**NAME: ATIF KHAN**

**ID: 16080**

**SECTION: A**

**CIVIL ENGINEERING DEPARTMENT**

**BASIC ELECTRO MECHANICAL ENGINEERING**

**FINAL TERM EXAM**

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**Q No 1** What is Diode? Differentiate between Half-wave rectification and Full-wave rectification.

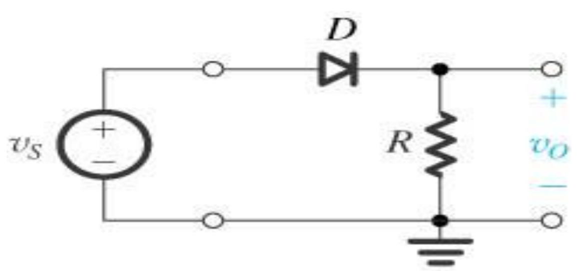
## Part A:

### Diode:

A diode is an electronic component that has two terminals and it is limits current to one direction. Diodes have an anode and a cathode. Positive current normally flows from the anode to the cathode. Diodes are useful for protecting circuitry from harmful voltage or current. Diodes are a basic building block of the charge-collecting element in many detectors.

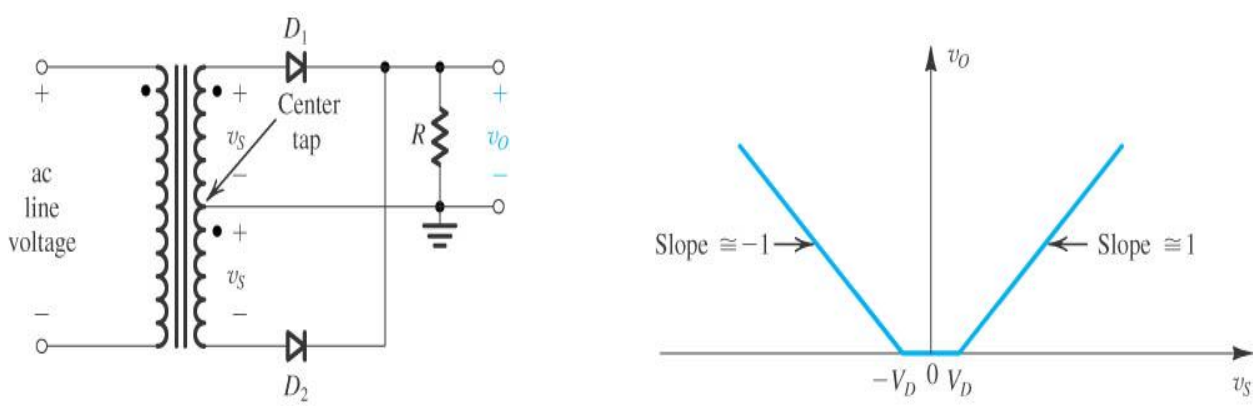
### Half-Wave Rectifier:

A device which is used to convert ac to dc. It operating cycle is half. In positive cycle it converts but not in negative cycle. Half Wave rectifier is shown below;




### Full-Wave Rectifier:

A device which is used to convert ac to dc. It operating in both cycle. In positive and negative cycle. Half Wave rectifier is shown below;




(a) (b)

## Part B:

A 97.0 g sample of gold at 785°C is dropped into 323 g of water, which has an initial temperature of 15.0°C. If gold has a specific heat of 0.129 J/g°C, what is the final temperature of the mixture? Assume that the gold experiences no change in state of matter.(water specific heat=4.184 J/g°C).

## Solution:

As losses formula is;

$-Lose_{heat}=Gain_{heat}$

And we can also write it as;

**- [($C_{Au}$) (mass) (ΔT)] = ($C_{H_2o}$) (mass) (ΔT)**

**Putting values, we get;**

- [(0.129 J/g°C) (97 g) ($T_f$ - 785°C)] = (4.184 J/g°C) (323 g) ($T_f$ - 15°C)]

- [(12.5) ($T_f$ - 785°C)] = ($1.35 \times 10^3$) ($T_f$ - 15°C)]

$-12.5\ T_f + 9.82 \times 10^3 = 1.35 \times 10^3 T_f - 2.02 \times 10^4$

$3 \times 10^4 = 1.36 \times 10^3 T_f$

**Final temperature= $T_f$ = 22.1°C**

**Q No 2** Explain the Isobaric process, Isometric process, Isothermal process and adiabatic process on the basis of first law of thermodynamics.

## Part A:

### FIRST LAW OF THERMODYAMICS

The net heat put into a system is equal to the change in internal energy of the system plus the work done BY the system.

ΔQ = ΔU + ΔW............eq.1

Δ=(final - initial)...........eq.2

Conversely, the work done ON a system is equal to the change in internal energy plus the heat lost in the process.

