Registration No.: ..... (B)

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

School of Electrical Skills

Session: 2019-20 (Summer Semester)

B. Voc. Program, 5th 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 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

Registration No.: .....

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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.

Set-B

Course Name:- Fundamentals of Power Electronics

Course code - ELE1501

Section-A

1. Ans → (d)
2. Ans → (a)
3. Ans → (b)
4. Ans → (b)
5. Ans → (b)
6. Ans → (b)
7. Ans → (b)
8. Ans → (c)
9. Ans → (c)
10. Ans → (b)

Section - B

1 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. 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.

3. Ans: —

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

4. 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, $\boxed{R_{DCf} = 3\,\Omega}$

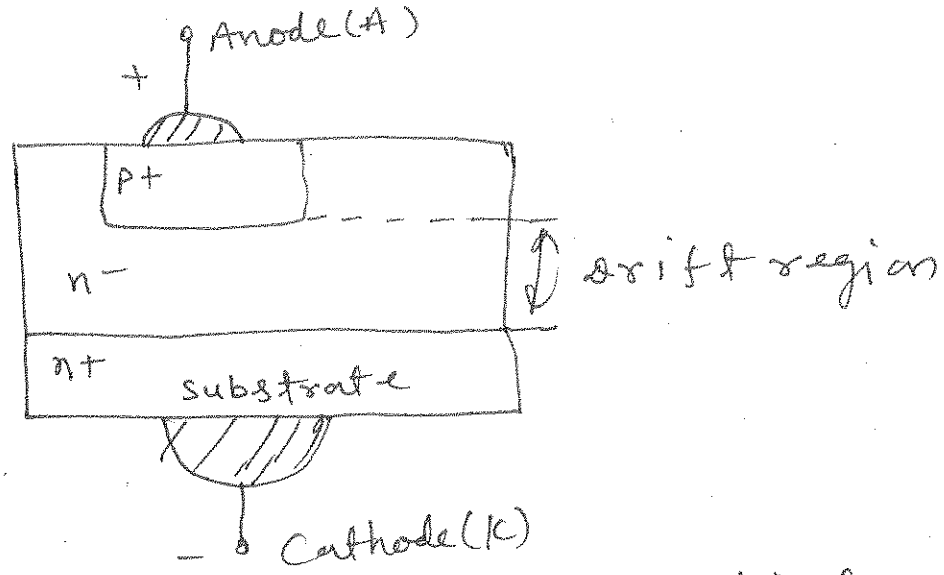
Similarly DC Reverse resistance (R_{DCR})

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

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

Section - C

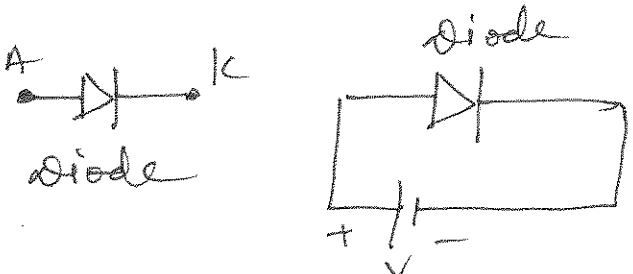
1. Ans:



(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.

2. Ans: —



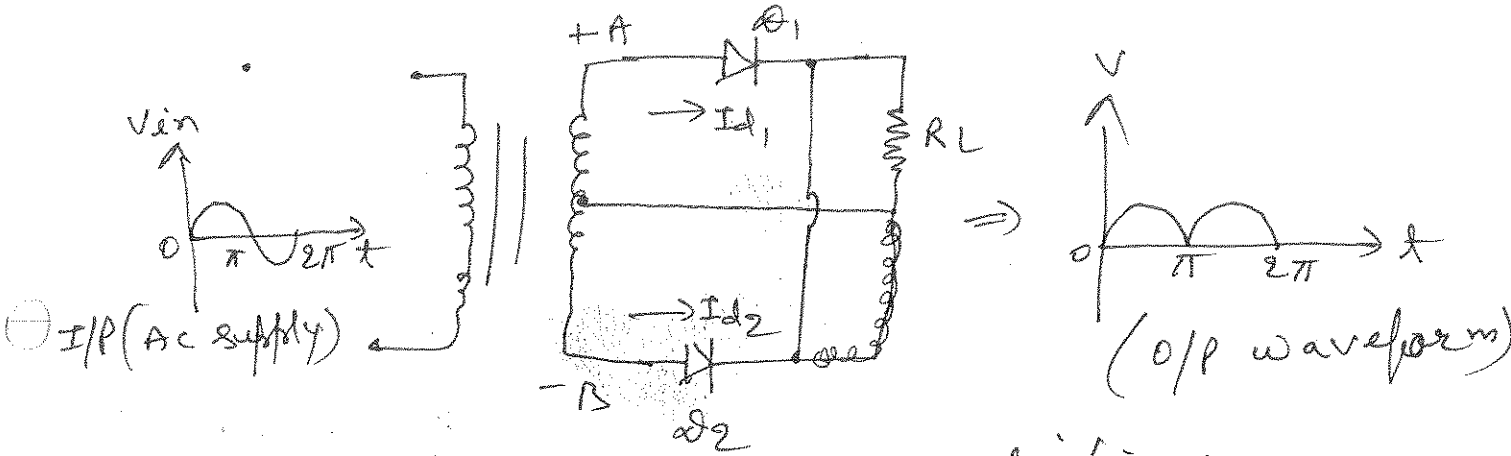
(forward biasing) of Pn-jn. diode.

