THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

UNIVERSITY EXAMINATIONS

FINAL EXAM – November / December 2021

EEE 3112

ELECTRICAL ENGINEERING PRACTICE

TIME	:	Three (3) hours
INSTRUCTIONS	:	Answer any Four Questions in section A and Any One (1) question (compulsory) in section B.
ADDITIONAL INFORMATION	:	Submit SECTION A and SECTION B in Separate Answer Booklets.

SECTION A: ANSWER ANY FOUR (4) QUESTIONS FROM THIS SECTION

QUESTION ONE

1. Two small resistors have the following colours:

   Resistor 1: Red, Violet, Gold and Silver.

   Resistor 2: Violet, Grey, Silver, and Silver.

   State the values of the resistor and their tolerance. **[2Marks]**

2. Design an automatic solar powered lamp circuit diagram. The design should automatically switches on three parallel high power white LEDs each 2.7Volts, 30mA in the evening and stay on for 5 hours using a 6 Volt, 4.5Ah rechargeable battery. During the day time the solar panel should charge the 4.5Ah battery and switches off the white LEDs. The design should consist the following: **[5Marks]**

   - 12V, solar panel, used to charge the battery during the day time.
   - 6Volt 100 ohms PCB Relay which switches on and off the LED lights during the evening and night respectively.
   - Charger controller resistor connected in series with Silicon diode D1 with 0.7V and the solar panel to drop the voltage and block the battery reverse current flowing back to the solar panel.
   - Charger indicator Red LED with 1.8V, 15mA capacity-during the day time it is switched on and off during the evening when the battery is not charging.
   - The high value 4700μF capacitor C1 to act as a buffer for the smooth switching of the relay and also to prevent relay clicking when the input voltage reduces momentarily
   - Switch S1, S2, and S3 to turn off the lamps separately when not in use.

   a) What size of resistor is needed to connect in series with the white LED to restrict the current flow through LEDs? **[1Marks]**

   b) What size of the resistor should be connected in series with the charger indicator red LED to restrict the current flow through the LED? **[1Marks]**

   c) What size of solar panel active power in watts is required to charge the battery to full capacity for the period of 5hrs after being used for 5hrs supplying the white LEDs, assuming the battery was initial full charged before used ? **[5Marks]**

The figure 1 below shows a simple AM Radio circuit diagram. Identify the components making the circuit and make the list of components and their rating (bill of quantity) for the circuit. **[4Marks]**

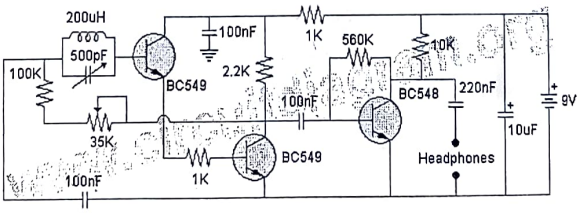

Fig 1: Simple AM Radio Circuit Diagram

Total [20Marks]

QUESTION TWO √

a) State and briefly describe the four types of diagrams commonly used in electrical and electronics drawing. **[4 Marks]**

b) Design a solar based multipurpose charger circuit diagram. A 12 V, 5W solar panel is used as the source of current. The circuit diagram should be able to charge a 3.7V Mobile phone batteries, 6V NiCd batteries, and 12V lead acid batteries. The following components should be used in the circuit diagram

- IC1 7812 to give 12V output
- IC2 7806 to give 6V output, with resistor R3=47Ω to restrict the charging current.
- IC3 7805 to give 5V output, with resistor R2=47Ω to restrict charging current to a safer level
- High value capacitors C1 and C2 4700μF, 16V to act as current buffers so that a short duration interruption in current flow from the panel will not affect the charging process.
- Red LED 2V, 30mA,to indicate the charging process
- Diode D1 1N6204 to protect battery current to flow back to solar panel

Calculate the resistance of the resistor to connect in series with a Red LED to restrict the current flow through LED? **[6 Marks]**

c) Design a 230VAC main supply based multipurpose mobile and laptop charger. A 230VAC main supply is used as source of current. The circuit diagram should be able to charger a 3.7V, 600mA mobile phone battery and 19V, 3.42A laptop battery. The following components should be used in the circuit diagram

- IC1 KIA7820API to give 20V output
- Use a Zener Diode as regulator to give 3.7V output, with resistor R2 to restrict charging current to a safer level and restrict current through Zener diode
- High value capacitors C1 and C2 4700μF, 25V to act as current smoother and buffers so that a short duration interruption in current flow from the panel will not affect the charging process.
- Red LED 2V, 30mA,to indicate the charging process
- Diode D1 1N6204 to protect battery current to flow back to solar panel
- Diode D2-D5 1N6204 for converting AC to DC
- A step down transformer 240/19V 7000mA **[6Marks]**

a) Calculate the resistance of the resistor to connect in series with a Red LED to restrict the current flow through LED. **[1 Mark]**

b) Calculate the resistance of the resistor to limit the current through the Zener diode and the resistor power rating. **[2 Mark]**

c) Calculate the Zener power rating. **[1 Mark]**

Total [20Marks]

QUESTION THREE ✓

a) Explain briefly how you would test the following components using a digital multimeter. **[8Marks]**

i) Diode

ii) NPN transistor
iii) Resistor
iv) Capacitor

b) Outline series of logical steps you would use to speed up the troubleshooting process in fault finding of any instrument. **[5Marks]**

c) The circuit in figure Q1works on the principle that when the switch S is closed the LED is turned on. But the LED does not turn on even if S is closed, describe the troubleshooting process you would use to rectify the fault. **[7Marks]**

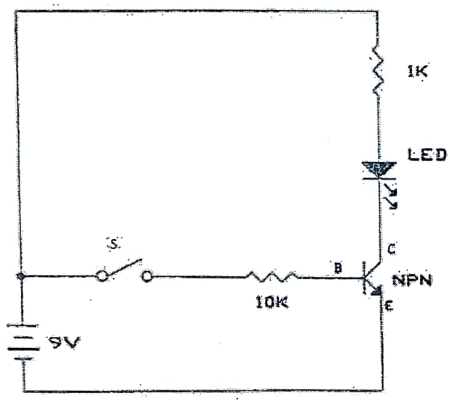

Figure Q3.

