UNIVERSITY OF RUHUNA

Faculty of Engineering

Mid-Semester 6 Examination in Engineering: October 2015

Module Number: ME 6319

Module Name: Automatic Control Engineering (Old Curriculum)

[Two Hours]

[Answer **all questions**, each question carries **five** marks]

Q1. a) Find the Laplace transforms of the following functions.

i. $f(t) = e^{-0.4t} cos 12t$

ii. $f(t) = sin(5t + \frac{\pi}{4})$

iii. $f(t) = t^2 e^{-at}$

[3 Marks]

b) Find the inverse Laplace transforms of the following functions.

i. $F(s) = \frac{5s + 2}{(s + 1)(s + 2)^2}$

ii. $F(s) = \frac{s + 1}{s(s^2 + 2s + 2)}$

[2 Marks]

Q2. Obtain the transfer function $X_1(s)/U(s)$ and $X_2(s)/U(s)$ of the mechanical system shown in Figure Q2 with usual notations.

[5 Marks]

Q3. Figure Q3 shows a block diagram of a speed control of a turbine, in which b=0.1 and J=1. Determine the transfer functions $\Omega(s)/R(s)$ and $\Omega(s)/D(s)$ and hence determine the steady state error for (a) unit-step input and (b) for a unit-step disturbance. Also obtain the time response for a unit-step input assuming $K_1 = 1$.

[5 Marks]

Q4. Figure Q4 shows a speed control system where the wheel and motor dynamics is given by;

$$G_p(s) = \frac{s + 6}{(s + 2)(s + 4)}$$

A controller is designed as;

$$G_C(s) = \frac{K}{s + 9}$$

For a unit step-input, under no external disturbances, it is desired to have the steady-state speed within 5% of the desired speed (steady-state error should be 5%). Determine the required gain K to achieve the steady-state requirement. For this gain, determine the steady state error for unit step disturbance ($T_d = 1/s$) when $R(s) = 0$.

[5 Marks]

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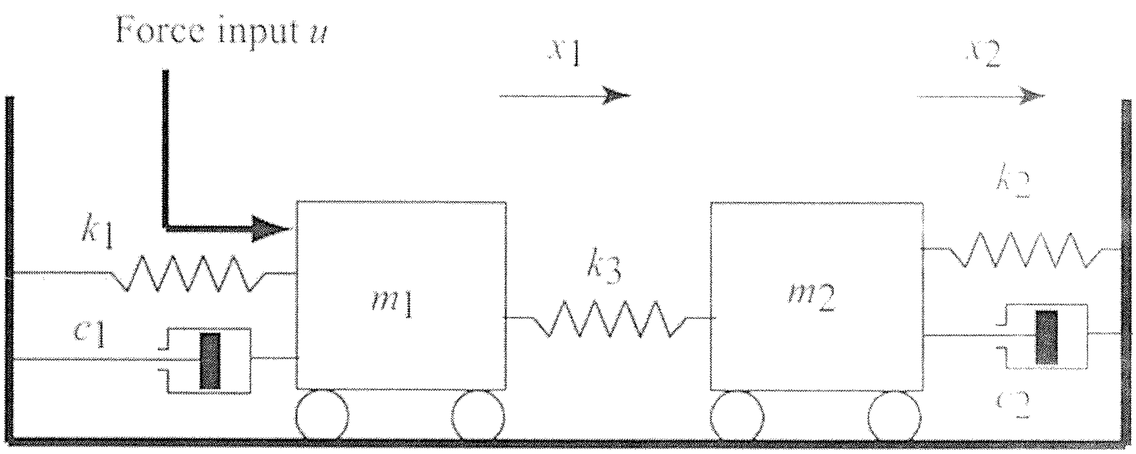
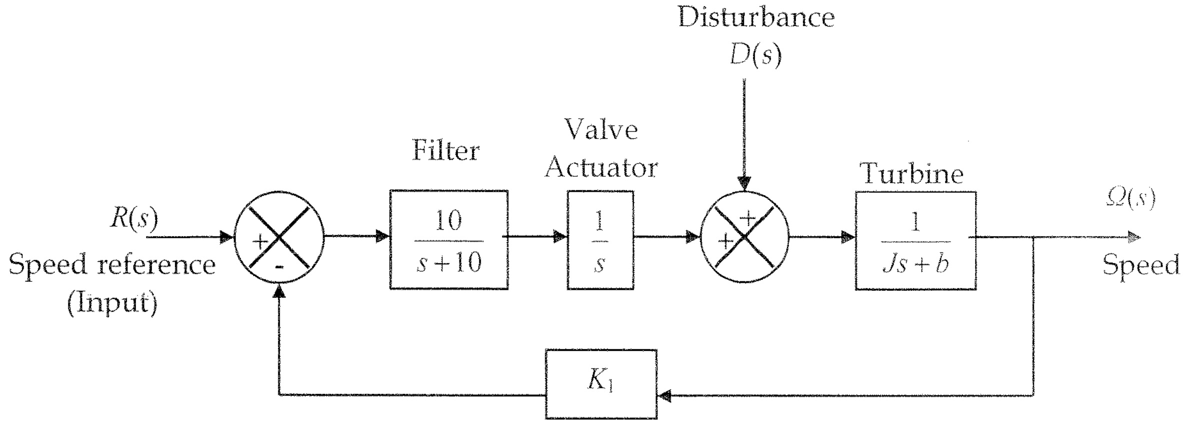


Figure Q2



K_1, J and b are constants, and other representations follow the usual notations

Figure Q3

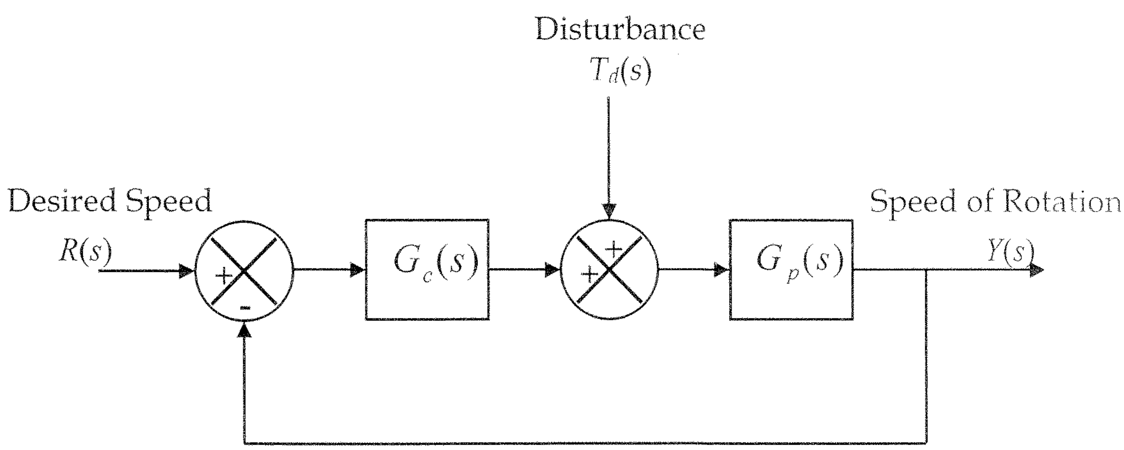


Figure Q4