BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of Electrical Skills

Session: 2021-22 (Summer Semester)

B. Voc. Program, V Semester,
End – Sem. Examination

Course Code: ELE 1501 **Time: 2 Hours**
Course Name: Fundamental of Power Electronics **Max. Marks: 50**

Instruction: Answer all questions from each and every section. Section A, each question carries one mark, section B, each question carries four marks and in section C, each question carries six marks. Scientific calculator is allowed.

Section – A

10X01 = 10 Marks

1. When the diode is reverse biased, it is equivalent to:
   (a) Zero resistance (b) An On switch (c) A high resistance (d) None of these
2. The p-region has a greater concentration of _____ as compared to the n-region in a P-N junction:
   (a) holes (b) electrons (c) phonons (d) None of these
3. Which of the below mentioned statements is false regarding a p-n junction diode?
   (a) Diode are uncontrolled devices (b) Diodes are rectifying devices
   (c) Diodes are unidirectional devices (d) Diodes have three terminals
4. A silicon controlled rectifier (SCR) is a:
   (a) Unijunction device (b) Device with three junction
   (c) Device with four junctions (d) None of these
5. Which of the following is true in case of an unbiased p-n junction diode?
   (a) Diffusion does not take place
   (b) Diffusion of electrons & holes goes on infinitely
   (c) There is zero electrical potential across the junctions
   (d) Charges establish an electric field across the junctions
6. Which of the following devices does not belong to the transistor family?
   (a) IGBT (b) MOSFET (c) GTO (d) BJT
7. Which of the following terminals does not belongs to the MOSFET?
   (a) Drain (b) Gate (c) Base (d) Source
8. Choose the correct statement:
   (a) MOSFET is a uncontrolled device
   (b) MOSFET is a voltage controlled device
   (c) MOSFET is a current controlled device
   (d) MOSFET is a temperature controlled device
9. The three terminals of the IGBT are:
   (a) Base, emitter & collector (b) Gate, source & drain
   (c) gate, emitter & collector (d) Base, source & drain
10. Which terminal does not belongs to the SCR?
    (a) Anode (b) Gate (c) Base (d) Cathode

Set-A

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Section – B

04X04 = 16 Marks

1. What is power electronics? What are the applications of power electronics?
2. Define the term barrier potential.
3. Draw the V-I characteristics of typical Si and Ge diode.
4. A forward potential of 5 V is applied to a PN junction diode. A resistance of 5 KΩ is also in series with the diode. Determine the value of current.

Section – C

04X06 = 24 Marks

1. What are the types of power electronic converters? Write down the advantages of power electronics controllers?
2. With neat diagram, explain the working principle of pn-junction diode.
3. Explain the working principle of full wave rectifier.
4. A diode carries forward current of 60-mA when forward voltage applied is 0.2V. Find its D.C. forward resistance. It carries reverse current of 25 μ-A when reverse voltage is 60V, find its D.C. reverse resistance.

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

Answer Key

Course Code: ELE 1501
Course Name: Fundamental of Power Electronics

School of Electrical Skills

Session: 2021-22 (Summer Semester)

B. Voc. Program, V Semester,
End – Sem. Examination

Section – A

10X01 = 10 Marks

1. When the diode is reverse biased, it is equivalent to:
   Ans: (c) A high resistance
2. The p-region has a greater concentration of _____ as compared to the n-region in a P-N junction:
   Ans: (a) holes
3. Which of the below mentioned statements is false regarding a p-n junction diode?
   Ans: (d) Diodes have three terminals
4. A silicon controlled rectifier (SCR) is a:
   Ans: (b) Device with three junction
5. Which of the following is true in case of an unbiased p-n junction diode?
   Ans: (d) Charges establish an electric field across the junctions
6. Which of the following devices does not belong to the transistor family?
   Ans: (c) GTO
7. Which of the following terminals does not belongs to the MOSFET?
   Ans: (c) Base
8. Choose the correct statement:
   Ans: (b) MOSFET is a voltage controlled device
9. The three terminals of the IGBT are:
   Ans: (c) Gate, emitter & collector
10. Which terminal does not belongs to the SCR?
    Ans: (c) Base

Section – B

04X04 = 16 Marks

1. What is power electronics? What are the applications of power electronics?

Ans: Generally, power electronics is the process of using semiconductor switching devices to control and convert electrical power flow from one form to another to meet a specific need. In other words, power electronics enables the control of the power flow as well as its form ac or dc and the magnitude of currents and voltages.

Applications of power electronics range in size from a switched mode power supply in an AC adapter, battery chargers, audio amplifiers, fluorescent lamp ballasts, through variable frequency drives and DC motor drives used to operate pumps, fans, and manufacturing machinery, up to gigawatt-scale high voltage direct current power transmission systems used to interconnect electrical grids.

2. Define the term barrier potential.

Ans: The barrier potential or potential barrier in the p-n junction diode is the barrier which does not allow charge flow across the junction normally. This barrier is created by the charge present in the space charge region. When p-type material is brought in contact to a n-type material, the charge flow across the junction takes place due to concentration gradient between the two sides (n and p type). But after some time the immobile ions are created near the contact which create electric field which opposes flow of current. This resistance to the flow of charge is known as barrier potential.

3. Draw the V-I characteristics of typical Si and Ge diode.

Ans:

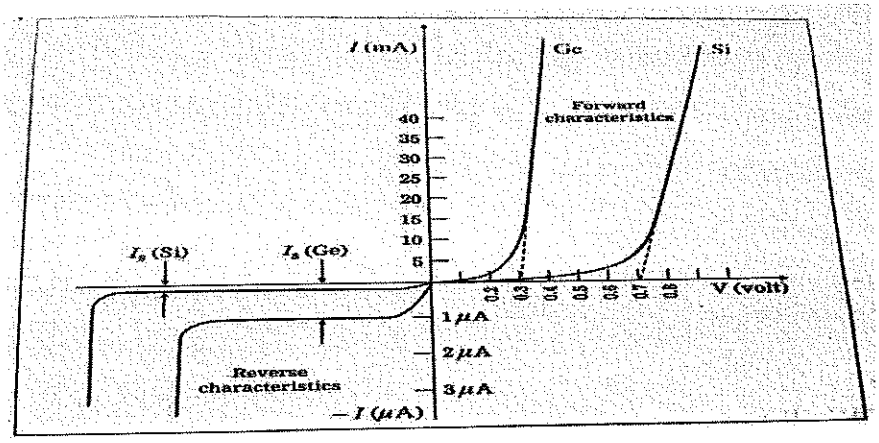


Fig: V-I characteristics of typical Si and Ge diode

Junction diode characteristics, Ge and Si

Explanation :

(1) Forward bias characteristics : There is forward current only after the barrier potential of the pn-junction is overcome. Then there is an exponential rise in the current beyond the knee region. The forward - bias voltage required to reach the region of upward swing is called the threshold voltage VT or cut in voltage. When rounded off to the nearest , the threshold voltage is 0.3 V for a germanium diode and 0.7 V for a silicon diode.

(2) Reverse bias characteristics : In the reverse bias, the potential barrier at the junction is large and the current due to majority carriers in each region is zero. However, minority charge carriers are able to cross the junction and constitute a very small current in the reverse direction.

This reverse current quickly reaches its maximum or saturation value and remains fairly constant with increase in the reverse - bias voltage. It is called the reverse saturation current Is, which is typically a few nanoamperes for a silicon diode and a few microamperes for a germanium diode

4. A forward potential of 5 V is applied to a PN junction diode. A resistance of 5 KΩ is also in series with the diode. Determine the value of current.

Ans:

It is given

Forward potential $V_f = 5V$

Resistance $R_L = 5K\Omega$

For Si-diode the barrier potential is 0.7V.

So, drop in forward voltage = 5 − 0.7 = 4.3V.

So, current $I = V/R = \frac{4.3}{5 \times 10^3} = 0.86mA$.

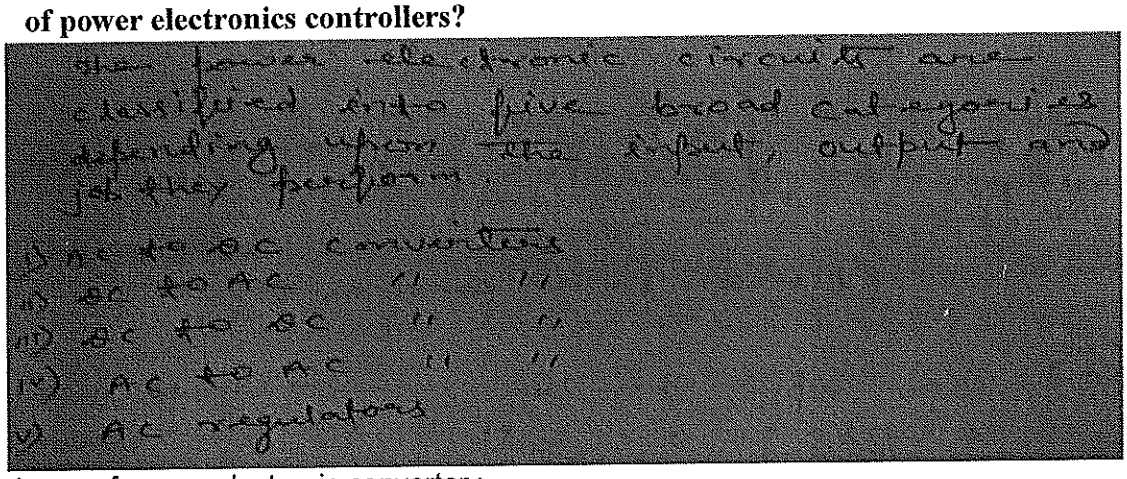
So, $I = 0.86\ mA$

Section – C

04X06 = 24 Marks

1. What are the types of power electronic converters? Write down the advantages of power electronics controllers?

Ans:

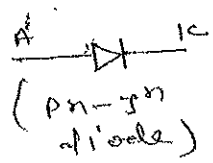


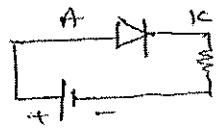
Advantages of power electronic converter :

- Long life
- Small size.
- High efficiency because of loss is low in power semiconductor devices.
- High reliability of power-electronic converter system.
- Can handle large output current.
- Less maintenance due to the absence of any moving part.

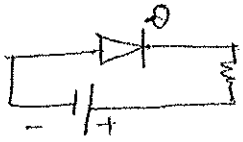
2. With neat diagram, explain the working principle of pn-junction diode.

Ans: A pn junction diode is a two terminal single crystal semiconductor device whose one side is doped with acceptors and other side by donors. Doping with acceptor creates p type semiconductor while doping with donors produces n type. Thus a pn junction is formed in diode.





(Forward biasing)

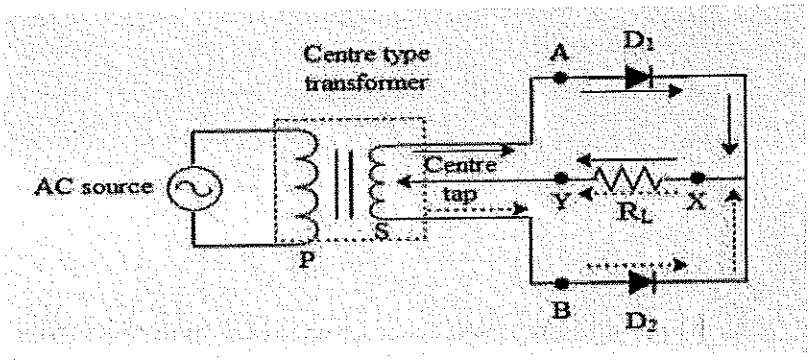


(Reverse biasing)

The process of applying the voltage across the pn-junction diode is called biasing of diode.
In forward biasing mode +ve terminal of battery is connected to P-type and negative terminal of battery is connected to n-type.
In Reverse bias +ve terminal of battery is connected to n-type and -ve terminal of battery is connected to P-typ.
Applied vol. above the barrier Pot. val. diode starts conducting in forward biasing.

3. Explain the working principle of full wave rectifier.

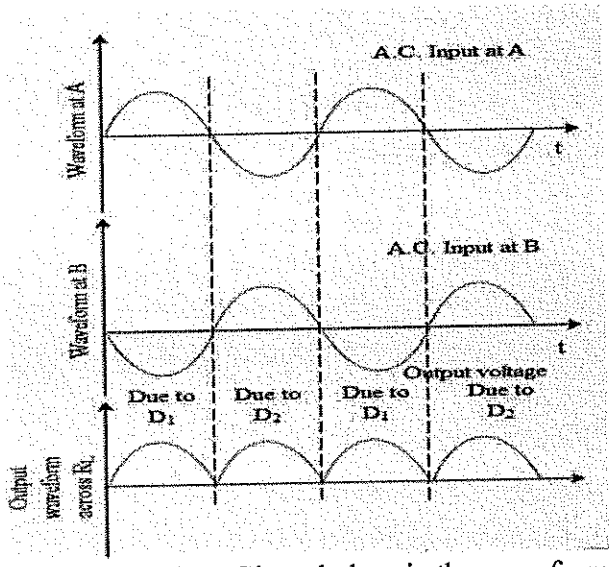
Ans: A full-wave rectifier converts the whole of the input waveform to one of constant polarity (positive or negative) at its output.



So let us begin by drawing the circuit diagram.

A simple full way rectifier consists of two transformers mutually inducted and two diodes which filter the negative cycle of alternating current. At any instant the voltage at A(input voltage of diode 1) and end B (input voltage of diode 2) of the secondary with respect to the centre tap will be out of phase. Suppose during a positive half

cycle of Ac input, the end A is positive and end B is negative with respect to the centre tap. Then diode 1 gets forward biased (allows the flow of current) and diode 2 gets reversed biased (does not allow the flow of current). Hence the current flows through the diode 1 towards the centre tap along the path AXY as shown in the above diagram. Similarly, during the negative half cycle of Ac input the end B becomes positive and end A becomes negative. Hence diode 1 gets reversed biased and diode 2 gets forward biased resulting in the current to flow from diode 2 to the centre tap along the path BXY as shown in the above diagram. As during both the half cycles the input a.c. the current through the load resistor will flow from X to Y and will keep on pulsating. Given below is the waveform for the full wave rectifier indicating inputs of AC and the output voltage.



