

Wednesday 6 January 2016 – Afternoon

PRINCIPAL LEARNING LEVEL 3 ENGINEERING

F559/01 Instrumentation and Control Engineering

Candidates answer on the Question Paper.

OCR supplied materials:
None

Other materials required:

- Scientific calculator

Duration: 2 hours



Candidate forename		Candidate surname	
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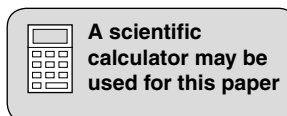
Centre number						Candidate number				
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INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions in **Section A** and any **four** questions from **Section B**.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is **60**.
- This document consists of **20** pages. Any blank pages are indicated.



SECTION A

Answer **all** questions in the spaces provided.

- 1 Draw a labelled block diagram of a system showing control, output and input blocks.

[3]

- 2 State which one of the following terms relates to the definition given below:

- feed – backward
- open loop control
- feed – forward
- closed loop control.

Definition:

A pathway within a system which passes a controlling signal from an external source to a load elsewhere in its external environment.

..... [1]


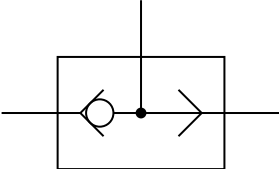
- 3 Name the controller in which a 'steady state error mode' will not occur when there is a change to the set value of the control system.

.....
..... [2]

- 4 Calculate the cross sectional area of a pneumatic cylinder piston when the force exerted by the out-stroking piston is 10 kN and the working pressure in the cylinder is 5000 kNm⁻².

.....
.....
.....
..... [2]

5 Complete the table by naming each component from its graphical symbol shown.

Graphical symbol	Component
	
	

[2]

6 Explain what is meant by the term 'piezo-electric sensor'.

.....

.....

..... [2]

7 State **two** problems associated with using wire cables to transfer signals over a long distance.

1

2

[2]

8 Name **two** control circuit simulation software packages.

1

2

[2]

9 Give **two** applications of a strain gauge.

.....
.....
..... [2]

10 Explain how simulation software can be of benefit to a design engineer.

.....
.....
.....
..... [2]

[Total: 20]

5
SECTION B

Answer any **four** questions in the spaces provided.

1 (a) Fig. 1 shows a block diagram of a control system.

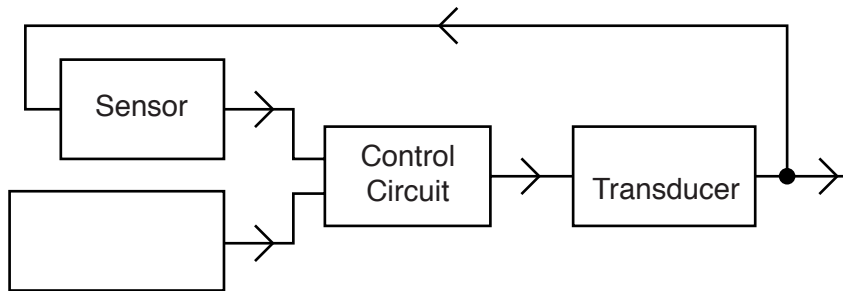


Fig. 1

(i) Name the type of control system shown in Fig. 1.

..... [1]

(ii) Label the block diagram with the terms:

Feedback pathway
Input
Output.

[3]

(b) An amplifier has an overall gain of 500 with open loop gain of 100.
Calculate the feedback fraction when positive feedback is applied.

.....
.....
.....
.....
.....
.....
.....
.....
..... [6]

[Total: 10]

2 (a) Describe the operation of an LED.

.....
..... [2]

(b) (i) Draw a labelled circuit diagram showing an LED in series with a 500 R resistor connected to a +9V supply.

[3]

(ii) Explain the purposes of the 500 R resistor in the LED circuit.

.....
.....
..... [2]

(c) An LED rated at 2V 10mA is connected through a series resistor to a 6V supply.

Calculate:

(i) the potential difference across the resistor

.....
..... [1]

(ii) the value of the resistor.

