Registration No.: .....

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

School of Electrical Skills

Session: 2020-21 (Winter Semester)

B. Voc. Program, 5th Semester,

End – Sem. Examination

Set-B

Course Code: ELE 1501 **Time: 2 Hours**

Course Name: Fundamental of Power Electronics **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 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

2. 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

3. The knee voltage (cut in voltage) of Si diode is:
   (a) 0.2 V (b) 0.7 V (c) 0.8 V (d) 1.0 V

4. A silicon controlled rectifier (SCR) is a:
   (a) Unijunction device (b) Device with three junction
   (c) Device with four junction (d) None of these

5. 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

6. 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

7. 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

8. Which terminal does not belong to the SCR?
   (a) Anode (b) Gate (c) Base (d) Cathode

9. A PN junction acts as a:
   (a) Controlled switch (b) Bidirectional switch
   (c) Unidirectional switch (d) None of these

10. 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

Set-B Rishi

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Section – B

04X04 = 16 Marks

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

2. Differentiate between holding and latching current.

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

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.

Section – C

04X06 = 24 Marks

1. Explain the constructional features of power diode.

2. With neat diagram, explain the forward biasing operation of PN-junction diode.

3. Explain the working principle of full wave rectifier.

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 50HZ than calculate the value of maximum voltage and current.

Registration No.: .....

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

School of Electrical Skills
Session: 2020-21 (Winter Semester)
B. Voc. Program, 5th Semester,
End – Sem. Examination Solution

Set B
Answer key

Course Code: ELE 1501
Course Name: Fundamental of Power Electronics
Set – B

Section – A

10X01 = 10 Marks

1. Which of the below mentioned statements is false regarding a p-n junction diode?

   Ans: (d) Diodes have three terminals

2. The knee voltage (cut in voltage) of Ge diode is:
   Ans: (a) 0.3 V
3. The knee voltage (cut in voltage) of Si diode is:
   Ans: (b) 0.7 V
4. A silicon controlled rectifier (SCR) is a:
   Ans: (b) Device with three junction
5. The arrow symbol in the diode indicates:
   Ans: (b) Direction of hole flow (Direction of conventional current)
6. A power transistor is a:
   Ans: (b) three layer, two junction device
7. When the diode is forward biased, it is equivalent to:
   Ans: (b) An On switch
8. Which terminal does not belong to the SCR?
   Ans: (c) Base
9. A PN junction acts as a:
   Ans: (c) Unidirectional switch
10. Choose the correct statement:
    Ans: (b) MOSFET is a voltage controlled device

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Section – B

04X04 = 16 Marks

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

Ans:

the power electronics devices in electrical power systems basically perform the following functions by periodically switching the current on and off at a desired frequency.

(I) Convert Ac in to Dc.

(II) Convert Dc in to Ac.

(III) Convert frequency

(IV) Control Ac and Dc voltages

2. Differentiate between holding and latching current.

Ans:

Holding current is the minimum amount of current below which SCR doesn't conduct.

Latching current is the minimum amount of current required for the SCR to conduct.

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

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

Ans:

For high frequency applications, MOSFET is preferred, because MOSFET has low switching losses compare to IGBT. For low frequency applications having frequency range up to 20 kHz, we use IGBT.
For high frequency applications having frequency range more then 200 kHz we prefer MOSFET.

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})

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

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

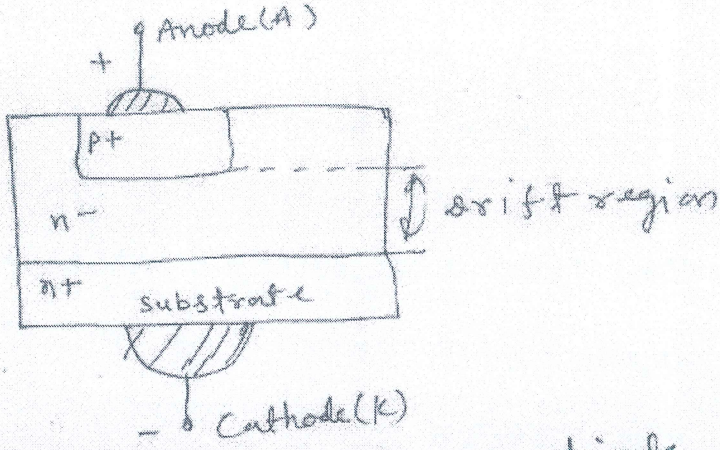
BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Section – C

04X06 = 24 Marks

1. Explain the constructional features of power diode.

Ans:



(structure of power diode

Power diode consists of heavely doped n+ substrate, on it a lightely doped n− layer is grown. Heavely doped p+ layer is diffuse into n− layer to form the anode.

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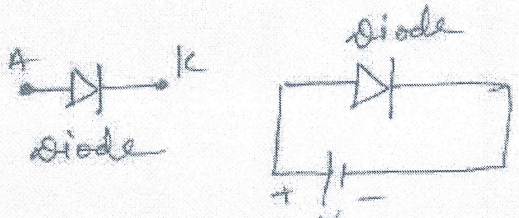
2. With neat diagram, explain the forward biasing operation of PN-junction diode.

Ans:



(Forward biasing) of Pn-jn. diode.

