Bachelor of Engineering (Mechanical Engineering) - Fourth Year - Second Semester, 2024

Subject: Electrohydraulic Control Systems

Time : Three hours **Full Marks: 100**

*Answer any **five** questions*

1. (a) What is the requirement of a Pressure reducing valve in an intensifier circuit?

   (b) Neatly sketch a schematic diagram of a 4 way 3 position under-lapped Direction Control Valve (hand operated).

   (c) Justify the statement: 'Meter out circuits are hydraulically more efficient than meter in circuits'.

   (d). Justify the statement: 'Positive displacements pumps are preferred over rotodynamic pumps in case of fluid power applications'. **[5×4]**

2. (a) Briefly describe the operation of a *regenerative* circuit, as used in a fluid power system, with the help of a neat sketch.

   (b) Briefly describe the operation of a *sequencing [1-2-1-2]* circuit, as used in a fluid power system, with the help of a neat sketch. **[8+12]**

3. (a) Explain the function of a pressure-compensated flow control valve with a neat sketch and explain its advantage over a simple flow control valve.

   (b) With a neat sketch, describe the operation of a two stage pressure relief valve and mention it's advantage over a single stage PRV. **[10+10]**

4. (a) Explain how a tandem-centred 4-way DCV can be used for multi cylinder actuation.

   (b) For the system with transfer function $G(s) = C(s)/R(s) = 2(s^2+9s+19)/ (2s^3+s^2+2s+1)$, what are the poles and zeroes. Indicate them in the Argand diagram and comment on the stability of the system. **[08+12]**

5. (a) Consider a tank of cross-sectional area A being filled with a liquid. The liquid flows out of the tank through a pipe of equivalent hydraulic resistance R_h. For a step input of inflow q_i, obtain the differential equation relating instantaneous water level $h(t)$ and q_i. Draw the block diagram and obtain the system transfer function. Hence obtain the response $h(t)$ as a function of time for a step input $q_i(t) = q_o$. Comment on the stability of the plant.

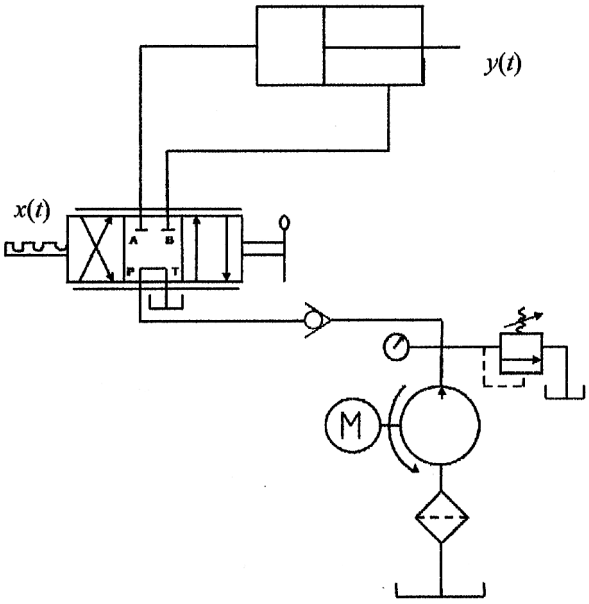
   (b) In the previous problem, suggest how a Proportional controller can be implemented. Comment how stability and speed of response can be affected by tuning the controller parameter (s). **[10+10]**

6. (a) What is the main drawback of a P controller? State how a PI controller can overcome the this drawback.

   (b) Using *Routh's Criteria,* comment on stability of the system with characteristic equation

   $$3s^5 + 4s^3 + 2s^2 + 2s + 5 = 0$$ **[8+12]**

7.



Explain the symbols in the above figure. Consider an actuating mass m and an appropriate form of cylinder friction to obtain the differential equation relating $x(t)$ & $y(t)$ during piston extension assuming oil as incompressible. **[20]**