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.

3. 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. 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 $I_m = 1.626\,A$

Registration No.: ..... (B)

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

School of Electrical Skills

Session: 2019-20 (Summer Semester)

B. Voc. Program, 5th Semester,

End – Sem. Examination

Course Code: ELE-1502 **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. In practice what is the value of diversity factor:
   (a) Less than Unity (b) Geater than Unity
   (c) Equal to or greater than Unity (d) Less than zero

2. A load curve is a plot of:
   (a) Load versus generation capacity (b) Load versus current
   (c) Load versus time (d) Load versus cost of power.

3. The load of a consumer is generally measured in terms of:
   (a) Volts (b) Amperes (c) Ampere hour (d) kW

4. The normal connected load of a domestic consumer is usually:
   (a) up to 10 kW (b) 10 to 20 kW (c) 25 to 50 kW (d) 50 to 100 kW.

5. Load factor during a period is:
   (a) Average Load / Installed Capacity (b) Average Load / Maximum Load
   (c) Maximum Load / Average Load (d) Maximum Load / Installed Capacity.

6. During summer months the increased load is due to:
   (a) Increased water supply (b) Vacations in institutions
   (c) Increased business activity (d) Increased use of fans and air conditioners.

7. In a system if the base load is the same as the maximum demand, then load factor will be:
   (a) 1 (b) Zero (c) Infinity (d) 1 percent

8. Load of one-ton air conditioner is nearly:
   (a)100W (b) 200 to 500 W (c) 1 kW to 2 kW (d) 5 kW to 10 kW

9. Which domestic utility item has highest power rating?
   (a) Refrigerator (b) Ceiling fan (c) Tube light (d) Electric iron

10. Which of the following represents the annual average load?
   (a) (KWh supplied in a day)/24 (b) {(KWh supplied in a day)/ 24 } × 365
   (c) {(KWh supplied in a month)/(30 x 24) (d) (KWh supplied in a year) / (24 × 365)

B

Registration No.: .....

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Section – B

04X04 = 16 Marks

1. What are the names of interlocking done with isolators? Also state any four types of substations according to the service.
2. State the relative merits of indoor and outdoor substations.
3. What is depreciation?
4. Define Demand Factor and Diversity Factor.

Section – C

04X06 = 24 Marks

1. What is the role of NLDC?
2. A residential consumer has the following connected load: 8 bulbs of 100 watts each, 2 fans of 60 watts each and 2 light points of 100 watts each. His use of electricity during a day is as under:

12 midnight to 5 AM	one fan
5 AM to 7 AM	2 fans and one light point
7 AM to 9 AM	NIL
9 AM to 6 PM	2 fans
6 PM to Midnight	2 fans and 4 bulbs

Find (a) connected load (b) maximum demand (c) demand factor (d) energy consumed during 24 hours (e) energy consumed in 24 hours if all devices are used all the day.

3. Determine the generation cost per unit of energy from the following plant data:

   Installed capacity = 120 MW

   Capital cost of plant = Rs. 40000 per kW

   Interest and depreciation = 15%

   Fuel consumption = 0.64 kg/kWh

   Salaries, wages, repairs and other

   Operating costs per annum = Rs. 50,000,000

   Peak load = 100 MW

   Load Factor = 60%

4. Classify the substations according to the nature of their duties and service rendered.

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School of Electrical Skills

Session: 2019-20 (Summer Semester)

B. Voc. Program, 5th Semester,

End-Sem. Examination

Course Code: ELE-1502 **Time: 2 Hours**

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

Section – A

10X01 = 10 Marks

10 objective type questions, each question carries 01 mark.

1. **(b) Geater than Unity**
2. **(c) Load versus time**
3. (d) kW.
4. (a) up to 10 kW
5. (b) Average Load / Maximum Load
6. (d) Increased use of fans and air conditioners.
7. (a) 1
8. (c) 1 kW to 2 kW
9. (d) Electric iron.
10. (d) (KWh supplied in a year) / (24 × 365)

Section – B

04X04 = 16 Marks

04 short answer type questions, each question carries 04 marks.

Q1 What are name the interlocking provided with isolators. Also state any four types of substations according to the service?

Ans: The interlocking provided with isolators are:

1. Interlocking between three poles for simultaneous operation.
2. Interlocking with circuit breakers

The substations, according to the service rendered are:

(1) Transformer substations,

(2) Switching substations,

(3) Converting substations and

(4) Frequency changing substations.