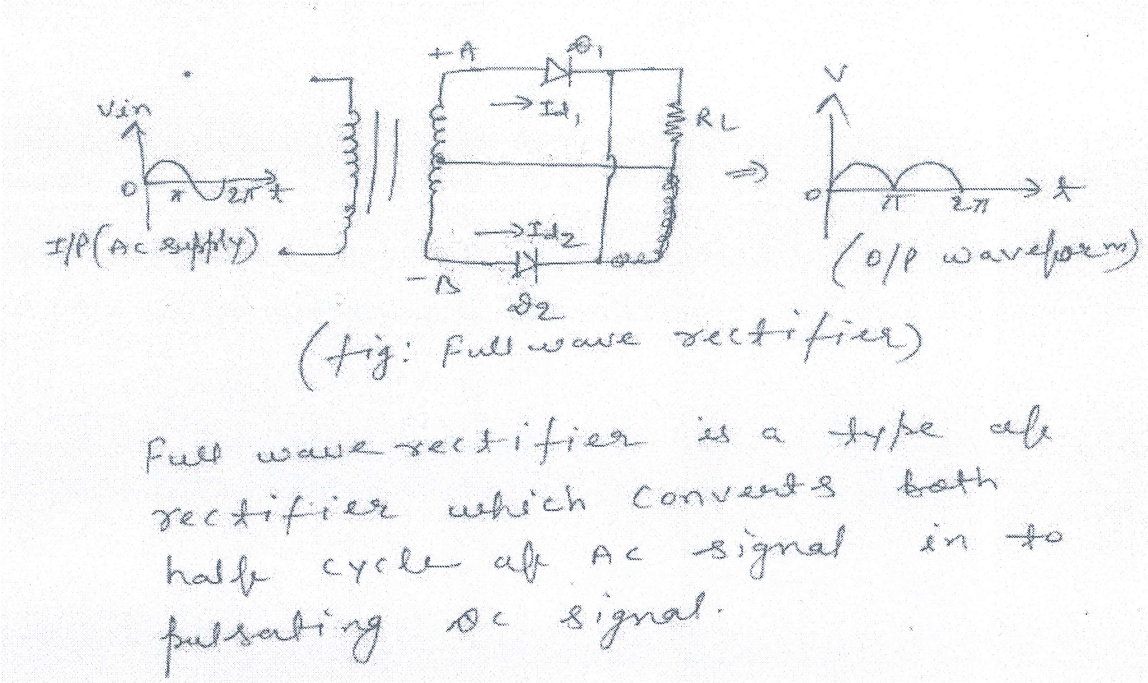
The process of applying the voltage across the Pn-junction diode is called called biasing of diode.

In forward biasing mode +ve terminal of battery is connected to P-type and negative terminal of battery is connected to n-type. when. In forward biasing diode starts Conducting above the cut in val. of diode and a exponential forward current obtain.

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

3. Explain the working principle of full wave rectifier.

Ans:



(fig: Full wave rectifier)

Full wave rectifier is a type of rectifier which converts both half cycle of AC signal in to pulsating DC signal.

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 50HZ than calculate the value of maximum voltage and current.

Ans:

It is given that

$$\frac{E_{Prms}}{E_{Srms}} = \frac{10}{1}$$

or, $E_{Srms} = \frac{E_{Prms}}{10} = \frac{230}{10} = 23\,V$

since

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

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

$$I_m = \frac{E_m}{R_L} = \frac{32.52}{20} = 1.626\,A$$

So, max^m. value of voltage $E_m = 32.52$
max^m current $I_m = 1.626\,A$

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of Electrical Skills

Session: 2020-21 (Winter Semester)

B. Voc. Program, Vth 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. The size of Gas Insulated Substation is significantly small compared to conventional substation because
   (a) High electronegative property of SF6 gas
   (b) High dielectric property of SF6 gas
   (c) High Insulation property of SF6 gas
   (d) All the above
4. Which of the following is usually not the generating voltage?
   (a) 6.6 kV (b) 9.9 kV
   (c) 11kV (d) 13.2 kV.
5. Which is equipment is installed first in the substation for taking the supply from transmission line system
   (a) Circuit breaker (b) Lightning arrester
   (c) Current transformer (d) Transformer
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

set-B

a) Industrial consumers
b) Residential consumers
c) Agriculture consumers
d) Commercial consumers

Section – B

04X04 = 16 Marks

1. Define the terms: demand factor, maximum demand and connected load.
2. What is substation? Classify the substations according to the operating voltages and their important features.
3. What are the advantages and disadvantages of outdoor substations over indoor substations?
4. What do you understand by Tariff and what are its objectives?

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. The load on a power plant on a typical day is as under:

Time	12-5 AM	5-9 AM	9-6 PM	6 PM - 10 PM	10 PM – 12 AM
Load (MW)	20	40	80	100	20

   Plot the chronological load curve and load duration curve. Find the load factor of the plant and the energy supplied by the plant in 24 hours.

