The University of Zambia
Department Mechanical Engineering
ENG 3165 - Fluid Mechanics and Thermodynamics

Term 2 - Academic Year 2020/2021

MID-TERM TEST – October 2021

CLOSED BOOK Examination
TIME: TWO HOURS

Instructions to candidates:

1. Candidates must ensure that their computer numbers are clearly written on each answer sheet used.
2. **ANSWER ALL QUESTIONS**
3. Clearly label all answered question

Question One

a) Define the term pure substance
b) What is a working substance?
c) Define the term Thermodynamic system
d) A gas expanding in the combustion space of a reciprocating engine has an initial pressure of 50 bar and an initial temperature of 1623°C. The initial volume is 50,000 mm^3 and the gas expands through a volume ratio of 20 according to the law $PV^{1.25}$ = constant.
Calculate
   i) The work transfer
   ii) The heat transfer during the expansion process.

Take R=270 J/kg.K and C_v= 800 J/kg.K **[3+3+6+13 marks]**

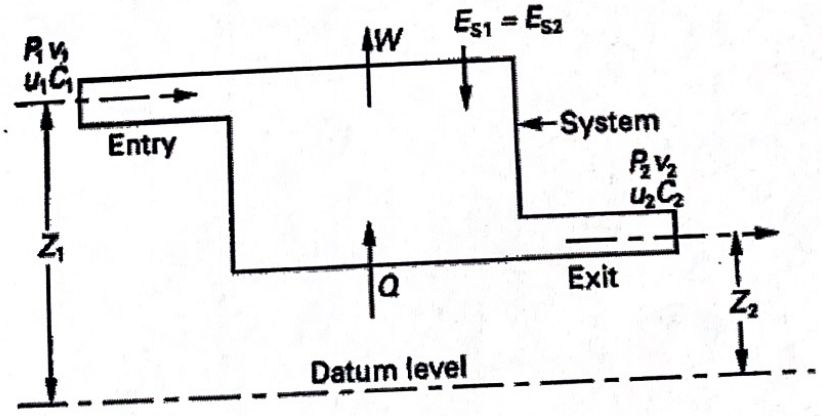
Question Two

(a) Define the Zeroth Law of Thermodynamics
(b) State two limitations of the First Law of Thermodynamics
(c) Define the term Cycle
(d) A Carnot engine absorbs 1000 J of heat from a reservoir at 127C and rejects 600 J of heat during each cycle.
Calculate
i) The efficiency of the engine.
ii) The temperature of the sink
iii) The amount of the useful work done during each cycle.

[6+4+3 + 12 marks]

Question Three

a) Define the term Internal Energy
b) Using the first law equation, prove mathematically that for an isolated system, there is no change in internal energy.
c) In a steady-flow open system, a fluid flows at the rate of 5.5kg/s. It enters the system at a pressure of 650kN/m^2, a velocity of 235m/s, internal energy of 2250kJ/kg and specific volume of 0.4m^3/kg. It leaves the system at a pressure of 165kN/m^2, a velocity of 145m/s, internal energy 1750 kJ/kg and specific volume of 1.6m^3/kg. During its passage through the system, the substance has a loss by heat transfer of 50 kJ/kg to the surroundings.



Determine the power of the system, stating whether it is from the system or to the system. Neglect any change of gravitational potential energy.

[4+6+15 marks]

Question Four

a) Briefly define a heat engine; giving its main processes and characteristics. What are some common examples?
b) Define heat capacity at constant pressure.
c) What four processes make up an ideal Otto Cycle?
d) The compression ratio of an air-standard Otto cycle is 9.5. Prior to the isentropic compression process, the air is at 100 kPa, 35°C, and 600 cm^3 . The temperature at the end of the isentropic expansion process is 800 K. Using specific heat values at room temperature, determine;
   i) the highest temperature and pressure in the cycle;
   ii) the amount of heat transferred in, in kJ;
   iii) the thermal efficiency;
   iv) the mean effective pressure.

[6+3+4+12 marks]

END OF TEST

ALL THE BEST!!

THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

UNIVERSITY EXAMINATIONS

2021 ACADEMIC YEAR TEST

EEE 3112

ELECTRICAL ENGINEERING PRACTICE

TIME	:	Two (2) hours
INSTRUCTIONS	:	Answer all questions: Q1 and Q2 in book1 and Q3 and Q4 book2
ADDITIONAL	:	

Question one

1. Two small resistors have the following colors:

   Resistor 1: Red, Violet, Gold and Silver.

