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Uva Wellassa University of Sri Lanka
Faculty of Applied Sciences
Department of Science and Technology
1st Year 1st Semester Examination –July/August–2019
SCT 151-2 Mechanics, Waves and Vibrations

Uva Wellassa University

Instructions to candidates

Duration: 02 hours
Number of questions: 04
Answer all questions
Mark allocation: 100
(Consider the value of gravitational acceleration, $g = 9.80\ ms^{-2}$)

1. A mass m_1 of 200 g is placed on a smooth plane inclined at 30° with the horizontal. Another mass m_2 of 105 g which is freely hanging vertically by a string that passing through a small smooth pulley at the top of the plane is attached to m_1.
   a. Draw the free body diagram for m_1.

      (04 marks)

   b. Draw the free body diagram for m_2.

      (04 marks)

   c. Calculate the distance m_2 descend from rest in 2 s.

      (06 marks)

   d. Find the tension in the string.

      (05 marks)

   e. If the coefficient of kinetic friction (m_k) between m_1 and the inclined surface is 0.25, find the tension in the string.

      (06 marks)

2. A small object of mass m is suspended using a string having length L. The object revolves with constant speed v in a horizontal circle of radius r as shown in Figure 1.

   a. Draw the free body diagram for mass m.

      (05 marks)

   b. Find an expression for v.

      (06 marks)

c. If the semi-vertical angle of the conical pendulum of length 1.5 m is 30°.

I. Find the period of revolution of the pendulum.

(08 marks)

II. If the mass of the bob is 0.2 kg, calculate the tension in the string when the pendulum is revolving as above.

(06 marks)

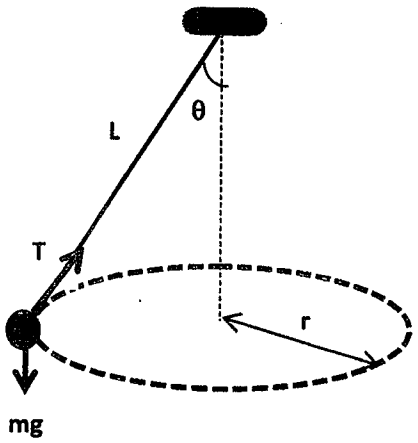

Figure 1: Conical pendulum

3.

a. Write definition for each of the following term.

I. Doppler effect

(03 marks)

II. Shock wave

(03 marks)

III. Mach number

(03 marks)

b. A traffic officer sets up a stationery radar device to measure the speed of a moving vehicle. The radar emits waves with a speed of 3×10^{8} ms^{-1} and a frequency of 3.3 GHz towards the vehicle.

I. Calculate the speed of the vehicle if the radar device receives a signal with a frequency of 3.30000003 GHz.

(06 marks)

II. If the speed limit for this section of road is 120 kmh^{-1} determine whether the vehicle exceeded the speed of limit or not.

(05 marks)

c. A plane is flying at Mach 1.2, and an observer on the ground hears the sonic boom 15.00 seconds after the plane is directly overhead. What is the altitude of the plane? Assume the speed of the sound is 343 ms^{-1}.

(05 marks)

4.

a. The displacement of a particle at t=0.25 s is given by the expression $x=(4.0m)\cos(3.0\pi t+\pi)$, where x is in meters and t is in seconds. Determine

I. the frequency and period of the motion

(03 marks)

II. the amplitude of the motion

(03 marks)

III. the phase constant

(03 marks)

IV. the displacement of the particle at t=1.25 s

(03 marks)

V. the equation of the velocity of the particle

(03 marks)

VI. the equation of the acceleration of the particle

(03 marks)

b. A mass m is oscillating freely on a vertical spring. When m= 0.810 kg and the period is 0.910 s.

I. Determine the spring constant k

(03 marks)

II. An unknown mass on the same spring has a period of 1.16 s. Determine the unknown mass.

(04 marks)

Part B

1. .

a. Name two circuits that can be used to rectification.

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(2 marks)

A student used the circuit diagram in the Figure 01 to rectification. Input will be a sinusoidal wave.