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of Electrical Skills

Session: 2020-21 (Winter Semester)

B. Voc. Program, Vth Semester,

End-Sem. Examination

Answer key

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. The size of Gas Insulated Substation is significantly small compared to conventional substation because
   (a) High electronegative property of SF6 gas
   (b) High dielectric property of SF6 gas
   (c) High Insulation property of SF6 gas
   (d) All the above
4. Which of the following is usually not the generating voltage?
   (a) 6.6 kV **(b) 9.9 kV**
   (c) 11kV (d) 13.2 kV.
5. Which is equipment is installed first in the substation for taking the supply from transmission line system
   (a) Circuit breaker **(b) Lightning arrester**
   (c) Current transformer (d) Transformer
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

Section – B

04X04 = 16 Marks

1. Define the terms: demand factor, maximum demand and connected load.
   Ans: Demand factor is the ratio of the maximum demand to the connected load.
   Maximum demand of a consumer means the maximum power that his circuit is likely to draw at any time.
   Connected load of a consumer means the sum of the continuous ratings of all the devices and outlets installed on his distribution circuit
1. What is substation? Classify the substations according to the operating voltages and their important features.
   Ans: Substation: A power substation is a subsidiary station of an electricity generation, transmission and distribution system where voltage is transformed from high or medium to low or the reverse using transformers. Electric power flows through several substations between generating plant and consumer changing the voltage level in several stages. At first substations were connected to only one power station where the generator was housed and were subsidiaries of that power station.
   Generally, electrical substation is a point in distribution system where:
   - A place where several electrical equipments are installed and used for electrical energy in power system.
   - A place where the safety of the system is providing by automatically protection scheme.
   - A place where one or several incoming and outgoing circuit are met at one or more busbar system and controlled by high voltage switching equipment which is used for switching.
   - A place where voltage value is changed and controlled.
   - A place where load is distributed, controlled and protected

   Classification of Substation on the basis of operating voltage: The substations, according to operating voltage, may be categorized as

   1. High Voltage Substations (HV Substations): involving voltages between 11 kV and 66 kV.
   2. Extra High Voltage Substations (EHV Substations): involving voltages between 132 kV and 400 kV.
   3. Ultra High Voltage Substations (UHV Substations): operating on voltage above 400 kV.

   Classification of Substation on the basis of importance:

   1. Grid Substations: these are the substations from where bulk power is transmitted from point to another point in the grid. These are important because any disturbance in these substations may cause the failure of the grid.
   2. Town Substations: these substations step-down the voltages at 33/11 kV for further distribution in the towns and any failure in such substations results in the failure of supply for whole of the town.

2. What are the advantages and disadvantages of outdoor substations over indoor substations?

   Ans: The outdoor substations have the following main advantages over indoor substations

i. All the equipment is within view and therefore fault location is easier.
ii. The extension of the installation is easier, if required.
iii. The time required in erection in erection of such substations is lesser.
iv. The smaller amount of building materials (steel-concrete) is required.
v. The construction work required is comparatively smaller and cost of the switchgear installation is low.
vi. There is practically no danger of a fault which appears at one point being carried over to another point in the installation because the apparatus of the adjoining connections can be spaced liberally, without any appreciable increase in costs.
vii. Repairing work is easy.

The Disadvantages of Outdoor installations in comparison of Indoor installations are:

i. The various switching operations with the isolators, as well as supervision and maintenance of the apparatus is to be performed in the open air during all kinds of weather.

ii. More space is required for the substation.

iii. Protection devices are required to be installed for protection against lightning surges.

iv. The length of control cables required is more.

v. The influence of rapid fluctuation in ambient temperature and dust and dirt deposits upon the outdoor substation equipment makes it necessary to install apparatus specially designed for outdoor service and, therefore, more costly.

3. 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.

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. The load on a power plant on a typical day is as under:

Time	12-5 AM	5-9 AM	9-6 PM	6 PM - 10 PM	10 PM – 12 AM
Load (MW)	20	40	80	100	20

Plot the chronological load curve and load duration curve. Find the load factor of the plant and the energy supplied by the plant in 24 hours.

Solution. The chronological load curve is plotted in figure 1. The duration of load is an under:

Load (MW)	100	80 and above	40 and above	20 and above
Duration	4	13	17	24

The load duration curve is plotted in figure 2. The energy produced by the plant in 24 hours

= 100 × 4 + 80 × (13-4) + 40 × (17-13) + 20 × (24-17) = 1420 MWh

Load factor = 1420 / (100 × 24) =0.5917 or 59.17%

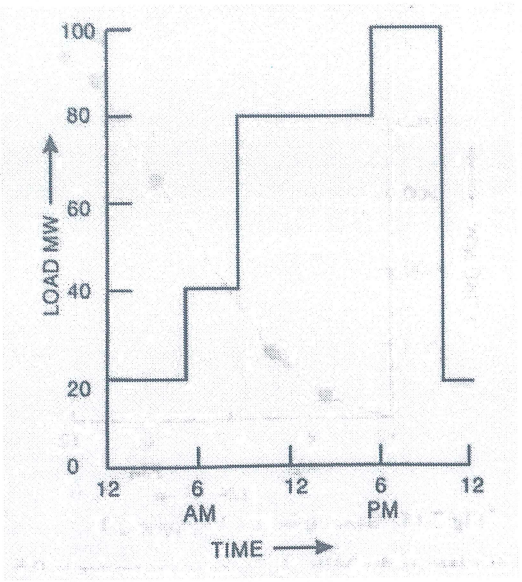


Figure 1

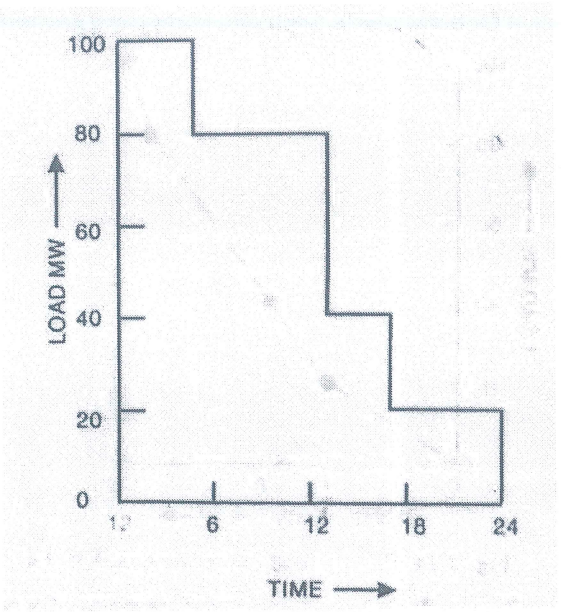


Figure 2

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Set-B

Registration No.: .....