Total [20Marks]

QUESTION FOUR ✓

a) A 1mA meter movement with an internal resistance of 100Ω is to be converted into an ammeter with ranges of 10 mA 50 mA and 100 mA. With the help of a diagram calculate the value of shunt resistances required for the ranges. **[8Marks]**

b) Figure Q4.b for Wheatstone bridge is shown below with resistances R1= 220Ω, R2 = 550Ωand R4 = 1000Ω. Calculate the resistance R3. **[5Marks]**

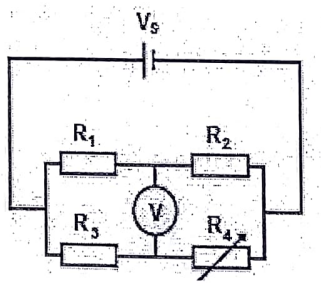

Figure Q4.b

c) A 50 µA meter movement with an internal resistance of 200Ω is to be converted into an ~~ammeter~~ Voltmeter with ranges of 10 V and 20 V. With the help of a diagram calculate the value of multiplier resistances required for the ranges. **[3Marks]**

d) Figure Q4.d shows an ac voltmeter using full wave bridge rectifier. If the ac voltage to the input terminals is 10V rms find the reading of the galvanometer in volts. **[4Marks]**

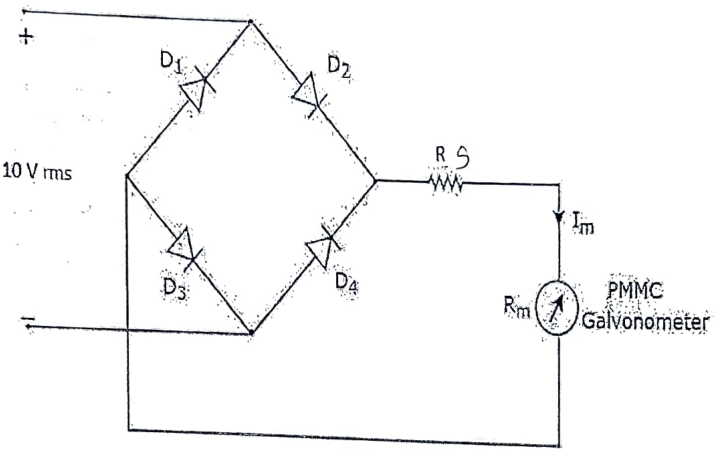

Figure Q4.d AC Voltmeter

Total [20Marks]

SECTION B: YOU MUST ANSWER ONE (1) QUESTION FROM THIS SECTION

QUESTION FIVE √

A beam, which is supported through pin joints at its ends, is acted upon by a couple M in a plane containing the axis of the beam,
applied at a point three quarters of the span from one end.
Find expressions for the:

(a) slope of the beam at both ends **[10 Marks]**
(b) maximum deflection. **[10 Marks]**

Total [20Marks]

QUESTION SIX

You have been commissioned to design the suspension for a new sports utility vehicle (SUV). The net weight of the SUV is 3500kg,
distributed 45% on the rear axle and 55% on the front axle. When fully loaded an additional 1000kg is added to the SUV, distributed
60% on the rear axle and 40% on the front axle. You are using, on the front axle 2 identical helical close coiled springs in parallel,
and on the rear axle 2 identical leaf springs in parallel. Your design constraint is, completely unloaded to fully loaded, the maximum
static deflection on either axle should not exceed 20 cm. given for:
Helical spring:

Mean coiled diameter	=	30cm
Modulus of rigidity	=	83.5 GN/m^2
Wire diameter	=	35mm

Leaf spring:

Length	=	1 m
Number of leaves	=	8
Width to thickness ratio	=	8:1
Elastic modulus	=	125 GN/m^2

Find:

(a) The number of complete coils required in the helical springs **[5Marks]**

(b) The width of the leaf springs **[5Marks]**

(c) The deflection at both axles when acted upon the net weight of the pickup only. **[5Marks]**

If the distance between the rear and front axle is 4 m what is the magnitude and direction of the shift in the centre gravity of the pickup when loaded with the additional 1000kg. **[5Marks]**

Total [20Marks]

QUESTION SEVEN

You are designing the spring damper system for a 2050 kg luxury motor vehicle. The test road is sinusoidal in undulation with
a maximum displacement of 30cm. If the maximum allowable displacement of the vehicle relative to the road is 34cm, determine:

(a) the damping ratio and state whether it is over, critically or under damped **[5Marks]**

If the length of one undulation is 5m, and the damping coefficient is 12000kg/s, determine:

(b) the stiffness of the suspension **[4Marks]**

(c) the speed in km/h of the vehicle at maximum displacement **[5Marks]**

(d) the maximum displacement of the vehicle if the and the vehicle is moving a 210km/h **[6 Marks]**

Total [20Marks]

END OF EEE3112 – EXAM