4. **A diode carries forward current of 60-mA when forward voltage applied is 0.2V. Find its D.C. forward resistance.**
   It carries reverse current of 25 μ-A when reverse voltage is 60V, find its D.C. reverse resistance.

Ans:

It is given

$I_f = 60\,mA$

$V_f = 0.2\,V$

$I_R = 25\,\mu A$

$V_R = 60\,V$

So,

D.C. forward Resistance $R_{DCf} = \frac{V_f}{I_f}$

$= \frac{0.2}{60 \times 10^{-3}}$

$= 0.003 \times 10^{-3}\,\Omega$

or, $R_{DCf} = 3\,\Omega$

Similarly dc Reverse resistance (R_{DCR})

$R_{DCR} = \frac{V_R}{I_R} = \frac{60}{25 \times 10^{-6}} = 2.4 \times 10^{6}\,\Omega$

$R_{DCR} = 2.4 \times 10^{6}\,\Omega$

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of Electrical Skills

Session: 2021-22 (Summer Semester)

B. Voc. Program, V Semester,
End – Sem. Examination

Course Code: ELE 1501 **Time: 2 Hours**
Course Name: Fundamental of Power Electronics **Max. Marks: 50**

Instruction: Answer all questions from each and every section. Section A, each question carries one mark, section B, each question carries four marks and in section C, each question carries six marks. Scientific calculator is allowed.

Section – A

10X01 = 10 Marks

1. Diode allows electric current when it is:
   (a) forward biased (a) reverse biased (c) open circuited (d) none of these
2. The n-region has a greater concentration of _____ as compared to the p-region in a P-N junction.
   (a) Holes (b) Electrons (c) Both (a) & (b) (d) Phonons
3. The cut in voltage of Si diode is:
   (a) 0.2 V (b) 0.7 V (c) 0.8 V (d) 1.0 V
4. Which of the below mentioned statements is false regarding a p-n junction diode?
   (a) Diode are uncontrolled devices (b) Diodes are rectifying devices
   (c) Diodes are unidirectional devices (d) Diodes have three terminals
5. The knee voltage (cut in voltage) of Ge diode is:
   (a) 0.3 V (b) 0.7 V (c) 0.8 V (d) 1.0 V
6. A silicon controlled rectifier (SCR) is a:
   (a) Unijunction device (b) Device with three junction
   (c) Device with four junctions (d) None of these
7. The arrow symbol in the diode indicates:
   (a) Direction of electron flow.
   (b) Direction of hole flow (Direction of conventional current)
   (c) Opposite to the direction of hole flow
   (d) None of the above
8. A power transistor is a:
   (a) three layer, three junction device (b) three layer, two junction device
   (c) two layer, one junction device (d) four layer, three junction device
9. When the diode is forward biased, it is equivalent to:
   (a) An off switch (b) An On switch (c) A high resistance (d) None of these
10. Which terminal does not belong to the SCR?
    (a) Anode (b) Gate (c) Base (d) Cathode

Set-B

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Section – B

04X04 = 16 Marks

1. What types of functions performed by power electronic devices in electrical power systems?
2. Define the term power electronics. In the modern technology what is the place of power electronics?
3. For high frequency applications will you prefer MOSFET or IGBT Why?
4. A forward potential of 5 V is applied to a PN junction diode. A resistance of 5 KΩ is also in series with the diode. Determine the value of current.

Section – C

04X06 = 24 Marks

1. What is barrier potential? What are the parameters over which barrier potential depends?
2. With neat diagram, explain the working principle of pn-junction diode.
3. Define rectifier. With neat diagram, and wave form explain the working principle of full wave rectifier.
4. A full wave rectifier uses a center-tap transformer whose turn's ratio to half secondary is 10:1 and is supplied with230V at 50HZ. If the load resistance is 50 ohm, then calculate the value of maximum voltage and current.

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

Answer Key

Course Code: ELE 1501
Course Name: Fundamental of Power Electronics

School of Electrical Skills

Session: 2021-22 (Summer Semester)

B. Voc. Program, V Semester,
End – Sem. Examination

Section – A

10X01 = 10 Marks

1. Diode allows electric current when it is:
   Ans: (a) forward biased
2. The n-region has a greater concentration of _____ as compared to the p-region in a P-N junction.
   Ans: (a) Holes
3. The cut in voltage of Si diode is:
   Ans: (b) 0.7 V
4. Which of the below mentioned statements is false regarding a p-n junction diode?
   Ans: (d) Diodes have three terminals
5. The knee voltage (cut in voltage) of Ge diode is:
   Ans: (a) 0.3 V
6. A silicon controlled rectifier (SCR) is a:
   Ans: (b) Device with three junction
7. The arrow symbol in the diode indicates:
   Ans: (b) Direction of hole flow (Direction of conventional current)
8. A power transistor is a:
   Ans: b) three layer, two junction device
9. When the diode is forward biased, it is equivalent to:
   Ans: (b) An On switch
10. Which terminal does not belong to the SCR?
    Ans: (c) Base

Section – B

04X04 = 16 Marks

1. **What types of functions performed by power electronic devices in electrical power systems?**

Ans: Power electronic devices: are the electronic devices that can be directly used in the power processing circuits to convert or control electric power. The following functions performs by it:

- DC/DC converters are used in most mobile devices (mobile phones, PDA etc.) to maintain the

voltage at a fixed value whatever the voltage level of the battery is. These converters are also used for electronic isolation and power factor correction. A power optimizer is a type of DC/DC converter developed to maximize the energy harvest from solar photovoltaic or wind turbine systems.

- AC/DC converters (rectifiers) are used every time an electronic device is connected to the mains (computer, television etc.). These may simply change AC to DC or can also change the voltage level as part of their operation.
- AC/AC converters are used to change either the voltage level or the frequency (international power adapters, light dimmer). In power distribution networks AC/AC converters may be used to exchange power between utility frequency 50 Hz and 60 Hz power grids.
- DC/AC converters (inverters) are used primarily in UPS or renewable energy systems or emergency lighting systems. Mains power charges the DC battery. If the mains fails, an inverter produces AC electricity at mains voltage from the DC battery. Solar inverter, both smaller string and larger central inverters, as well as solar micro-inverter are used in photovoltaics as a component of a PV system.

2. Define the term power electronics. In the modern technology what is the place of power electronics?

Ans: Generally, power electronics is the process of using semiconductor switching devices to control and convert electrical power flow from one form to another to meet a specific need. In other words, power electronics enables the control of the power flow as well as its form ac or dc and the magnitude of currents and voltages.

In modern time Power electronics is a key technology i.e. it is a vital transformational technology that is quietly operating in the background – unseen and unheard – yet, embedded into products that people use every day to make life more enjoyable.

We use Power Electronics to charge our smartphones and electric vehicles, and we use it to increase cooking efficiency through induction cooktops/hobs. The world's industries are also becoming increasingly dependent on PE to increase efficiency in solutions. For example, PE is used to power large-scale aluminum production and efficiently transmit power across countries and seas. Power Electronics is revolutionizing the world's energy systems – and can be increasingly found everywhere!

3. For high frequency applications will you prefer MOSFET or IGBT. Why?

Ans: For High frequency applications, MOSFET is the right choice of the device.
Because MOSFET has low switching losses compare to that of IGBT.
General rule of thumb is for low-frequency applications having frequency range upto 20kHz, we have to use IGBT.
For high frequency applications having frequency range of more than 200kHz, we have to use MOSFET.

4. A forward potential of 5 V is applied to a PN junction diode. A resistance of 5 KΩ is also in series with the diode. Determine the value of current.

Ans:

It is given
Forward potential $V_f = 5V$
Resistance $R_L = 5K\Omega$
For Si-diode the barrier potential is 0.7V.
So, drop in forward voltage $= 5 - 0.7 = 4.3V$.

So, current $I = V/R = \frac{4.3}{5 \times 10^3} = 0.86mA$.

So, $I = 0.86mA$

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Section – C

04X06 = 24 Marks

1. **What is barrier potential? What are the parameters over which barrier potential depends?**

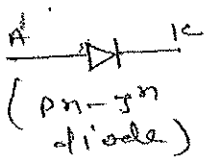
Ans: The barrier potential or potential barrier in the p-n junction diode is the barrier which does not allow charge flow across the junction normally. This barrier is created by the charge present in the space charge region. When p-type material is brought in contact to a n-type material, the charge flow across the junction takes place due to concentration gradient between the two sides (n and p type). But after some time the immobile ions are created near the contact which create electric field which opposes flow of current. This resistance to the flow of charge is known as barrier potential.

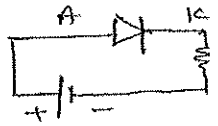
The barrier potential depends on:

- Type of semiconductor materials used (For Si,Vb=0.7V and for Ge,Vb = 0.3 V)
- Amount of doping and
- Temperature.

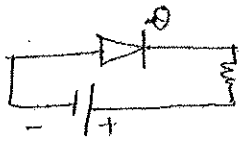
2. **With neat diagram, explain the working principle of pn-junction diode.**

Ans: A pn junction diode is a two terminal single crystal semiconductor device whose one side is doped with acceptors and other side by donors. Doping with acceptor creates p type semiconductor while doping with donors produces n type. Thus a pn junction is formed in diode.





(Forward biasing)



(Reverse biasing)

The process of applying the voltage across the pn-junction diode is called biasing of diode.
In forward biasing mode +ve terminal of battery is connected to p-type and negative terminal of battery is connected to n-type.
In Reverse bias +ve terminal of battery is connected to n-type and -ve terminal of battery is connected to p-typ.
Applied vol. above the barrier pot. val. diode starts conducting in forward biasing.

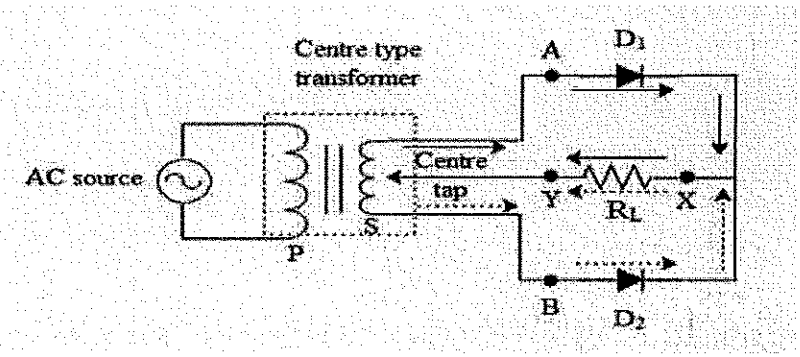
3. **Define rectifier. With neat diagram, and wave form explain the working principle of full wave rectifier.**

Ans:

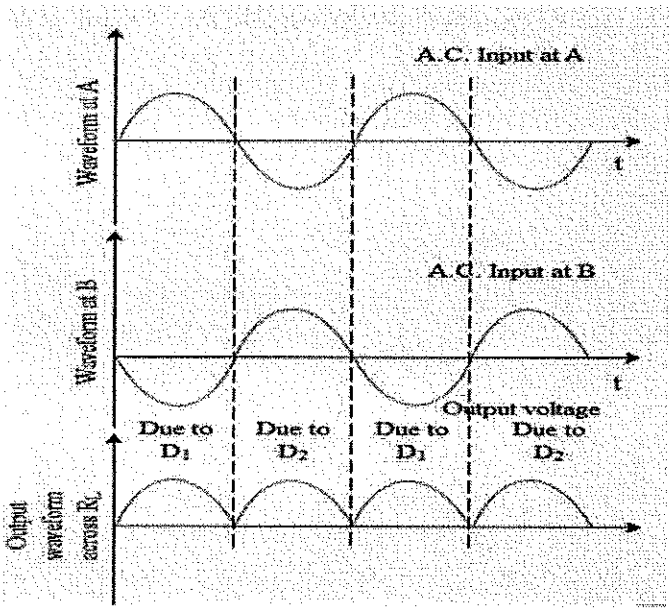
A rectifier is a device that converts AC signal in to pulsating DC signal.

Complete step-by-step solution

So let us begin by drawing the circuit diagram.



A simple full way rectifier consists of two transformers mutually inducted and two diodes which filter the negative cycle of alternating current. At any instant the voltage at A(input voltage of diode 1) and end B (input voltage of diode 2) of the secondary with respect to the centre tap will be out of phase. Suppose during a positive half cycle of Ac input, the end A is positive and end B is negative with respect to the centre tap. Then diode 1 gets forward biased(allows the flow of current) and diode 2 gets reversed biased(does not allow the flow of current). Hence the current flows through the diode 1 towards the centre tap along the path AXY as shown in the above diagram. Similarly, during the negative half cycle of Ac input the end B becomes positive and end A becomes negative. Hence diode 1 gets reversed biased and diode 2 gets forward biased resulting in the current to flow from diode 2 to the centre tap along the path BXY as shown in the above diagram. As during both the half cycles the input a.c. the current through the load resistor will flow from X to Y and will keep on pulsating. Given below is the waveform for the full wave rectifier



indicating inputs of AC and the output voltage.

4. A full wave rectifier uses a center-tap transformer whose turns ratio to half secondary is 10:1 and is supplied with230V at 50HZ. If the load resistance is 50 ohm, then calculate the value of maximum voltage and current.

Ans: It is given that (I/p and O/p waveform)

$$\frac{E_{prms}}{E_{srms}} = \frac{10}{1}$$

$$\text{or, } E_{s(rms)} = \frac{E_{prms}}{10} = \frac{230}{10} = 23\text{V}$$

Since,

$$E_{srms} = \frac{E_m}{\sqrt{2}}$$

$E_m = \sqrt{2} \times 23 = 32.52\ V$

$I_m = \frac{E_m}{R_L} = \frac{32.52}{50} = 0.65\ A$

So, max^m. val. $E_m = 32.52\ V$

max^m. current $I_m = 0.65\ A$

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of Electrical Skills

Session: 2021-22 (Summer Semester)

B. Voc. Program, V Semester,

End-Sem. Examination

Course Code: ELE1502 **Time: 2 Hours**

Course Name: Substation Practices and Supervision **Max. Marks: 50**

Instruction: Answer all questions from section A, each question carries one mark. Answer all questions from section B, each question carries four marks. Answer all questions from section C, each question carries six marks. Scientific calculator is allowed.

