2017 VCE Systems Engineering examination report

General comments

The majority of students made a reasonable attempt at most questions on the 2017 Systems Engineering examination. There were some questions that required analysis of diagrams, which seemed to challenge students. Other issues arose when students confused radius and diameter.

Specific information

This report provides sample answers or an indication of what answers may have included. Unless otherwise stated, these are not intended to be exemplary or complete responses.

The statistics in this report may be subject to rounding resulting in a total more or less than 100 per cent.

Section A – Multiple-choice questions

Question	% A	% B	% C	% D	% No answer	Comments
1	1	2	9	87	0	
2	11	11	67	10	0	Options A, B and D are unsafe practices.
3	68	10	8	14	0	Oscillating motion is when something moves from side to side like a pendulum.
4	54	40	5	1	0	There are four pulleys going in a clockwise direction. One of them is the drive pulley. There are three others.
5	4	6	11	78	0	The other gears involve only rotary motion.
6	60	10	28	2	0	
7	22	56	11	10	1	Work done = force × distance Work done = 200 × 40 = 8000 J = 8 kJ
8	7	23	39	29	2	power = energy/time power = 8000/12.6 = 635 W There were other ways of obtaining this answer.
9	17	13	25	46	0	Gear ratio = driven/driver = 60/20 × 40/40 = 3:1

Question	% A	% B	% C	% D	% No answer	Comments
10	17	44	10	28	1	The pressure in both cylinders is the same. The area of Piston B is nine times that of the area of Piston A. The force is therefore nine times greater than the force on Piston A.
11	18	14	65	3	0	Add the three 10 Ω resistors in series first to get 30 Ω. Two 30 Ω resistors in parallel gives 15 Ω (option C).
12	83	3	2	13	0	
13	6	16	22	56	0	The total current through the circuit is V/R = 12/20 = 0.6 A or 600 mA There are two ammeters so the current would be split in two.
14	14	14	33	39	0	The output would be high only when both the inputs are high as there is an AND gate.
15	27	16	44	13	0	Engineering notation has the indices being a multiple of 3.
16	5	29	42	24	0	The Zener diode lets current through in one direction up to the breakdown voltage. This breakdown voltage is applied in circuits as a voltage regulator.
17	69	5	18	7	0	The total efficiency is the product of the individual efficiencies (as a decimal). 0.2 × 0.9 × 0.5 = 0.09 or 9%
18	12	45	12	31	0	Hydrogen cells do not involve the burning of hydrogen.
19	15	64	3	17	0	Power = voltage × current Current = 2A, so power = 24 × 2 = 48 W
20	20	11	63	5	1	The transformer drops the input voltage by a factor of 10. There is 12 V across the 60 Ω resistor. The current is 12/60 = 0.2 = 200 mA

Section B

Question 1

Marks	0	1	Average
%	11	89	0.9

2 m

One quarter of 8 is 2 m.

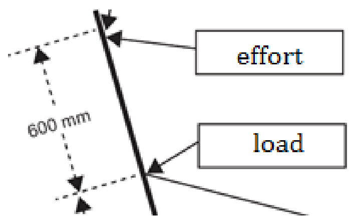
Question 2

Marks	0	1	2	3	Average
%	16	23	31	30	1.8

Item	Form of energy
wood	chemical
steam	heat
moving locomotive	kinetic

Question 3a.

Marks	0	1	2	Average
%	4	16	80	1.8



Question 3b.

Marks	0	1	Average
%	35	65	0.7

Class 2

Question 3c.

Marks	0	1	2	Average
%	47	19	34	0.9

T = Fd 20 × 0.6 = 12 Nm

12 = 1.2 F

F = 10 N

A simpler way to look at this question is to realise that if the distance from the pivot to the load is doubled, the force is halved. Half of 20 N is 10 N.

Question 3d.

Marks	0	1	Average
%	43	57	0.6

The force is reduced. If the distance from the pivot to the force is halved, the force on the handle is also halved (5 N).

Question 4a.

Marks	0	1	Average
%	49	51	0.5

The maximum length of the stroke is the diameter of the drive pin motion (150 mm).

Question 4b.

Marks	0	1	2	Average
%	21	65	13	0.9

Torque = force × distance. The distance is the radius of the drive pin portion, which is 76 mm of 0.075 m. Torque = 4000 × 0.075 = 300 Nm

Question 4c.

Marks	0	1	2	Average
%	74	14	11	0.4

Force = torque/distance. The torque is 300 Nm. The distance is 200 mm or 0.2 m, so force = 300/0.2 = 1500 N.

