2003 Systems and Technology GA 3: Written examination

GENERAL COMMENTS

The 2003 examination was based on all areas of study of Units 3 and 4 of the revised Systems and Technology Study Design. The following criteria were used to set the examination:

1. Knowledge of technological concepts and principles associated with integrated systems
2. Knowledge of technological principles associated with the control of integrated systems
3. Understanding of the function of and interrelationships between a system and its subsystems
4. Understanding of the relationship between technological systems and the natural environment
5. Understanding of the role diagnosis, evaluation and repair
6. Understanding of the role of design in the production of a technological system.

Students were required to answer all questions on the paper.

Following are comments about each question and how marks were assigned. In the case of descriptive answers, samples have been supplied.

SPECIFIC INFORMATION

The following should be read in conjunction with the Systems and Technology 2003 examination paper.

In Question 1, students were required to demonstrate understanding of their production work. A large range of different answers were given. The advice below gives the detail required in answering this question. Examples from student examination papers are included.

Question 1

Name the integrated system you produced.

Sample answer

Pneumatic can crushing system.

a

Marks	0	1	Average
%	65	35	**0.35**

Define the term integrated system.

Sample answer

An integrated system is a system made up of subsystems from the mechanical and electrical/electronic area (answers as above or similar; mechanical includes pneumatic and hydraulic).

b

Marks	0	1	2	Average
%	10	28	62	**1.51**

Explain the purpose of your integrated system.

The explanation of the purpose must be related to the system named above.

Sample answer

My system crushes cans. The can falls onto a SPDT switch which activates a solenoid valve that allows pressurised air through into a pneumatic cylinder which crushes the can.

c

Marks	0	1	2	Average
%	18	30	52	**1.34**

Name the two subsystems that made up your integrated system.

The subsystems named should have one subsystem from the mechanical area and one subsystem from the electrical/electronic area.

Sample answer

The SPDT switch and the two solenoid valves.

The double acting pneumatic cylinder.

Where students included both subsystems from the same category only 1 mark was awarded.

d

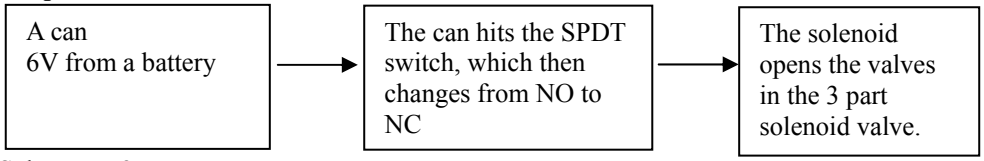
Marks	0	1	2	3	4	5	6	Average
%	16	2	8	22	12	9	31	**3.63**

Draw a systems block diagram which describes in terms of input, process and output, the operation of each of the subsystems you named in 1c.

Subsystem 1

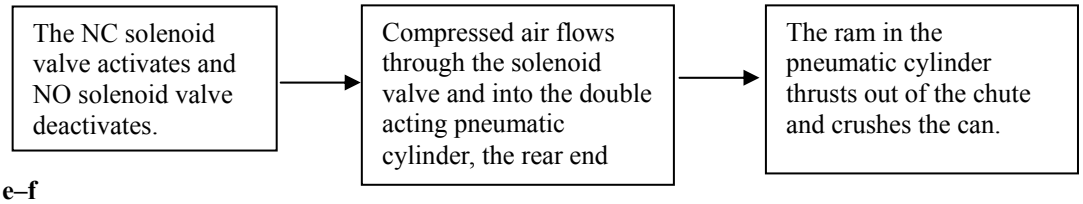
Input – A clearly related description of the input.
Process – How the input is processed.
Output – A clear related description of the output.

Sample answer



Subsystem 2
Input – A clearly related description of the input.
Process – How the input is processed.
Output – A clear related description of the output.

Sample answer



e–f

Marks	0	1	2	3	Average
%	15	7	25	53	**2.16**

e

Name a device that controlled your integrated system.

