B.E. MECHANICAL ENGINEERING 3rd Year 2nd Semester Examination, 2018

Subject: Electrohydraulic Control Systems

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

Group A

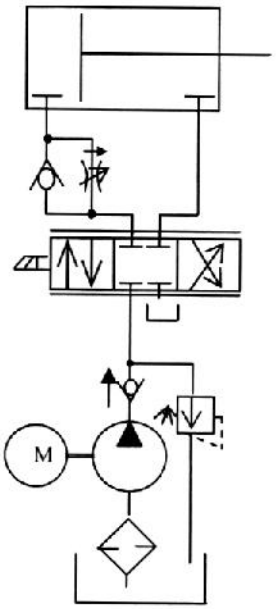
[Answer any two]

1(a) Design a suitable circuit for the following operation:

An workpiece is to be clamped at first after being moved from its initial position to some other suitable position, then a piercing operation requiring high force is to be done on the same, afterwards the tool and the workpiece are to be retracted back in their initial positions simultaneously one after the other. **[12]**

(b) Discuss the role of an *accumulator* in a fluid power circuit. **[08]**

2(a) Redraw the circuit with necessary corrections, label the components and name the circuit. **[10]**



(b) What is the reason of having multiple cylinders in an axial-piston pump? **[05]**

(c) Why the spring of the pilot valve of a two-stage relief valve has higher stiffness than that of the main valve? **[05]**

3(a) Consider a circuit with valve connections in a manner such that an unequal area actuator could be operated either with usual supply from a pump and return to a reservoir for both extension and retraction strokes or with regeneration for the extension stroke. A 4-way 3-position direction control valve and a 3-way 2-position direction control valve are to be used in the circuit along with a pressure relief valve. Consider 40 *mm* bore diameter and 15 *mm* rod diameter for the cylinder with 0.2 *l/s* supply at 10.0 MPa pressure to find all possible normal and regenerative speeds in both directions, and normal and regenerative thrusts available at the actuator during the extension stroke. **[10]**

(b) What is the requirement of a pressure reducing valve in an intensifier circuit? **[05]**

(c) With a neat sketch discuss the working principle of a pilot operated check valve. **[05]**

Group B

[Answer any one]

4. Consider a plant comprising of a critically lapped servovalve and a symmetric actuator negotiating an external load. Considering compressibility effect of the oil in the cylinder and orifice flow in the metering ports, model the system with the spool displacement as the input and the actuator displacement as the output. **[20]**

5. Consider a single solenoid motor driving a spring-loaded external mass against stiction and Stribeck friction. Obtain a mathematical model of the system with current in the solenoid as the input and the displacement of the mass as the output. **[20]**

Group C

[Answer any one]

6(a) For the system with transfer function $G(s) = \dfrac{5(s+0.5)}{s^2+11s+18}$, what are the characteristic equation, poles and zeroes? Why is the characteristic equation so called? **[3+4]**

(b) Find the time domain response for a unit step input to a system with transfer function $G(s)=\dfrac{1}{s^2+s+10}$. Comment on the difference that the system overshoot would undergo, if the coefficient of s in the denominator is increased from 1 to 2. **[5+3]**

7. For the system with transfer function $G(s) = \dfrac{5(s+0.5)}{s^2+11s+18}$, obtain the equations for system gain and phase variations with frequency and sketch the Bode plots for each. **[15]**

Group D

[Answer any one]

8(a) Show that corresponding to a step demand to a system, the steady state error is a non-zero constant and zero respectively for a P and an I controllers. **[10]**

(b) Find the condition of system robustness for a system with transfer function G operated with a transfer function H in the feedback path. **[05]**

9. Find the number of unstable poles for the system with characteristic equation $s^5+2s^4+3s^3+6s^2+2s+1=0$. **[15]**

Group E

[Answer any one]

10. Consider a hydraulic circuit comprising of a symmetric actuator under constant external load and a solenoid operated servovalve fed by a constant pump pressure. Design a feedforward position controller for the extension stroke for negligible actuator friction. **[10]**

11. A linear force motor with force constant k_f and magnetic elastance k_m drives a mass m against a fixed external force F and friction force $F_f = F_0 - \alpha(dx/dt)$, where x is the displacement. Find an expression for feedforward current and the constrain condition for the derivative gain that would lead to a stable design. **[10]**