School of Electrical Skills

Session: 2020-21 (Winter Semester)

B. Voc. Program, Vth Semester,

End-Sem. Examination

Course Code: ELE 1503 **Time: 2 Hours**

Course Name: Electrical Machines-II **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. Squirrel Cage Induction Motor is having
   a) High Starting Torque b) Low Starting Torque c) Both A&B d) None of these
2. RMF Means
   a) Rotating Motive Force b) Rotating Magnetic Field
   c) Rotating Mechanical force d) None
3. 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
4. Slip of Induction motor
   a) Ns-Nr/Ns b) Nr-Ns/Ns c) Ns-Nr/Nr d) None of these
5. Induction Motor operates on the principle of
   a) Induction b) Conduction c) Both A&B d) None of these
6. External Resistance is observed in
   a) Squirrel Cage Induction Motor b) Slip Ring Induction Motor
   c) Both A&B d) None of these
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. A pole pitch in electrical machine _____
   a) = 180° electrical b) = 180° mechanical
   c) > 180° electrical d) < 180° electrical.
9. Current in the field winding is _____
   a) AC always b) DC always c) Both AC and DC d) Either AC or DC
10. Slip of Induction Motor at Starting
    a)0 b)1 c)0.5 d)0.3

Set-B

Section – B

04X04 = 16 Marks

1. Explain the Faraday's law of Electromagnetic Induction.
2. What are the advantages of Stationary Armature and Rotating Field System?
3. Define: (a) Dynamically Induced EMF (b) Statically Induced EMF
4. To generate an output frequency of 6oHz, what would be the rpm speed need to be with an eight pole alternator?

Section – C

04X06 = 24 Marks

1. Derive the equation for torque developed by an induction motor and also draw a typical torque – slip curve.
2. Describe the principal of energy-conversion. From a consideration of the various energies involved, develop the model of an electromechanical energy-conversion device.
3. Explain why a synchronous motor does not have starting torque and also mention some specific applications of synchronous motor.
4. Write difference between Induction and Synchronous Motor.

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Answer-Sheet

School of Electrical Skills

Session: 2020-21 (Winter Semester)

B. Voc. Program, Vth Semester,

End-Sem. Examination

Course Code: ELE 1503 **Time: 2 Hours**

Course Name: Electrical Machines-II **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. Squirrel Cage Induction Motor is having

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

   Ans:b

2. RMF Means

   a) Rotating Motive Force b) Rotating Magnetic Field

   c) Rotating Mechanical force d) None

   Ans:b

3. 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

   ANS: a

4. Slip of Induction motor

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

   Ans:a

5. Induction Motor operates on the principle of

   a) Induction b) Conduction c) Both A&B d) None of these

   Ans:a

6. External Resistance is observed in

   a) Squirrel Cage Induction Motor b) Slip Ring Induction Motor

   c) Both A&B d) None of these

   Ans:b

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

   Ans: c

   Explanation: Either electric field or magnetic field can be used, however most commonly we use magnetic field because of its greater energy storage capacity.

Set-B

8. A pole pitch in electrical machine _____

a) = 180° electrical b) = 180° mechanical

c) > 180° electrical d) < 180° electrical

Ans: a

Explanation: Pole pitch is always expressed in electrical degrees, rather than in mechanical degrees.
pole pitch = 180 electrical degrees or π electrical radians.

9. Current in the field winding is _____

a) AC always b) DC always c) Both AC and DC d) Either AC or DC

Ans: b

Explanation: Field winding is always given DC supply and hence current is also DC.

10. Slip of Induction Motor at Starting

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

Ans:b

Section – B

04X04 = 16 Marks

1. Explain the Faraday's law of Electromagnetic Induction.

Ans: Faraday's first law of electromagnetic induction states that "Whenever a conductor is placed in a varying magnetic field, an electromotive force is induced. Likewise, if the conductor circuit is closed, a current is induced, which is called induced current."

Faraday's first second law of electromagnetic induction states that the induced emf in a coil is equal to the rate of change of flux linkage.

Faraday's law describes how changing magnetic fields can cause current to flow in wires.

The negative sign indicates that the direction of the induced emf and change in the direction of magnetic fields have opposite signs.

2. What are the advantages of Stationary Armature and Rotating Field System?

Ans: The advantages of the stationary armature and rotating field system are as follows:

- The coils of the stationary armature can be insulated easily.
- The cooling of the winding is more efficient.
- In the motor high peripheral speed can be achieved.
- In this Slip rings and brushes are not necessary, and we can easily supply the output current to the load circuit.

3. Define: (a) Dynamically Induced EMF (b) Statically Induced EMF

Ans: When the flux linking with the coil or circuit changes, an emf is induced in the coil or circuit.