Q2 **State the relative merits of indoor and outdoor substations.**

Ans: Merits of Indoor Substation: Less requirement of space, less maintenance and control cable length; protection from lightning; flexibility in installation, no dust and dirt.

Merits of Outdoor Substations: No building requirement, short erectionn time; Easy fault finding due to visibility of equipment; Easy repair work; Easier installation/extension; Availability of sufficient space between equipments.

Q3 what is depreciation?

Ans: 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 od 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. The life of heavy electrical equipment and steam turbines is generally taken as 20-25 years, hydraulic turbines 30 years and civil engineering works 50 years. The depreciation charge may be based on straight line method or sinking fund method or fixed percentage method.

Q4 Define Demand Factor and Diversity Factor.

Ans: **Demand factor** is the ratio of the sum of the maximum **demand** of a system (or part of a system) to the total connected load on the system (or part of the system) under consideration. **Demand factor** is always less than one.

Demand Factor = Maximum Demand/Connected Load

Diversity factor is defined as the ratio of the sum of the maximum demands of the various part of a system to the coincident maximum demand of the whole system. The maximum demands of the individual consumers of a group do not occur simultaneously. Thus, there is a diversity in the occurrence of the load. Due to this diverse nature of the load, full load power supply to all the consumers at the same time is not required.

$$Diversity\ factor = \frac{(sum\ of\ individual\ maximum\ demands)}{(coincident\ maximum\ demand\ of\ the\ whole\ system)}$$

Section – C

04X06 = 24 Marks

04 long type questions, each question carries 06 marks.

Q1 What are the roles of NLDC?

Ans: Role of NLDC:

According to notification dated 2nd March 2005, by the Ministry of Power, Government of India, under Section 26(2) of the Act NLDC has following functions. This would also include such other functions assigned by the Government of India through resolutions issued from time to time:

(a) Supervision over the Regional Load Despatch Centers.

(b) Scheduling and despatch of electricity over inter-regional links in accordance with grid standards specified by the Authority and grid code specified by Central Commission in coordination with Regional Load Despatch Centers.

(c) Coordination with Regional Load Despatch Centers for achieving maximum economy and efficiency in the operation of National Grid.

(d) Monitoring of operations and grid security of the National Grid.

(e) Supervision and control over the inter-regional links as shall be required for ensuring stability of the power system under its control.

(f) Coordination with Regional Power Committees for regional outage schedule in the national perspective to ensure optimal utilization of power resources.

(g) Coordination with Regional Load Despatch Centers for the energy accounting of inter-regional exchange of power.

(h) Coordination for restoration of synchronous operation of national grid with Regional Load Despatch Centers.

(i) Coordination for trans-national exchange of power.

(j) Providing operational feedback for national grid planning to the Authority and the Central Transmission Utility.

(k) Levy and collection of such fee and charges from the generating companies or licensees involved in the power system, as shall be specified by the Central Commission. 14

(l) dissemination of information relating to operations of transmission system in accordance with directions or regulations issued by Central Electricity Regulatory Commission and the Central Government from time to time."

Q2 A residential consumer has the following connected load : 8 bulbs of 100 watt each, 2 fans of 60 watt each and 2 light points of 100 watt each. His use of electricity during a day is as under:

12 midnight to 5 AM	one fan
5 AM to 7 AM	2 fans and one light point
7 AM to 9 AM	NIL
9 AM to 6 PM	2 fans
6 PM to Midnight	2 fans and 4 bulbs

Find (a) connected load (b) maximum demand (c) demand factor (d) energy consumed during 24 hours (e) energy consumed in 24 hours if all devices are used all the day.

Ans:

(c) Energy consumed in 24 hours if all devices are used all the day.

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 = 220 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 $= \frac{520}{1120} = 0.464$

(*d*) Energy consumed

from 12 midnight to 5 am	60 × 5 = 300 Wh
from 5 am to 7 am	220 × 2 = 440 Wh
from 7 am to 9 am	NIL
from 9 am to 6 pm	120 × 9 = 1080 Wh
from 6 pm to 12 midnight	520 × 6 = 3120 Wh

Total energy consumed during 24 hours = 300 + 440 + 1080 + 3120
= 4940 Wh = 4.94 kWh

(*e*) If all devices are used throughout the day, the energy consumed is
= 1120 × 24 = 26880 Wh
= 26.88 kWh

I. GROUP DIVERSITY FACTOR

Q3 Determine the generation cost per unit of energy from the following plant data:

Installed capacity = 120 MW

Capital cost of plant = Rs. 40000 per kW

Interest and depreciation = 15%

Fuel consumption = 0.64 kg/kWh

Salaries, wages, repairs and other

Operating costs per annum = Rs. 50,000,000

Peak load = 100 MW

Load Factor = 60%

Ans:

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Average load	$= 100 \times 0.6 = 60$ MW
Energy generated	$= 60 \times 1000 \times 8760 = 5256 \times 10^5$ kW-hr
Total Investment	$= 120 \times 10^3 \times 40000 = \text{Rs. } 4800 \times 10^6$
Interest and depreciation	$= \text{Rs. } 4800 \times 10^6 \times \frac{15}{100} = \text{Rs. } 720 \times 10^6$ per year
Fuel consumption	$= 0.64 \times 5256 \times 10^5$ kg/year $= 3363.84 \times 10^5$ kg per year
Fuel cost	$= \text{Rs. } 3363.84 \times 10^5 \times \frac{1500}{1000}$ per year
	$= \text{Rs. } 504.576 \times 10^6$ per year
Salaries, wages etc.	$= \text{Rs. } 50 \times 10^6$ per year
Annual Plant cost	$= \text{Rs. } 1274.576 \times 10^6$ per year
Generation cost	$= \text{Rs. } \frac{1274.576 \times 10^6}{5256 \times 10^5} = \text{Rs. } 2.425/\text{kWh}$

Q4 Classify the substations according to the nature of duties and service rendered.

Ans: The substations, on the basis of nature of duties, may be classified into the following three categories:

1. Step-Up or Primary Substations: Such substations are usually associated with generating stations. The generated voltage, which is usually low (11 or 33 kV), is stepped up to primary transmission voltage so that huge blocks of power can be transmitted over long distances to the load centres economically.
2. Primary Grid Substations: Such substations are located at suitable load centres along the primary transmission lines. In these substations, the primary transmission voltages are stepped down to different suitable secondary voltages. The secondary transmission lines are carried over to the secondary substations situated at the load centres where the voltage is further stepped down to sub-transmission or primary distribution voltages.
3. Step-Down or Distribution Substations: Such substations are located at the load centres, where the sub-transmission/primary distribution voltage is stepped down to secondary distribution voltage (415/240 V). These are the substations which feed the consumers through distribution network and service lines.

The substations, according to service rendered are:

1. Transformer Substations: Transformer are installed on such substations to transform the power from one voltage level to another level as per needs.
2. Switching Substations: Such substations are meant for switching operation of power lines without transforming the voltage. At such substations different connections are made between various transmission lines.
3. Converting Substations: Such substations are meant for either converting AC to DC or DC to AC vice versa or converting frequency from higher to lower or vice versa.

Registration No.: .....

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

School of Electrical Skills

Session: 2019-20 (Summer Semester)

B. Voc. Program, 5th Semester,

End – Sem. Examination

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

Course Name: Electrical Machines **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. Ns is the synchronous speed and s the slip, then actual running speed of an induction motor will be:

   (a) Ns (b) s.N (c) (1-s)Ns (d) (Ns-l)s

2. In a shaded pole motor, the shading coil usually consist of:
   (a) A single turn of heavy wire which is in parallel with running winding
   (b) A single turn of heavy copper wire which is short-circuited and carries only induced current
   (c) A multilayer fine gauge copper wire in parallel with running winding
   (d) None of the above

3. 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

4. Star-delta starting of motors is not possible in case of:
   (a) single phase motors (b) variable speed motors
   (c) low horse power motors (d) high speed motors

5. Which of the following methods is easily applicable to control the speed of the squirrel-cage induction motor?
   (a) By changing the number of stator poles
   (b) Rotor rheostat control
   (c) By operating two motors in cascade
   (d) By injecting e.m.f. in the rotor circuit

6. It is advisable to avoid line-starting of induction motor and use starter because:
   (a) motor takes five to seven times its full load current
   (b) it will pick-up very high speed and may go out of step
   (c) it will run in reverse direction
   (d) starting torque is very high rotor runs at a speed?

7. A shaded pole motor can be used for:
   (a) Toys (b) Hair dryers (c) Circulators (d) Any of these

8. Speed of the universal motor is:
   (a) Dependent on frequency of supply
   (b) Proportional to frequency of supply
   (c) Independent of frequency of supply
   (d) None of the above

9. The shaded pole motor is used for:
   (a) High starting torque
   (b) Low starting torque
   (c) Medium starting torque
   (d) Very high starting torque

10. Three-phase induction motor is mainly suitable for which of the following application:
   (a) For running different machine tools where several speeds are required
   (b) For running paper machine requiring exact speed control
   (c) For running rolling mills needing exact speed control
   (d) None of these

Section – B

04X04 = 16 Marks

1. Prove that the slip of an induction motor is equal to one at standstill condition.
2. Draw the active power flow diagram of an induction motor and explain.
3. An 8-pole, 3-phase, 60 Hz, star connected induction motor has a slip of 5%. Calculate full load speed of motor.
4. Explain the working principle of shaded pole motor.

Section – C

04X06 = 24 Marks

1. Draw and explain the equivalent circuit of a transformer.
2. A 4 pole 50Hz induction motor, Calculate the rotor frequency in following condition:
   i. Motor is running at 500 rpm in opposite direction of filed
   ii. Motor is running at 2000 rpm in same direction of filed
3. With the help of a Suitable example, explain different modes of operation of induction motor.
4. Derive the relationship between line voltage and phase voltage, line current and phase current in a delta connected system.