Section – A

10X01 = 10 Marks

1. A tariff should be such that it encourages the consumers to have low power factor.
   a) True b) False
2. Two part tariff is generally used for
   a) Industrial consumers
   b) Residential consumers
   c) Agriculture consumers
   d) Commercial consumers
3. A tariff should provide incentive for using power during off-peak hours.
   a) True b) False
4. Pole mounted sub stations are used for..... distribution
   a) Primary
   b) Secondary
   c) Both A and B
   d) None of the above
5. With which of the following are step-up substations associated?
   a) Concentrated load
   b) Consumer location
   c) Distributors
   d) Generating stations
6. Which among these types of bus bars can be used outdoor?
   a) Tubular
   b) ACSR
   c) AAC
   d) All of these
   e) None of these
7. Which sequence is followed first while closing a circuit breaker?
   a) Close the isolator
   b) Open earthing switch
   c) Close circuit breaker
   d) Any of these
8. Depreciation is generated due to
   a) Increase in the value of liability
   b) Decrease in capital
   c) Wear and tear
   d) Decrease in the value of assets
9. According to straight line method of providing depreciation, the depreciation
   a) Remains constant
   b) Increase each year.
   c) Decrease each year
   d) None of them.

Set - A

10. Salvage value means
    a) Definite sale price of the asset
    b) Cash to be received when life of the asset ends
    c) Cash to be paid when asset is disposed off
    d) Estimated disposal value

Section – B

04X04 = 16 Marks

1. What is depreciation reserve? Why is it necessary to maintain it?
2. What are the objectives of Indian Electricity Grid Code (IEGC) or Grid Code?
3. What are different types of busbar arrangement Schemes in Substations?
4. Explain the objectives of tariff.

Section – C

04X06 = 24 Marks

1. The monthly electricity consumption of a residence can be approximated as under:
   Light load = 5 tube lights 40 watt each working for 3 hours daily
   Fan load = 3 fans 100 watt each working for 5 hours daily
   Refrigerator load = 1 kWh daily
   Misc. load = 1 kW for one hour daily
   Find the monthly bill at the following tariff:
   First 15 units = Rs. 2.74 per kWh
   Next 25 units = Rs. 2.70 per kWh
   Remaining units = Rs. 2.32 per kWh
   Constant charge = Rs. 7.00 per month
   Discount for prompt payment 5%
2. A power station is erected at a cost of Rs 2*10^8. Assuming a salvage value of 15% a useful life of 25 years and interest rate 8%, find the annual depreciation reserve
   (a) By straight line method
   (b) By sinking fund method
   (c) By fixed percentage method
3. A residential consumer has the following connected ; 8 bulbs of 100 W each , 2 fans 60 W each and 2 light plug points of 100 W each . His use of electricity during a day is as under:

12 midnight to 5 am	One fan
5 am to 7 am	Two fans and one light point
7 am to 9 am	NIL
9 am to 6 pm	Two fans
6 pm to midnight	Two fans and four bulbs

   Find (a) connected load (b) maximum demand (c) demand factor
4. A steam station has two 110 WW units. The cost data is as under:

Unit 1	Unit 2
UC_1 = Rs. 18000 per kW	UC_2 = Rs. 30000 per kW
FCR_1 = 10 per cent	FCR_2 = 10 per cent
CF_1 = 0.55	CF_2 = 0.60
Fuel consumption = 0.7 kg / kWh	Fuel consumption = 0.65 kg / kWh
Fuel cost = Rs. 1500 per 1000 kg	Fuel cost = Rs. 1500 per 1000 kg
OM_1 = 20 per cent of annual fuel cost	OM_2 = 15 per cent of annual fuel cost
Utilization factor = 1	Utilization factor = 1

   Calculate:

   (a) Annual plant cost and generation cost of unit 1
   (b) Annual plant cost and generation cost of unit 2
   (c) Overall generation cost of the station.

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of Electrical Skills

Session: 2021-22 (Summer Semester)

B. Voc. Program, V Semester,

End-Sem. Examination

Course Code: ELE1502 **Time: 2 Hours**

Course Name: Substation Practices and Supervision **Max. Marks: 50**

Section – A

10X01 = 10 Marks

1. A tariff should be such that it encourages the consumers to have low power factor.
   a) True **b) False**
2. Two part tariff is generally used for
   a) Industrial consumers
   b) Residential consumers
   c) Agriculture consumers
   d) Commercial consumers
3. A tariff should provide incentive for using power during off-peak hours.
   a) **True** b) False
4. Pole mounted sub stations are used for..... distribution
   a) Primary
   b) Secondary
   c) Both A and B
   d) None of the above
5. With which of the following are step-up substations associated ?
   a) Concentrated load
   b) Consumer location
   c) Distributors
   d) Generating stations
6. Which among these types of bus bars can be used outdoor?
   a) Tubular
   b) ACSR
   c) AAC
   d) All of these
   e) None of these
7. Which sequence is followed first while closing a circuit breaker?
   a) Close the isolator
   b) Open earthing switch
   c) Close circuit breaker
   d) Any of these
8. Depreciation is generated due to
   a) Increase in the value of liability
   b) Decrease in capital
   c) Wear and tear
   d) Decrease in the value of assets
9. According to straight line method of providing depreciation, the depreciation
   a) Remains constant
   b) Increase each year.
   c) Decrease each year
   d) None of them.
10. Salvage value means
    a) Definite sale price of the asset
    b) Cash to be received when life of the asset ends
    c) Cash to be paid when asset is disposed off
    d) Estimated disposal value

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Section – B

04X04 = 16 Marks

1. What is depreciation reserve? Why is it necessary to maintain it?

   Ans: **Depreciation** is an accounting method of allocating the cost of a tangible or physical asset over its useful life or life expectancy. **Depreciation** represents how much of an asset's value has been used up.

   The value of the power plant decreases from its initial value to the salvage value at the end of its useful life. This depreciation is due to ageing, wear and tear of machinery, corrosion, weathering, inadequacy and obsolescence of equipment etc. At the end of the useful life of the plant, funds must be available to replace the equipment. The depreciation charge represents the amount which is set aside from income every year and placed in depreciation reserve. For calculating this charge, it is necessary to estimate the useful life of plant.

2. What are the objectives of Indian Electricity Grid Code (IEGC) or Grid Code?

Ans: The IEGC brings together a single set of technical and commercial rules, encompassing all the Utilities connected to/or using the inter-State transmission system (ISTS) and provides the following:

3. Documentation of the principles and procedures which define the relationship between the various Users of the inter-State transmission system (ISTS), National Load Despatch Centre, as well as the Regional and State Load Despatch Centres
4. Facilitation of the optimal operation of the grid, facilitation of coordinated and optimal maintenance planning of the grid and facilitation of development and planning of economic and reliable National / Regional Grid
5. Facilitation for development of power markets by defining a common basis of operation of the ISTS, applicable to all the Users of the ISTS.
6. Facilitation of the development of renewable energy sources by specifying the technical and commercial aspects for integration of these resources into the grid.

3. What are different types of busbar arrangement Schemes in Substations?

Ans: Different switching schemes or busbar arrangement scheme employed in switch-yard are:

- Single Bus Scheme
- Double bus single breaker scheme
- Main and Transfer busbar scheme
- Double bus single breaker scheme
- Breaker and half scheme
- Ring main bus scheme

4. Explain the objectives of tariff.

Ans: Electric utilities derive their income from customers through electricity bills. Different methods of charging customers are known as tariffs. A tariff should fulfill the following objectives and requirements:

1. Cost of capital investment in generation, transmission and distribution equipment must be recovered.
2. Cost of operation, supplies, maintenance and losses must be recovered.
3. Cost of metering, billing, collection and miscellaneous services must be recovered.
4. A satisfactory net return on the capital investment must be ensured.
5. It should be simple and comprehensible to the public.
6. It should be uniform over large population.
7. It should be such that persons creating a desirable and relatively inexpensive type of load make full use and benefit of the electrical appliances.
8. It should provide incentive for using power during the off-peak hours.
9. It should have a provision for higher demand charges for high loads demanded at system peak.
10. It should have a provision of penalty for low factors.
11. It should apportion equitably the cost of service to the different categories of consumers.

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Section – C

04X06 = 24 Marks

1. The monthly electricity consumption of a residence can be approximated as under:
   Light load = 5 tube lights 40 watt each working for 3 hours daily
   Fan load = 3 fans 100 watt each working for 5 hours daily
   Refrigerator load = 1 kWh daily
   Misc. load = 1 kW for one hour daily
   Find the monthly bill at the following tariff:
   First 15 units = Rs. 2.74 per kWh
   Next 25 units = Rs. 2.70 per kWh
   Remaining units = Rs. 2.32 per kWh
   Constant charge = Rs. 7.00 per month
   Discount for prompt payment 5%
   Ans: Total energy consumption in 30 days = (5*40*3*30 + 3*100*5*30)*(1/1000) + 30 +30 = 18 + 45 + 30 +30 = 123 Units
   The monthly bill = Rs. (7.00 + 2.74*15 + 2.70*25 + 2.32*83) = Rs 308.16
   The net monthly bill = 30.8.16*0.95 = Rs. 292.76
2. A power station is erected at a cost of Rs 2*10^8. Assuming a salvage value of 15% a useful life of 25 years and interest rate 8%, find the annual depreciation reserve
   (a) By straight line method
   (b) By sinking fund method
   (c) By fixed percentage method
   Ans: (a) Annual straight line depreciation reserve = Rs. 2*10^8(1-0.15)/25

   (b) Annual sinking fund depreciation reserve = Rs.[2*10^8 (1-0.15)][0.08/{(1.08)^25 – 1}]

   (c) C = Rs. 2*10^8, n = 25 years, S =Rs. 2*10^8*0.15

   1 – x/100 = (0.15)^1/25 = 0.927 or x = 7.3%

3. A residential consumer has the following connected ; 8 bulbs of 100 W each , 2 fans 60 W each and 2 light plug points of 100 W each . His use of electricity during a day is as under:

12 midnight to 5 am	One fan
5 am to 7 am	Two fans and one light point
7 am to 9 am	NIL
9 am to 6 pm	Two fans
6 pm to midnight	Two fans and four bulbs

   Find (a) connected load (b) maximum demand (c) demand factor

   Solution. (a) Connected load = 8 × 100 + 2 × 60 + 2 × 100 = 1120 W

   (b) Total wattage at different times is

12 midnight to 5 am	60 W
5 am to 7 am	2 × 60 + 1 × 100 = 200 W
7 am to 9 am	NIL
9 am to 6 pm	2 × 60 = 120 W
6 pm to midnight	2 × 60 + 4 × 100 = 520 W

   The maximum demand is 520 W

   (c) Demand Factor = 520/1120 = 0.464

4. A steam station has two 110 WW units. The cost data is as under:

Unit 1	Unit 2
UC_1 = Rs. 18000 per kW	UC_2 = Rs. 30000 per kW
FCR_1 = 10 per cent	FCR_2 = 10 per cent
CF_1 = 0.55	CF_2 = 0.60
Fuel consumption = 0.7 kg / kWh	Fuel consumption = 0.65 kg / kWh
Fuel cost = Rs. 1500 per 1000 kg	Fuel cost = Rs. 1500 per 1000 kg
OM_1 = 20 per cent of annual fuel cost	OM_2 = 15 per cent of annual fuel cost
Utilization factor = 1	Utilization factor = 1

Calculate:

(a) Annual plant cost and generation cost of unit 1
(b) Annual plant cost and generation cost of unit 2
(c) Overall generation cost of the station.

Solution:

(a) AFC_1 = Rs. (10/100) (18000) (110×10^3) = Rs. 198×10^6
E_1 = 8760 (.55) (110×10^3) = 52998×10^4 kWh
Annual fuel consumption of unit 1 = $52998 \times 10^4 \times 0.7 = 37098.6 \times 10^4$ kg
FC_1 = (37098.6×10^4) (1500 / 1000) = Rs. 556479×10^3
OM_1 = 0.2 (556479×10^3) = Rs 111295.8×10^3
AOC_1 = Rs. ($556479 \times 10^3 + 111295.8 \times 10^3$) = Rs. 667774.8×10^3
APC_1 = Rs. ($198 \times 10^6 + 667774.8 \times 10^3$) = Rs. 865774.8×10^3
GC_1 = (865774.8×10^3) / (52998×10^4) = Rs. 1.6336 / kWh

(b) AFC_2 = Rs. (10/100) (30000) (110×10^3) = Rs. 330×10^6
E_2 = 8760 (.60) (110×10^3) = 57816×10^4 kWh
Annual fuel consumption of unit 2 = $57816 \times 10^4 \times 0.65 = 375804 \times 10^3$ kg
FC_2 = (375804×10^3) (1500 / 1000) = Rs. 563706×10^3
OM_2 = 0.15 (563706×10^3) = Rs 845559×10^2
AOC_2 = Rs. ($563706 \times 10^3 + 845559 \times 10^2$) = Rs. 6482619×10^2
APC_2 = Rs. ($330 \times 10^6 + 6482619 \times 10^2$) = Rs. 9782619×10^2
GC_1 = (9782619×10^2) / (57816×10^4) = Rs. 1.692 / kWh

(c) OGC = (865774800 + 978261900) / ($52998 \times 10^4 + 57816 \times 10^4$) = Rs. 1.664 / kWh

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of Electrical Skills

Session: 2021-22 (Summer Semester)

B. Voc. Program, V Semester,

End-Sem. Examination

Course Code: ELE1502 **Time: 2 Hours**

Course Name: Substation Practices and Supervision **Max. Marks: 50**

Instruction: Answer all questions from section A, each question carries one mark. Answer all questions from section B, each question carries four marks. Answer all questions from section C, each question carries six marks. Scientific calculator is allowed.