Sample answer

Single pole double throw switch (SPDT).

f

Explain how this device operated to control your system.
The explanation must be related to the device named in Question 1e and describe the control of the system.

Sample answer

In NO mode it allows current to the solenoid valve which allows compressed air into the cylinder to keep it closed. And when the can hits, it switches to NC mode and allows current to the solenoid valve that allows air to flow to the rear of the cylinder to shoot the ram out.

g–h

Marks	0	1	2	3	Average
%	16	13	30	41	**1.96**

g

Name the design or modification work that you carried out.
Students should name a sensible design or modification that relates to the system named in Question 1.

Sample answer

Modification of the can holder chamber.

h

Explain the intended purpose of the design or modification work.
The explanation of the purpose should be of a plausible nature and relate to that named in Question 1g.

Sample answer

I modified it so that it would accommodate a SPDT switch between the holders.

i

Marks	0	1	2	Average
%	24	30	46	**1.22**

Describe an important factor that you took into consideration when carrying out your design or modification work.
Examples of this could be:
When designing an engine stand the selection of steel needed to be sufficiently strong enough to support the engine.
When designing an LED display the batteries chosen had to have sufficient capacity to run the display for 1 hour.

Sample answer

I took into consideration that I may have needed to fit two switches between the holders so I made a hole right up the middle of the chamber between the holders.

Question 2

Name the integrated system on which you were required to carry out a diagnostic test.

Sample answer

The pneumatic crushing system.

a–b

Marks	0	1	2	3	Average
%	13	12	29	46	**2.08**

a

Name the specific test that you carried out.

The answer should relate to a test that could be carried out on the system named.

Sample answer

I tested the kilo pascals needed to crush the can.

b

Explain in detail the purpose of the test.

Students needed to provide a detailed description of what they hoped to achieve from the named test.

Sample answer

My system was unable to crush cans and I couldn't figure out why, so the first step that I had to take was to find out how much pressure I needed to actually crush a regular can.

ci–iii

Marks	0	1	2	3	Average
%	14	10	28	48	**2.11**

ci

Name the one piece of test equipment that you used to take measurements on this system.

A relevant piece of test equipment that could be used to carry out tests on the named system needed to be named.

Sample answer

Hydraulic stress tester.

cii

Describe the function of this piece of test equipment.

The test equipment should be able to carry out the function described.

Sample answer

This piece of equipment uses the power of hydraulics to crush something and shows on a meter the force in kpa.

ciii

Name the specific unit of measurement read from the test equipment that you named in part ci.

The item of test equipment named in 2ci must be capable of measuring the unit of measurement named.

Sample answer

Kilo pascals.

d

Marks	0	1	2	Average
%	26	32	42	**1.15**

Describe an appropriate adjustment, repair or maintenance procedure that was carried out as a result of your test.

The procedure described here should be relevant and plausible for the system named.

Sample answer

I had to modify the hydraulic stress tester and create a new piece for it so it would accommodate a can. I concluded that my solenoid valves were letting out some of the pressure. Because it takes 120 kpa or 4 bars of pressure (from the test) to crush a can. But I was using 6 bars and it wasn't crushing.

Question 3

Name the technological system that you studied.

Sample answer

Ocean swell powered reusable energy system.

ai–iii

Marks	0	1	2	3	4	Average
%	11	8	20	32	29	**2.59**

ai

Name a negative environmental effect associated with the operation of the system.

The negative effect should be plausible and related to the named system.

Sample answer

It takes the power out of waves; seals and other sea life can be in danger.

aii

Describe how this negative environmental effect impacts on the environment.

The description should detail a negative environmental effect that is related the effect named in Question 3ai.

Sample answer

You can't surf near it. Seals and other sea life can be sucked into the generator intake.

aiii

Suggest a method for reducing this negative environmental effect.

The method should be plausible and relate to the system named.

Sample answer
Don't surf near it, put wire mesh over the blow hole intake; use signage.

b

Marks	0	1	2	Average
%	38	24	38	**1.00**

Name and describe a positive effect of the technological system on the environment.
The negative effect should be plausible and related to the named system and there must be a description.