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School of Electrical Skills
5st Semester, End-Sem. Examination
B. Voc. Program, Summer Semester (2019-20)

Course Code: ELE 1503 **Time: 2 Hours**
Course Name: Electrical Machines **Max. Marks: 50**

Section – A

10X01 = 10 Marks

1. (c) (l-s)Ns
2. (b) A single turn of heavy copper wire which is short-circuited and carries only induced current
3. (c) Can be operated either on dc or ac supply
4. (a) single phase motors
5. (a) By changing the number of stator poles
6. (a) motor takes five to seven times its full load current
7. (d) Any of the above
8. (a) Dependent on frequency of supply
9. (b) Low starting torque
10. (b) For running different machine tools where several speeds are required

Section – B

04x04= 16 Marks

1. Prove that the slip of an induction motor is equal to one at standstill condition?

$$S=\frac{Ns-Nr}{Ns}\ \text{rpm}$$

Where s is the *slip*

Notice that : if the rotor runs at synchronous speed

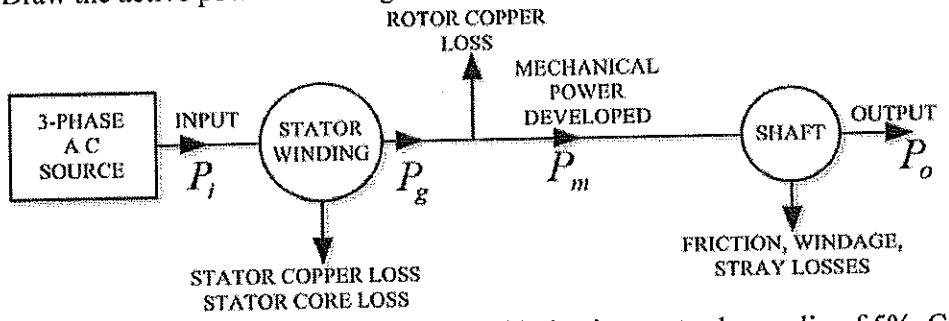
$s = 0$

if the rotor is stationary

$s = 1$

Slip may be expressed as a percentage by multiplying the above eq. by 100, notice that the slip is a ratio and doesn't have units

2. Draw the active power flow diagram of an induction motor and explain?



3. An 8-pole, 3-phase, 60 Hz, star connected induction motor has a slip of 5%. Calculate full load speed of motor.?
: In Induction Motor,
Speed Ns=(120* frequency)/(No.of poles)
Speed Ns= (120*60)/8=900 rpm.
So the slip S= (Ns-N)/Ns
0.05= (900-N)/900
N= 855 rpm

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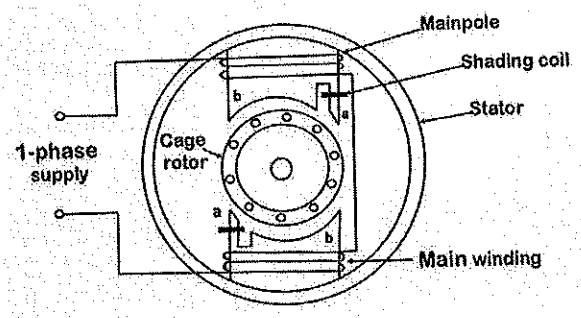
4. Explain the working principle of shaded pole motor
   A shaded-pole motor is a simple type of self-starting single-phase induction motor. It consists of a stator and a cage-type rotor. The stator is made up of salient poles. Each pole is slotted on the side, and a copper ring is fitted on the smaller part. This part is called the shaded pole. The ring is usually a single-turn coil and is known as shading coil.

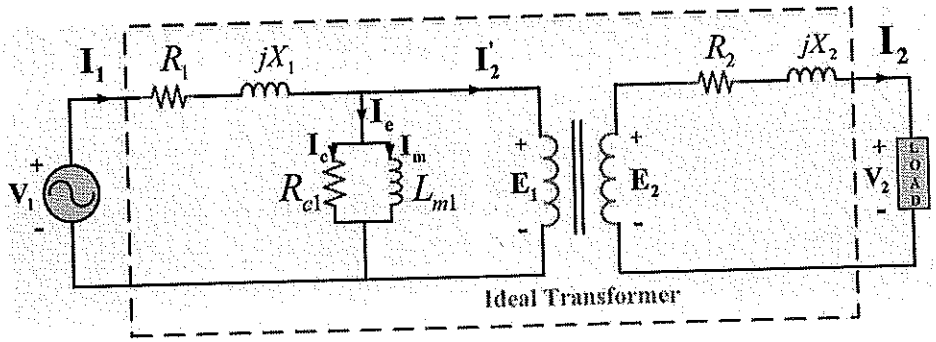


Applications:

1. Shaded-pole motors are used to drive devices which require low starting torque.
2. These motors are very suitable for small devices like relays, fans of all kinds, etc. because of their low initial cost and easy starting.
3. The most common application of these motors is in table fans, exhaust fans, hair dryers, fans for refrigeration and air-conditioning equipment, electronic equipment, cooling fans, etc.

