Registration No.: .....

Bhartiya Skill Development University Jaipur

School of Electrical Skills
Session: 2019-20 (Summer Semester)
B. Voc. Program, 3rd Semester,
2nd In-Sem. Examination

Course Code: ELE1301 **Time: 1 Hour**
Course Name: Automation and Control **Max. Marks: 20**

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

Section – A

05X01 = 05 Marks

1. Full form of the RDOL starter is:
   (a) Reverse Direct Online Starter (b) Reverse Dual Online Starter
   (c) Reverse Direct Overload starter (d) None of these

2. Full form of the VFD is:
   (a) Variable Frequency Device (b) Variable Frequency Drive
   (c) Voltage Frequency Device (d) All of these

3. Full form of the ANN is:
   (a) Arithmetic Neural Network (b) Artificial Negative Network
   (c) Artificial Neural Network (d) None of these

4. No. of Contactors required to make star-delta starter:
   (a) One (b) Two
   (c) Three (d) Four

5. Required to protect the low-level signals from electrostatic and magnetic coupling:
   (a) Grounding (b) Shielding
   (c) Insulation (d) None of these

Section – B

03X02 = 06 Marks

1. Explain the Scan Cycle of PLC program with diagram.
2. Explain the Shielding.
3. Draw the control circuit and power circuit diagram of star-delta starter.

Section – C

03X03 = 09 Marks

1. Explain the Rack Installation in detail.
2. Explain Fault diagnosis technique and Troubleshooting.
3. Explain the Surge Suppressors with diagram.

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School of Electrical Skills

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Answers sheet

Section A

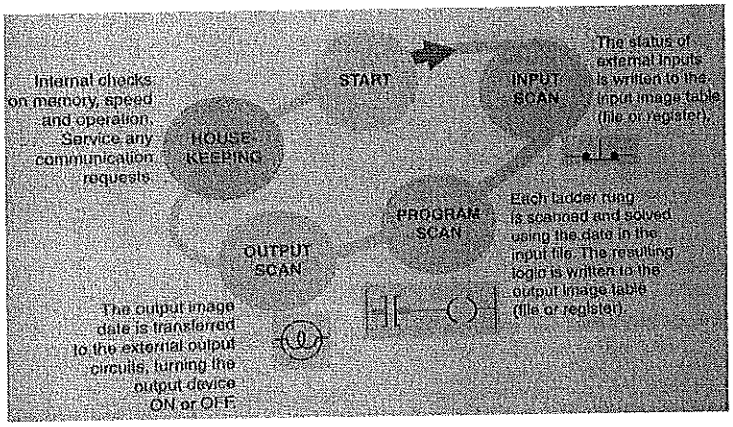
1. **(a)**
2. **(b)**
3. **(c)**
4. **(c)**
5. **(b)**

Section B

1. Ans.

Scan Cycle of PLC: During each operating cycle, the processor reads all the inputs, takes these values, and energizes or de-energizes the output according to the user program. This process is known as program scan cycle. Fig. illustrates a single PLC operating cycle consisting of the input scan, program scan, output scan and house-keeping duties. It constantly repeats this cycle as long as the PLC is in the RUN mode.

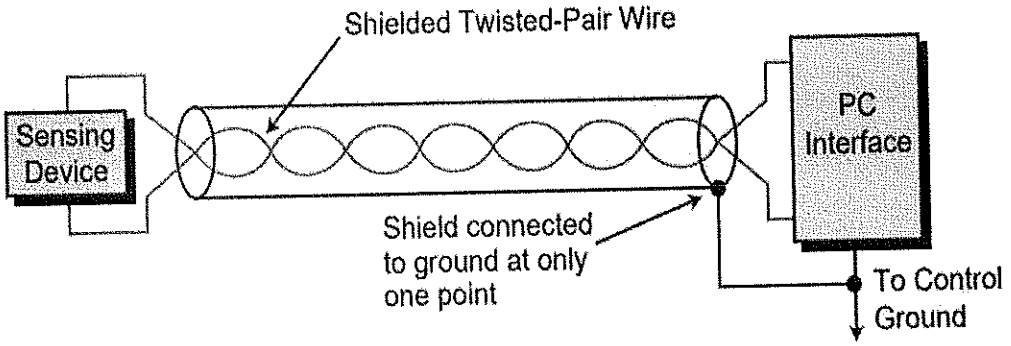
"The scan is normally a continuous and sequential process of reading the status of inputs, evaluating the control logic, and updating the output.