Sample answer
This system is non-polluting and creates a lagoon behind it and creates an artificial reef which aquatic life can use.

Question 4

a

Marks	0	1	2	3	Average
%	6	7	24	63	**2.43**

Describe the operation of the sluice gate in terms of its input, process and output.

Sample answer

Input
Human energy creates the mechanical movement of the gear handle turning it in a rotary direction.

Process
Gear A turns gears B and C and as a result gear D moves in a vertical direction.

Output
The sluice gate operates in a vertical direction to either allow or stop the water flow.

b

Marks	0	1	2	3	Average
%	20	12	14	54	**2.01**

If **gear A** moves in a clockwise direction as illustrated in Figure 1, write the direction of movement of each of the other gears in the table below. You must use the words clockwise or anticlockwise and up or down.

Gear A	Gear B	Gear C	Gear D
Clockwise	Clockwise	Clockwise	Up

c

Marks	0	1	Average
%	76	24	**0.24**

What factor is likely to reduce the efficiency of the gear system?
Friction.

d

Marks	0	1	2	Average
%	36	25	39	**1.03**

Name the two types of motion that occur in the gear system when the sluice gate is opening or closing.
Rotary motion; Linear motion

e

Marks	0	1	2	Average
%	65	12	23	**0.58**

Name the type of force acting on the connecting rod on the line provided below each diagram.

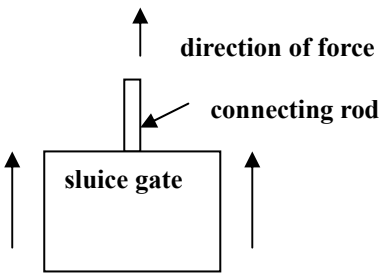


Figure 2. Lifting sluice gate
Force: Tension

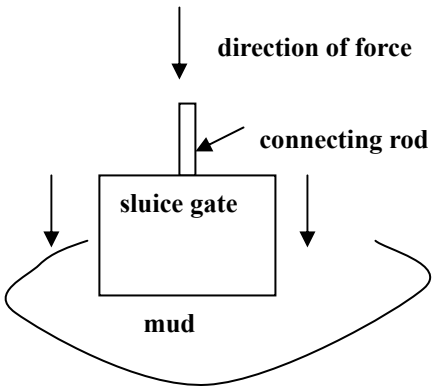


Figure 3. Closing sluice gate
Force: Compression

f

Marks	0	1	2	3	Average
%	28	4	10	58	**1.96**

On the diagram below (Figure 4) draw a lever and pivot that will gently lift the sluice gate from the dried mud. Mark in the correct places on your lever the load **(l)** the effort **(e)** and the fulcrum **(f)**.

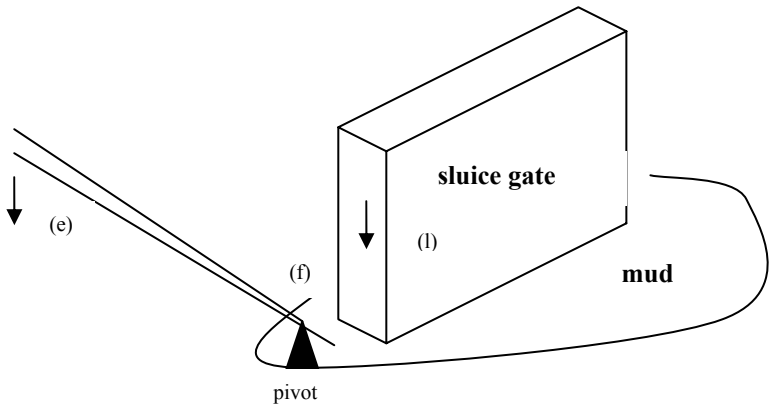


Figure 4

Question 5

a

Marks	0	1	2	3	Average
%	32	17	14	37	**1.54**

From the three logic gates illustrated below, name the logic gate that will allow the circuit to operate as described above. Explain why you chose this logic gate.