Section – C

1. Draw and explain the equivalent circuit of transformer



2. A 4 pole 50Hz induction motor, Calculate the rotor frequency in following condition
   a. Motor is running at 500 rpm in opposite direction of filed
   b. Motor is running at 2000 rpm in same direction of filed

➢ A 4 pole 50Hz IM
Calculate the rotor frequency in following condition
➢ Motor is running at 500 rpm in opposite direction of filed

$$Ns=\frac{120f}{P}$$

$$\frac{120*50}{4} = 1500 \text{ rpm}$$

$$S=\frac{Ns-Nr}{Ns}$$

Here, Nr=-500

$$S=\frac{1500-(-500)}{1500} \qquad S=1.33$$

Rotor frequency $fr = s * fs = 1.33 * 50 = 66.5Hz$

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- A 4 pole 50Hz IM

Calculate the rotor frequency in following condition

- Motor is running at 2000 rpm in same direction of filed

$$Ns=\frac{120f}{P}$$

$$=\frac{120*50}{4} \quad =1500 \text{ rpm}$$

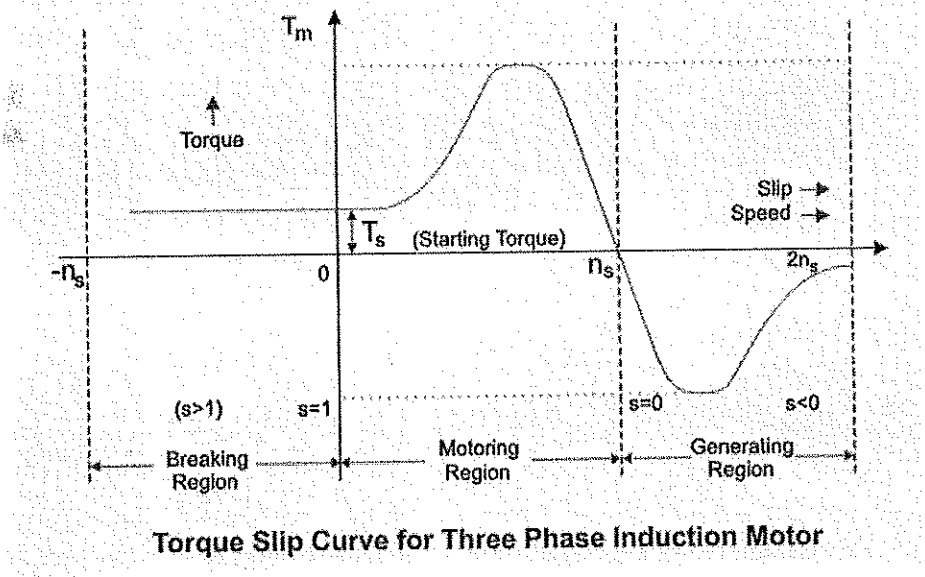
Here, Nr=2000

$$S=\frac{Ns-Nr}{Ns}$$

$$S=\frac{1500-(2000)}{1500} \qquad S=-0.33$$

Rotor frequency $fr = s * fs = -0.33 * 50 = -16.66Hz$

3. With Suitable example explain different modes of operation of induction motor?



Torque Slip Curve for Three Phase Induction Motor

Motoring Mode

In this mode of operation, supply is given to the stator sides and the motor always rotates below the synchronous speed. The induction motor torque varies from zero to full load torque as the slip varies. The slip varies from zero to one. It is zero at no load and one at standstill. From the curve it is seen that the torque is directly proportional to the slip.

That is, more is the slip, more will be the torque produced and vice-versa. The linear relationship simplifies the calculation of motor parameter to great extent.

Generating Mode

In this mode of operation induction motor runs above the synchronous speed and it should be driven by a prime mover. The stator winding is connected to a three phase supply in which it supplies electrical energy. Actually, in this case, the torque and slip both are negative so the motor receives mechanical energy and delivers electrical energy. Induction motor is not much used as generator because it requires reactive power for its operation.

That is, reactive power should be supplied from outside and if it runs below the synchronous speed by any means, it consumes electrical energy rather than giving it at the output. So, as far as possible, induction generators are generally avoided.