Question 4d.

Marks	0	1	2	3	Average
%	35	24	17	24	1.3

Force = pressure × area. In this case, the area of the circle is 3.14×0.05^2 .

$12\,000 = P \times 3.14 \times 0.05^2$

Pressure = $12\,000/3.14 \times 0.05^2$

Pressure = 1530 kPa

Question 5a.

Marks	0	1	Average
%	11	89	0.9

60 J/600 J = 0.1 or 10%

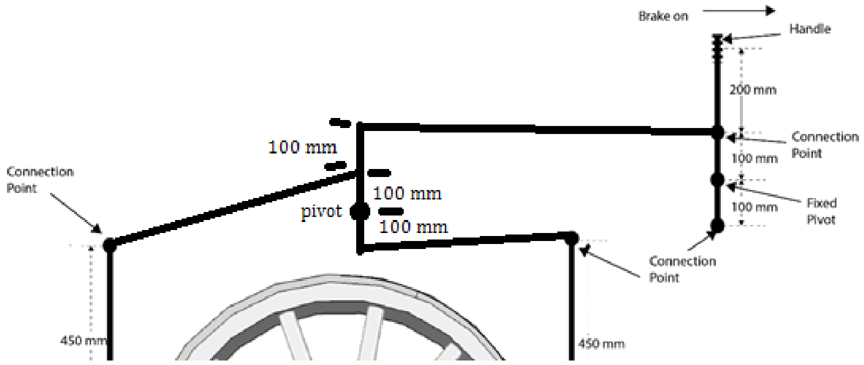
Question 5b.

Marks	0	1	2	Average
%	38	35	27	0.9

There were a number of feasible answers to this question, including friction of parts, rolling resistance, loss of heat/pressure and air resistance.

Question 6a.

Marks	0	1	2	3	4	Average
%	62	25	8	4	1	0.6



Rods and pivot should have been named. Only solutions where all rods were under tension were given full marks. Other solutions exist.

Question 6b.

Marks	0	1	Average
%	81	19	0.2

Rods will bend under compression.

Question 7

Marks	0	1	2	Average
%	28	30	42	1.2

The difference between the peaks in the graph (300 ms or 0.3 s) is the time it takes the steam locomotive to travel 60 mm of 0.6 m. The speed = d/t = 0.6/0.3 = 2 m/s

Question 8a.

Marks	0	1	2	Average
%	39	19	42	1.1

Factors could have been who uses the crossing, the time it takes for the gates to close or other relevant factors. The reason for the factor varied depending on the factor.

Question 8b.

Marks	0	1	2	Average
%	42	34	24	0.8

So that you have a plan, that the outcome is feasible, tools, difficulties. (Any issue from the 'design and model the system' stage of the Systems Engineering process was accepted.)

Question 8c.

Marks	0	1	2	Average
%	22	62	17	1

Evaluation takes place throughout the entire process. This allows for any changes due to issues that arise during design, planning, production and use of a system.

Question 9

Marks	0	1	2	Average
%	60	15	25	0.7

The boom gate is effectively a balance beam where the force down × distance (f.d.) is the same on both sides of the pivot.

f.d = f.d, 1.2 × 5 = f × 0.2

6/0.2

F = 300 N or 30 Kg

Or, the distance from the pivot is one sixth the distance of the centre of mass, so the force down or mass of the counter weight is 6 times as much.

Question 10a.

Marks	0	1	Average
%	9	91	0.9

Fifty pulses at 1.5° gives 50 × 1.5 = 75°

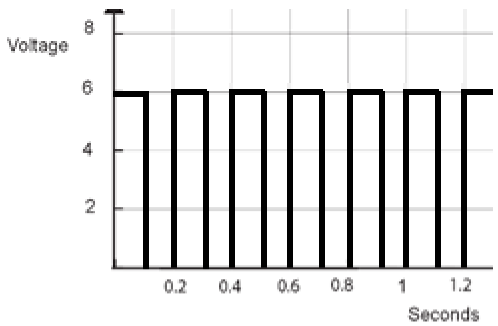
Question 10b.

Marks	0	1	2	Average
%	36	30	34	1

Fifty pulses in 10 seconds gives 50/10 = 5 Hz

Question 10c.

Marks	0	1	2	Average
%	36	31	33	1



The period of the pulse is 0.2 seconds with a peak voltage of 6 V.

Question 11a.