EMF can be induced by changing the flux linking in two ways:

a) By increasing or decreasing the magnitude of the current producing the linking flux. In this case, there is no motion of the conductor or of coil relative to the field and, therefore, emf induced in this way is known as statically induced

b) By moving a conductor in a uniform magnetic field and emf produced in this way is known as *dynamically induced emf*

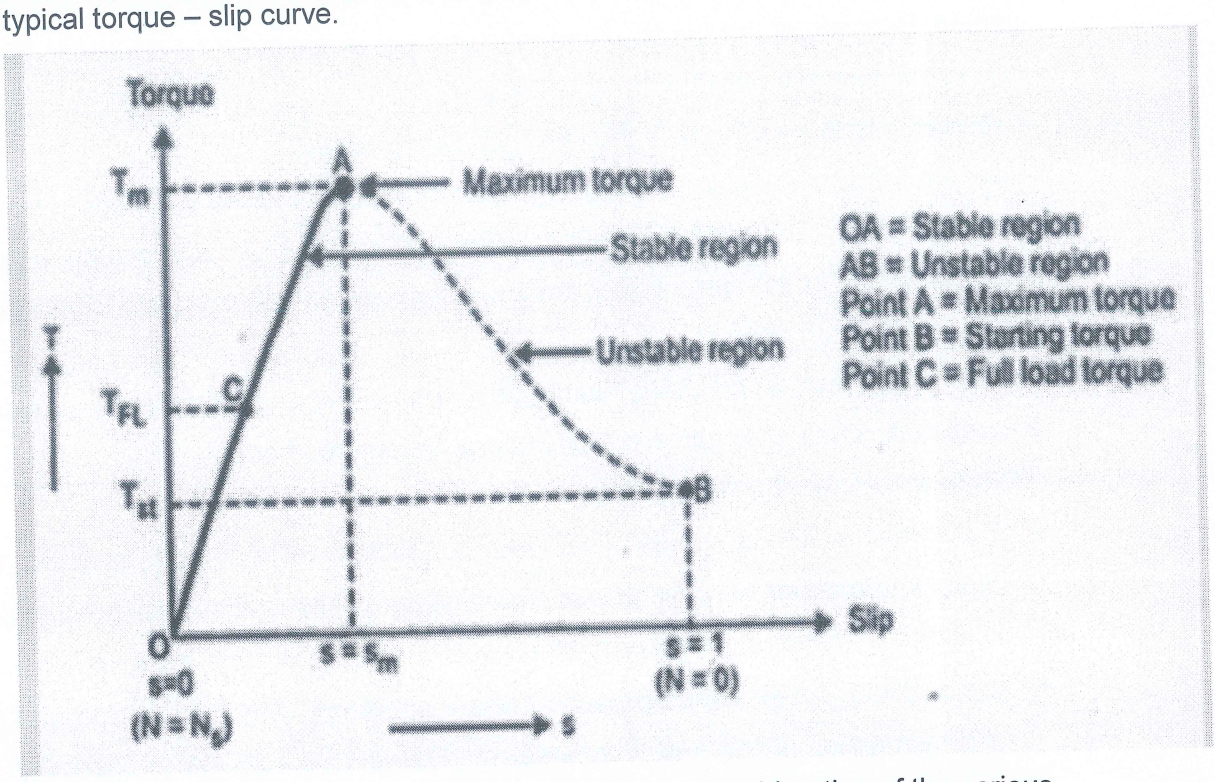
4. To generate an output frequency of 6oHz, what would be the rpm speed need to be with an eight pole alternator?

Ans: n=120∗fp=120∗608=900RPM

Section – C

04X06 = 24 Marks

1. Derive the equation for torque developed by an induction motor and also draw a typical torque – slip curve.



2. Describe the principal of energy-conversion. From a consideration of the various energies involved, develop the model of an electromechanical energy-conversion device.

Ans: 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

$$\begin{bmatrix}\text{Electrical}\\ \text{energy}\\ \text{input}\end{bmatrix} = \begin{bmatrix}\text{Energy to}\\ \text{electrical}\\ \text{losses}\end{bmatrix} = \begin{bmatrix}\text{Energy to field}\\ \text{storage in the}\\ \text{electrical system}\end{bmatrix} = \begin{bmatrix}\text{Mechanical}\\ \text{energy}\\ \text{output}\end{bmatrix}$$

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

$$\begin{bmatrix}\text{Total mechanical}\\ \text{energy input}\end{bmatrix} = \begin{bmatrix}\text{Electrical energy}\\ \text{output}\end{bmatrix} + \begin{bmatrix}\text{Total energy}\\ \text{stored}\end{bmatrix} + \begin{bmatrix}\text{Total energy}\\ \text{dissipated}\end{bmatrix}$$

3. Explain why a synchronous motor does not have starting torque and also mention some specific applications of synchronous motor.

Ans: The moment of inertia of rotor stops the large-sized synchronous motors from self-starting. Because of this inertia of the rotor, it is not possible for a rotor to get in sync with the stator's magnetic-field at the very instance power is applied. So some additional mechanism is required to help the rotor get synchronized.

Induction winding is included in the large motors which generate sufficient torque required for acceleration. For very large motors, to accelerate the unloaded machine, pony motor is used. Changing stator current frequency, electronically operated motors can accelerate even from the zero speed.

For very small motors, when the moment of Inertia of the rotor and the mechanical load are desirably small, they can start without any starting methods.

Application of Synchronous Motors

- Synchronous motor having no load connected to its shaft is used for power factor improvement. Owing to its characteristics to behave at any electrical power factor, it is used in power system in situations where static capacitors are expensive.
- Synchronous motor finds application where operating speed is less (around 500 rpm) and high power is required. For power requirement from 35 kW to 2500 KW, the size, weight and cost of the corresponding three phase induction motor is very high. Hence these motors are preferably used. Ex- Reciprocating pump, compressor, rolling mills etc.

