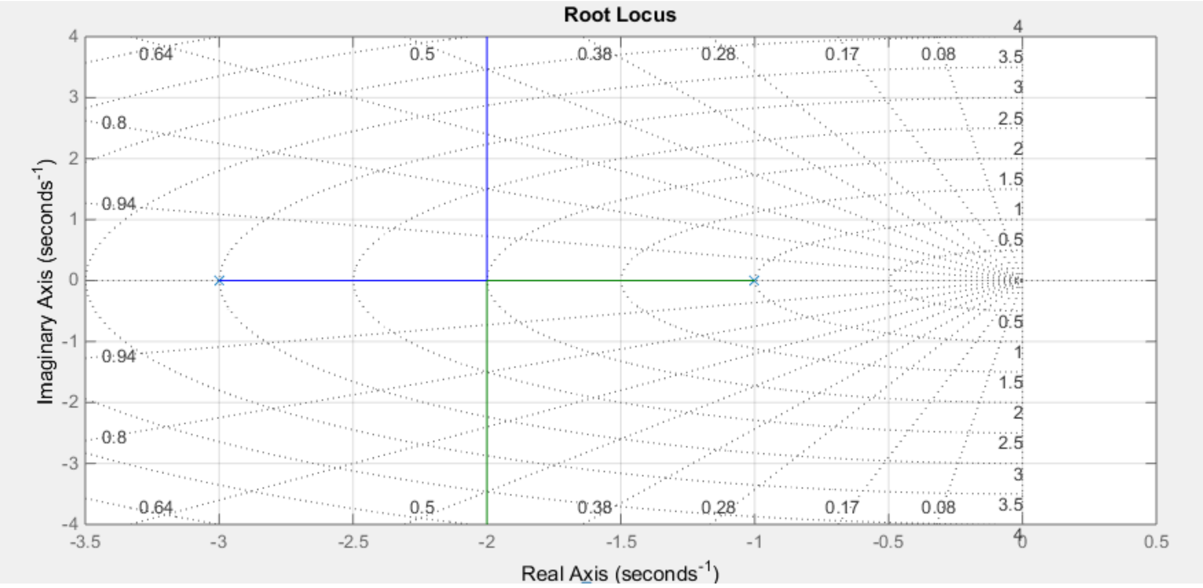

Figure 7

5B. For the rotational system shown in Figure 8, find the transfer function, G(s) = $\theta_2(s)/T(s)$. **5**

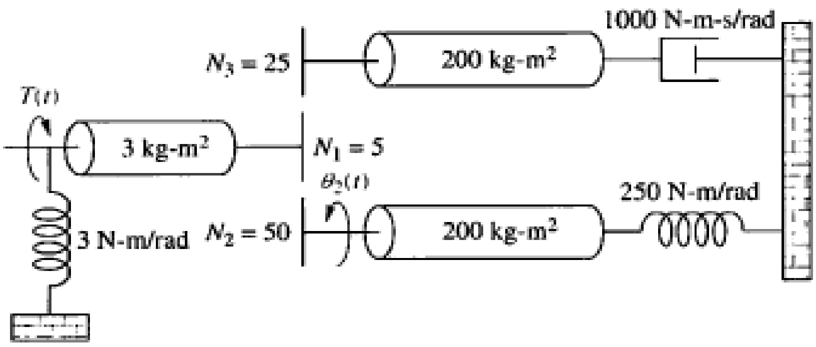

Figure 8

6A. Construct the root locus diagram of a negative unity feedback system with OLTF, **5**

$G(s) = \frac{K(s+2)}{(s+1)(s+3)(s+4)}$

6B. Design a passive compensator to yield a closed-loop step response with 17.8% overshoot with 2 fold reduction in settling time for the system described in **Qn 6A**. **3**

6C. Verify the design in **Qn 6B** **2**