Section – A

10X01 = 10 Marks

1. Which of the following equipment is not installed in a substation?
   (a) Shunt reactors (b) Exciters
   (c) Voltage transformers (d) Series capacitors.
2. Which range of voltage comes under the category of ultra-high voltage?
   (a) 1 kV and above (b) Voltage between 11 kV and 66 kV
   (c) Voltage between 132 kV and 400 kV (d) Above 400 kV.
3. Outdoor Sub Station requires .....space
   a) Less
   b) More
   c) Medium
   d) Any of the above
4. Most of the substations in the power system change .....of electric supply.
   a) Current level
   b) Voltage level
   c) Both A and B
   d) None of the above
5. An ideal location for the substation would be at the .....of load.
   a) Centre of gravity
   b) Load centre
   c) Nearer to consumer
   d) None of the above
6. What is a load curve?
   a) A plot of load Vs current.
   b) A plot of load Vs time.
   c) A plot of load Vs duration of time.
   d) Total number of units generated Vs time.
7. What is the diversity factor?
   a) A ratio of kWh generated to the product of plant capacity and the number of hours for which the plant is in operation.
   b) The ratio of sum of individual maximum demands to the maximum demand on power stations.
   c) The ratio of actual energy produced to the maximum possible energy.
   d) The ratio of maximum demand on the power station to the connected load.
8. The salaries of operating labour is a part of operating cost
   a) True b) False
9. A tariff should provide incentive for using power during off-peak hours.
   a) True b) False
10. Two part tariff is generally used for
    a) Industrial consumers
    b) Residential consumers

Set B

c) Agriculture consumers
d) Commercial consumers

Section – B

04X04 = 16 Marks

1. What are the purpose and advantages of grid synchronization?
2. What are different Bus bar materials used in Substation?
3. What are the functions of a substation?
4. What do you understand by Tariff and what are its objectives?

Section – C

04X06 = 24 Marks

1. A consumer has maximum demand of 200 kW at 40% load factor. If the tariff is Rs. 100 per kW of maximum demand plus 10 paise per kWh, find the overall cost per kWh.
2. A distribution transformer costs Rs 2,00,000 and has a useful life of 20 years. If the salvage value is Rs 10,000 and rate of annual compound interest is 8%, calculate the amount to be saved annually for replacement of the transformer after the end of 20 years by sinking fund method.
3. A residential consumer has the following connected ; 8 bulbs of 100 W each , 2 fans 60 W each and 2 light plug points of 100 W each . His use of electricity during a day is as under:

12 midnight to 5 am	One fan
5 am to 7 am	Two fans and one light point
7 am to 9 am	NIL
9 am to 6 pm	Two fans
6 pm to midnight	Two fans and four bulbs

Find (a) connected load (b) maximum demand (c) demand factor

4. A steam station has two 110 WW units. The cost data is as under:

Unit 1	Unit 2
UC_1 = Rs. 18000 per kW	UC_2 = Rs. 30000 per kW
FCR_1 = 10 per cent	FCR_2 = 10 per cent
CF_1 = 0.55	CF_2 = 0.60
Fuel consumption = 0.7 kg / kWh	Fuel consumption = 0.65 kg / kWh
Fuel cost = Rs. 1500 per 1000 kg	Fuel cost = Rs. 1500 per 1000 kg
OM_1 = 20 per cent of annual fuel cost	OM_2 = 15 per cent of annual fuel cost
Utilization factor = 1	Utilization factor = 1

Calculate:

(a) Annual plant cost and generation cost of unit 1
(b) Annual plant cost and generation cost of unit 2
(c) Overall generation cost of the station.

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of Electrical Skills

Session: 2021-22 (Summer Semester)

B. Voc. Program, V Semester,

End-Sem. Examination

Course Code: ELE1502 **Time: 2 Hours**

Course Name: Substation Practices and Supervision **Max. Marks: 50**

Section – A

10X01 = 10 Marks

1. Which of the following equipment is not installed in a substation?
   (a) Shunt reactors **(b) Exciters**
   (c) Voltage transformers (d) Series capacitors.
2. Which range of voltage comes under the category of ultra-high voltage?
   (a) 1 kV and above (b) Voltage between 11 kV and 66 kV
   (c) Voltage between 132 kV and 400 kV **(d) Above 400 kV.**
3. Outdoor Sub Station requires .....space
   a) Less
   b) **More**
   c) Medium
   d) Any of the above
4. Most of the substations in the power system change .....of electric supply.
   a) Current level
   b) Voltage level
   c) Both A and B
   d) None of the above
5. An ideal location for the substation would be at the .....of load.
   a) Centre of gravity
   b) Load centre
   c) Nearer to consumer
   d) None of the above
6. What is a load curve?
   a) A plot of load Vs current.
   b) **A plot of load Vs time**.
   c) A plot of load Vs duration of time.
   d) Total number of units generated Vs time.
7. What is the diversity factor?
   a) A ratio of kWh generated to the product of plant capacity and the number of hours for which the plant is in operation.
   b) The ratio of sum of individual maximum demands to the maximum demand on power stations.
   c) The ratio of actual energy produced to the maximum possible energy.
   d) The ratio of maximum demand on the power station to the connected load.
8. The salaries of operating labour is a part of operating cost
   a) **True** b) False
9. A tariff should provide incentive for using power during off-peak hours.
   a) **True** b) False
10. Two part tariff is generally used for
    a) Industrial consumers
    b) Residential consumers
    c) Agriculture consumers
    d) Commercial consumers

Set B

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Section – B

04X04 = 16 Marks

1. What are the purpose and advantages of grid synchronization?
   Ans: Synchronization must occur while connecting the generator to a grid. Synchronization can be achieved manually or automatically. The purpose of synchronization is to monitor, access, enable, and automatically take the control action to prevent the abnormalities of voltage and frequency. Advantages:
   1. It secures the power of the grid coming from different power stations by detecting the abnormal conditions of frequency and voltage beyond its acceptable range.
   2. It prevents the synchronization failure between power grid and feeder.
   3. It requires less maintenance and less time for performing the operation of detection.
   4. It does not require more expensive parts, so it is low cost, effective and economical model.
   5. It is more reliable.
2. What are different Bus bar materials used in Substation?
   Ans: Busbars are generally made of copper and Aluminum. Aluminim has the advantage of one third the weight of the copper and also Aluminum requires less maintenance and proper use of alloys provide necessary rigidity required for bus material. Aluminum is used widely in EHV and HV stations
3. What are the functions of a substation?

   Ans: The functions of an electric substations are:

   - ✓ It receives electric energy from an incoming line at a voltage and supplies the same to outgoing lines at a reduced voltage level employing power transformers.
   - ✓ It acts as a connection point for local networks.
   - ✓ It regulates voltage to compensate for system voltage drop by injecting reactive power to the transmission or distribution circuits.
   - ✓ It acts as a monitoring point for control centre using current and potential transformers.
   - ✓ It acts as a switchyard for switching electric transmission and distribution circuits into and out of the system using bus bars, circuit-breakers and isolators.
   - ✓ It protects the electric system insulation against abnormal over voltages caused due to lightning and switching, employing protective devices like surge diverters.
   - ✓ It protects the system equipments against abnormal short-circuit currents employing relays and circuit-breakers.
4. What do you understand by Tariff and what are its objectives?
   Ans: Electric utilities derive their income from customers through electricity bills. Different methods of charging customers are known as tariffs. A tariff should fulfill the following objectives and requirements:

   1. Cost of capital investment in generation, transmission and distribution equipment must be recovered.
   2. Cost of operation, supplies, maintenance and losses must be recovered.
   3. Cost of metering, billing, collection and miscellaneous services must be recovered.
   4. A satisfactory net return on the capital investment must be ensured.
   5. It should be simple and comprehensible to the public.
   6. It should be uniform over large population.
   7. It should be such that persons creating a desirable and relatively inexpensive type of load make full use and benefit of the electrical appliances.
   8. It should provide incentive for using power during the off-peak hours.
   9. It should have a provision for higher demand charges for high loads demanded at system peak.
   10. It should have a provision of penalty for low factors.
   11. It should apportion equitably the cost of service to the different categories of consumers.

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Section – C

04X06 = 24 Marks

1. A consumer has maximum demand of 200 kW at 40% load factor. If the tariff is Rs. 100 per kW of maximum demand plus 10 paise per kWh, find the overall cost per kWh.

   Ans: Units consumed / year = max. demand * Load Factor * hours in a year

   = 200 * 0.4 * 8760 = 7,00,800 kWh

   Annual Charges = Annual max. demand charges + Annual energy charges

   = Rs (100 * 200) + (0.1*7,00,800) = Rs 90,080

   Overall cost / kWh = Rs (90,080 / 7,00,800) = Rs. 0.1285 = 12.85 paise

2. A distribution transformer costs Rs 2,00,000 and has a useful life of 20 years. If the salvage value is Rs 10,000 and rate of annual compound interest is 8%, calculate the amount to be saved annually for replacement of the transformer after the end of 20 years by sinking fund method.

   Ans: Initial cost of transformer, $P = Rs\ 2,00,000$

   Useful life, $n = 20$ years

   Salvage value of transformer, $S = Rs\ 10,000$

   Annual interest rate, $r = 8\% = 0.08$

   Annual payment for sinking fund,

   $q = (P - S)\,[r / ((1 + r)^n - 1)]$

   $= (2,00,000 - 10,000)\,[\,0.08 / ((1 + 0.08)^{20} - 1)]$

   $= 1,90,000\,[0.08 / (4.66 - 1)]$

   = Rs 4153.

3. A residential consumer has the following connected ; 8 bulbs of 100 W each , 2 fans 60 W each and 2 light plug points of 100 W each . His use of electricity during a day is as under:

12 midnight to 5 am	One fan
5 am to 7 am	Two fans and one light point
7 am to 9 am	NIL
9 am to 6 pm	Two fans
6 pm to midnight	Two fans and four bulbs

   Find (a) connected load (b) maximum demand (c) demand factor

   Solution. (a) Connected load = 8 × 100 + 2 × 60 + 2 × 100 = 1120 W

   (b) Total wattage at different times is

12 midnight to 5 am	60 W
5 am to 7 am	2 × 60 + 1 × 100 = 200 W
7 am to 9 am	NIL
9 am to 6 pm	2 × 60 = 120 W
6 pm to midnight	2 × 60 + 4 × 100 = 520 W

   The maximum demand is 520 W

   (c) Demand Factor = 520/1120 = 0.464

4. A steam station has two 110 WW units. The cost data is as under:

Unit 1	Unit 2
UC_1 = Rs. 18000 per kW	UC_2 = Rs. 30000 per kW
FCR_1 = 10 per cent	FCR_2 = 10 per cent
CF_1 = 0.55	CF_2 = 0.60
Fuel consumption = 0.7 kg / kWh	Fuel consumption = 0.65 kg / kWh
Fuel cost = Rs. 1500 per 1000 kg	Fuel cost = Rs. 1500 per 1000 kg
OM_1 = 20 per cent of annual fuel cost	OM_2 = 15 per cent of annual fuel cost
Utilization factor = 1	Utilization factor = 1

Calculate:

(a) Annual plant cost and generation cost of unit 1
(b) Annual plant cost and generation cost of unit 2
(c) Overall generation cost of the station.

Solution:

(a) AFC_1 = Rs. (10/100) (18000) (110×10^3) = Rs. 198×10^6
$E_1 = 8760\ (.55)\ (110 \times 10^3) = 52998 \times 10^4$ kWh
Annual fuel consumption of unit 1 = $52998 \times 10^4 \times 0.7 = 37098.6 \times 10^4$ kg
$FC_1 = (37098.6 \times 10^4)\ (1500 / 1000)$ = Rs. 556479×10^3
$OM_1 = 0.2\ (556479 \times 10^3)$ = Rs 111295.8×10^3
AOC_1 = Rs. ($556479 \times 10^3 + 111295.8 \times 10^3$) = Rs. 667774.8×10^3
APC_1 = Rs. ($198 \times 10^6 + 667774.8 \times 10^3$) = Rs. 865774.8×10^3
$GC_1 = (865774.8 \times 10^3) / (52998 \times 10^4)$ = Rs. 1.6336 / kWh

(b) AFC_2 = Rs. (10/100) (30000) (110×10^3) = Rs. 330×10^6
$E_2 = 8760\ (.60)\ (110 \times 10^3) = 57816 \times 10^4$ kWh
Annual fuel consumption of unit 2 = $57816 \times 10^4 \times 0.65 = 375804 \times 10^3$ kg
$FC_2 = (375804 \times 10^3)\ (1500 / 1000)$ = Rs. 563706×10^3
$OM_2 = 0.15\ (563706 \times 10^3)$ = Rs 845559×10^2
AOC_2 = Rs. ($563706 \times 10^3 + 845559 \times 10^2$) = Rs. 6482619×10^2
APC_2 = Rs. ($330 \times 10^6 + 6482619 \times 10^2$) = Rs. 9782619×10^2
$GC_1 = (9782619 \times 10^2) / (57816 \times 10^4)$ = Rs. 1.692 / kWh

(c) OGC = (865774800 + 978261900) / ($52998 \times 10^4 + 57816 \times 10^4$) = Rs. 1.664 / kWh

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of Electrical Skills

Session: 2021-22 (Summer Semester)

B. Voc. Program, V Semester,

End-Sem. Examination

Course Code: ELE1505 **Time: 2 Hours**

Course Name: Advance Automation and Control **Max. Marks: 50**

Instruction: Answer all questions from each and every section. Section A, each question carries one mark, section B, each question carries four marks and in section C, each question carries six marks. Scientific calculator is allowed.

Section – A

10X01 = 10 Marks

1. Physical timer, counter, contactors & relays are used in: -
   (a) Hard wire controlling (b) Logic gate controlling
   (c) Manual controlling (d) None of these
2. The full form of TLS is: -
   (a) Total Least Square (b) Transport Layer Security
   (c) Telephone Line Simulator (d) None of these
3. The origin of the word "Automation" is attributed to: -
   (a) Richard E. Morley (b) George Klir
   (c) D.S. Harder (d) None of these
4. Reverse accelerating quadrant with negative speed and torque is: -
   (a) Quadrant I (b) Quadrant III
   (c) Quadrant II (d) Quadrant IV
5. The_____instruction is an output instruction that marks the end of the subroutine file: -
   (a) SBR (b) RET
   (c) JSR (d) None of these
6. Graphic objects on the HMI screen can_____ data to the PLC.
   (a) Accept(read) (b) Send(write)
   (c) Both (a) and (b) (d) None of these
7. Distributed SCADA systems is the: -
   (a) First Generation SCADA (b) Second Generation SCADA
   (c) Third Generation SCADA (d) Fourth Generation SCADA
8. One PLC failure would not halt the complete process in _____system: -
   (a) SCADA (b) Manual automation
   (c) DCS (d) None of these
9. The intermediate circuit in VFD is also called: -
   (a) Rectifier circuit (b) Inverter circuit
   (c) DC-link (d) None of these

Set-A

10. Full form of IED in smart power system is: -

(a) Intelligent Electronic Devices (b) Improvised Explosive Device

(c) Intelligent Edge Detection (d) None of these

Section – B

04X04 = 16 Marks

1. Explain the direct torque control of an induction motor.
2. What is SCADA? Explain the architecture of SCADA system
3. What are the needs and role of automation?
4. Compare the PLC with DCS system.

