Kafr El-sheikh University
Faculty of Engineering
Course code: MEP3110

Mechanical power engineering department
3rd Year final exam of 1st semester 2017 - 2018
Automatic control Time allowed: 3 Hours

The maximum mark for the examination paper is 90 marks, and the mark obtainable for each part of a question is shown in brackets alongside the question.

Question number one [40 Marks]

1. Modify the given block diagram to show how the closed-loop drug delivery system, drives a pump that injects the drug into the patient's blood could be digitally controlled. Afterward, clarify the role played by successive approximation register to produce the desired code. Assume that a voltage of 3.217V is the input to 4-bit ADC device with a dynamic range of 0 to 5V. Show how the ADC with successive approximation register arrive the digitized value for the output. [10 Marks]

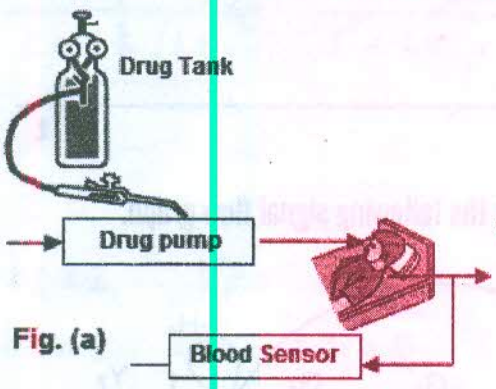


Fig. (a)

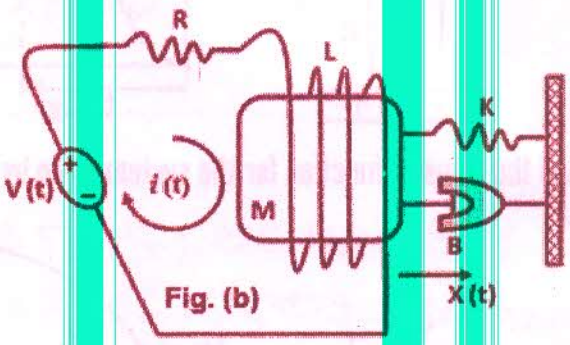


Fig. (b)

2. Find the overall transfer function for the electro-mechanical system given in Fig. (b). [12 Marks]
3. Consider the system whose open loop transfer function is given by;

$$P(s) = \frac{K(S-2)}{(S+3)(S^2+2S+17)}$$

a) Sketch the approximate root locus as K increases. [13 Marks]
b) By applying Routh's criterion to the system, find the range of K>0 such that the system is asymptotically stable. [5 Marks]

Question number two [50 Marks]

1. Tell me why lead compensator degrades steady state error performance. Given is a plant described by the following open loop transfer function

$$G(S)H(S) = \frac{10}{S(S+1)}$$

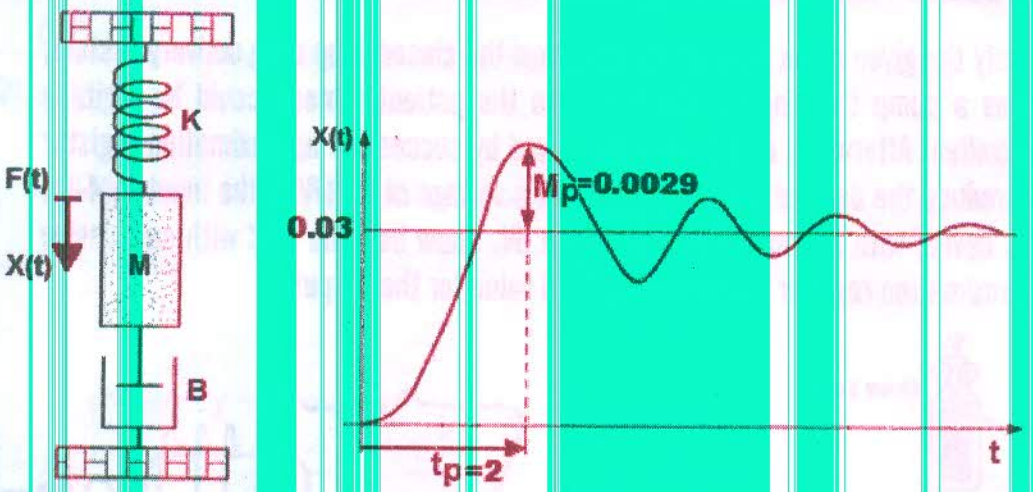
For this plant a lead compensator must be designed using root locus approach, such that the step response of the closed loop shows the following properties $M_P = 15\,\%$ and $T_D = 0.435$ and $e_{ss} \leq 0.2$. [15 Marks]

2. A second order system has an open-loop transfer function as:

$$G(S) = \frac{\omega_n^2}{S^2 + 2\xi\omega S + \omega_n^2} \quad \& \quad R(S) = \frac{1}{S}$$

a) Find and sketch both C(t) and e(t) given that, $0 < \xi < 1$. [10 Marks]

b) The following figure shows a mechanical vibratory system. When a force of "8.9 N" is applied to the system, the mass oscillates as that shown in the given time response. Find the values of M, B, and K. [15 Marks]



3. Find the transfer function for the system given by the following signal flow graph. [10 Marks]