2008 Systems Engineering GA 3: Written examination

GENERAL COMMENTS

The 2008 Systems Engineering examination was based on all Areas of Study in Units 3 and 4 of the *VCE Systems Engineering Study Design.* The examination was based on the key knowledge and skills of the outcomes for Units 3 and 4. Students were required to answer all questions.

There was a good spread of marks with all students achieving some success. There were also some challenging questions for high achieving students.

As clearly stated in the explanation at the beginning of Units 3 and 4, mechanical systems includes pneumatic and hydraulic systems and subsystems. It was flagged in last year's Assessment Report that there could be hydraulics questions in this year's examination, however it appeared that there were still some students who had not covered hydraulics and pneumatics as part of their study of mechanical systems. Teachers and students should note that pneumatics is also a part of the study design. The principles governing pneumatics are the same as hydraulics. No matter the type of system as defined in the study design, students are expected to be able to read a technical diagram.

Students should look at the number of marks allocated to a question. If one mark is allocated, a simple, straightforward answer is expected. If two marks are allocated, students should show some working or write a descriptive answer. Students should also take care with any units of measurement.

The following information should be read in conjunction with the VCE Systems Engineering 2008 examination.

SPECIFIC INFORMATION

Section A – Multiple-Choice questions

The table below indicates the percentage of students who chose each option. The correct answer is indicated by shading.

Question	% A	% B	% C	% D	% No Answer	Comments
1	7	1	6	85	0	
2	16	30	39	14	1	Work done = force x distance could have been used to calculate the correct answer. The distance from X to Z was 50 cm.
3	10	3	2	85	0	
4	22	15	4	58	0	
5	1	5	16	77	0	
6	10	2	1	86	0	The liquid must flow around the outside between the teeth of each cog and not through the middle. No fluid can pass through the centre between gears A and B.
7	28	56	15	1	0	
8	55	2	6	36	0	
9	17	17	53	13	0	If the rope is pulled 3 metres, the weight is raised 1 metre. As a result, a force of (12/3 =) 4N is necessary.
10	9	64	7	21	0	
11	10	53	13	25	0	
12	14	39	28	18	1	
13	25	8	50	17	0	
14	26	17	40	17	0	
15	28	18	50	4	0	
16	9	27	13	49	1	

Question	% A	% B	% C	% D	% No Answer	Comments
17	56	19	19	5	0	
18	2	94	1	3	0	
19	65	7	17	11	0	
20	6	3	73	18	0	

Questions 2, 6 and 9 were poorly done.

Section B – Short answer questions

Question 1

Marks	0	1	2	3	Average
%	36	24	3	37	1.4

- Grinding Wheel: Class 3
- Tip truck: Class 2
- Trolley: Class 1

The responses to this question showed improvement from last year's responses to the question on classes of levers.

Question 2a.

Marks	0	1	2	3	4	Average
%	27	20	16	12	26	1.9

Most students made a reasonable attempt at this question and often the simplest solutions were the best. Students were asked to draw and label a self-closing mechanism using the materials and diagram provided. A simple compression spring, drawn in the correct position and labelled, was enough to achieve full marks. Some students designed an automatic opening gate rather than what was required.

Question 2b.

Marks	0	1	Average
%	40	60	0.6

The safety problems were many and varied and depended upon the student's answer to Question 2a. The important issue was recognising possible safety issues, generally related to the equipment that would be used during the construction of the self-closing mechanism.

Question 3

Marks	0	1	2	3	Average
%	5	11	27	57	2.4

Students were required to complete the systems block diagram. One mark was awarded for each of:

- input: electricity
- process: electrical energy is converted the integrated system into motion
- output: gate opening.

Question 4a.

Marks	0	1	Average
%	10	90	0.9

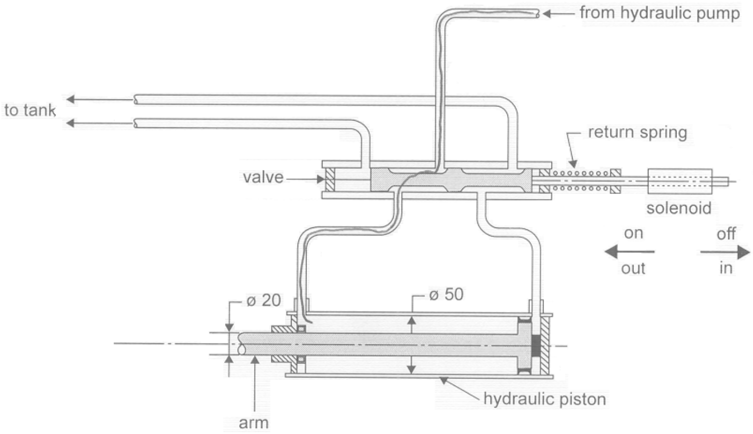
Question 4b.

Marks	0	1	2	Average
%	40	12	47	1.1

Students were able to recognise the necessity of the arm being able to pivot. Common design solutions to secure the nut on the bolt involved lock nuts or a split pin through the bottom of the bolt. Some students wanted to put a spot weld on the bottom of the bolt.