Section – C

04X06 = 24 Marks

1. What is PID controller in detail.
2. What is "Master Control Reset" instruction? Explain in detail.
3. Explain the VFD in detail.
4. Explain one of the application of SCADA system.

Answers Key

Course Code: ELE1505, Course Name: Advance Automation and Control
School of Electrical Skills, Session: 2021-22 (Summer Semester)
B. Voc. Program, V Semester, End-Sem. Examination

Registration No.: .....

Section – A

10X01 = 10 Marks

1. Physical timer, counter, contactors & relays are used in: -
   (a) Hard wire controlling
2. The full form of TLS is: -
   (b) Transport Layer Security
3. The origin of the word "Automation" is attributed to: -
   (c) D.S. Harder
4. Reverse accelerating quadrant with negative speed and torque is: -
   (b) Quadrant III
5. The_____instruction is an output instruction that marks the end of the subroutine file: -
   (b) RET
6. Graphic objects on the HMI screen can_____ data to the PLC.
   (c) Both (a) and (b)
7. Distributed SCADA systems is the: -
   (b) Second Generation SCADA
8. One PLC failure would not halt the complete process in _____system: -
   (c) DCS
9. The intermediate circuit in VFD is also called: -
   (c) DC-link
10. Full form of IED in smart power system is: -
    (a) Intelligent Electronic Devices

Section – B

04X04 = 16 Marks

1. Explain the direct torque control of an induction motor.

Ans. Direct Torque Control

Another control method, known as direct torque control (DTC), is similar to field oriented control, in that it decouples torque and flux and controls them independently. But DTC controls motor torque *directly*, without a modulator, so torque response is much faster.

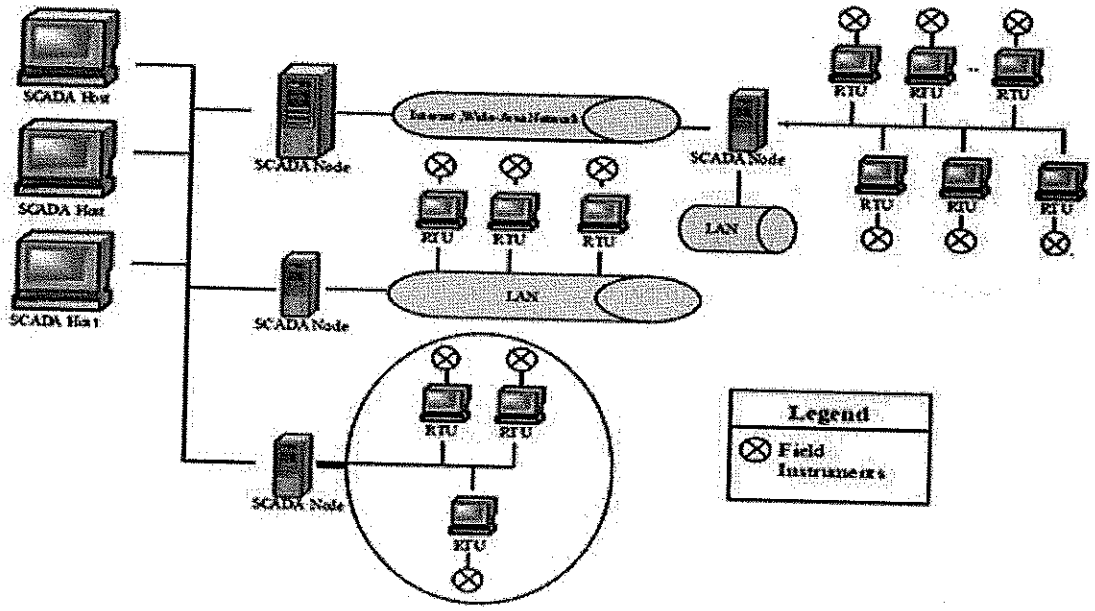
2. What is SCADA? Explain the architecture of SCADA system

Ans. SCADA: "SCADA stands for Supervisory Control and Data Acquisition; it is an industrial computer-based control system employed to gather and analyse the real-time data to keep track, monitor and control industrial equipment in different types of industries."

Architecture of SCADA

Answers Key

Course Code: ELE1505, Course Name: Advance Automation and Control
School of Electrical Skills, Session: 2021-22 (Summer Semester)
B. Voc. Program, V Semester, End-Sem. Examination



3. **What are the needs and role of automation?**

Ans. Reduce Worker Fatigue and Effort or Labour Intensive Operation: Typically, humans dislike banal, repetitive tasks. However, computer systems perform them without complaint.

- **Prevent Products or Materials from Being Damaged or Destroyed**: Humans make mistakes when they fatigue. This embodies the sentiment of the "human condition." Mistakes using tools mean damaging raw materials, components, assemblies, and end products.
- **Prevent Non-conforming Product from Shipping:** Computers controlling robots do not forget steps. Neglecting to put in a screw requires a human touch.
- **Increase Efficiency**: Improving processes for efficiency makes a company more competitive, but do people always do the same thing, in the same way, every time they do it? No, human variation exists. Automated systems allow for improvements that benefit from consistent execution.
- **Collect Better Data**: Remove the accidental data entry or missed data point from logging. Different sensors regulate it.
- **Improve Metrics:** Sending reliable data directly to a database provides an ongoing resource. Correlation of associated process data with pass/fail records provides insight rather than guessing "what is causing this?".
- **Devise the Right Process Improvements**: Automated systems now collect reliable data. The database provides a searchable forum. It makes "continuous improvement," make changes with better information.
- **Save Money :** Cost savings through making processes more regular and collecting data for making confident decisions.

Answers Key

Course Code: ELE1505, Course Name: Advance Automation and Control
School of Electrical Skills, Session: 2021-22 (Summer Semester)
B. Voc. Program, V Semester, End-Sem. Examination

4. **Compare the PLC with DCS system.**

Ans.

Sr. no.	PLC	DCS
1	PLCs are primarily used for small applications and sequential control.	DCS are used for large applications and closed loop control
2	PLCs are much cost-effective for both small and large applications.	DCS are very costly for small applications.
3	PLCs are better for logic, are faster and have more rugged I/O.	DCS are superior in communication redundancy and data security.
4	This system is more easier to design.	This system is more difficult to design.

Section – C

04X06 = 24 Marks

1. **Explain the PID controller in detail.**

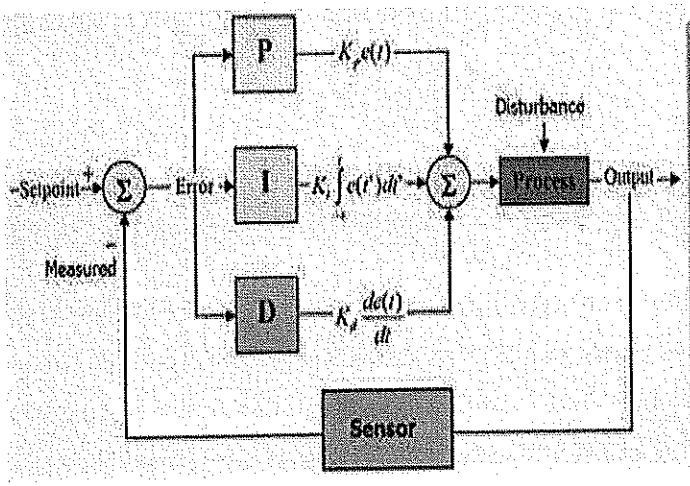
Ans. Proportional Derivative Integral Controller (PID): It is a combination of Proportional, Derivative and an Integral controller the output (also called the actuating signal) is equal to the summation of proportional, derivative and integral of the error signal. Now let us analyse proportional, derivative and integral controller mathematically. As we know in a proportional, derivative and integral controller output is directly proportional to the summation of proportional of error signal, derivative of error signal and integration of the error signal, writing this mathematically we have,

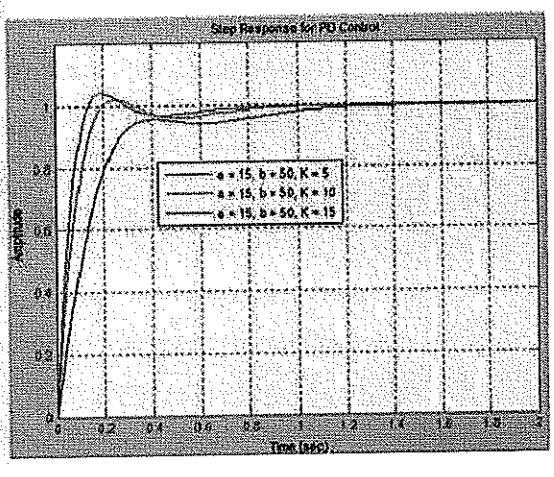
Removing the sign of proportionality, we have,

Where, K_d, K_i and k_p proportional constant, integral constant and derivative constant

$$A(t) = K_d \frac{de(t)}{dt} + K_p e(t) + K_i \int_0^t e(t)dt$$

respectively.





Answers Key

Course Code: ELE1505, Course Name: Advance Automation and Control
School of Electrical Skills, Session: 2021-22 (Summer Semester)
B. Voc. Program, V Semester, End-Sem. Examination

2. What is "Master Control Reset" instruction? Explain in detail.

Ans. Master Control Reset Instruction

These instructions function in a similar manner to the hardwired master control relay; that is, when the instruction is true, the circuit functions normally, and when the instruction is false, non-retentive outputs are switched off. Because these instructions are not hardwired but programmed, for safety reasons they should *not* be used as a substitute for a hardwired master control relay, which provides *emergency* I/O power shutdown. A *Master Control Reset (MCR)* instruction is an output coil instruction that functions like a master control relay. MCR coil instructions are used in pairs and can be programmed to control an entire circuit or to control only selected rungs of a circuit. MCR-controlled areas must contain only two MCR instructions—one to define the start and one to define the end.

The operation of the program can be summarized as follows:

- When the MCR instruction is false, or de-energized, all non-retentive (non-latched) rungs below the MCR will be de-energized even if the programmed logic for each rung is true.
- All *retentive* rungs will remain in their *last state*.
- The MCR instruction establishes a zone in the user program in which all non-retentive outputs can be turned off simultaneously.
- *Retentive* instructions should not normally be placed within an MCR zone because the MCR zone maintains retentive instructions in the last active state when the instruction goes false.
- An off-delay timer will start timing when in a de-energized MCR zone.

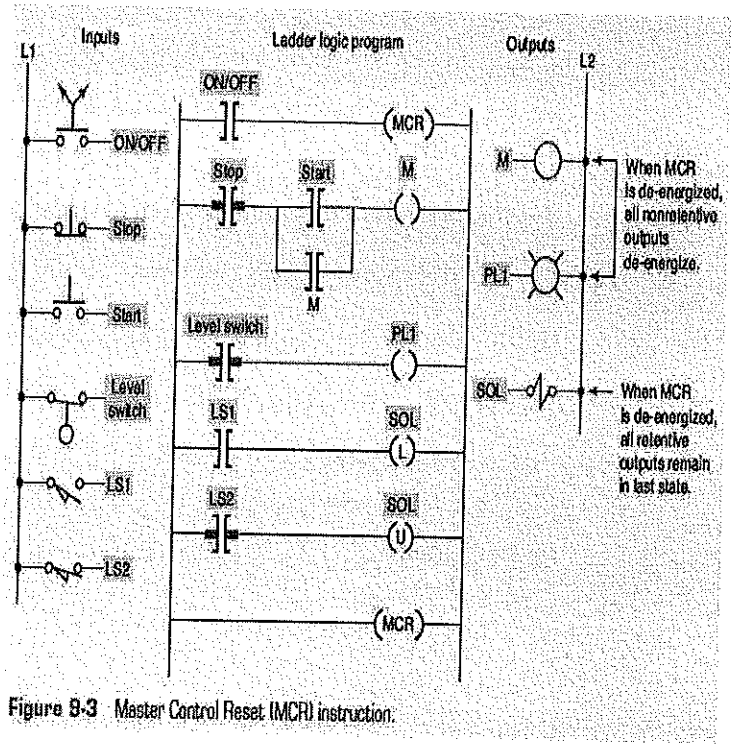


Figure 9-3 Master Control Reset (MCR) instruction.

3. Explain the VFD in detail.

Ans. Variable-frequency drive

"A variable-frequency drive (VFD) or adjustable-frequency drive (AFD), variable-voltage/variable-frequency (VVVF) drive, variable speed drive (VSD), AC drive, micro drive or inverter drive is a type of adjustable-speed drive used in electro-

mechanical drive systems to control AC motor speed and torque by varying motor input frequency and voltage."

VFDs are used in applications ranging from small appliances to large compressors. About 25% of the world's electrical energy is consumed by electric motors in industrial applications, which can be more efficient when using VFDs in centrifugal load service.

The VFD controller is a solid-state power electronics conversion system consisting of three distinct sub-systems: a rectifier bridge converter, a direct current (DC) link, and an inverter.

Most drives are AC-AC drives in that they convert AC line input to AC inverter output. However, in some applications such as common DC bus or solar applications, drives are configured as DC-AC drives.

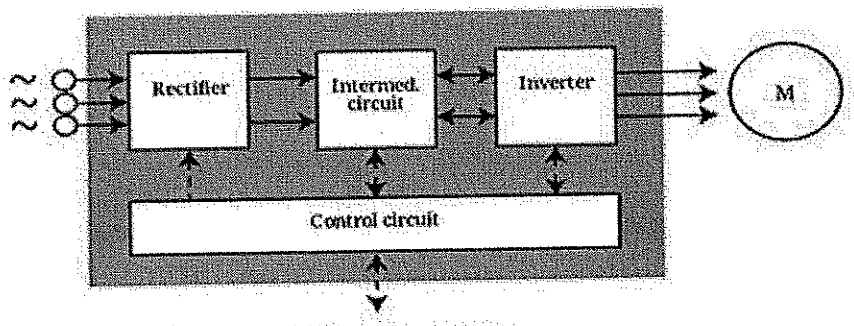
Working principle of VFD

The block diagram of the variable frequency drive is shown in the below diagram.