AND Gate

The AND gate is the only gate which gives a 1 output when both inputs are 1.

b

Marks	0	1	Average
%	20	80	**0.80**

The sluice gate pictured below (Figure 6), shows the position **(x)** of one water level sensor for the water level circuit. On the diagram (Figure 6) mark with the letter **y** the position of the second sensor.

Note: The sluice gate only opens when there is maximum water. **The water level must touch both sensors x and y.**

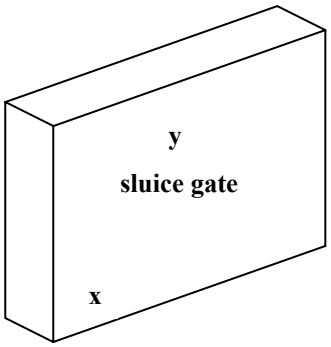


Figure 6

c

Marks	0	1	2	3	Average
%	31	32	26	11	**1.15**

Explain in detail how the automatic sluice gate system operates as a closed-loop system. You may use words and/or diagrams.

Sample answer
Once the power is applied and the water reaches the correct level the sluice gate begins to open. At this point the timer takes over control of the operation and the sluice gate continues to open and water flows into the irrigation channel. After the preset time the timer drops out and the sluice gate closes allowing the cycle to automatically begin again.

Question 6

a

Marks	0	1	2	3	4	5	6	Average
%	11	9	14	16	15	20	15	**3.36**

Name each component on the line provided.

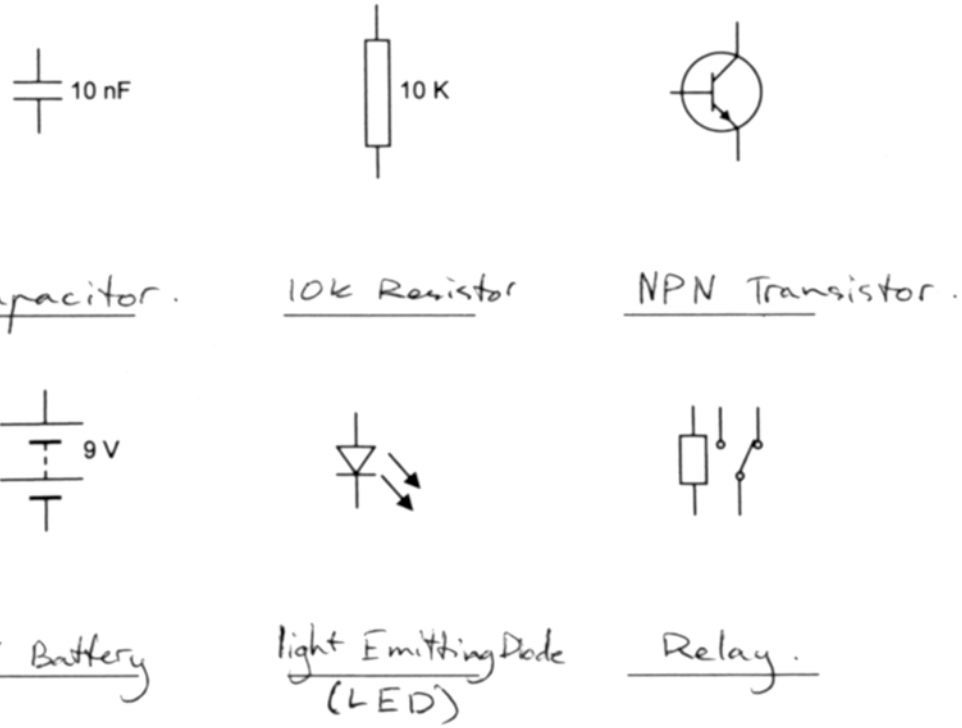


Figure 7

bi–ii

Marks	0	1	2	3	4	Average
%	54	12	3	11	20	**1.30**

bi

The following symbol has the leads b, c and e. What do the letters b, c and e stand for on this symbol?

b _ base
c _ collector
e _ emitter

bii

State one function of this component.