.....
..... [2]

[Total: 10]

3 (a) State **two** functions of pneumatic components.

1

.....

2

.....

[2]

(b) Fig. 2 shows a pneumatic signal inversion system.

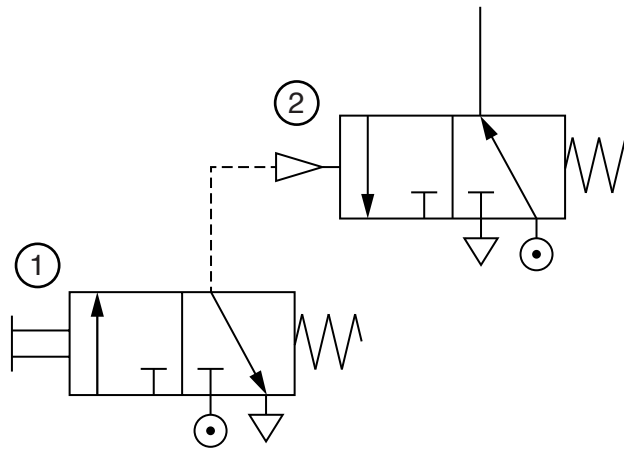


Fig. 2

(i) Name the type of control valve that is being used in this system.

..... [1]

(ii) State by what means control valve 1 is being operated.

.....

..... [2]

(iii) Complete the explanation of how this circuit works.

When operating control valve 1, control valve 2 will

When control valve 1 ceases operation and is restored to its original position, control valve 2 will

Therefore, at any given time, the pressure output of control valve 1 is control valve 2.

In logic terms this is gate.

[5]

[Total: 10]

- 4 (a) Complete the table below by matching an application from the following list to each type of control system:

Process vessels
Burglar alarm
Multiplexing
Factory production lines
A/D Converter
Power assisted steering systems.

Control System	Application
Servo	
Temperature	
Positional	

[3]

- (b) Name a signal processing element that could be used in the following situations:

- (i) To select one of a number of analogue signals for further processing.

..... [1]

- (ii) To transform an input of an analogue voltage into a digital signal.

..... [1]

10

- (c) Draw a labelled diagram of the action of a Wheatstone bridge being used in a strain gauge system.

.....

.....

.....

.....

.....

.....

..... [5]

[Total: 10]

- 5 (a) Explain the difference between a Programmable Logic Controller (PLC) and a Proportional plus Integral plus Derivative mode Controller (PID).

.....

 [6]

(b) Fig. 3 shows the error input to a controller.