4. Write difference between Induction and Synchronous Motor.

BASIS OF DIFFERENCE	SYNCHRONOUS MOTOR	INDUCTION MOTOR
Type of Excitation	A synchronous motor is a doubly excited machine.	An induction motor is a single excited machine.
Supply System	Its armature winding is energized from an AC	Its stator winding is energized from an AC source.

BASIS OF DIFFERENCE	SYNCHRONOUS MOTOR	INDUCTION MOTOR
	source and its field winding from a DC source.	
Speed	It always runs at synchronous speed. The speed is independent of load.	If the load increased the speed of the induction motor decreases. It is always less than the synchronous speed.
Starting	It is not self starting. It has to be run up to synchronous speed by any means before it can be synchronized to AC supply.	Induction motor has self starting torque.
Operation	A synchronous motor can be operated with lagging and leading power by changing its excitation.	An induction motor operates only at a lagging power factor. At high loads the power factor becomes very poor.
Usage	It can be used for power factor correction in addition to supplying torque to drive mechanical loads.	An induction motor is used for driving mechanical loads only.
Efficiency	It is more efficient than an induction motor of the same output and voltage rating.	Its efficiency is lesser than that of the synchronous motor of the same output and the voltage rating.
Cost	A synchronous motor is costlier than an induction motor of the same output and voltage rating	An induction motor is cheaper than the synchronous motor of the same output and voltage rating.

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Set-B

Registration No.: .....

School of Electrical Skills

Session: 2020-21 (Winter 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 origin of the word "Automation" is attributed to: -
   (a) Richard E. Morley (b) George Klir
   (c) D.S. Harder (d) None of these

2. The_____instruction is an output instruction that marks the end of the subroutine file: -
   (a) SBR (b) RET
   (c) JSR (d) None of these

3. Physical timer, counter, contactors & relays are used in: -
   (a) Hard wire controlling (b) Logic gate controlling
   (c) Manual controlling (d) None of these

4. 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

5. The full form of TLS is: -
   (a) Total Least Square (b) Transport Layer Security
   (c) Telephone Line Simulator (d) None of these

6. Distributed SCADA systems is the: -
   (a) First Generation SCADA (b) Second Generation SCADA
   (c) Third Generation SCADA (d) Fourth Generation SCADA

7. One PLC failure would not halt the complete process in _____system: -
   (a) SCADA (b) Manual automation
   (c) DCS (d) None of these

Set-B Finished

8. 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

9. The intermediate circuit in VFD is also called: -
   (a) Rectifier circuit
   (b) Inverter circuit
   (c) DC-link
   (d) None of these

10. Reverse accelerating quadrant with negative speed and torque is: -
   (a) Quadrant I
   (b) Quadrant III
   (c) Quadrant II
   (d) Quadrant IV

Section – B

04X04 = 16 Marks

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

Section – C

04X06 = 24 Marks

1. What is "Master Control Reset" instruction? Explain in detail.
2. What is star-delta starter? Draw the control circuit, power circuit and ladder logic diagram for star-delta starter.
3. Explain the application of SCADA in smart power system.
4. Explain the VFD in detail.

Answers Key

Course Code: ELE1505, Course Name: Advance Automation and Control
School of Electrical Skills, Session: 2020-21 (Winter Semester)
B. Voc. Program, V Semester, End-Sem. Examination

Section – A

10X01 = 10 Marks

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

Section – B

04X04 = 16 Marks

1. 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

Set-B

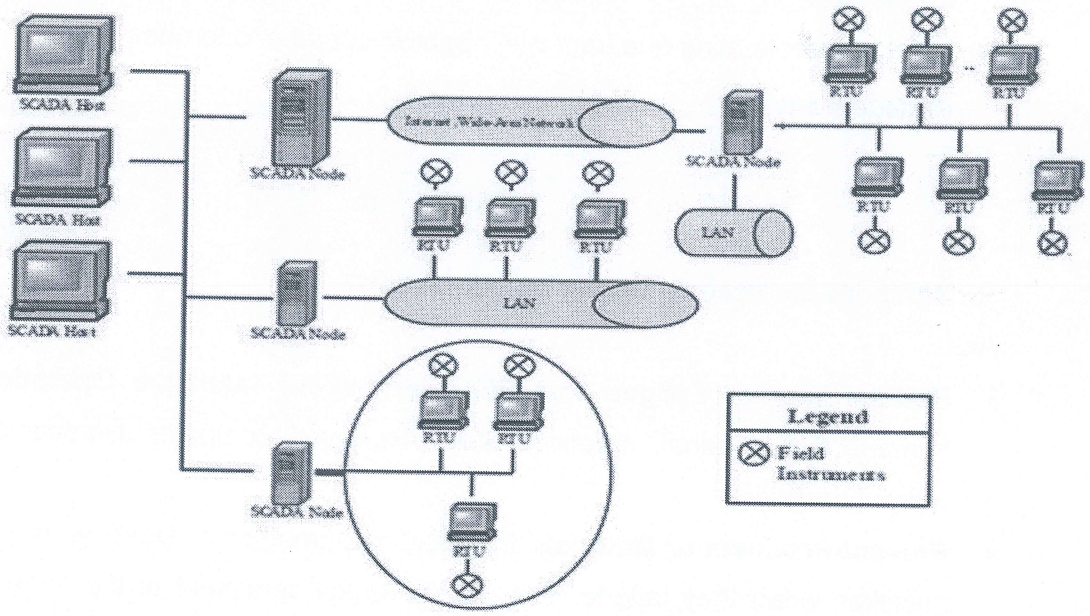
do it? No, human variation exists. Automated systems allow for improvements that benefit from consistent execution.

