2016 VCE Systems Engineering examination report

General comments

Most students made a good attempt at the questions on the 2016 VCE Systems Engineering examination, but there were many errors when calculations were made. These errors included mixing up radius and diameter, and not being able to transform equations. Students could calculate the torque using torque = force × distance, yet had difficulty calculating the force using force = torque/distance.

Another common related error was using the correct units. When using the torque formula, distances need to be in metres, not millimetres. Resistance needs to be in ohms, not kilo ohms. When using a formula, substitution using values with the correct units is essential. Students should state the formula, substitute values and then give the final answer to the nearest integer (unless otherwise stated).

Engineering notation was assessed for the first time in this examination. This topic, along with any other topic in the study design, is examinable.

Pseudocode was acceptable for any question that required a flowchart or programming.

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

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	43	47	9	1	0	Leather gloves and hard hats are inappropriate for using any machinery.
2	1	3	3	92	0	Only certain types of fire extinguishers can be used on electrical fires.
3	36	52	1	10	0	The position of the handle extension is critical. If the handle extension were at the other end of the original handle, there would be no change to the setting.
4	12	17	64	8	0	
5	0	1	1	99	0	Safety is everyone's responsibility.

6	42	12	18	28	0	The question asked for the best description of what a torque setting indicates, which is how tight a bolt should be.
7	7	3	88	2	0	
8	11	79	1	9	0	
9	7	12	1	80	0	
10	33	47	9	11	0	Many students used 1200 mm as the distance from the force to the pivot instead of 1800 mm. 600 N × 0.6 m = 360 Nm 360 Nm = 1.8 m × F F = 200 N
11	28	4	64	4	0	The 'maximum reading' implies using the tolerance of the resistors in the calculation. Series total is 200 Ω. Adding 5% gives 200 + 10 or 210 Ω.
12	13	22	48	17	0	Capacitors in series add like resistors in parallel. 1/10 + 1/10 = 1/5 (in μF). Capacitors in parallel add like resistors in series. 5 + 20 = 25 μF
13	2	2	57	39	0	The number of ropes that seem to come from the moving pulley is the key.
14	20	25	35	20	1	A common error was to treat the OR gate as an AND gate. Other students did not take into account the NOT gates.
15	5	71	14	10	0	Four 100 Ω resistors in parallel give 25 Ω.
16	22	10	64	4	0	
17	11	70	8	11	0	
18	53	9	27	11	0	
19	20	5	26	50	0	Engineering notation is in the study design. The index must be a multiple of three.
20	26	18	45	10	0	

Section B

Question 1

Marks	0	1	Average
%	24	76	**0.8**

Wind

Some students incorrectly answered with kinetic or potential energy.

Question 2a.

Marks	0	1	2	3	Average
%	7	10	0	83	2.6
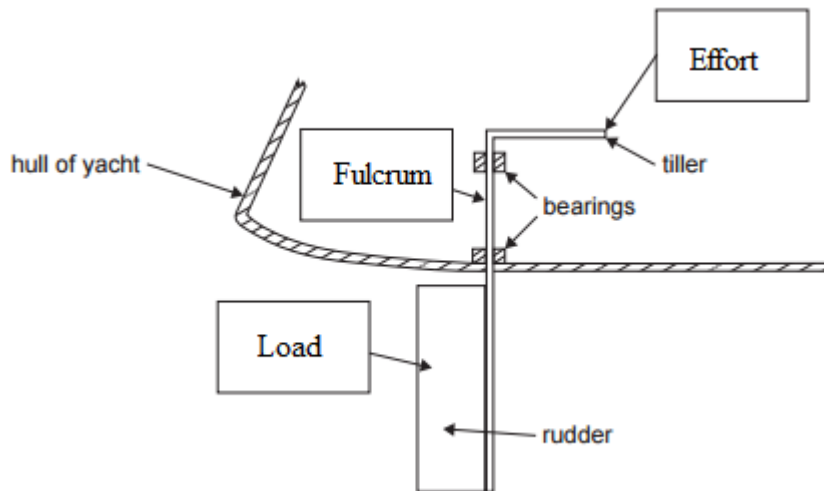
Question 2b.