Braking Mode

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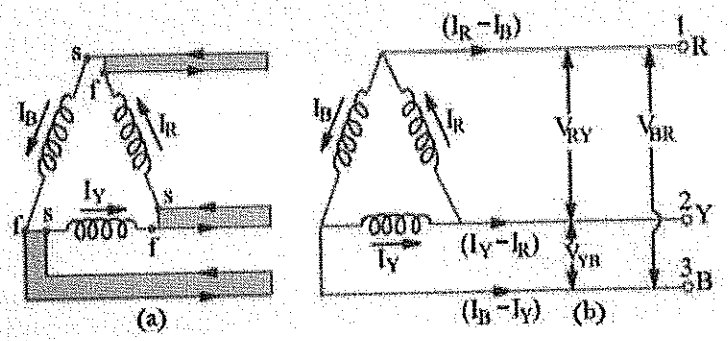
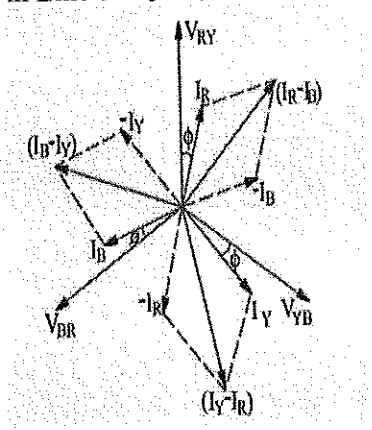
In the Braking mode, the two leads or the polarity of the supply voltage is changed so that the motor starts to rotate in the reverse direction and as a result the motor stops. This method of braking is known as plugging. This method is used when it is required to stop the motor within a very short period of time. The kinetic energy stored in the revolving load is dissipated as heat. Also, motor is still receiving power from the stator which is also dissipated as heat. So as a result of which motor develops enormous heat energy. For this stator is disconnected from the supply before motor enters the braking mode.

4. Derive the relationship between line voltage and phase voltage, line current and phase current in a delta connected system.



- Current in Line 1= $I_1 = I_R - I_B$
- Current in Line 2 =$I_2 = I_Y - I_R$
- Current in Line 3 =$I_3 = I_B - I_Y$



The current of Line 1 can be found by determining the vector difference between I_R and I_B and we can do that by increasing the I_B Vector in reverse, so that, I_R and I_B makes a parallelogram. The diagonal of that parallelogram shows the vector difference of I_R and I_B which is equal to current in Line 1= I_1. Moreover, by reversing the vector of I_B, it may indicate as ($-I_B$), therefore, the angle between I_R and $-I_B$ (I_B, when reversed = $-I_B$) is 60°. If,

$I_R = I_Y = I_B = I_{PH}$ …. The phase currents

Then;

The current flowing in Line 1 would be;

I_L or $I_1 = 2 \times I_{PH} \times \text{Cos}\ (60°/2)$

$= 2 \times I_{PH} \times \text{Cos}\ 30°$

$= 2 \times I_{PH} \times (\sqrt{3}/2)$ …… Since Cos 30° = $\sqrt{3}/2$

$I_L = \sqrt{3}\ I_{PH}$

i.e. **In Delta Connection, The Line current is $\sqrt{3}$ times of Phase Current.**

Registration No.: ..... (B) .....

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

School of Electrical Skills

Session: 2019-20 (Summer Semester)

B. Voc. Program, 5th Semester,

End – Sem. Examination

Course Code: ELE 1504 **Time: 2 Hours**

Course Name: Solar PV Technology **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. How much time does the light from the sun taken to reach the earth?

(a) 8 seconds (b) 8 minutes (c) 20 seconds (d) 100 seconds

2. A String is a:

(a) Series-arrangement of solar panel (b) Parallel arrangement of solar panel

(c) Random arrangement of solar panel (d) None of the above

3. Solar radiation which reaches the earth surface after scattering or absorbed is called

(a) Beam Radiation (b) Infrared radiation

(c) Ultraviolet radiation (d) Diffuse radiation

4. If a PV cell produces 0.5 V, then four PV cells connected in series will produce:

(a) 2.0 V (b) 0.5 V (c) 2.5 V (d) 1.0 V

5. What is the total output power, if three PV cells of 0.7V connected in series and a single PV cell produces 1A current?

(a) 2.1 W (b) 0.5 W (c) 2.5 W (d) 1.0 W

6. MNRE stand for:

(a) Ministry of New and Right energy

(b) Mandate for Non-renewable Energy

(c) Ministry of New and Renewable Energy

(d) Ministry of Natural and Renewable Energy

7. Sunlight reaches the earth through

(a) Direct radiation (b) Diffuse Radiation (c) Scattered radiation (d) All of the above

8. The position of sun when it is located directly overhead is called:

(a) Sun at beneath (b) Sun at inclination (c) Sun at zenith (d) Sun at top

9. Solar PV systems can be:

(a) connected to the power grid (b) used to sell power to the grid

(c) a stand-alone source of electricity (d) all of above

B

10. Which of the following is not an application of solar photovoltaic system?

(a) Solar lantern (b) Biogas plant (c) Solar water heater (d) Solar air heater

Section – B

04X4 = 16 Marks

1. What are the limitations of solar energy?
2. Distinguish between solar thermal conversion and solar photovoltaic conversion.
3. Define the terms:

(i) Photovoltaic Effect (ii) Solar constant

4. The current density of solar cell having an area of 100 cm^2 at STC is given as 35 mA/ cm^2. Find out the output current of solar cell.