Marks	0	1	2	Average
%	24	9	67	1.5

v = d/t or d = vt

3 × 15 = 45 m

Question 11b.

Marks	0	1	Average
%	35	65	0.7

A shadow or stray light source could activate the switch.

Question 11c.

Marks	0	1	Average
%	43	57	0.6

A piezo sensor uses pressure; an induction sensor uses magnetic field; a heat sensor uses heat from engine

Question 11d.

Marks	0	1	2	Average
%	63	26	11	0.5

The question asked how the electric signal would be produced. A change in pressure/magnetic field causes current to flow in the piezo or induction sensor.

Change in heat causes change in voltage difference in bimetallic strips.

Question 12a.

Marks	0	1	2	3	4	5	6	7	8	Average
%	10	7	9	17	19	17	11	6	3	3.8

This question asked for the function of the component in the context of the circuit. Even though the transistor can be used as an amplifier, in this circuit the transistor is used as a switch.

Component	Name	Specific purpose of component
A	LED	flashing light
B	resistor	timing or to limit the charge of the capacitors
C	transistor	(electronic) switch
D	relay	turns timing circuit (flashing lights) on/off

Question 12b.

Marks	0	1	2	3	Average
%	41	26	25	7	1

The switch in relay D becomes open. The switch in relay E becomes open. The lights turn off.

Question 12c.

Marks	0	1	2	3	Average
%	45	29	15	12	1

A flowchart, pseudocode or algorithm was accepted.

A typical algorithm was:

Step 1 Sensor 1 is activated.

Step 2 Turn LED 1 on.

Delay 0.5 seconds.

Turn LED 1 off.

Turn LED 2 on.

Delay 0.5 seconds.

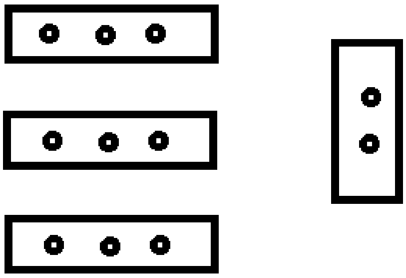
Turn LED 2 off.

Step 3 If Sensor 2 is not activated, go to step 2.

Step 4 Stop

Question 13a.

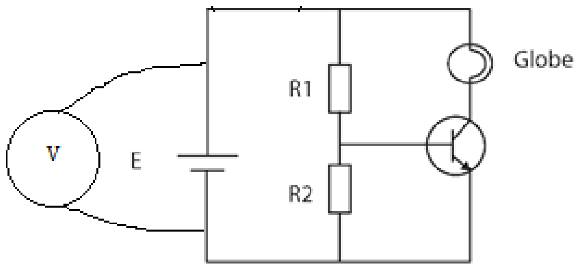
Marks	0	1	2	Average
%	50	13	37	0.9



Other equivalent variations were accepted. The question asked for a circuit board, but some students mistakenly drew a circuit diagram.

Question 13b.

Marks	0	1	Average
%	55	45	0.5



Question 13c.

Marks	0	1	2	Average
%	21	29	51	1.3

P = VI

P = 12 × 0.12 = 1.44 W

Question 13d.

Marks	0	1	Average
%	12	88	0.9

Twelve volts at 1.5 volts per battery gives 12/1.5 = 8 batteries.

Question 14a.

Marks	0	1	2	Average
%	61	23	17	0.6

Methanol, ethanol, butanol (alcohols), biodiesel

Some students mistakenly gave solid biofuels in their answers.

Question 14b.

Marks	0	1	2	Average
%	34	27	40	1.1

Wheat, potatoes and sugarcane are some of the common crops used.

Question 14c.

Marks	0	1	2	Average
%	47	24	29	0.9

Crops usually used for food and larger areas of land needed for agriculture were common issues.

Question 14d.

Marks	0	1	2	Average
%	50	20	30	0.8

Biofuel can be used like any other fuel to generate electricity. This includes a power source and a generator. Some students gave other valid descriptions on how electricity could be produced.

Question 15

Marks	0	1	2	3	4	5	Average
%	17	10	18	34	15	7	2.4

Students were asked to describe how a possible application would work and discuss possible implications for society. A large number of students only addressed only one of these aspects.

For example, the driverless car could be used. There are many different sensors including speed, GPS, proximity and road sensors that could be inputs to the computers, which would then control the movement of the driverless car. The implications to society could include improved road safety, reduced travel times, who is responsible for accidents, change in available jobs or even a different road network. Not all of these ideas were needed but a good understanding of the application and the implications for society were required.