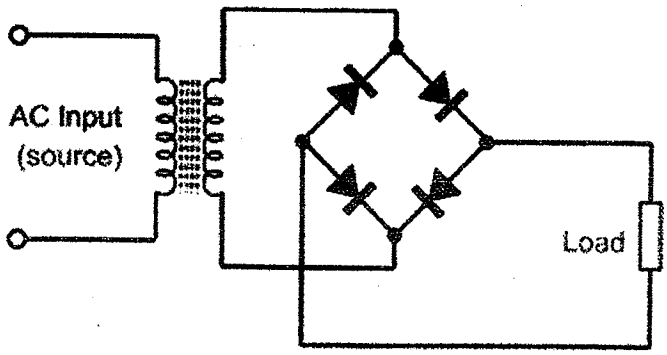
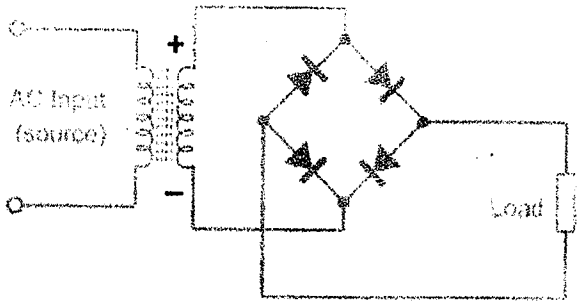


Figure 01

b. Draw the current flowing path for positive half of the cycle.



(2 marks)

c. Explain why there is no current flow through the circuit in negative half of the input.

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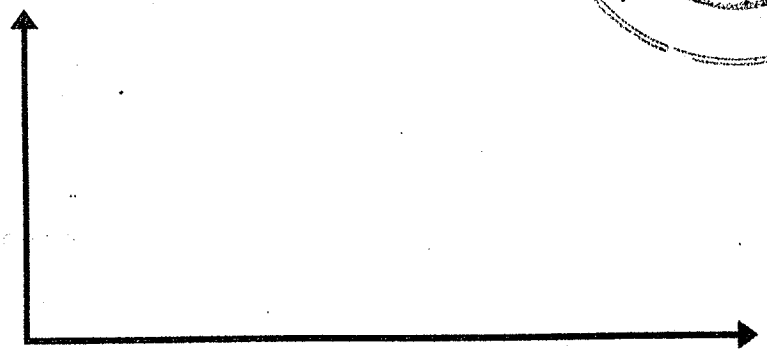
(2 marks)

d. Draw the expected output of the circuit.

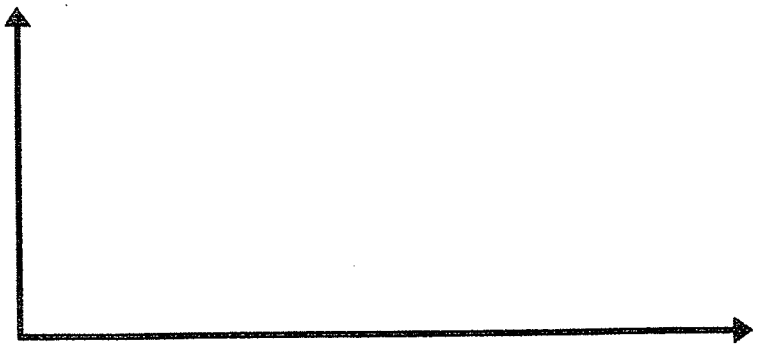


(2 marks)

e. Draw the corrected circuit.

(2 marks)

f. Draw the expected output after the correction.



(2 marks)

g. What is the modification that you do to the circuit to smooth out the current?