Marks	0	1	Average
%	33	67	0.7

Class 1

Question 3a.

Marks	0	1	2	Average
%	23	14	63	1.4

torque = force × distance

      = 400 N × 0.3 m

      = 120 Nm

Question 3b.

Marks	0	1	2	Average
%	57	30	13	0.6

force = torque/distance

      = 120 Nm/.05 m

      = 2400 N

or

The distance is reduced by a factor of 6, so the force is increased by a factor of 6.

400 × 6 = 2400 N

Some students incorrectly used 100 mm or 0.1 m.

Question 4a.

Marks	0	1	Average
%	29	71	0.7

While there were other solutions, pawl and ratchet were the most suitable answers.

Question 4b.

Marks	0	1	2	Average
%	31	23	46	1.2

It allows the winch to rotate in one direction only.

As the winch and ratchet rotate, the pawl locks into position so that the winch cannot unwind.

Question 5

Marks	0	1	Average
%	70	30	0.3

1200 N

There are three ropes coming from the moving pulley, so the force is multiplied by 3, thus 400 × 3.

Question 6

Marks	0	1	2	Average
%	35	11	55	1.2

No. The proposed set-up would require a greater force to move the beam because the distance to the fulcrum is halved.

Some students said the proposed set-up was a bad idea but could not give the correct explanation as to why.
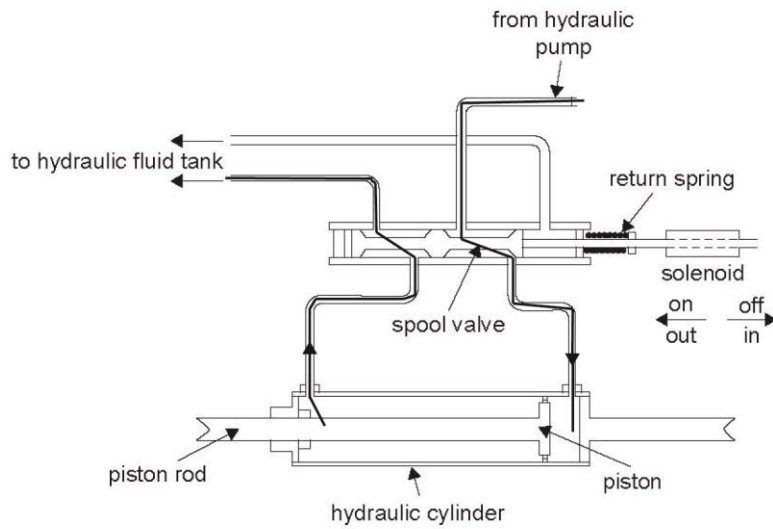
Question 7

Marks	0	1	Average
%	25	75	0.8

To the right

Question 8

Marks	0	1	2	Average
%	23	34	43	**1.2**

Question 9a.

Marks	0	1	2	Average
%	48	28	24	**0.8**

F = P.Area F = 200 000 × 0.002826

Area = πr^2 = 0.002826

565.2 N

Some students struggled to find the area of the circle.

Question 9b.

