PART C — (1 × 15 = 15 marks)

16. (a) The operation of a hydraulic punching press requires three hydraulic linear actuators one each for clamping the job, actuating the press and moving the finished part to a moving conveyor. The actuator of the punching press is to remain in the extended position (punching takes place) for 5 seconds. The cycle should continue until 100 parts are produced and should be restarted manually. The pressure should not exceed 40 bars for the press and 70 bars for the entire circuit.

(i) Draw the hydraulic power circuit and select the appropriate valves to be used to balance the self-load of the press in the vertical direction. Provide a meter-in flow control circuit to control the extension speed of the clamping cylinder to prevent damage to the component and select appropriate sensors that can be used for identifying the end positions of the actuators. (5)

(ii) Develop an electrical control circuit to execute this task. In addition, an instantaneous stop module is to be incorporated. (10)

Or

(b) The operation of a drilling machine requires three pneumatic linear actuators one each for clamping the job, spindle feed and moving the finished part to a moving conveyor. Identify the sequence of operation, provide a pneumatic power circuit and develop an electrical control circuit along with an emergency module that will stop the sequence at the end of the commenced step. The sequence commences on pressing a start switch and should continue until a stop switch is pressed.

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Question Paper Code : 30259

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2023.

Fourth Semester

Mechanical Engineering

ME 3492 — HYDRAULICS AND PNEUMATICS

(Common to Mechanical Engineering (Sandwich))

(Regulations 2021)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define flash and fire points. How is it relevant in the selection of hydraulic fluid?

2. What are pump characteristic curves? Draw the same for the positive displacement pumps.

3. Draw the cut sectional view of cushioning mechanism in a linear actuator.

4. List out the basic types of filtering methods used in a fluid system.

5. What are the factors to be considered while designing a hydraulic circuit?

6. An intensifier with an intensification ratio of 20:1 is being used in a system with a maximum pump pressure of 7000 KPa and a flow rate of 40 LPM. What are the flow rate and the pressure output of the intensifier?

7. State the need for Quick Exhaust Valve in pneumatic circuits.

8. With a neat sketch, illustrate the operation of an electrical timer.

9. Write three sources of heat generation in a hydraulic system.

10. What three devices are commonly used in the troubleshooting of hydraulic circuits?

PART B — (5 × 13 = 65 marks)

11. (a) A hydraulic cylinder is to compress a body down to bale size in 10s. The operation requires a 3 m stroke and a 40000 N force. If a 10 MPa pump has been selected, assuming the cylinder to be 100% efficient, find

(i) The required piston area

(ii) The necessary pump flow rate

(iii) The hydraulic power delivered to the cylinder

(iv) The output power delivered to the load

(v) Also, solve parts (i) to (iv) assuming a 400 N friction force and a leakage of 1 LPM. What is the efficiency of the cylinder with the given friction force and leakage?

Or

(b) A pump has a displacement volume of 120 cm^3. It delivers 0.0015 m^3/s at 1440 RPM and 60 bar. If the prime mover input torque is 130 Nm.

(i) What is the overall efficiency of the pump? (6)

(ii) What is the theoretical torque required to operate the pump? (4)

(iii) The pump is driven by an electric motor having an overall efficiency of 88%. The hydraulic system operates 12 hours/day for 250 days per year. The cost of electricity is Rs 8 per kWh. Determine the yearly cost of electricity to operate the hydraulic system. (3)

12. (a) 'A vertical punching machine requires a hydraulic valve to prevent the piston from free falling due to gravity' — with a neat sketch, design a hydraulic circuit appropriate for this application. Also, explain the construction and working principle of the hydraulic valve.

Or

(b) (i) A hydraulic motor receives a flow rate of 72 LPM at a pressure of 12000 kPa. If the motor speed is 800 RPM and if the motor has a power loss of 3 kW, find the motor's actual output torque and overall efficiency. (6)

(ii) Define the displacement and torque ratings of a hydraulic motor. (4)

(iii) Why the torque output from a fixed-displacement hydraulic motor operating at constant pressure is the same regardless of speed changes? (3)

13. (a) Design the circuits for the following applications:

(i) Synchronous actuation of two similar hydraulic actuators (5)

(ii) Fail-Safe Operation (4)

(iii) Regenerative (4)

Or

(b) (i) With a block diagram explain the working of electro-hydraulic servo valves. (6)

(ii) What are proportional valves? Explain how to control the force and spool position in proportional hydraulic valves. (7)

14. (a) Construct a pneumatic sequential circuit for the sequence $A+B+B-C-C+A-$ using the cascade method and incorporate a cycle selection module.

Or

(b) Badges are to be produced from a very thin metal sheet. A press with a stamping die is available for this purpose. The double-acting cylinder should extend when both the push buttons S1 and S2 are pressed simultaneously. The return stroke is to occur automatically only after the forward end position and preset pressure have been reached to get consistent quality. The cylinder should immediately retract if the emergency push button S3 is pressed. Draw an electro-pneumatic ladder diagram for the above application.

15. (a) (i) Discuss the criteria for the selection of cylinders. (5)

(ii) Briefly explain the important factors in the maintenance of hydraulic and pneumatic systems. (8)

Or

(b) (i) Draw the schematic layout of a typical hydraulic power pack and explain the function of its elements. (7)

(ii) Discuss compressors and their classifications in detail. Also, discuss the various stages of air treatment. (6)