### ISOCHORIC PROCESS

CONSTANT VOLUME, DV = 0, DW = 0

DQ = DU + DW so that DQ = DU

Heat in= Increase in heat energy

Heat out= Decrease in heat energy

### ISOBARIC PROCESS

CONSTANT PRESSURE, DP = 0

DQ = DU + DW But DW = P DV

Heat in=Wout + Increase in heat energy

Heat out= Wout + Decrease in heat energy

### ISOTHERMAL PROCESS

CONST. TEMPERATURE, DT = 0, DU = 0

DQ = DU + DW AND DQ = DW

Heat input= Work O/p

Work Input = Heat Out

### ADIABATIC PROCESS

NO HEAT EXCHANGE, DQ = 0

*DQ = DU + DW ; DW = -DU or DU = -DW*

Work done at EXPENSE of internal energy

INPUT Work INCREASES internal energy

## Part B:

A steam engine absorbs 600 J of heat at 500 K and the exhaust temperature is 300 K. If the actual efficiency is only half of the ideal efficiency, how much work is done.

## Solution:

First we need to calculate the efficiency of system;

As, Efficiency is;

$e = 1 - T_C / T_H$

$e = 1 - (300\text{ K}/ 500\text{ K})$

**e = 40% (efficiency)**

Actual $e = 0.5e_i = 20\%$

As efficiency is $e = W/Q_H$

As from above equation the formula for work become;

$W = e\, Q_H = 0.20\ (600\text{ J})$

**Work = 120 J.**

## Q No 3 Differeniate between internal combustion engine and external combustion engine.

## Part A: Difference between internal combustion engine and external combustion engine:

External engines have a working fluid that is heated by the fuel. Internal combustion engines rely on the explosive power of the fuel within the engine to produce work. In internal combustion engines, the explosion forcefully pushes pistons or expels hot high-pressure gas out of the engine at great speeds. Both moving pistons and ejected high-speed gas have the ability to do work. In external combustion engines, combustion heats a fluid which, in turn, does all the work.

## Part B:

A diatomic gas at 300 K and 1 atm is compressed adiabatically, decreasing its volume by 1/12. ($V_A = 12V_B$). What is the new pressure and temperature? ($Y = 1.4$)

Solution:

**PaVa=PbVb^gema**

**Pb=Pa(12Vb/Vb)^1.4**

=Pb=Pa(12)^1.4

Putting values;

Pb=(1 atm) (12^1.4)

Pb=32.4 atm

Or

**Pb=3284*Pa**

**b)**

**Delta Q=0**

(PaVa)/Ta=(PbVb)/Tb

Putting values, We get;

=(1atm)(12Vb)/300k

=(32.4atm)(1Vb)/Tb

Tb=(32.4)(Vb)

**Tb=810K**

**Q No 4** Differentiate between conduction and convection.

**Part A:**

| **Conduction** | **Convection** |
|---|---|
| In conduction, heat transfer takes place between objects by direct contact. | In convection, the heat transfer takes within the fluid. |
| The heat transfer takes place due to the difference in temperature. | The heat transfer occurs due to the difference in density. |
| The heat transfer in conduction is slow | The heat transfer in convection is faster. |
| The heat transfer occurs through a heated solid object. | The heat transfer occurs through intermediate objects. For example, heat transfer between air and water. |
| It does not follow the law of reflection and refraction. | It does not follow the law of reflection and refraction. |

## Part B:

A 75.0 g piece of lead (specific heat = 0.130 J/g.$^{o}$C), initially at 435$^{o}$C is set into 125.0 g of water (specific heat = 4.18 J/g.$^{o}$C), initially at 23.0$^{o}$C. What is the final temperature of the mixture?

## Solution:

Final temperature of the mixture=?

As we know that;

Qwater=-Qpb

**Mwater*cwater*Twater=-(mpb *Cpb*Tpb)**

**Putting values;We get**

125(4.18)(Tf-23)=-75(0.13)(Tf-435)

522.5Tf-12017.5=-9.75 + 4241.25

9.75Tf + 12017.5 + 9.75Tf + 12017.5

532.25 Tf=16258.75

**Tf=30.5 C**

## Q No 5

The roof of an electrically heated home is 6 m long, 8 m wide,and 0.25 m thick, and is made of a flat layer of concrete whose thermal conductivity is k 0.8 W/m · °C . The temperatures of the inner and the outer surfaces of the roof one night are measured to be 25°C and 0°C, respectively, for a period of 10 hours.Determine the rate of heat loss through the roof that night and the cost of that heat loss to the home owner if the cost of electricity is $0.2/kWh.

## Solution:

The area of roof can be calculated as;

Area= Length * width

A= 6 m×8 m=48 m$^2$.

The steady rate of heat transfer through the roof is determined

$\dot{Q}=kA(T_1-T_2)/L$

Q= (0.8)(48 )(25-0)/0.25

= **3840 W= 3.84 kW**

As we have to calculate for 10h

The amount of heat lost through the roof during a 10-hour period and its cost are determined from;

$Q = \dot{Q}.\Delta t$

*Q*=(3.84 kW)(10 h) = 38.4 kWh

**Cost/day** = (Amount of energy)(Unit cost of energy)

Cost/Day = (38.4 kWh)($0.2/kWh) =**$7.68**

**Cost/month =** (cost/day)×(30day/month)= $7.68×30=**$230.4**