Marks	0	1	2	3	Average
%	52	16	14	19	**1**

Subtracting pressure due to rod

Area = $\pi r^2 - \pi r^2$ = 0.002826 – 0.00031

= 0.002511

F = P.Area = 200 000 × 0.002511

502 N

Question 10

Marks	0	1	2	3	4	Average
%	31	22	26	17	4	1.4
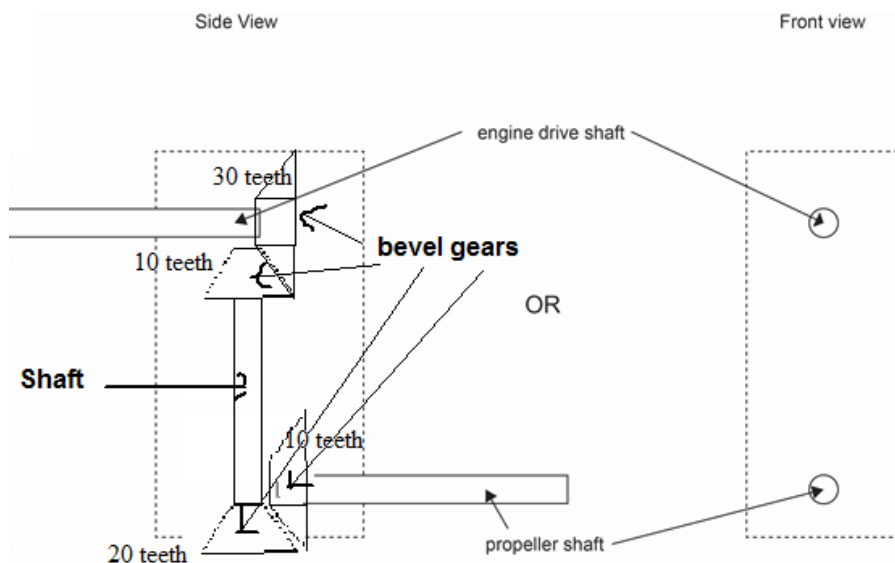
Chains and sprockets were most commonly used. Many students did not label their diagrams. Students who designed a system where the drive shaft could not rotate did not score any marks.

Question 11a.

Marks	0	1	2	Average
%	8	18	74	1.7

The stages that can be undertaken are:

- identify and document the problem
- research feasibility
- design the system
- plan, build and fabricate the system
- test and analyse the performance
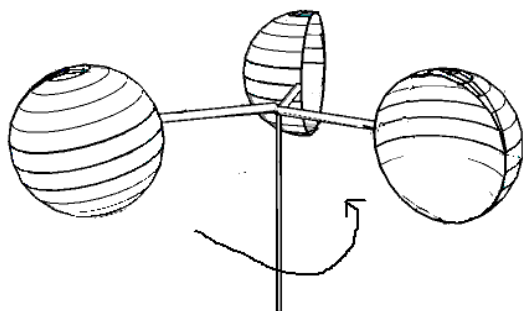- evaluate and report.

Question 11b.

Marks	0	1	Average
%	23	77	0.8

The outline of the process had to match the stage for marks to be awarded.

Question 12

Marks	0	1	Average
%	14	86	0.9

Question 13

Marks	0	1	Average
%	2	98	1

10 rpm

Question 14a.

Marks	0	1	Average
%	49	51	0.5

The question asked for a sensor, not a system. Light sensor was the most common answer. A laser beam by itself could not be used, but in conjunction with a light sensor it could be a part of a system.

Any sensor that required a pressure switch to be activated would disrupt the rotation of the anemometer.

Question 14b.

Marks	0	1	2	Average
%	47	21	33	0.9

The sensor could be connected so that the rotation of the anemometer interrupted the light beam, which then provided pulses that are counted.

Question 15a.

Marks	0	1	2	3	4	Average
%	21	16	21	22	20	2.1

Inputs could include speed, GPS, angle of sail or rudder angle.