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

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

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:
   [6 Marks]

   - 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?
   [2 Marks]

   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? **[2 Marks]**

   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 ? Calculate active power of solar panel (use ohm's law)
   [7 Marks]

3. 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. **[6 Marks]**

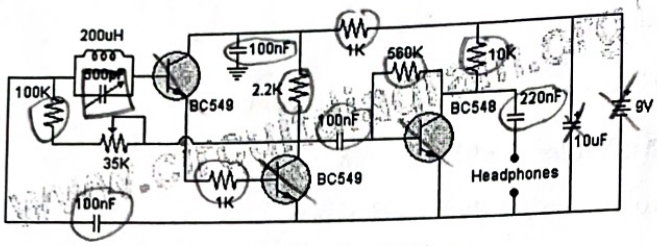


Fig 1: Simple AM Radio Circuit Diagram

Total [25Marks]

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?
[8 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 [9 Marks]

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 [25 Marks]

Question three

a) Define the following performance characteristic of an instrument: accuracy, precision, resolution, sensitivity. [4 marks]

b) Define absolute error. An expected voltage value of a power supply is 20V. Measurement of the power supply gives 18V. Calculate the following:
   i) Absolute error. [2 marks]
   ii) Percentage of error. [2 marks]
   iii) Relative accuracy. [2 marks]
   iv) Percentage of accuracy [2 marks]

c) From the given table below, calculate the most precise reading Xn. [10 marks]

Number	Xn
1	98
2	101
3	102
4	97
5	101
6	100
7	103
8	98
9	106
10	99

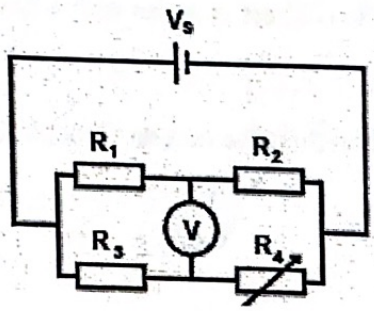
d) A voltmeter is 300V full range with an accuracy of ±2%. Calculate an instrument error when a voltmeter is used to measure 220 V AC source. [3 marks]

e) Calculate the following with regard to rules of significant figures. [2 marks]
   i) 9V/0.003A
   ii) 9V*0.002A

Question four

a) What is a kelvin bridge? Explain appropriate diagrams the difference between a kelvin bridge and a Wheatstone bridge. [1, 4 marks]

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



c) The values of resistances R1, R2, R3, and R4 of the Wheatstone bridge in Q4.b are 20, 15, 30, and 35 respectively. Calculate the current passing through the battery of negligible resistance. Which instrument is used as a null detector in the Wheatstone bridge? [9, 1 marks].

d) Figure Q4.d shows an ac voltmeter using half wave rectifier diode. If the ac voltage to the input terminals is 10V rms find the reading of the galvanometer in volts. [5 marks]

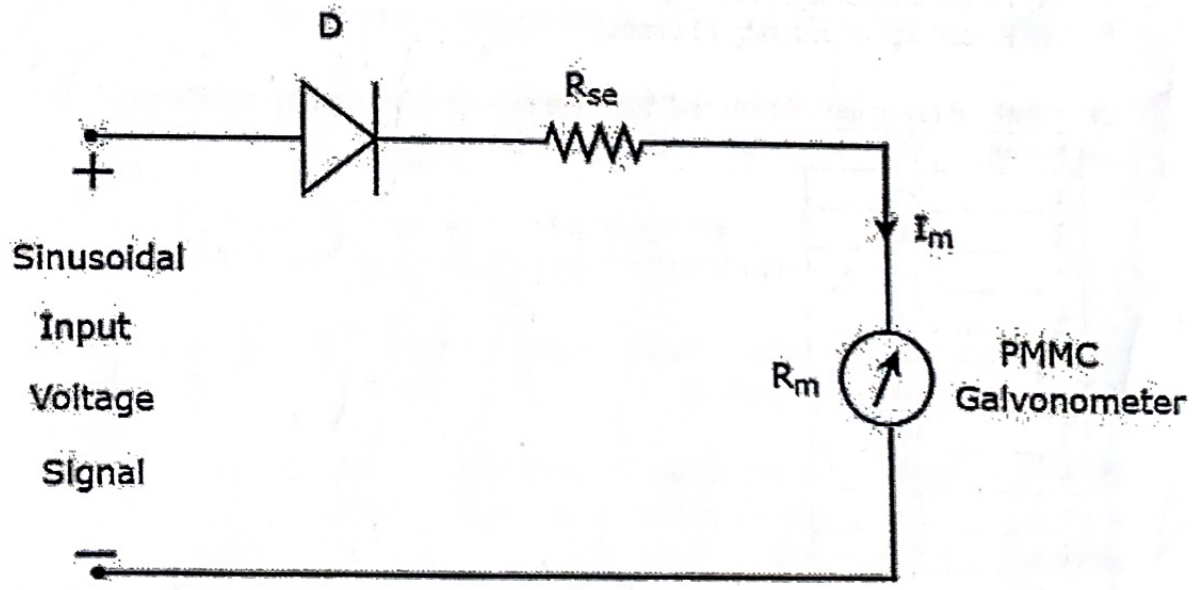


Figure Q4.d AC Voltmeter