A Variable Frequency Drive (VFD) is a type of motor speed controller that drives an Induction motor by varying the frequency and voltage supplied to the electric motor.

Variable frequency drive(VFD) mainly has a Rectifier, Intermediate circuit, and Inverter to convert back DC voltage into AC as shown in the block diagram.

Rectifier: The supply voltage applied to the rectifier is a three-phase alternating voltage or a single-phase AC voltage with a frequency of 50 Hz or 60 Hz. The rectifier is a circuit that converts the alternating voltage into the direct voltage. Rectifiers made up of diodes and thyristors, to convert AC supply voltage into the DC.



Simplified frequency converter

4. **Explain one of the application of SCADA system.**

Ans. SCADA in Smart Power System:

Answers Key

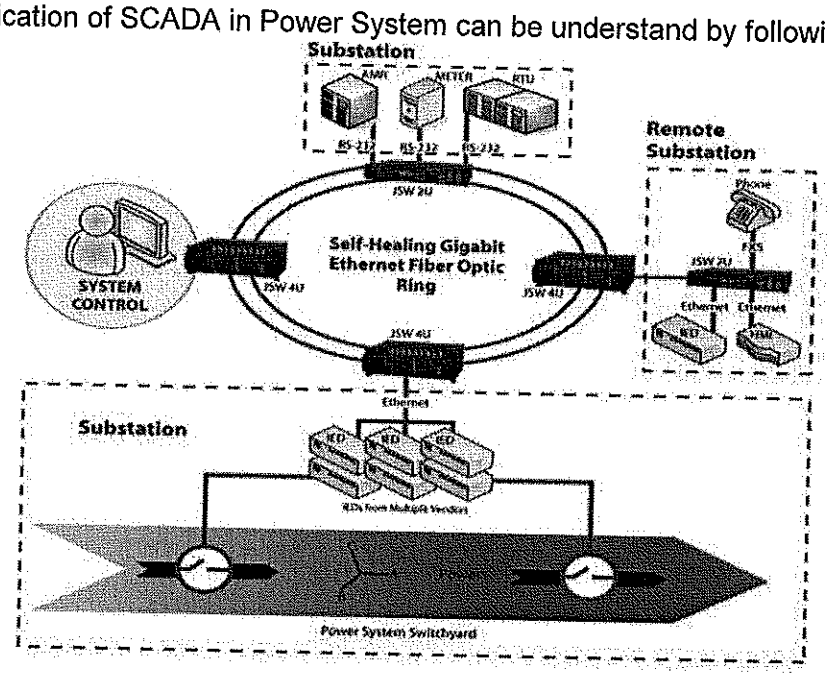
Course Code: ELE1505, Course Name: Advance Automation and Control
School of Electrical Skills, Session: 2021-22 (Summer Semester)
B. Voc. Program, V Semester, End-Sem. Examination

Power system can be defined as constituent of power generation, transmission and distribution. All these sectors are needed to be monitored regularly for improving the system efficiency.

Thus, the application of SCADA in power system improves the overall efficiency of the system by providing the supervision and control over the generation, transmission and distribution systems.

SCADA in the power system network increases the system's reliability and stability for integrated grid operation.

Application of SCADA in Power System can be understand by following fig.



BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of Electrical Skills

Session: 2021-22 (Summer Semester)

B. Voc. Program, V Semester,

End-Sem. Examination

Course Code: ELE1505 **Time: 2 Hours**

Course Name: Advance Automation and Control **Max. Marks: 50**

Instruction: Answer all questions from each and every section. Section A, each question carries one mark, section B, each question carries four marks and in section C, each question carries six marks. Scientific calculator is allowed.

Section – A

10X01 = 10 Marks

1. The compressed air and hydraulic pressure is used in: -
   (a) Pneumatic controlling (b) Logic gate controlling
   (c) Manual controlling (d) None of these
2. One PLC failure would not halt the complete process in _____system: -
   (a) SCADA (b) Manual automation
   (c) DCS (d) None of these
3. The term automation was coined in the automobile industry about_____: -
   (a) 1950 (b) 1900
   (c) 1946 (d) None of these
4. The_____ is used to transfer the electrical energy from one circuit to another circuit using light: -
   (a)Piezoelectric element (b) Optocoupler
   (c) Transformer (d) None of these
5. The VFD is used to control: -
   (a) Frequency (b) Voltage
   (c) Both (a) and (b) (d) None of these
6. Graphic objects on the HMI screen can_____ data to the PLC: -
   (a) Accept(read) (b) Send(write)
   (c) Both (a) and (b) (d) None of these
7. Monolithic or Early SCADA systems is the: -
   (a) First Generation SCADA (b) Second Generation SCADA
   (c) Third Generation SCADA (d) Fourth Generation SCADA
8. SCADA systems were first used in the: -
   (a) 1960 (b) 1860
   (c) 1900 (d) None of these
9. Forward accelerating quadrant with positive speed and torque is: -
   (a) Quadrant I (b) Quadrant III
   (c) Quadrant II (d) Quadrant IV

Set-B

10. Full form of AMR in smart power system is: -

(a) Average Message Rate
(b) Automatic Meter Reading
(c) Audio Modem Riser
(d) None of these

Section – B

04X04 = 16 Marks

1. Explain the V/F control of an Induction motor.
2. Explain the Human Machine Interface.
3. What is PLC? Explain the architecture of PLC.
4. Compare the relay logic with PLC controlling.

Section – C

04X06 = 24 Marks

1. Explain the DCS system in detail.
2. Explain the subroutine function using JSR, SBR and RET instructions.
3. What is PID controller? What are the applications of PID controller?
4. Explain the application of SCADA system in smart power system.

Answers Key

Course Code: ELE1505, Course Name: Advance Automation and Control
School of Electrical Skills, Session: 2021-22 (Summer Semester)
B. Voc. Program, V Semester, End-Sem. Examination

Registration No.: .....

Section – A

10X01 = 10 Marks

1. The compressed air and hydraulic pressure is used in: -
   (a) Pneumatic controlling
2. One PLC failure would not halt the complete process in _____system:
   (c) DCS
3. The term automation was coined in the automobile industry about_____:
   (c) 1946
4. The_____ is used to transfer the electrical energy from one circuit to another circuit using light: -
   (b) Optocoupler
5. The VFD is used to control: -
   (c) Both (a) and (b)
6. Graphic objects on the HMI screen can_____ data to the PLC: -
   (c) Both (a) and (b)
7. Monolithic or Early SCADA systems is the: -
   (a) First Generation SCADA
8. SCADA systems were first used in the: -
   (a) 1960
9. Forward accelerating quadrant with positive speed and torque is: -
   (a) Quadrant I
10. Full form of AMR in smart power system is: -
    (b) Automatic Meter Reading

Section – B

04X04 = 16 Marks

1. **Explain the V/F control of an Induction motor.**

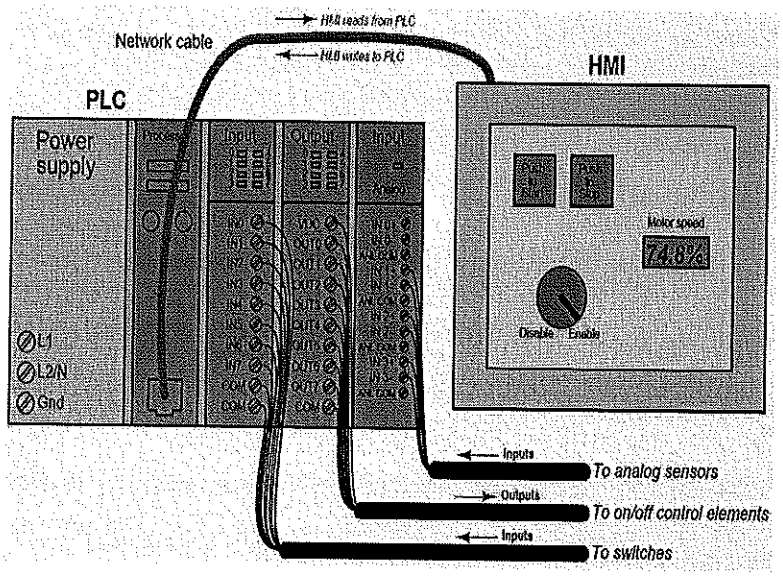
Ans. Ans. **V/F Control :** Variable frequency drives control AC induction motors through one of several control schemes. Scalar control (also referred to as V/Hz or V/f control) varies both the voltage and frequency of power supplied to the motor to maintain a fixed ratio between the two. This keeps the strength of the magnetic field at a constant level so that torque production remains stable. Scalar control is a simple, inexpensive control method, but it doesn't allow precise control of motor speed. V/F control principle is to produce a circuit called voltage-controller oscillator with oscillator frequency. It is a voltage-dependent capacitance, when subjected to a change in voltage, its capacity will change, and then the change in capacity will cause changes in the oscillation frequency, resulting in variable frequency. This controlled frequency is used to control the

frequency of the output voltage, in order to achieve speed changes of the controlled electric motors.

2. Explain the Human Machine Interface.

Ans. Human Machine Interface (HMI)

PLCs are built to input various signal types (discrete, analog), execute control algorithms on those signals, and then output signals in response to control processes. By itself, a PLC generally lacks the capability of displaying those signal values and algorithm variables to human operators.



In order for operators to monitor and adjust parameters inside the PLC's memory, we need a different sort of interface allowing certain variables to be read and written without compromising the integrity of the PLC by exposing too much information or allowing any unqualified person to alter the program itself.

One solution to this problem is a dedicated computer display programmed to provide selective access to certain variable's in the PLC's memory, generally referred to as Human-Machine Interface, or HMI.

3. What is PLC? Explain the architecture of PLC.

Ans. PLC: The programmable logic controller is an industrial computer that monitors input, make decisions based on its program and control the output to automate a process or machine. The automation of many different process, such as controlling machines or factory assembly lines, is done through the use of small computers called a programmable logic controller (PLCs).

Architecture of PLC

Input module accepts signals from sensors or buttons and convert signal into a logic signal. example: switches, push buttons, sensors etc.

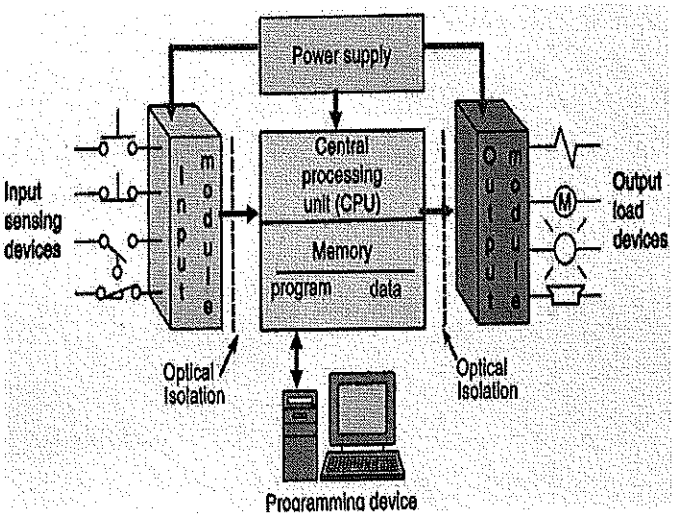
Output module convert control instructions or logic into mechanical output signal that can be used by output devices. example: lamps, alarm etc.

Answers Key

Course Code: ELE1505, Course Name: Advance Automation and Control
School of Electrical Skills, Session: 2021-22 (Summer Semester)
B. Voc. Program, V Semester, End-Sem. Examination

Power supply:- It Provides the particular voltage needed to run the primary PLC components.

Relay:- Relays are switches that open and close circuits electromechanically.
Relays control one electrical circuit by opening and closing contacts in another circuit.



The processor module consists of the central processing unit (CPU) and memory. In addition to a microprocessor, the CPU also contains at least an interface to a programming device and may contain interfaces to remote I/O and other communication networks.

Programing device is used to develop, Download and upload the ladder logic program into the processor of PLC.

4. Compare the relay logic with PLC controlling.

Ans.

Relay Logic	PLC
Hardwired logic Using relay switches	Software logic Using CPU and memory
Difficult to upgrade and maintain	Modular, easier to program
Limited in terms of speed size, complexity, and reliability	Superior in these terms
Dated technology	Current technology

Section – C

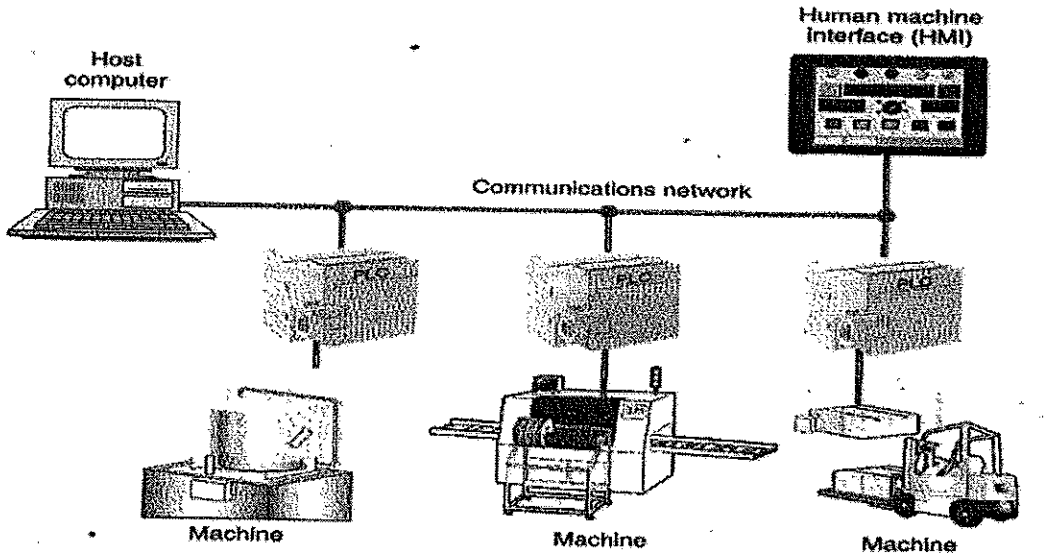
04X06 = 24 Marks

1. Explain the DCS system in detail.

Ans. Distributed control system(DCS): This is a network based system. Distributive control involves two or more PLCs communicating with each other to accomplish the complete control task. Each PLC controls different processes locally and the PLC are constantly exchanging information through communication link.