- **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.

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



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

Answers Key

Course Code: ELE1505, Course Name: Advance Automation and Control
School of Electrical Skills, Session: 2020-21 (Winter Semester)
B. Voc. Program, V Semester, End-Sem. Examination

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.

4. **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.

Section – C

04X06 = 24 Marks

1. **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.*

Answers Key

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- 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.

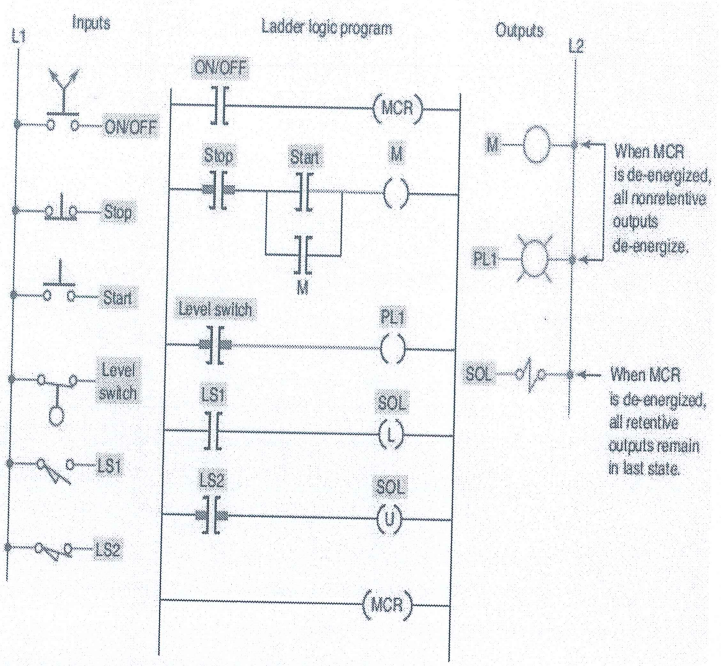
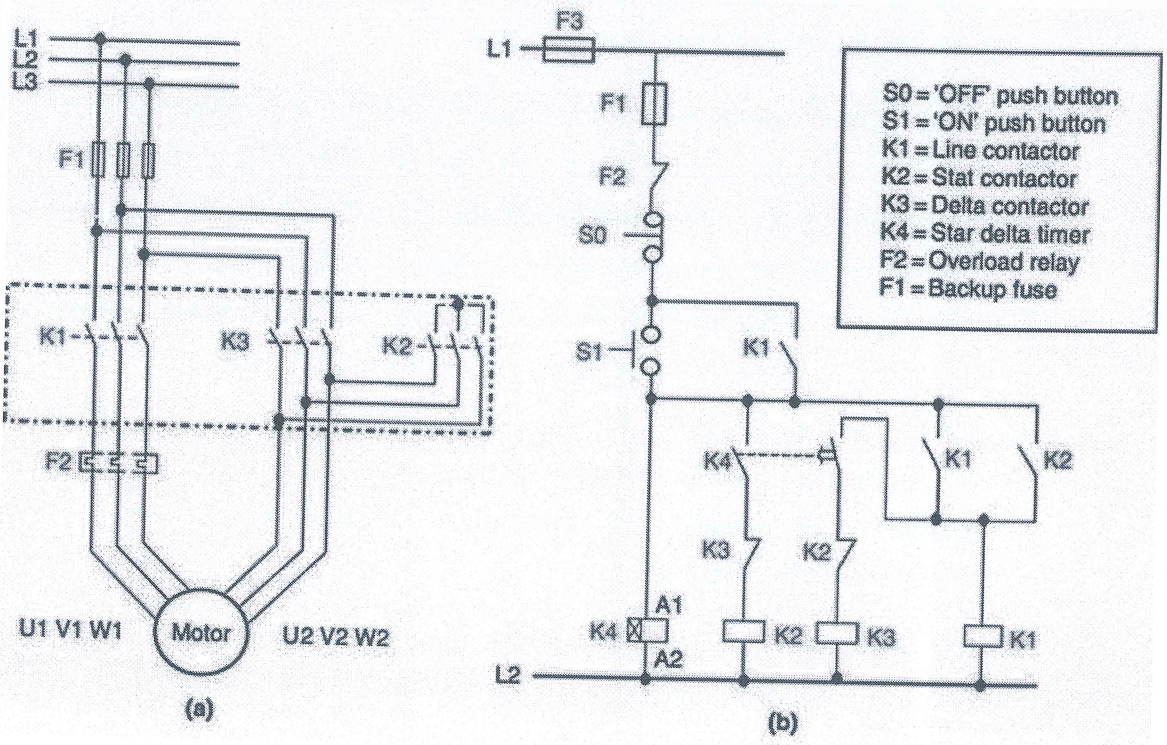


Figure 9-3 Master Control Reset (MCR) instruction.

2. **What is star-delta starter? Draw the control circuit, power circuit and ladder logic diagram for star-delta starter.**

Ans. The **Star Delta Starter** is a very common type of **starter** and is used extensively as compared to the other type of starting methods of the induction motor. A **star delta** is used for a cage motor designed to run normally on the **delta** connected stator winding.