2. Ans.

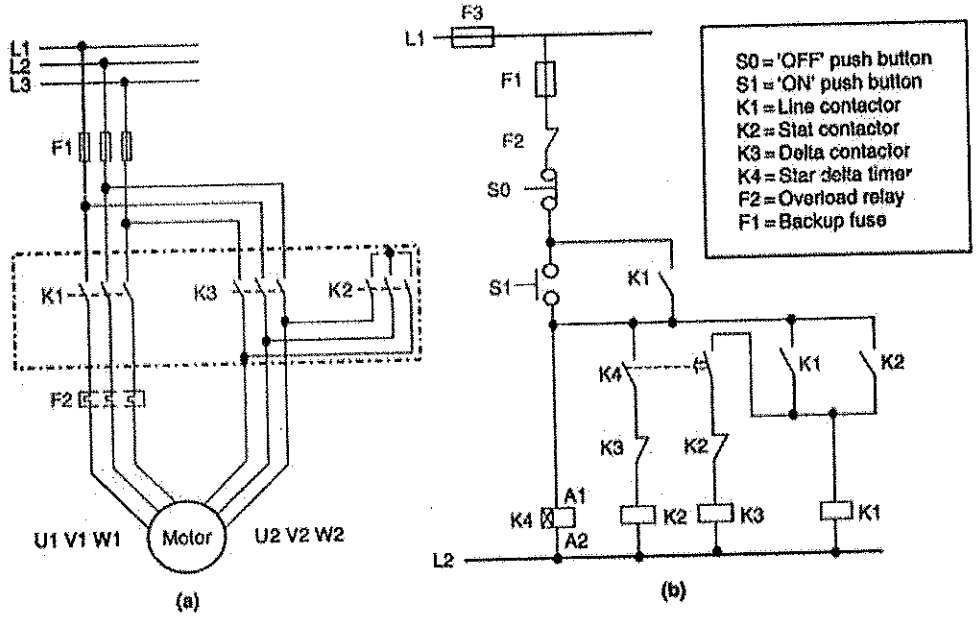
Shielding: shielded cable should be used for the control lines, to protect the low-level signals from electrostatic and magnetic coupling with both lines carrying 60 Hz power and other lines carrying rapidly changing currents. The shield should be connected to control ground at only one point and shield continuity must be maintained for the entire length of the cable. The

shielded cable should also be routed away from high noise areas, as well as insulated over its entire length.



3. Ans.

Star-Delta starter:



(a) Power circuit diagram

(b) Control circuit diagram

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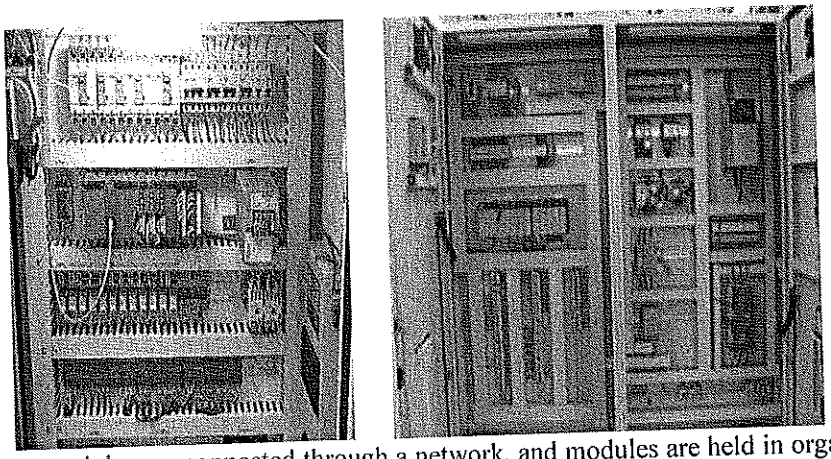
Section C

1. Ans.

Rack installation:

The rack mounting type of PLC is similar to the modular concept, but is implemented differently. Whereas each module in a modular PLC connects to the base unit directly, a rack mounting PLC keeps each module separate.



- All extra modules are connected through a network, and modules are held in organized racks. This approach allows for larger systems to be built without becoming overly cluttered and complicated. Modules are well organized on the rack and can be removed and reinserted as needed.
- The commercial unit is an industry-standard example of the rack mounting PLC type. There are essentially no limits on the number of modules that can be added to this system, each mounted on a standard rack chassis. This setup allows large, scalable automation solutions to be built and is common in factories.

2. Ans.

Fault diagnosis technique and Troubleshooting:

1. Preparation

Before you begin to troubleshoot any piece of equipment, you must be familiar with your organization's safety rules and procedures for working on electrical equipment. These rules and procedures govern the methods you can use to troubleshoot electrical equipment (including your lockout/ tag-out procedures, testing procedures etc.) and must be followed while troubleshooting.

2. Observation

Most faults provide obvious clues as to their cause. Through careful observation and a little bit of reasoning, most faults can be identified as to the actual component with very little testing.

3. Define Problem Area

To help you define the problem area you should have a schematic diagram of the circuit in addition to your noted observations.