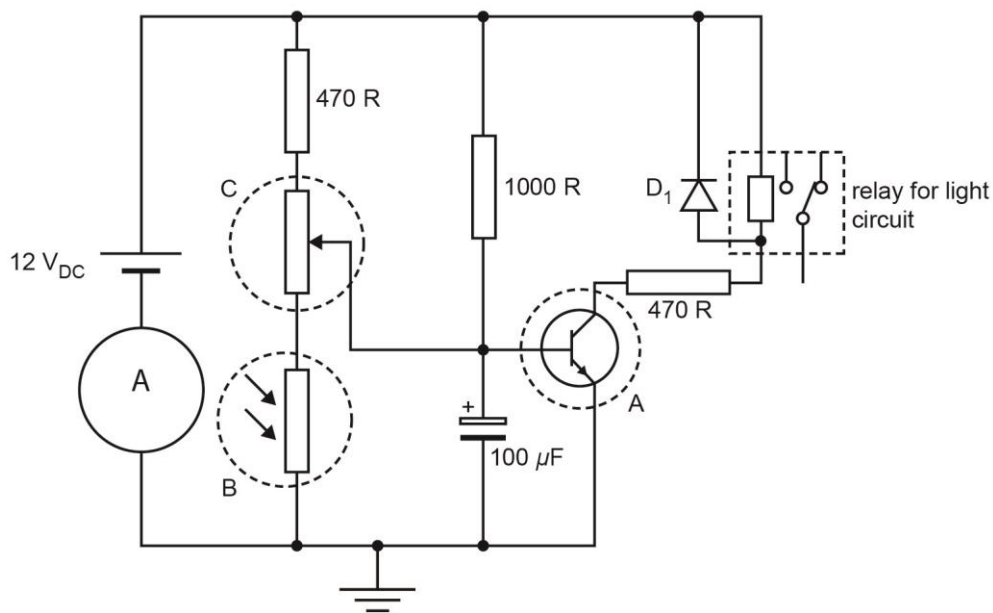Outputs could include rudder direction, angle of beam or motor.

Question 15b.

Marks	0	1	Average
%	67	33	0.4

The outputs such as the rudder direction and the angle of the beam will affect the velocity and GPS location.

Question 16a.

Marks	0	1	Average
%	54	46	0.5

Connecting the ammeter in parallel was a common error.

Question 16b.

Marks	0	1	Average
%	47	53	0.5

Yellow, violet, brown, gold

Many students got the multiplier wrong.

Question 16c.

Marks	0	1	2	3	4	5	6	Average
%	24	11	14	14	14	11	12	**2.7**

	Name of component	**Purpose in circuit**
A	Transistor	Switch
B	LDR (light-dependant resistor)	Detect light
C	Variable resistor (potentiometer)	Trim circuit. Fine adjustment so that the lights will come on at the right light intensity.

Question 17

Marks	0	1	2	3	Average
%	48	17	15	21	**1.1**
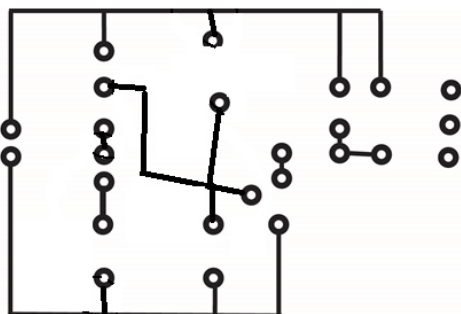
Connections to the relay were not necessary.

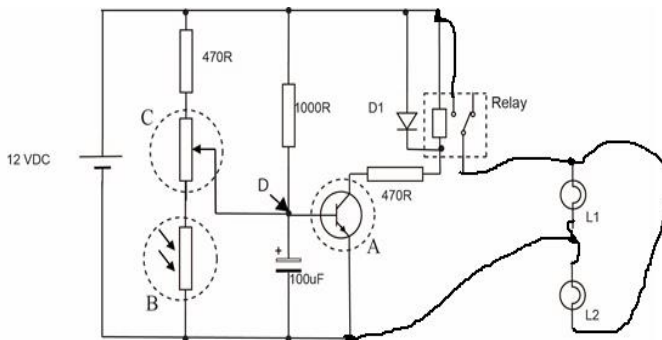Many students could not relate the schematic diagram to the circuit board.

Question 18

Marks	0	1	Average
%	80	20	**0.2**

This is not a good idea. A transformer needs AC and cannot operate using DC.

Question 19a.

Marks	0	1	2	3	Average
%	67	23	7	3	**0.5**

Many students did not know the difference between series and parallel circuits. The lights are 12 V and there is a 12 V supply, so the inference is that the lights are in parallel.