Switch or amplifier.

c

Marks	0	1	2	Average
%	40	33	27	**0.86**

Calculate the current drawn by the system if the sluice gate has a power consumption of 1.2 kW from a 24 volt supply. The formula was on page 20 of the examination booklet and all working needed to be shown.

$$I = \frac{P}{V}$$

$$= \frac{1200}{24}$$

$$= 50 \text{ Amperes}$$

Question 7

The task of lifting the sluice gate is now performed by a solenoid and gear arrangement (Figure 8 in examination). A solenoid is a piston and cylinder that is operated by an electromagnet.

a

Marks	0	1	2	Average
%	55	29	16	**0.60**

Describe the **two** factors in the system which act together to close the sluice gate when the solenoid is de-energised.

- the opening of the solenoid by the spring on the solenoid piston
- the weight of the sluice gate.

b–c

Marks	0	1	2	Average
%	12	15	73	**1.61**

b

Name the component which joins gear F to gear G.

Chain

c

Explain why gear F and G will always turn in the same direction

Sample answer

The chain joins them together and will always drive them in the same direction.

d

Marks	0	1	2	Average
%	29	10	61	**1.32**

Gear J will need to move 200 mm to lift the sluice gate into the open position. Gear J has a pitch of 5 degrees. How many teeth will gear H require to move gear J 200 mm? (Formula given on page 20 and all working to be shown).

Number of teeth on driver gear $= \frac{\text{distance moved by driven gear}}{\text{driver gear pitch}}$

$= \frac{200}{5}$

$= 40$

Question 8

When setting up the new automatic sluice gate system, diagnostic tests of measurement are needed on the individual subsystems before the system is used. These diagnostic checks can be either mechanical or electrical/electronic.

a–c

Marks	0	1	2	3	Average
%	54	11	17	18	**0.99**

a

Name a mechanical test that could be performed on one of the sluice gate subsystems.

There are at least three possible answers:

Measure the length of rope attached to the sluice gate.

or

Measure the spring tension on the solenoid.

or

Measure the weight of the sluice gate.

b

Describe briefly the purpose of this test.

There are at least three possible answers:

Measure if the rope is long enough to allow the sluice gate to close and open properly.

or

To determine its strength and ability to fully open the piston on the solenoid.

or

To determine if the weight of the sluice gate matches the weight on the drawing.

c

Name a measuring device that could be used to perform the test.

There are at least three possible answers:

Metric tape measure or metric ruler.

or

Press.

or

Metric scales.

d–f

Marks	0	1	2	3	Average
%	36	11	20	33	**1.50**

d

Name an electrical/electronic test that could be performed on one of the sluice gate subsystems.

Measure the charge in the 24 volt battery.

e

Describe briefly the purpose of this test

To establish if the batteries are fully charged.

f

Name a measuring device that could be used to perform the test.

Multimeter or voltmeter.

Question 9

a

Marks	0	1	Average
%	18	82	**0.82**

What effect will the rising water have on the sluice gate if there are no runners to guide/keep the sluice gate in place?

The rising water will push the sluice gate aside.