Answers Key

Course Code: ELE1505, Course Name: Advance Automation and Control
School of Electrical Skills, Session: 2021-22 (Summer Semester)
B. Voc. Program, V Semester, End-Sem. Examination



2. **Explain the subroutine function using JSR, SBR and RET instructions.**

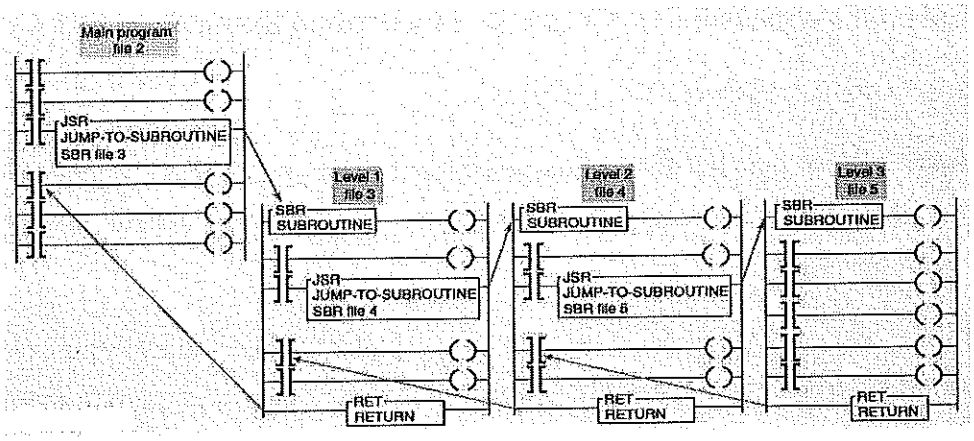
Ans. Subroutine Functions: When a subroutine is called from the main program, the program is able to escape from the main program and *go to* a program *subroutine* to perform certain functions and *then return* to the main program. In situations in which a machine has a portion of its cycle that must be repeated several times during one machine cycle, the subroutine can save a great deal of duplicate programming.

Jump to Subroutine (JSR) —The JSR instruction is an output instruction that causes the scan to jump to the program fi le designated in the instruction. It is the only parameter entered in the instruction. When rung conditions are true for this output instruction, it causes the processor to jump to the targeted subroutine file. Each subroutine must have a unique file number.

Subroutine (SBR) —The SBR instruction is the first input instruction on the first rung in the subroutine file. It serves as an identifier that the program file is a subroutine. This file number is used in the JSR instruction to identify the target to which the program should jump. It is always true, and although its use is optional. it is still recommended.
Return (RET) The RET instruction is an output instruction that marks the end of the subroutine file. It causes the scan to return to the main program at the instruction following the JSR instruction where it exited the program. The scan returns from the end of the file if there is no RET instruction. The rung containing the RET instruction may be conditional if this rung precedes the end of the subroutine. In this way, the processor omits the balance of a subroutine only if its rung condition is true.

Answers Key

Course Code: ELE1505, Course Name: Advance Automation and Control
School of Electrical Skills, Session: 2021-22 (Summer Semester)
B. Voc. Program, V Semester, End-Sem. Examination



3. **What is PID controller? What are the applications of PID controller?**

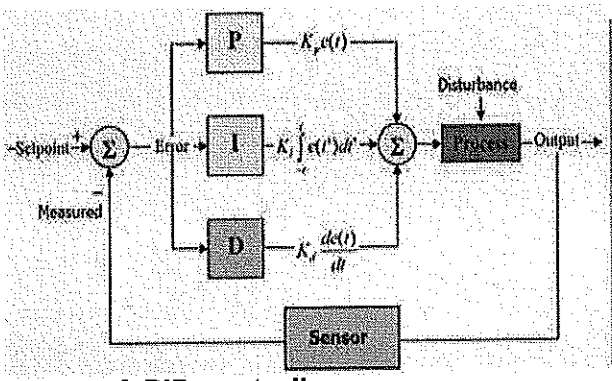
Ans. **Proportional Derivative Integral Controller (PID):** It is a combination of Proportional, Derivative and an Integral controller the output (also called the actuating signal) is equal to the summation of proportional, derivative and integral of the error signal. Now let us analyse proportional, derivative and integral controller mathematically. As we know in a proportional, derivative and integral controller output is directly proportional to the summation of proportional of error signal, derivative of error signal and integration of the error signal, writing this mathematically we have,

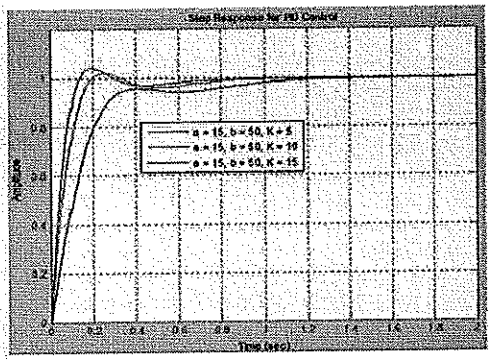
$$A(t) \propto \frac{de(t)}{dt} + A(t) \propto e(t) + A(t) \propto \int_0^t e(t)dt$$

Removing the sign of proportionality, we have,

$$A(t) = K_d \frac{de(t)}{dt} + K_p e(t) + K_i \int_0^t e(t)dt$$

Where, K_d, K_i and k_p proportional constant, integral constant and derivative constant respectively.





Applications of PID controller

- Temperature Control of Furnace
- MPPT Charge Controller
- The Converter of Power Electronics
- Closed Loop Control for a Brushless DC motor

Answers Key

Course Code: ELE1505, Course Name: Advance Automation and Control
School of Electrical Skills, Session: 2021-22 (Summer Semester)
B. Voc. Program, V Semester, End-Sem. Examination

4. Explain the application of SCADA system in smart power system.

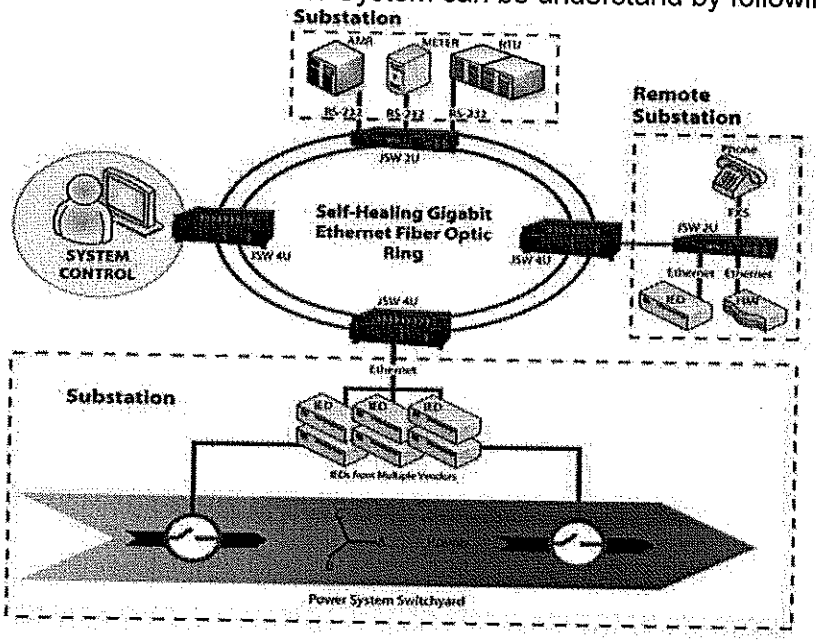
Ans. SCADA in Smart Power System:

Power system can be defined as constituent of power generation, transmission and distribution. All these sectors are needed to be monitored regularly for improving the system efficiency.

Thus, the application of SCADA in power system improves the overall efficiency of the system by providing the supervision and control over the generation, transmission and distribution systems.

SCADA in the power system network increases the system's reliability and stability for integrated grid operation.

Application of SCADA in Power System can be understand by following fig.



BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of Electrical Skills

Session: 2021-22 (Summer Semester)

B. Voc. Program, V Semester,

End-Sem. Examination

Course Code: ELE 1506 **Time: 2 Hours**

Course Name: Electrical Machine-II **Max. Marks: 50**

Instruction: Answer all questions from each and every section. Section A, each question carries one mark, section B, each question carries four marks and in section C, each question carries six marks. Scientific calculator is allowed.

Section – A

10X01 = 10 Marks

1. Squirrel Cage Induction Motor is having

   a) High Starting Torque b) Low Starting Torque c) Both A&B d) None of these

2. Synchronous Speed(Ns)

   a) 120f/P b) 120P/f c) Both A&B d)None of these

3. Slip of Induction motor

   a)Ns-Nr/Ns b)Nr-Ns/Ns c) Ns-Nr/Nr d) None of these

4. Three Phase Squirrel cage Induction motor rotor is having

   a) Three phase winding b) Single Phase winding

   c) Two Phase winding d) Short Circuited Copper Bars

5. An electro-mechanical energy conversion device is one which converts _____

   a) Electrical energy to mechanical energy only

   b) Mechanical energy to electrical energy only

   c) Electrical to mechanical and mechanical to electrical

   d) None of the mentioned

6. In a full pitch coil, the two coil sides are how many electrical space degrees apart?

   a) 180 electrical degrees b) 90 electrical degrees

   c) 45 electrical degrees d) none of the mentioned

7. The purpose of the starter is to

   a) Limit the starting current b) Limit the speed

   c) Protect against over voltage d) Produce back emf

8. A repulsion motor is equipped with

   a) Slip rings b) Commutator c) Both (a) and (b) d)None of the above

9. Shade pole motor is the category of _____

   a) DC motor b) Compound Motor c) Induction Motor d) Any of the above

10. Generator is a machine which converts

    a) Mechanical Energy into Electrical Energy

    b) Electrical Energy into Mechanical Energy

    c)Both A&B d) None of these

Set A

Section – B

04X04 = 16 Marks

1. Define a) Pole Pitch & b) Coil Span.
2. Define Universal motor and also write its application.
3. A 3 phase, 4-pole alternator has 48 stator slots carrying a 3 phase distributed winding. Each coil of the winding in short chorded by one slot-pitch. Calculate the winding factor (K_w).
4. Why a 3-phase synchronous motor will always run at synchronous speed?

Section – C

04X06 = 24 Marks

1. Explain the condition for parallel operation of 3 phase alternator.
2. Explain V-curves and inverted V-curves.
3. Write the equation for torque developed by an induction motor. Draw a typical torque – slip curve and deduce the condition for maximum torque.
4. Draw a schematic diagram indicating flow of energy in the conservation of mechanical energy to electric form.

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Answers Key

Course Code: ELE 1506 , Course Name: Electrical Machine-II
School of Electrical Skills, Session: 2021-22 (Summer Semester)
B. Voc. ELE Program, V Semester, End-Sem. Examination

Section – A

10X01 = 10 Marks

1. Squirrel Cage Induction Motor is having
   b) Low Starting Torque
2. Synchronous Speed(Ns)
   a) 120f/P
3. Slip of Induction motor
   a)Ns-Nr/Ns
4. Three Phase Squirrel cage Induction motor rotor is having
   d)Short Circuited Copper Bars
5. An electro-mechanical energy conversion device is one which converts _____
   c) Electrical to mechanical and mechanical to electrical
6. In a full pitch coil, the two coil sides are how many electrical space degrees apart?
   a) 180 electrical degrees
7. The purpose of the starter is to
   a) Limit the starting current
8. A repulsion motor is equipped with
   b) Commutator
9. Shade pole motor is the category of _____
   c) Induction Motor
10. Generator is a machine which converts
    a) Mechanical Energy into Electrical Energy

Section – B

04X04 = 16 Marks

1. Define a) Pole Pitch & b) Coil Span.
   Pole pitch is defined as the distance between the Centres of two adjacent poles. In which one pole pitch is equal to 180 electrical degrees. We can also describe it as the number of slots per pole.
   Coil Span is defined as the distance between the two coil sides of a coil. We can also express it in electrical degrees or many slots.

2. Define Universal motor and also write its application.
   The motor which is designed to operate on AC and DC power both is known as Universal motor or Series wound motor. It performs very well on AC because in case of AC the current in both the field and the armature alternates in synchronism manner and hence, the resulting mechanical force occurs in the constant direction of rotation.
3. A 3 phase, 4-pole alternator has 48 stator slots carrying a 3 phase distributed winding. Each coil of the winding in short chorded by one slot-pitch.The winding factor (K_w) is

$$K_d = \frac{\sin(m\alpha/2)}{m\sin\alpha/2}$$

$$\text{where alpha is slot angle} = \frac{180 \text{ electrical}}{\text{No of slots/pole}}$$

$$\alpha = \frac{180 \times 4}{48} = 15^\circ$$

$$\text{m} = \text{no of slots per pole per phase}$$

$$m = \frac{48}{4 \times 3} = 4$$

$$\therefore K_d = \frac{\sin(60^\circ/2)}{4\sin(15^\circ/2)}$$

$$K_d = 0.9576$$

Pitch factor K_P is

$$K_P = \cos\frac{\alpha}{2}$$

$$K_P = \cos\frac{15^\circ}{2}$$

$$K_P = 0.9914$$

Sometimes distribution factor (K_d) and pitch factor (K_p) of an alternator are combined into a single factor called winding factor (K_w). The winding factor is the product of K_d and K_p i.e.

$$K_w = K_p \times K_d$$

$$K_w = 0.9576 \times 0.9914$$

$$K_w = 0.9494$$

4. Why a 3-phase synchronous motor will always run at synchronous speed?
Because of the magnetic coupling between the stator poles and rotor poles the motor runs exactly at synchronous speed.

Section – C

04X06 = 24 Marks

1. Explain the condition for parallel operation of 3 phase alternator.

1. The rms line voltage of the two generators must be equal.
2. The two generators must have the same phase sequence.
3. The frequency of the incoming alternator must be slightly higher than the frequency of the running system.

