Tutorial 1

1. Write an essay on brief history of control system development. Include major historical developments in control engineering with its importance in modern society.

2. What is control system? Differentiate control system with their block diagram, advantages and disadvantages. Why closed loop control system are preferred in automation?

3. Describe a closed loop control system with an example. What is the importance of feedback on closed loop control system?

Tutorial 2

1. Explain the stages of control system design and analysis.

2. Describe typical sensors that can measure each of following:
   (a) Linear position
   (b) Velocity
   (c) Temperature
   (d) Pressure
   (e) Force

3. Describe the typical actuators that can convert the following:
   (a) Fluidic energy to mechanical energy
   (b) Electrical energy to mechanical energy

4. What is mathematical modelling? Explain the term accuracy vs complexity in mathematical modelling.

5. Describe the block diagram of the speed control system of a motorcycle with a human driver.

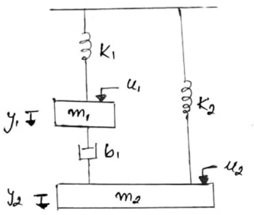
6. An automobile driver uses a control system to maintain the speed of the car at a prescribed level. Sketch a block diagram to illustrate this feed back system.

7. Obtain the systems of differential equation describing the dynamics of following mechanical system and find the respective transfer functions.
   (a) Find the transfer function $\frac{Y_1(s)}{U_2(s)}$ and $\frac{Y_2(s)}{U_1(s)}$ in system shown in figure 1.a
   (b) Find the transfer function $\frac{X_2(s)}{F(s)}$ and $\frac{X_1(s)}{F(s)}$ for system shown in figure 1.b.
   (c) Obtain the transfer function $\frac{X_1(s)}{X_2(s)}$ for the system 1.c
   (d) For the rotational system shown in figure 1.d, find the transfer fucntion $\frac{\theta(s)}{\tau(s)}$.
   (e) Obtain the equivalent diagram with out gears in the system shown in figure 1.e and find the transfer function $\frac{\theta(s)}{\tau(s)}$

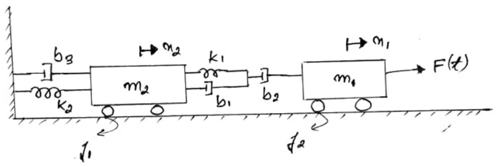
8. Obtain the systems of differential equation describing the dynamics of following electrical system and find the respective transfer functions.
   (a) Figure 2.a shows a typical differenciator circuit using op-amp. Obtain the transfer fuction $\frac{V_o(s)}{V_i(s)}$ of the system.
   (b) Figure 2.b shows a typical filter circuit used in ac circuits. Find the transfer function $\frac{V_{out}(s)}{V_{in}(s)}$ for the system.
   (c) Obtain the transfer function $\frac{V_{out}(s)}{V_{in}(s)}$ for typical op-amp circuit shown in figure 2.c.
   (d) Figure 2.d shows a RC ladder circuit. Find the transfer function $\frac{V_o(s)}{V_i(s)}$.

9. Discuss on the importance of analogous systems. Draw the F-V and F-I analogous circuit for the mechanical system shown in figure 1.a to 1.d.

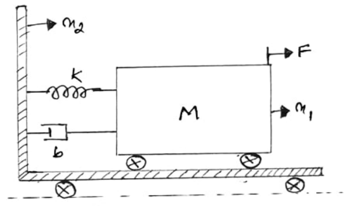
10. What do you mean by non-linear system? Explain with examples. How would you approximate non-linear mathematical models into linear mathematical model around the equilibrium point? Why should we have to linearize?



