

OLLSCOIL NA hÉIREANN
The National University of Ireland

National University of Ireland, Galway.

Trinity Examinations, 1998/99.

Third Year Mechanical and Biomedical Engineering Examination

AUTOMATED SYSTEMS

Professor J.J. O' Connor

Professor P.J. Nolan

Dr. P. Molloy

Attempt Five Questions.

Time Allowed: 3 Hrs.

1. Explain the operation of the following electro-pneumatic components and give examples of them in circuit schematics.

- (i) Quick exhaust valve
- (ii) 3/2 way valve
- (iii) 5/2 way valve
- (iv) pilot operated valve
- (v) solenoid
- (vi) reed switch
- (vii) relay
- (viii) capacitive and inductive proximity switch
- (ix) pneumatic/electrical convertor.

(20)

2. A form tool is to press a metal plate. Extension of the piston rod must be disabled until the supply pressure to the control valve reaches a preset pressure as measured by an adjustable pressure switch. Providing the preset pressure is reached, the operation of two push button switches advances the form tool. The advance and return speeds are to be adjustable. The piston rod must return when either push button is released.

Design an electro-pneumatic system, showing both pneumatic and electrical circuits, which can be used to control this pressing operation. (20)

3. A toggle lever clamp using a double acting pneumatic cylinder is used to clamp a workpiece at a drill station. The clamp is actuated by either of two push buttons and a further push button is used to control declamping. Use a capacitive proximity switch to detect if the workpiece is present and use an inductive proximity switch to ensure that the drill is fully retracted prior to unclamping the workpiece.

Design an electro-pneumatic system to control the operation of the clamping station and show both pneumatic and electrical circuits. (20)

4(a) Explain how any two of the following hydraulic circuit components operate:

- (i) poppet and spool valves when used as pressure relief valves
- (ii) bent axis piston pumps,
- (iii) axial and radial piston motors. (8)

(b) Design a simple electro-hydraulic press. The press uses two hydraulic cylinders - one to clamp the workpiece and the other to create the impression. Clamp and press operation are activated by operating electric switches which in turn activate solenoid valves. Pressure is supplied by a gear pump driven by an electric motor.

Show both hydraulic and electrical circuits and indicate what each component in your circuit is and what function it performs. (12)

5. Show, using sketches, the different types of accumulator available. Draw schematic diagrams for the following showing how accumulators are incorporated in the following designs :

- (i) leakage oil compensation (10)
- (ii) emergency operation of bearings (10)

6. A PLC is required to control a machine which counts and divides components into batches of either ten (A) or twenty (B) as they move past a sensor on a conveyor. A pneumatically operated flap deflects components down either routes A or B depending on the signal received from the PLC. Thus, the machine alternately directs ten components down route A, followed by 20 down route B, after which it resets itself and repeats the process.

Design an electro-pneumatic system with PLC control to effect this batching operation. Show the pneumatic, electric, ladder logic circuits and code used in your design and describe clearly how it operates. (20)

7(a) Describe the operation and use of the following:

- (i) set and reset of an auxiliary relay, (4)
- (ii) a timer circuit, and (4)
- (iii) a cascaded counter circuit. (4)

(b) Describe how a 'one-shot' timer circuit may be implemented using ladder symbols. (8)