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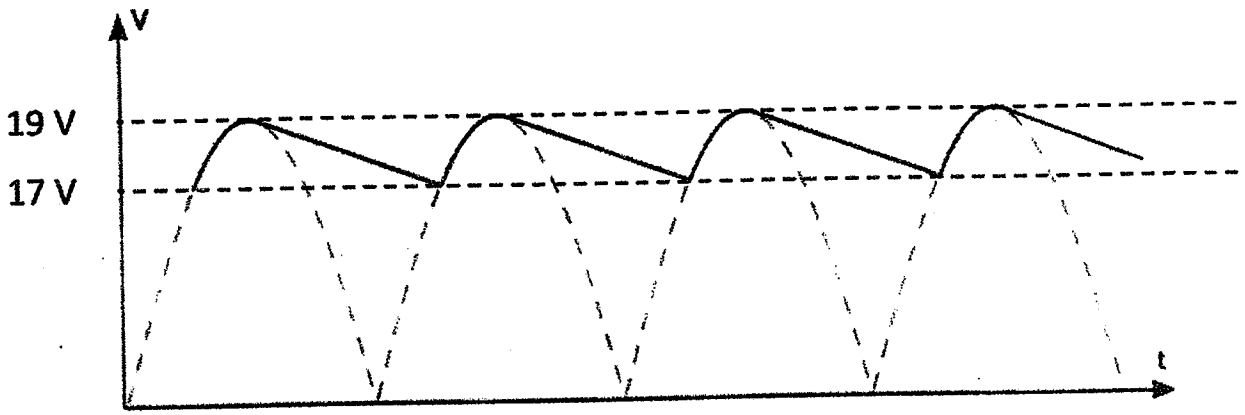
(1 mark)

h. After the modification the output voltage varies as shown in Graph 01. Another student suggested to connect the smoothed output from above circuit to the input of the circuit in Figure 02 to get a constant 9.1 V as the output.



Graph 01

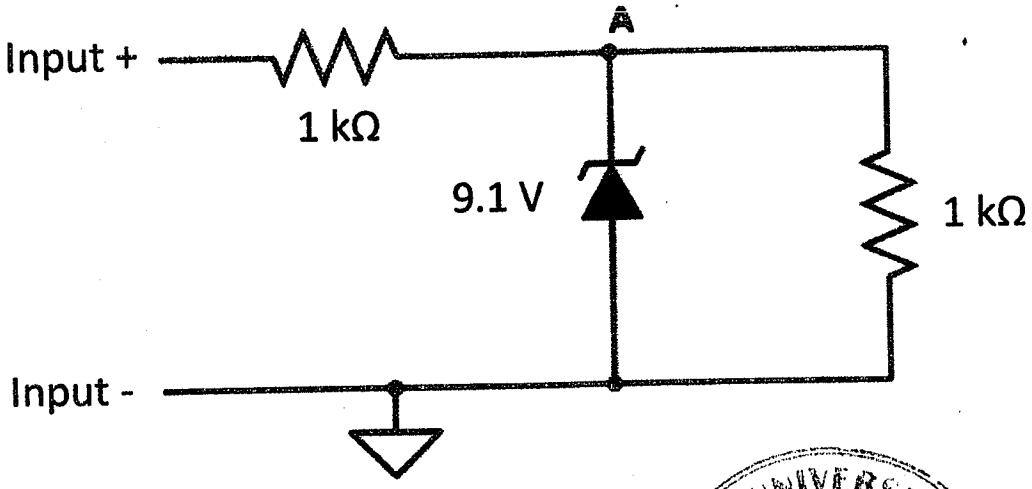


Figure 02

i. Show that the output of the circuit will be less than the expected value at the minimum input voltage value. Clearly state the assumptions you made

(7 marks)

j. Find the output voltage at the maximum input voltage.

(7 marks)

k. Calculate the minimum input voltage that outputs 9.1V at the output.

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(3 marks)

2. Capacitor charging circuit shown in the Figure 03.

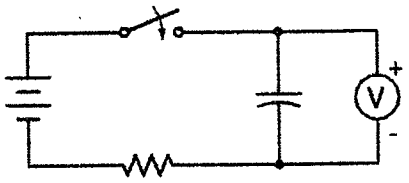

Figure 03

When the capacitor is charging;

- V_c = Potential difference across the capacitor.
- I_c = The instantaneous charging current.
- q = total charge on capacitor plate.

a. Using the above notations write down an expression for the supply voltage V at any instance.

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(2 marks)

b. Show that I_c can be written as $\frac{dV_c}{dt}$.