4. Identify Possible Causes

Once the problem area(s) have been defined, it is necessary to identify all the possible causes of the malfunction. This typically involves every component in the problem area(s).

5. Determine Most Probable Cause

Once the list of possible causes has been made, it is then necessary to prioritize each item as to the probability of it being the cause of the malfunction.

6. Test and Repair

Testing electrical equipment can be hazardous. The electrical energy contained in many circuits can be enough to injure or kill. Make sure you follow all your companies safety precautions, rules and procedures while troubleshooting.

3. **Ans.**

Surge Suppressors:

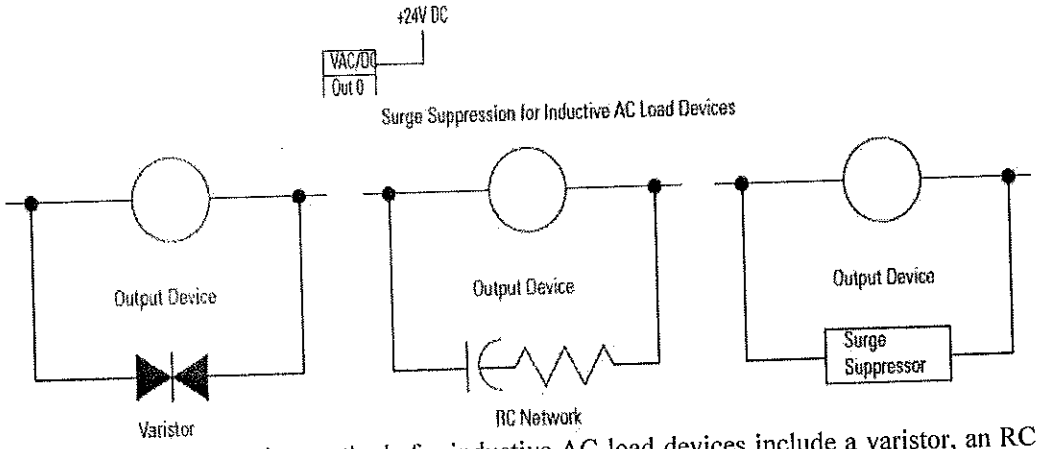
Because of the potentially high current surges that occur when switching inductive load devices, such as motor starters and solenoids, the use of some type of surge suppression to protect and extend the operating life of the controllers output contacts is required. Switching inductive loads without surge suppression can *significantly* reduce the life of relay contacts.

By adding a suppression device directly across the coil of an inductive device:

you prolong the life of the output or relay contacts.

You also reduce the effects of voltage transients and electrical noise from radiating into adjacent systems.

- If the outputs are DC, we recommend that you use an 1N4004 diode for surge suppression, as shown below. For inductive DC load devices, a diode is suitable.



- Suitable surge suppression methods for inductive AC load devices include a varistor, an RC network, or an Allen-Bradley surge suppressor, all shown below. These components must be appropriately rated to suppress the switching transient characteristic of the particular inductive device.

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School of Electrical Skills
Session: 2019-20 (Summer Semester)
B. Voc. Program, 3rd Semester,
2nd In-Sem. Examination

Course Code: ELE1302 **Time: 1 Hour**
Course Name: Electrical Machine Design Developer **Max. Marks: 20**

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

Section – A

05X01 = 05 Marks

1. Poles are always in:
   (a) Odd in number (b) Even in number
   (c) Can be even or odd in number (d) None of these
2. Laminated yokes are used:
   (a) In power electronics circuit (b) For large machines
   (c) For small machines (d) None of these
3. Commutator is used for:
   (a) For conversion of DC generation into AC (b) For conversion of AC generation into DC
   (c) For stepping up DC (d) None of these
4. In WAVE wound DC generator, no. of parallel paths equal to:
   (a) 2 (b) No. of poles (c) 4 (d) None of these
5. MNA full form:
   (a) Magneto Number Ampere (b) Magnetic Neutral Ampere
   (c) Magnetic Neutral Axis (d) None of the above

Section – B

03X02 = 06 Marks

1. Write advantages of Drum winding.
2. Differentiate between WAVE winding and LAP winding.
3. Explain with diagram why generated emf is always in alternating in nature.

Section – C

03X03 = 09 Marks

1. Explain construction of DC machine.
2. A 4 pole LAP connected DC shunt generator armature winding consists of 220 turns, each of 0.004ohm. Calculate armature resistance.
3. Develop simplex progressive LAP winding for 24 conductors and 4 poles. (For simplex winding, no. of conductors = no. of slots).

