

B.E. MECHANICAL ENGINEERING
THIRD YEAR SECOND SEMESTER EXAMINATION 2025
ELECTROHYDRAULIC CONTROL SYSTEMS

Time: Three Hours

Full Marks: 100

Question 1 is compulsory. Answer any four from the rest.

All the parts of a question must be answered together.

All abbreviations have the usual meanings

Question 1 is compulsory

1. (a) What are basic components of an electrohydraulic system?
- (b) What are the symbols of fixed displacement, variable displacement and pressure compensated variable displacement pump?
- (c) Explain for which type of cylinders a regenerative circuit is used.
- (d) State Routh's Criterion for stability of a linear system? [4x5=20]

Answer any four from the rest

- [2] (a) With the help of a symbolic diagram, explain the working of a hydraulic circuit with meter-out for both extension and retraction of a double-acting cylinder.
 - (b) Discuss the relative advantages and disadvantages electrohydraulic, mechanical and electrical systems for power transmission. Name two different fluids used in electrohydraulic systems. [10+10=20]
 - [3] (a) What is the role of an accumulator in a hydraulic system? Explain its application through a circuit diagram for a bi-directional motion control hydraulic system with a double-acting double rod cylinder, a solenoid operated 4/3 PV, an accumulator with a counterbalance valve and a fixed displacement pump with a PRV and CV.
 - (b) Obtain expressions for steady state flow force on a three-land spool valve. What is the steady-state flow force stiffness? [10+10=20]
 - [4] Consider an electrohydraulic circuit with a fixed displacement pump, relief valve, critically lapped proportional valve and a single-rod double-acting cylinder driving a spring load. Obtain an expression for the feedforward excitation signal to the valve solenoid for the extension stroke (positive cylinder piston velocity) of the piston by assuming oil as incompressible. Assume suitable symbols. [20]
 - [5] What is the advantage of using a variable displacement pump over a fixed displacement pump? With the help of a schematic, describe the working of the pressure compensation arrangement in a variable displacement swash plate type axial piston pump. [20]
 - [6] (a) For transfer function $G(s) = \frac{2(s+5)}{(s^2+4s+13)}$, what is its characteristic equation? Find system poles and zeroes. Comment on the stability of the system.
 - (b) Find the gain K_T which makes the loop shown, critically damped. [10+10=20]
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- [7] Using Routh's Criterion, indicate the stability of the following characteristic equation:

$$s^5 + s^4 + 5s^3 + 5s^2 + 4s + 4 = 0$$
[20]
 - [8] (a) What is meant by steady state error of a system? Show that the steady error $e(t)$ can be expressed as $\lim_{s \rightarrow 0} [sE(s)]$. Hence show that for a closed-loop system with unity feedback (feedback path transfer function $H(s)=1$) and forward path transfer function $G(s)$ with input $D(s)$, the steady state error can be expressed as $e_{ss} = \lim_{s \rightarrow 0} [sD(s)/\{1 + G(s)\}]$.
 - (b) Define a PID controller and express its transfer function. [15+5=20]
 - [9] Write short notes on any 4 (four): (a) Pressure relief valve; (b) Lap conditions in spool valve; (c) Sequence circuit; (d) Transient state flow force; (e) Force constant of a solenoid motor; (f) Open and closed loop systems. [4x5=20]