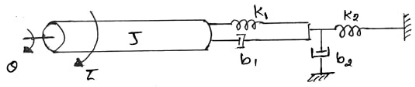
1.a



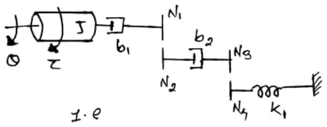
1.b



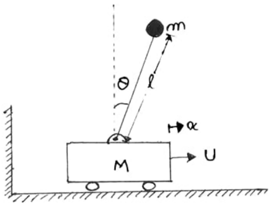
1.c



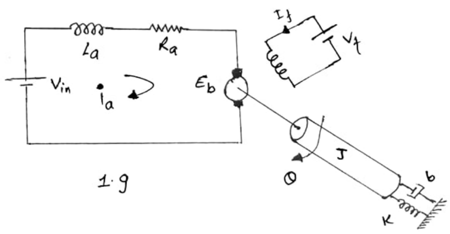
1.d



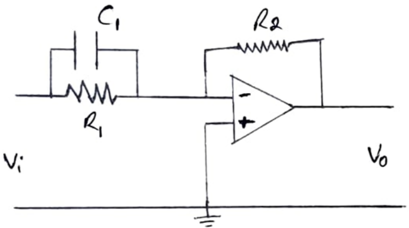
1.e



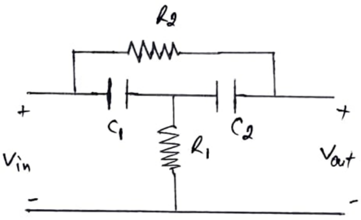
1.f



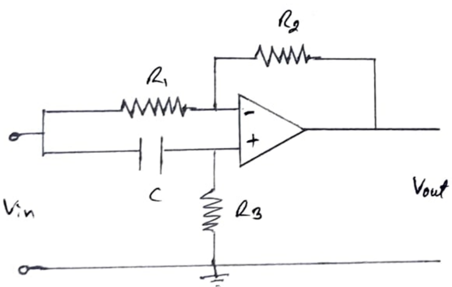
1.g



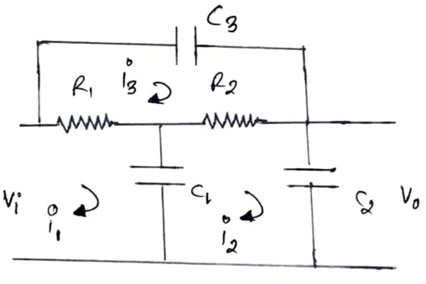
2.a



2.b



2.c



2.d

11. The mathematical model of the simple pendulum is given as:

$$\frac{d^2\theta}{dt^2} + \frac{g}{l} sin\theta = 0 \tag{1}$$

How would you get the solution for θ. (you have to linearize before getting solution). Discuss on the topic.

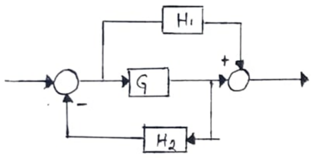
12. Obtain the system of equation for the dynamics of inverted pendulum as shown in figure 1.f. Perform linearization around the poing $\theta = 0$ (upright position) and obtain the transfer function $\frac{\theta(s)}{U(s)}$

13. Linearize the following non linear equation around the point $x = 2$

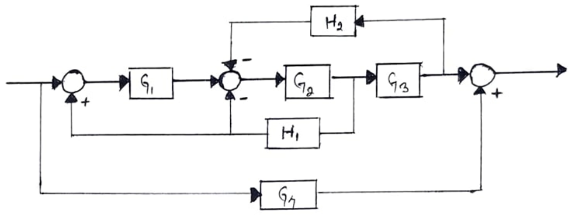
$$y = 0.1x^3 \tag{2}$$

14. Represent the armature controlled DC motor in block diagram and reduce to obtain the overall transfer function.

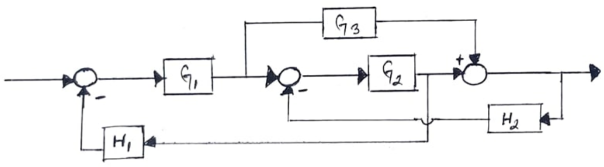
15. Perform block diagram reduction for the following problems using block diagram reduction algebra.



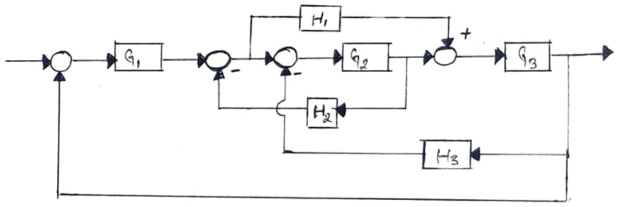
3.a



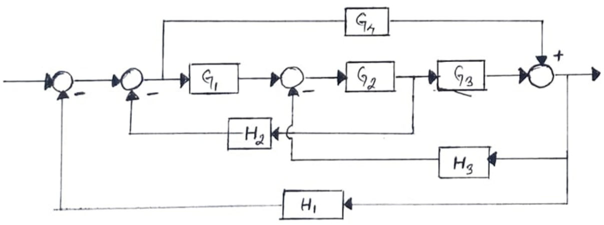
3.b



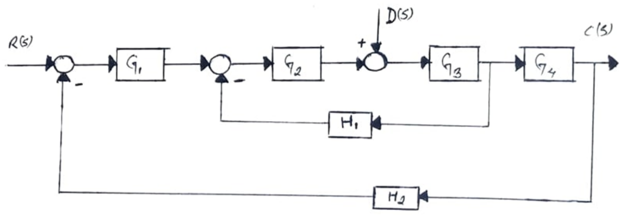
3.c



3.d



3.e



3.f

16. Represent the block diagrams shown above with signal flow graph and Obtain the transfer function between output and input using Mason Gain Formula.