B. MECHANICAL 3RD YR 2ND SEMESTER EXAMINATION 2019

ELECTROHYDRAULIC CONTROL SYSTEMS

Time: Three Hours **Full Marks: 100**

*All the parts of a **Module MUST** be answered **TOGETHER.***

Notations should be properly described.

Module: 1 (20 Marks)

1. Answer any **four.** **[4x5=20]**

   i) Outline the purpose of an electrohydraulic system. State some applications of such systems.

   ii) With the help of a simple sketch briefly describe the working of a solenoid-operated 4/3 on-off DCV.

   iii) Draw the symbols of different types of displacement pumps. Why is positive displacement pump preferred over rotodynamic pump in a hydraulic control circuit?

   iv) State the roles of an accumulator and an intensifier in a hydraulic circuit.

   v) Find the relation between normal extension speed and regenerative extension speed in terms of actuator sizing.

   vi) Draw a manually controlled meter-in circuit with the help of symbolic diagram. Why a separate flow control valve is not required if a proportional valve is used in the above circuit?

Module: 2 (20 Marks)

Answer any **two**

2. A double acting double rod cylinder is connected with a three landed spool valve. Considering compressibility, obtain the relation between the valve flow rate and pressure inside the actuator chamber. Also find the equation of piston motion stating necessary terms. **[10]**

3. What is meant by jet angle at a metering port of a spool valve? Obtain an expression for steady-state flow force on a four-land spool valve. **[10]**

4. Consider an armature with one of the flat end of its cylindrical core maintained at a gap from the similar core of a solenoid by a mechanical spring. The other end of the armature is connected to an external mass meant to slide on a solid horizontal surface corresponding to the excitation current in the solenoid coil. Obtain the equation of motion of the mass, the final 'steady' state displacement and comment on the stability corresponding to a constant current input in the solenoid and the opposing friction as constant. **[10]**

Module: 3 (20 Marks)

Answer any **two**

5. Draw a sketch showing feedback control with man-machine interface implemented in an electrohydraulic actuation system. **[10]**

6. (a) Discuss the relative merits and demerits of open-loop and closed-loop control systems.
   (b) Explain the term parameter variation in the context of a feedback control system in terms of flight control of an aircraft. **[5+5=10]**

7. (a) A closed-loop system provides performance enhancement through accurate feedback of the output measurement, nullifying uncertainties of the system modelling to a great extent. Justify the statement.

   (b) Define a PID controller and express it in transfer function form. **[6+4=10]**

Module: 4 (20 Marks)

Answer any **one**

8. Discuss the roles of the feedforward and the feedback in the control of a nonlinear system, when applied together. **[20]**

9. (a) Define steady state error.

   (b) Using usual notation, obtain an expression of steady error of a 1st order system under proportional controller with unity feedback and step demand. What is expected with change in the order of the system?

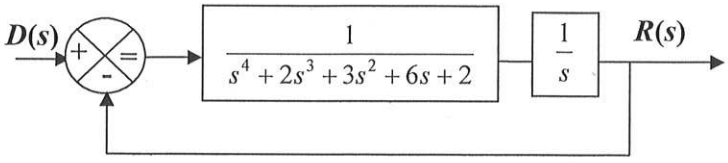
   (c) Find the steady state error for the same system with integral controller. **[4+10+6=20]**

Module: 5 (20 Marks)

Answer any **two**

10. A dynamic system is represented by $\dddot{r}+2\ddot{r}+2\dot{r}+r=d(t)$ having an input $d(t)$ and output $r(t)$. Obtain the system transfer function and find the poles and zeroes of the transfer function. Obtain response $r(t)$ for a unit step input of $d(t)$. Comment on the rate of decays associated with the poles. **[10]**

11. For the closed loop system shown below, find the equivalent open loop transfer function and comment on its stability using Routh's criterion. **[10]**



12. Starting from a general transfer function, obtain the Bode plot for a typical 1st order system. **[10]**