Section – C

04X06 = 24 Marks

1. Explain the components of solar PV system.
2. Explain the advantages and dis advantages of solar cell.
3. Draw I-V curve of solar cell and describe its parameters.
4. Calculate the output power for solar cells of efficiencies 16%. When the input power is say, 1000, 800 and 400 W/m^2 and area of solar cell is 0.1 m^2.

Set-B

Course Name :- Solar PV - technology

Course code :- ELE 1504

Section-A

1 Ans :- (b)

2. Ans :- (a)

3. Ans :- (d)

4. Ans :- (a)

5. Ans :- (a)

6. Ans :- (c)

7. Ans :- (d)

8. Ans :- (c)

9. Ans :- (d)

10. Ans :- (b)

Section-B

1. Ans:

The following are the limitations of solar energy:—

(i) Availability of solar energy depends on weather conditions.

(ii) It is not available during rainy days.

(iii) Large area is required to collect the energy.

2. Ans: —

Conversion of solar radiation in to heat energy is called solar thermal Conversion.

Conversion of solar radiation energy directly in to electrical energy is called solar PV - Conversion.

3. Ans:

(a) Photovoltaic effect:- when sunlight falls on solar cell an electrical energy is produces which is called photovoltaic effect.

(b) Solar constant :- The amount of energy received in unit time and unit area perpendicular to sun radiation is called solar constant. The value of solar constant is about $1367\ W/m^2$.

Ans:

It is given

J (current density) $= 35\ mA/cm^2$

$A = 100\ cm^2$ at STC.

Since

$$J = \frac{I_{out}}{A}$$

So, $I_{out} = J \times A$

$= 35\ mA/cm^2 \times 100\ cm^2$

$= 3500\ mA$

or, $\boxed{I_{out} = 3.5\ A}$

Section - C

1. Ans: —

The following components are present in solar PV-systems: -

(I) Solar PV-module: — It generates the electricity as long as sunlight is present.

(II) Battery: — Battery is required for storage for night applications or for cloudy conditions, when sunlight falloving on solar panel is very low.

(III) Inverter: — for converting DC generated electricity by solar panel to AC.

(IV) charge controller: — To protect battery from over-charging or discharging, we use it.

2. Ans: —

Advantages: —

(I) Absence of moving parts, so maintenance is very low.

(II) Easy to fabricate.

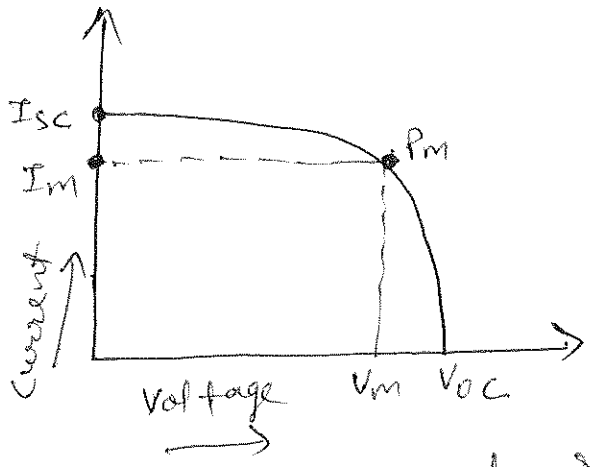
(III) Easy to operate.

(iii) Pollution free
(iv) They readily adopt for varying power requirements.

Disadvantages: —

(i) Absence of energy storage.
(ii) Requires large surface area to generate electricity.

3. Ans:



(I-V curve of solar cell)

Solar cell parameters: —

(i) Isc (short ckt current): — It is the max^m. current that a solar cell produces.
(ii) Voc (open ckt volt.) — It is the max^m. voltage that a solar cell produces.

(iii) P_m (max^m. Power point) — It is the max^m. power that a solar cell produces under STC.

(iv) I_m (current at P_m) — this is the current which solar cell produces when operating at P_m.

(v) V_m (val. at P_m) → this is the voltage which solar cell will produce when operating at P_m.

4. Ans:

It is given, $\eta = 16\%$.

I/P Power $P_{in} = 1000\ w/m^2$, $800\ w/m^2$ and $400\ w/m^2$

Area $(A) = 0.1\ m^2$

$$P_{out} = \eta \cdot P_{in} \cdot A$$

At $P_{in} = 1000\ w/m^2$

$$P_{out} = \frac{16}{100} \times 1000\ w/m^2 \times 0.1\ m^2$$

$$\boxed{P_{out} = 16\ W}$$

At $P_{in} = 800\ w/m^2$

$$P_{out} = \frac{16}{100} \times 800\ w/m^2 \times 0.1\ m^2 = 12.8\ W$$

$P_{out} = 12.8\,W$

At $P_{in} = 400\,W/m^2$

$$P_{out} = \frac{16}{100} \times 400\,W/m^2 \times 0.1\,m^2$$

$$= 6.4\,W$$

$P_{out} = 6.4\,W$