(a) Power circuit diagram (b) Control circuit diagram



Answers Key

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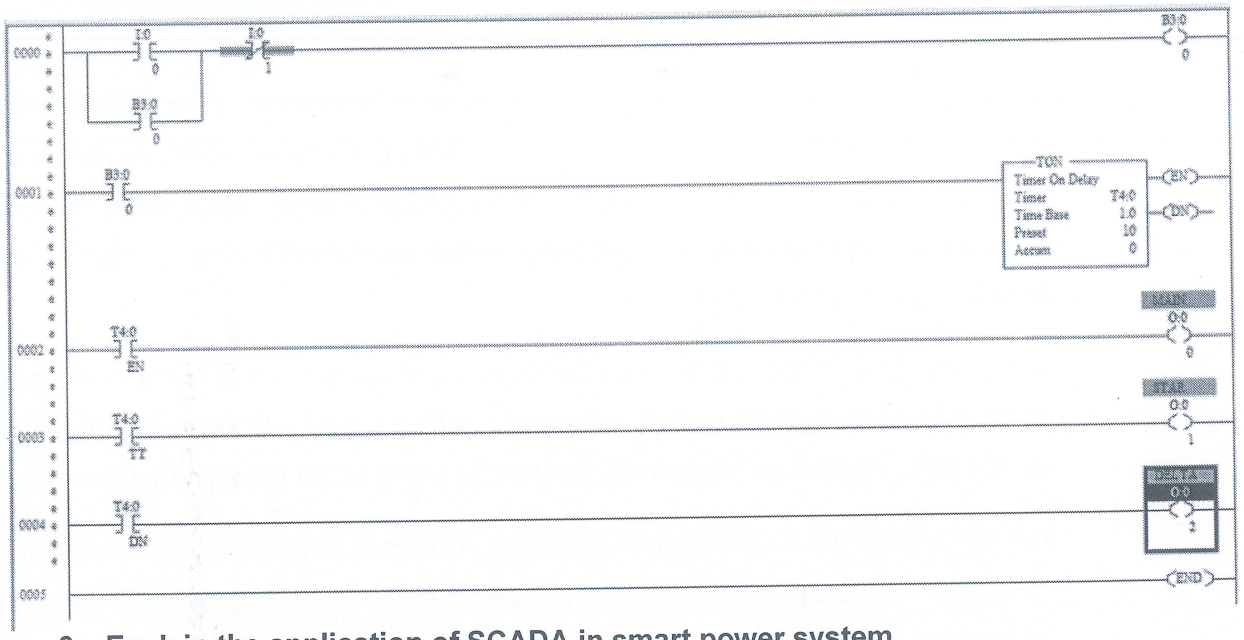
Ladder Logic Diagram:



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

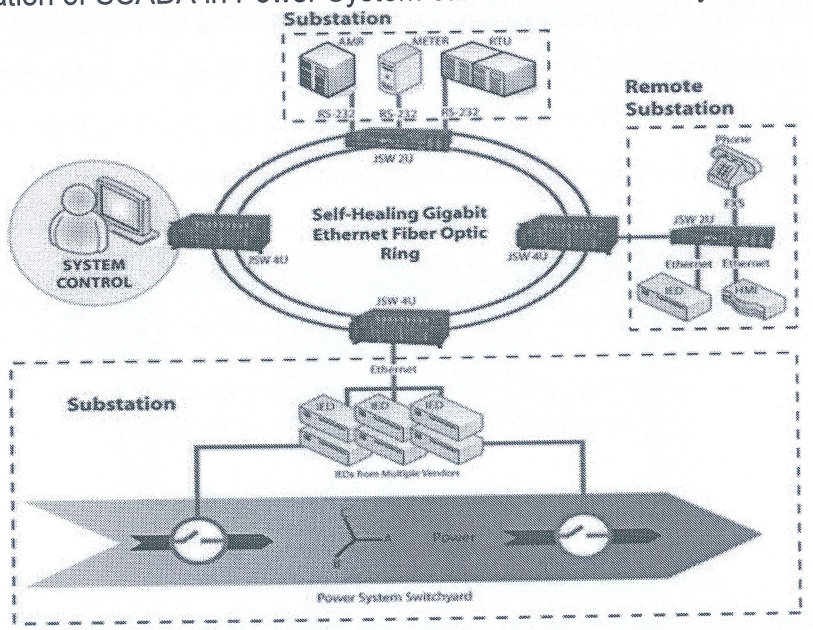
Ans. **SCADA in Smart Power System:**

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.



Answers Key

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4. 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.

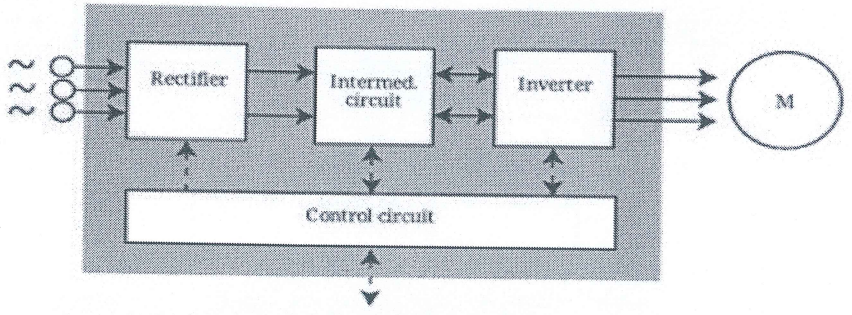
Working principle of VFD

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