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(2 marks)

c. Hence show that $V_c = V\left(1 - e^{-\frac{t}{CR}}\right)$.

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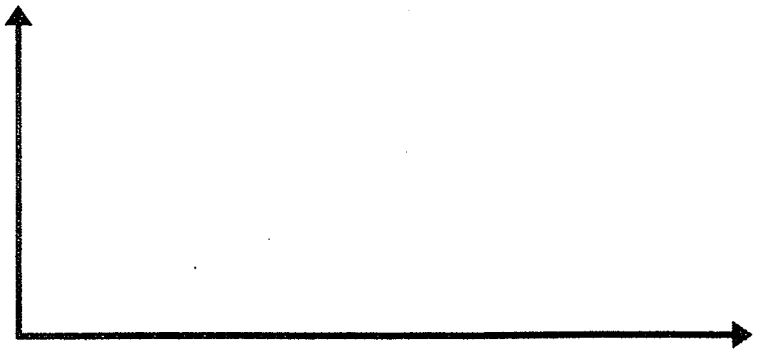
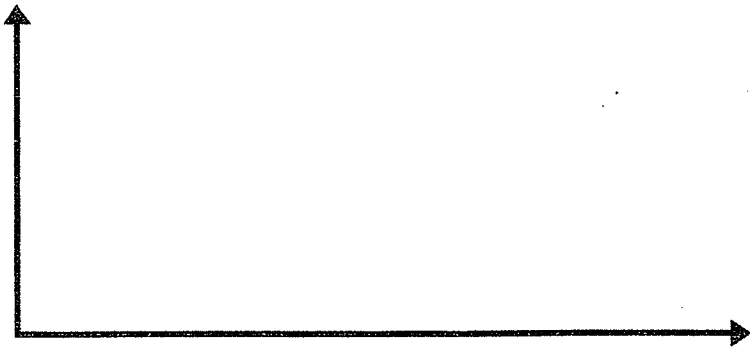
(6 marks)

d. Draw the shape of the general graph of voltage across a capacitor as it is charged when charging.



(2 marks)

e. Draw the general graph of current through a capacitor as it gets charged.



(2 marks)

f. Write down the equation for energy stored in a capacitor.

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(1 mark)

3. Find the Thevenin's equivalent circuit for the circuit shown in Figure 04.

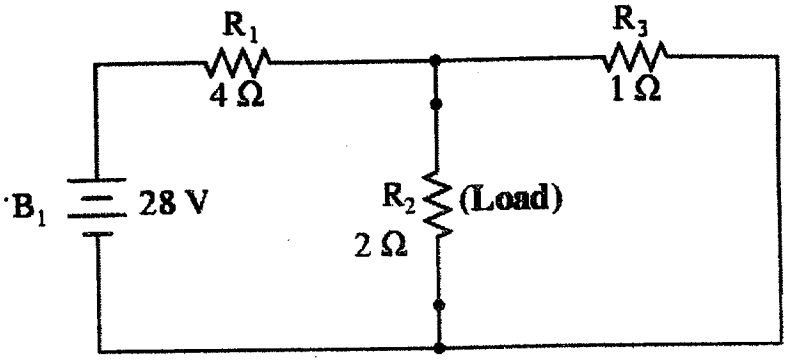

Figure 04

(12 marks)

a. If the LOAD resistor need to replace to gain the maximum power transfer through it, what will be the resistance of new resistor? (No need of calculation, but justify your answer.)

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(3 marks)

4. Write whether the following statements are TRUE or FALSE and briefly explain your answer.

a. Minority carriers in the P type semiconductor are holes.

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(5 marks)

b. Unwanted photo diode effects can be minimized by translucent housings.

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(5 marks)

c. Usually LEDs are used in reversed biased.

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(5 marks)

d. Minority carriers of I type semiconductor is free electrons.

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(5 marks)

e. If we supply positive potential to P type and negative potential to N type, always current will flow through PN junction no matter what we applied as the potential difference.

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(5 marks)

f. Any practical power source has internal resistance to it.

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(5 marks)

[End of Part B]