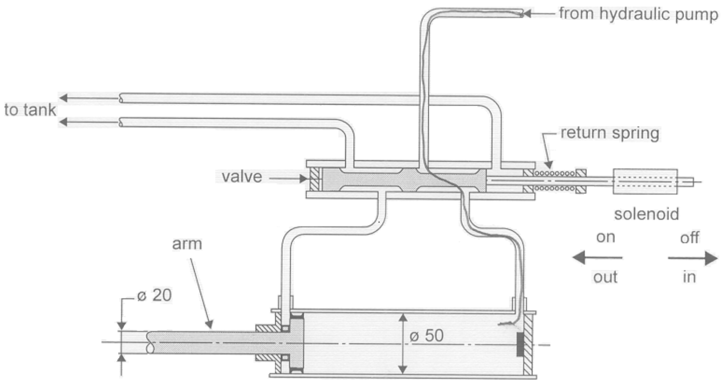
Question 5

Marks	0	1	Average
%	58	42	0.4



Question 6

Marks	0	1	Average
%	60	40	0.4



Question 7

Marks	0	1	Average
%	35	65	0.7

Most students realised that the forces are not equal for a hydraulic cylinder, yet some did not use this information for Question 8.

Question 8

Marks	0	1	2	3	4	Average
%	34	27	25	13	2	1.2

There were four critical points that students needed to understand when responding to this question. The first was the area of the piston. The second was to realise that if the piston is moving to the right, the area of the arm must be subtracted from the total area of the piston. Once the correct area was found, there was a direct application of the formula Force = pressure x area. Correct use of the radius, not diameter and other units, was essential for full marks.

Question 9

Marks	0	1	Average
%	54	46	0.5

The connection of the arm to the gate must be moved closer to the hinge to allow the gate to open and close fully. If the shaft can only move 400 mm, then the arm should be more than 400 mm from the hinge for the gate to fully open and close.

Question 10

Marks	0	1	Average
%	46	54	0.6

Clockwise

Question 11

Marks	0	1	2	Average
%	88	1	11	0.3

$$\frac{GearB}{GearA(15)} \times \frac{GearD(72)}{GearC} = 36$$

Gear teeth on Gear B and C could be any of the following pairs.

B	60	120	45	90	105	180
C	8	16	6	12	18	24

This question proved difficult for students. Even though there were many solutions, students had trouble generating a valid pair of gears. Students need to take care with their selection of gears as a gear with very few teeth will not work, for example, Gear B with 30 teeth and Gear C with four teeth is not feasible.

Question 12

Marks	0	1	Average
%	76	24	0.3

One quarter of the 80 teeth of the worm wheel gives 20 teeth.

Question 13

Marks	0	1	Average
%	73	27	0.3

At 40 rpm, the gate will take 30 seconds to open.

Question 14

Marks	0	1	Average
%	71	29	0.3

Again, some of the simplest suggestions were often the best. If the gate takes 30 seconds to open, then the motor is going at the rated rpm. Simply timing how long the gate takes to open would have been enough. Marking the worm gear or worm wheel and timing for a given number of time or timing a number of revolutions were also good suggestions. Trying to count the revolutions of the motor directly was not realistic.

Question 15

Marks	0	1	Average
%	84	16	0.2

Student answers to this question had to relate to the test they described in Question 14.

Question 16

Marks	0	1	Average
%	54	46	0.5

A possible solution was that the motion detector would detect the gate moving so the gate would never close.

Question 17

Marks	0	1	2	3	Average
%	35	18	14	32	1.5

One mark for each of:

- circuit 1 – the motor would not operate and the circuit would never be complete
- circuit 2 – the motor would turn on and off when switched
- circuit 3 – when switched, the motor would reverse its direction.

Question 18

Marks	0	1	2	Average
%	49	6	44	1

Current = Power/Voltage, Current = 20 A

One mark each was given for the formula and the answer.

Question 19

Marks	0	1	2	Average
%	42	11	47	1.1

$$\text{efficiency} = \frac{\text{output energy}}{\text{input energy}} \times 100\%$$

$$= \frac{150}{240} = 62.5\%$$

Question 20

Marks	0	1	Average
%	39	61	0.6

Several students suggested that the gate would bend or the gears may break. Students needed to think about the most likely parts of a system that could fail.

Question 21

Marks	0	1	2	Average
%	41	31	28	0.9

The feedback is via the sensors and the process causes the motor to be on or off.

Question 22

Marks	0	1	2	Average
%	23	37	40	1.2

This is an integrated system as it contains both mechanical and electronic/electronic subsystems.

Question 23

Marks	0	1	2	Average
%	37	18	45	1.1

This question caused some problems for students. They needed to provide a clear justification, often assisted by a definition of what an open or closed system is.

Question 24

Marks	0	1	2	3	Average
%	9	11	28	52	2.3

The safety precautions needed to be valid and related to the drilling of the hole in the bracket.

Some acceptable responses were:

- wear safety glasses
- use a clamp to hold the bracket
- check the cord of the drill for faults

- centre punch the hole.

Question 25

Marks	0	1	2	3	4	Average
%	20	17	15	16	32	2.2

- Component A: Transformer.
- Component B: Diode.
- Component C: Capacitor.
- Component D: Earth.

Question 26

Marks	0	1	Average
%	61	39	0.4

The possible answers to this question depended on whether students took the capacitor into consideration. As a result, the signal from a full wave rectifier was accepted as well as a smoothed signal because of the capacitor.

Question 27

Marks	0	1	2	Average
%	56	23	22	0.7

The voltmeter needs to be in parallel with the motor and the ammeter in series with the motor.

Question 28

Marks	0	1	2	Average
%	43	36	21	0.8

Wires from pin 2 to pin 6 and then to the capacitor were accepted.

Question 29

Marks	0	1	2	3	Average
%	11	19	27	43	2

- Input: Solar energy.
- Process: Conversion from solar to electrical energy.
- Output: Electrical energy.

Question 30

Marks	0	1	2	Average
%	14	49	36	1.2

Several answers were given, these included:

- produces less carbon dioxide
- visual pollution of electric wires.

The advantages needed to be environmental.

Question 31

Marks	0	1	2	Average
%	73	21	6	0.4

Students need to be aware that there are problems with the creation and disposal of any system and not just the immediate application of it.