Question 19b.

Marks	0	1	Average
%	54	46	**0.5**

Point D would go to 12 V.

Question 19c.

Marks	0	1	Average
%	49	51	**0.5**

As a result, the transistor could not switch on or off. The most likely consequence is that the transistor would blow.

Question 20a.

Marks	0	1	2	Average
%	7	36	58	**1.5**

Solar panels and hydro generator were the most common answers.

Question 20b.

Marks	0	1	2	Average
%	12	45	43	**1.3**

Answers varied depending on the method given in Question 20a. Most disadvantages related to costs and disruptions to production of electricity.

Question 21a.

Marks	0	1	Average
%	40	60	**0.6**

80 V

40 V and –40 V were common answers, but the question asked for peak-to-peak voltage.

Question 21b.

Marks	0	1	2	Average
%	42	7	51	**1.1**

Period: 0.04 s

Frequency: 25 Hz

Question 22a.

Marks	0	1	2	Average
%	55	17	29	**0.8**
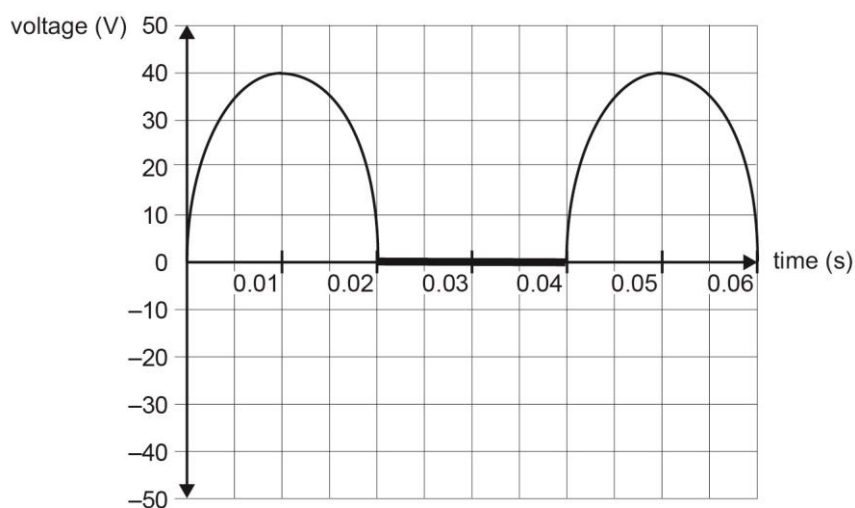
Incorrect answers included a full wave rectifier, sine waveform, rectangular waveform, waveform after smoothing capacitor and DC waveforms.

Question 22b.

Marks	0	1	2	Average
%	46	39	14	**0.7**

Any two of:

- capacitors
- voltage regulator
- bridge rectifier.

Question 23

Marks	0	1	2	Average
%	31	9	61	**1.3**

$0.45 \times 0.95 = 0.4575$

45.75%

Question 24

Marks	0	1	2	Average
%	53	6	41	**0.9**

Energy available = batteries × voltage × current × time = 2 × 12 × 240 = 5760

Energy used = voltage × current × time   5760 = 24 × 20 × time

Time = 12 hours

or

240 Ah/20 A = 12 hours (The batteries are in series.)

Question 25

Marks	0	1	2	3	Average
%	44	16	16	25	**1.2**

As long as students showed an understanding of the logical sequence, they gained marks. The main elements of the flow chart were:

- Turn light on
- Wait 2 seconds
- Turn light off
- Wait 1 second
- Repeat.

Question 26

Marks	0	1	2	3	4	5	Average
%	24	13	20	21	14	8	**2.1**

This question was well answered. Ideas included transmission of electricity, levitating trains, storage of electricity and use in electronic devices. The consequential decrease in energy production and hence the reduction of fossil fuels were advantages of these applications. The implications to society were wide and varied.