bi–ii

Marks	0	1	2	3	4	Average
%	17	8	25	15	35	**2.44**

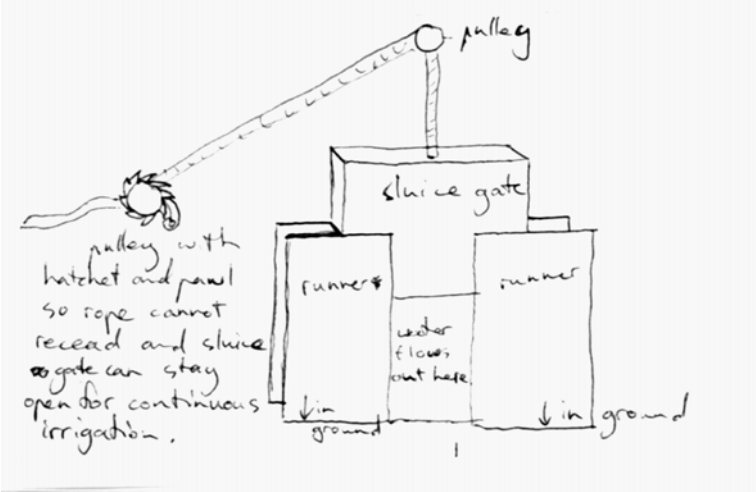
bi

Produce a drawing below which shows the sluice gate supported by two runners. Your drawing should show the sluice gate in the open position.

bii

On your drawing include and label a device that will keep the sluice gate in the open position to allow continuous irrigation.

Sample answer



Question 10

Marks	0	1	2	3	4	5	6	Average
%	19	4	7	11	19	24	16	**3.43**

On Figure 11 below, describe the input, process and output of the automatic sluice gate system. Include in each subsystem box the name of an electrical, an electronic and a mechanical subsystem that make up the system.

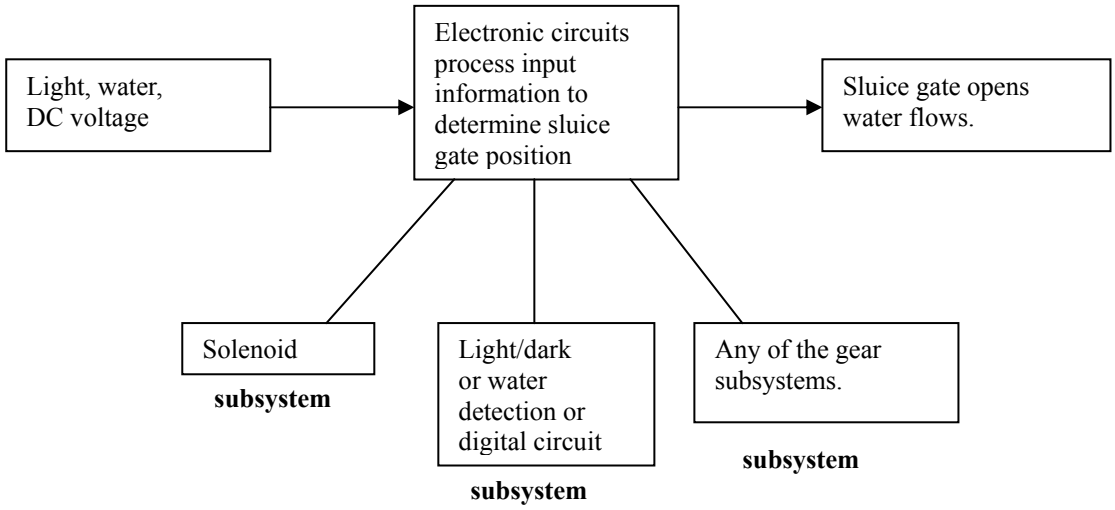


Figure 11

Question 11

A farm has a number of irrigation channels that have been converted to automatic operation. Electricity from rechargeable lead acid batteries will run the system. These will require replacement as they wear out.

A power source for recharging batteries has to be selected. This can be coal power or wind generators as the area has many days of high winds.

a

Marks	0	1	2	Average
%	20	41	39	**1.19**

State one advantage of using wind generators and coal power stations.

Sample answers

Wind generators: Clean energy or free energy or renewable.

Coal power stations: Constant power or no need to maintain power system.

b

Marks	0	1	2	Average
%	13	35	52	**1.39**

State one disadvantage of using wind generators and coal power stations.

Sample answers

Wind generators: Lack of wind or unsightly or the need to maintain the system.

Coal power stations: Pollution created by burning coal or long distances to run power cables.

c

Marks	0	1	2	Average
%	22	43	35	**1.13**

Name **two** advantages of using solar energy to charge the batteries.

Sample answers

Clean energy or renewable energy or free energy.