2. Explain V-curves and inverted V-curves.

V curve

V curve is the graph showing the relation of armature current as a function of field current in synchronous machines keeping the load constant. The purpose of the curve is to show the variation in the magnitude of the armature current as the excitation voltage of the machine is varied.

Inverted V curve

The **Inverted V Curve** is a graph showing the relation of power factor as a function of field current

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

3. Write the equation for torque developed by an induction motor. Draw a typical torque – slip curve and deduce the condition for maximum torque.

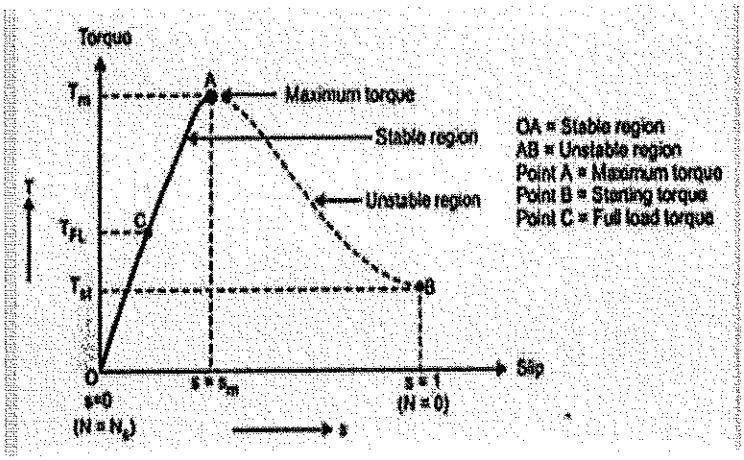
- Removing proportionality constant we get,

$$T = KsE_2^2 \frac{R_2}{\sqrt{R_2^2 + (sX_2)^2}}$$

$$This\ constant\ K = \frac{3}{2\pi n_s}$$

- Where, n_s is synchronous speed in r. p. s, $n_s = N_s / 60$. So, finally the equation of torque becomes,

$$T = sE_2^2 \times \frac{R_2}{R_2^2 + (sX_2)^2} \times \frac{3}{2\pi n_s} N - m$$



- In the equation of torque,

$$T = \frac{sE_2^2 R_2}{R_2^2 + (sX_2)^2} \times \frac{3}{2\pi n_s}$$

So, for torque to be maximum,

$$\frac{dT}{ds} = 0$$

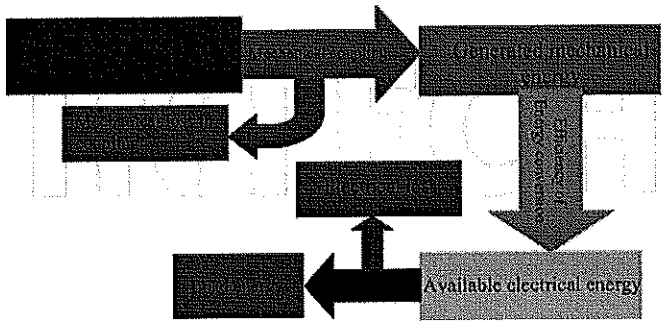
$$T = KsE_2^2 \frac{R_2}{R_2^2 + (sX_2)^2}$$

4. Draw a schematic diagram indicating flow of energy in the conservation of mechanical energy to electric form.

Electromechanical energy conversion is a conversion of mechanical energy into electrical energy (generator) or vice-versa (motor) with the aid of rotary motion (rotary machines) or translatory (linear) motion (linear machines and actuators)

An electromagnetic machine is one that links an electrical energy system to another (mechanical) energy system by providing a reversible means of energy flow via its magnetic field

• The magnetic field is therefore the coupling between the two systems and is the mutual link for electro-mechanical energy conversion



BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of Electrical Skills

Session: 2021-22 (Summer Semester)

B. Voc. Program, V Semester,

End-Sem. Examination

Course Code: ELE 1506 **Time: 2 Hours**

Course Name: Electrical Machine-II **Max. Marks: 50**

Instruction: Answer all questions from each and every section. Section A, each question carries one mark, section B, each question carries four marks and in section C, each question carries six marks. Scientific calculator is allowed.

Section – A

10X01 = 10 Marks

1. Slip of Induction Motor at Starting

   a) 0 b)1 c)0.5 d)0.3

2. Slip ring Induction Motor is having

   a)High Starting Torque b) Low Starting Torque c) Both A&B d) None of these

3. Synchronous Speed(Ns)

   a) 120f/P b) 120P/f c) Both A&B d)None of these

4. Three Phase Slip ring Induction motor rotor is having

   a) Three phase winding b) Single Phase winding

   c) Two Phase winding d) None of these

5. Shade pole motor is the category of _____

   a) DC motor b) Compound Motor c) Induction Motor d) Any of the above

6. What is the value of frequency when Ns=1000 RPM , P=6

   a) 30Hz b)40Hz c)50Hz d) 60Hz

7. What is the coupling field used between the electrical and mechanical systems in energy conversion devices?

   a) Magnetic field b) Electric field

   c) Magnetic field or Electric field d) None of the mentioned

8. The part of the coil in which EMF is generated is known as _____

   a) end connection b) coil sides c) coil span d) none of the mentioned

9. The torque speed characteristics of two phase induction motor is largely affected by

   a) Voltage b) Speed c) X/R ratio d) supply frequency

10. A universal motor is one which

    a) Is available universally

    b) Can be marketed internationally

    c) Can be operated either on dc or ac supply

    d) Runs at dangerously high speed on no-load

Set-B

Section – B

04X04 = 16 Marks

1. Why the efficiency of a three-phase induction is the motor is less than that of a three-phase transformer?
2. A 4-pole, 50 Hz, synchronous generator has 48 slots in which a double layer winding is housed. Each coil has 10 turns and is short pitched by an angle of 36° to electrical. The fundamental flux per pole is 0.25 Wb. Calculate the line to line induced emf, for a three phase star connection is approximately.
3. Can we add extra resistance in series with squirrel cage rotor? State the reason?
4. Why an induction motor will never run at its synchronous speed?

Section – C

04X06 = 24 Marks

1. Explain the condition for parallel operation of 3 phase alternator.
2. Define AC motor and also describe the basic parts of AC motor.
3. Draw the slip-torque characteristics for a three-phase induction motor and explain.
4. Describe the principle of energy conversion. From a consideration of the various energies involved, develop the model of an electromechanical energy conversion device.

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Answers Key

Course Code: ELE 1506, Course Name: Electrical Machine-II
School of Electrical Skills, Session: 2021-22 (Summer Semester)
B. Voc. ELE Program, V Semester, End-Sem. Examination

Section – A

10X01 = 10 Marks

1. Slip of Induction Motor at Starting
   b)1
2. Slip ring Induction Motor is having
   a)High Starting Torque
3. Synchronous Speed(Ns)
   a) 120f/P
4. Three Phase Slip ring Induction motor rotor is having
   a) Three phase winding
5. Shade pole motor is the category of _____
   c) Induction Motor
6. What is the value of frequency when Ns=1000 RPM , P=6
   c)50Hz
7. What is the coupling field used between the electrical and mechanical systems in energy conversion devices?
   c) Magnetic field or Electric field
8. The part of the coil in which EMF is generated is known as _____
   b) coil sides
9. The torque speed characteristics of two phase induction motor is largely affected by
   c) X/R ratio
10. A universal motor is one which
    c) Can be operated either on dc or ac supply

Section – B

04X04 = 16 Marks

1. Why the efficiency of a three-phase induction is the motor is less than that of a three-phase transformer?
   The efficiency of a three-phase induction motor is less than three-phase transformer because three-phase induction motor is like a rotating transformer and because of the rotating nature of induction motor there is friction and winding losses in it. Three phase transformer is a static device; therefore, there are no rotational losses.

2. A 4-pole, 50 Hz, synchronous generator has 48 slots in which a double layer winding is housed. Each coil has 10 turns and is short pitched by an angle of 36° to electrical. The fundamental flux per pole is 0.25 Wb. Calculate the line to line induced emf, for a three phase star connection is approximately.
   Solution: Given Data
   The number of Poles P = 4 No of slots = 48 Flux φ = 0.25 Wb No. of turns = 10
   For double layer winding,
   No of coils = No of slots = 48
   Total number of Turns = 48 × 10 = 480
   Hence turns per phase = 480/3 = 160
   Pitch factor KP is

KP=cosα/2
KP=cos(150/2) ; ; KP=0.9914

Now distribution factor Kd is given as
Kd=sin(mα/2)/ msin(mα/2)

∴ EMF per phase Eph of an alternator is
Eph = 4.44.Kp.Kd.φ.f.Tph
Eph = 4.44 × 0.9914 × 0.9576 × 0.25 × 50 × 160
Eph = 808.68
Line to Line induced EMF
EL = √3EPH
EL = √3 × 808.68
EL = 1400.67 V

3. Can we add extra resistance in series with squirrel cage rotor? State the reason?
We cannot add extra resistance in series with the rotor because all the copper bars of the rotor are short circuited in both the sides by copper end rings to have a closed circuit.

4. Why an induction motor will never run at its synchronous speed?
If it runs at synchronous speed then there would be no related speed between the two, hence no rotor emf, no rotor current so no rotor torques to maintain rotation. That is why the rotor runs at its synchronous speed.

Section – C

04X06 = 24 Marks

1. Explain the condition for parallel operation of 3 phase alternator.

1. The rms line voltage of the two generators must be equal.
2. The two generators must have the same phase sequence.
3. The frequency of the incoming alternator must be slightly higher than the frequency of the running system.

2. Define AC motor and also describe the basic parts of AC motor.

AC machines are electric motors. The working of AC machines is based on rotating magnetic field. DC motors which dosent has brush are actually an AC machine. It is operated by Alternate current. It converts electrical energy in to mechanical energy or mechanical energy in to electrical energy. When it converts mechanical to electrical then it is called generators. And if it converts electrical to mechanical then it is known as motors. AC machines are also known as induction motors.

Basic parts of AC motor:

Stator : produce rotating magnetic field and have coils, it is an outer part, it is connected with AC power supply

Rotor: produces torque, it is an inner part, squirrel cage is commonly used rotor, it is constructed with great density copper rods.

3. Draw the slip-torque charactertics for a three-phase induction motor and explain.

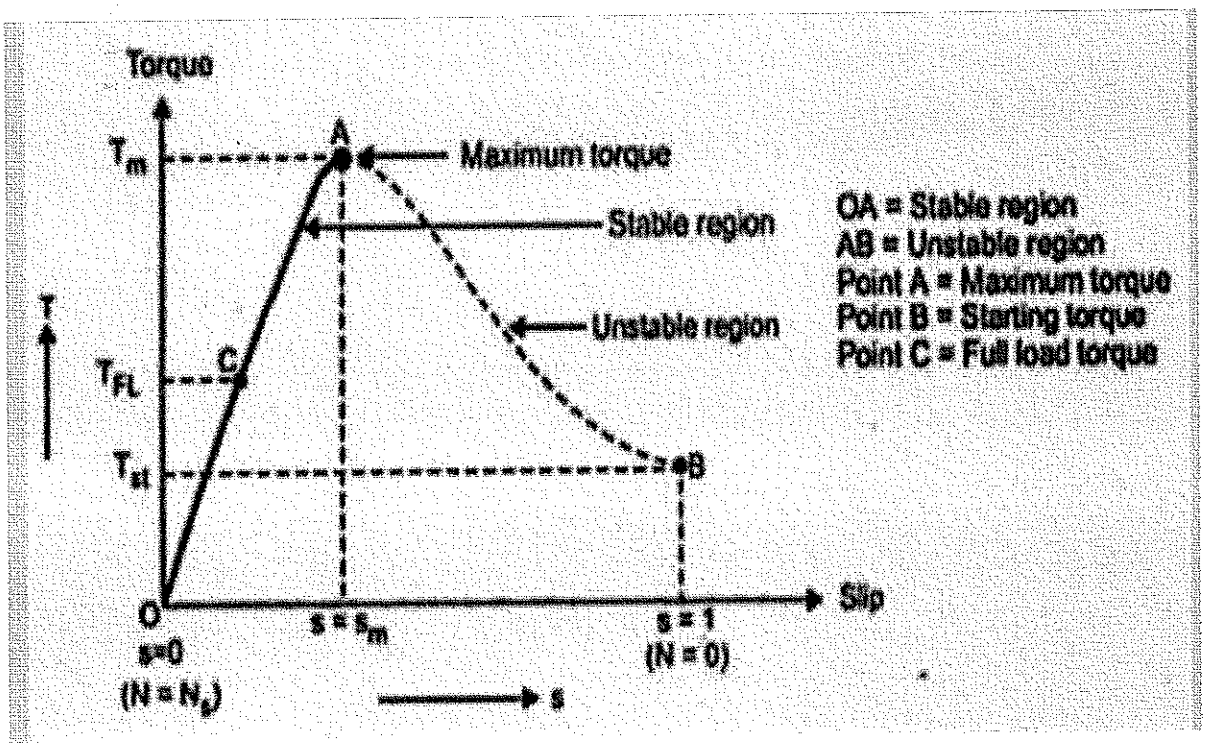
- Removing proportionality constant we get,

$$T = KsE_2^2 \frac{R_2}{\sqrt{R_2^2 + (sX_2)^2}}$$

$$This\ constant\ K = \frac{3}{2\pi n_s}$$

- Where, n_s is synchronous speed in r. p. s, $n_s = N_s / 60$. So, finally the equation of torque becomes,

$$T = sE_2^2 \times \frac{R_2}{R_2^2 + (sX_2)^2} \times \frac{3}{2\pi n_s} N - m$$



4. Describe the principle of energy conversion. From a consideration of the various energies involved, develop the model of an electromechanical energy conversion device.

An electromechanical energy conversion device is the device that converts electrical energy into mechanical energy or, mechanical energy into electrical energy. Electromechanical energy conversion takes place via the medium of a magnetic field or an electric field, but most practical converters use magnetic field as the coupling medium between electrical and mechanical systems, this is because the electric storing capacity of the magnetic field is much higher than that of the electric field.

According to the principle of conservation of energy, energy can neither be created nor be destroyed it can only be transformed from one state to another.

In an energy conversion device, the total input energy is equal to the sum of the following three components:

Thus, with an electromechanical conversion device, the energy balance equation can be written as

The above equation is for motor action. For generator action, the energy balance equation is written as