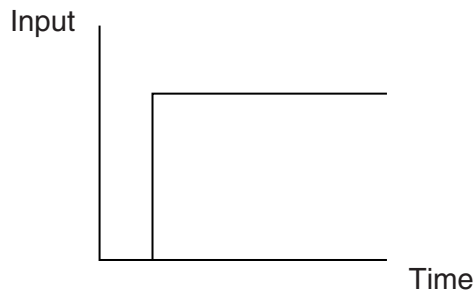


Fig. 3

Fig. 4 shows possible controller outputs

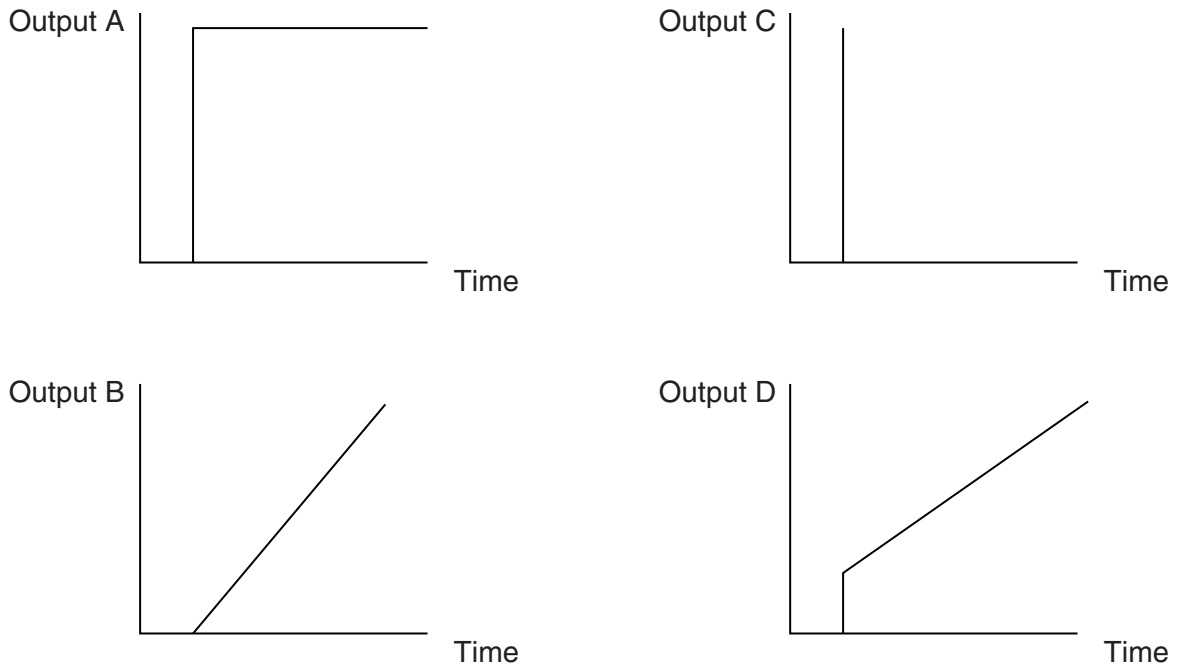


Fig. 4

With reference to Fig. 4:

- (i) State which output could be given by a proportional controller.
 [1]
- (ii) State which output could be given by a derivative controller.
 [1]
- (iii) State which output could be given by an integral controller.
 [1]
- (iv) State which output could be given by a proportional plus integral controller.
 [1]

[Total: 10]

6 (a) Explain what is meant by the following terms:

(i) Transducer.

.....
.....
.....
..... [2]

(ii) Actuator.

.....
.....
.....
..... [2]

(iii) Regulator.

.....
.....
.....
..... [2]

(iv) Instrument display.

.....

.....

.....

..... [2]

(b) Draw a labelled diagram of a single-digit seven-segment display.

[2]

[Total: 10]

7 (a) State what is meant by the term 'embedded control system'.

.....
.....
..... [1]

(b) Name an embedded control system that is used in a refrigerator and explain its function.

Name

Explanation

.....
.....
.....
..... [3]

(c) Give **three** reasons why an embedded control system is used instead of a manual control system in engineering situations.

1

.....

2

.....

3

..... [3]

(d) A modern car could incorporate many embedded systems to control various aspects of its use. State **three** applications of embedded systems used in a car.

1

.....

2

.....

3

..... [3]

[Total: 10]

8 (a) Name **two** items of equipment that can be found as virtual instruments in simulation software.

1

.....

2

.....

[2]

(b) Fig. 5 shows a circuit diagram of an inverting operational amplifier from a simulation software programme.

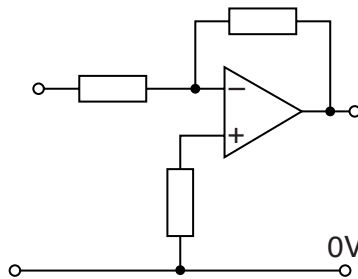


Fig. 5

(i) Label the circuit diagram in Fig. 5 with the terms:

- Inverting input
- Non-inverting input
- Feedback resistor.

[3]

(ii) Draw on the circuit diagram the symbols of an instrument that will measure the input signal and the output signal.

[2]

(iii) State the voltage you would measure at the inverting input if the non-inverting input was recorded as -5 volts.

..... [1]

(iv) Calculate the closed loop gain if the feedback resistance is 200 K and the input resistance is 10 K .

..... [2]

[Total: 10]

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