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School of Electrical Skills

3rd Semester, 2nd In-Sem. Examination

B. Voc. Program, Summer Semester (2019-20)

Course Code: ELE1302 **Time: 1 hour**

Course Name: Electrical Machine Design Developer **Max Marks: 20**

Section - A

A.1 (b)

A.2 (a)

A.3 (b)

A.4 (a)

A.5 (c)

Section – B

Ans. 1 Advantages of Drum Winding

1. Each winding, placed on the armature slots, surrounds the core and so that the entire length of the conductor, except the end connections, cut the main magnetic flux. Therefore the voltage induced in this type of armature winding is larger than the Gramme-ring winding.
2. The coils, before placing on the armature slots, can be pre-formed and insulated. Hence cost can be reduced.
3. The two sides of the coil placed under two different poles, one North Pole and another South Pole, hence the emf induced in them are always additive with the help of the end connection.
4. Fractional pitch winding can be used in drum winding. The advantage of fractional pitch winding is that it gives substantial savings in the copper of end connections. Commutation is also improved because of the lesser mutual inductor between the coils.
5. Fractional pitch winding: The span of the coils should be made equal to the pole pitch to get the maximum emf induced in the coil. However, it is possible to reduce the span of the coil as much as eight-tenths (8/10) of the pole pitch without much reduction in the induced emf. When it gets done, then the winding is called fractional-pitch winding.
6. Because of several conductors are placed in a single slot, the nos. of the slot get reduced in the armature core, the armature core teeth become mechanically stronger. The lamination and the protection of coils are also improved.

The manufacturing cost will be reduced in the drum type winding because here we have to construct fewer coils.

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Ans.2.

Basis For Comparison	**Lap Winding**	**Wave Winding**
Definition	The coil is lap back to the succeeding coil.	The coil of the winding form the wave shape.
Connection	The end of the armature coil is connected to an adjacent segment on the commutators.	The end of the armature coil is connected to commutator segments some distance apart.
Parallel Path	The numbers of parallel path are equal to the total of number poles.	The number of parallel paths is equal to two.
Other Name	Parallel Winding or Mulitiple Winding	Two-circuit or Series Winding.
EMF	Less	More
Number of Brushes	Equal to the number of parallel paths.	Two
Types	Simplex and Duplex lap winding.	Progressive and Retrogressive wave winding
Efficiency	Less	High
Additional Coil	Equalizer Ring	Dummy coil
Winding Cost	High (because more conductor is required)	Low
Uses	In low voltage, high current machines.	In high voltage, low current machines.

Ans. 3 Emf generation in generator:

Consider a simple rotating coil rotating between North and South poles. Locations marked from 1 to 8 is marked on the coil. We know that, when a conductor is moving with velocity v in a magnetic field then induced emf is given by,

$$e = BlvSin\Theta$$

Where, B = Magnetic field density

l = Effective length of the conductor

v = Velocity of the conductor

Θ = Angle between conductor and magnetic field lines

At position 1 and 5 conductor rotation is quite parallel to the flux lines, therefore there is no rate of change of flux linkage consequently induced emf is zero.

Axis along position 1 & 5 is known as Magnetic Neutral Axis(MNA) which is always 90^0 with the flux lines.

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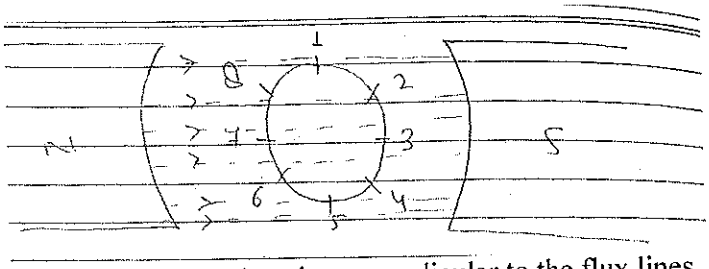
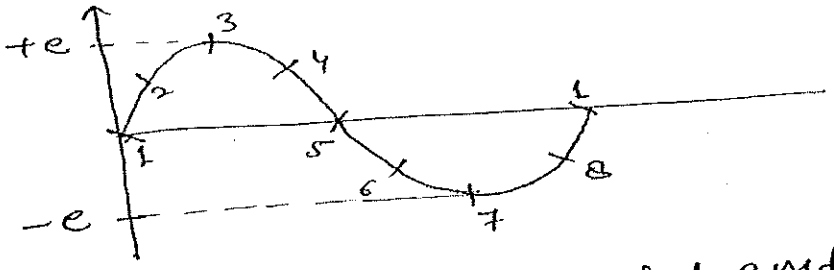


At position 3 & 7 conductor rotation is quite perpendicular to the flux lines. So maximum emf will induced in it for one complete mechanical rotation which is periodic in nature known as alternating voltage.

Angle	Sin θ	emf, e
0°	0	0
90°	1	Blv
180°	0	0
270°	−1	−Blv
360°	0	0



Waveform of generated emf

Section - C

Ans.1 Construction of DC machine:

Common features of rotating electrical m/c

- Gap b/w stator is approx 1.5 to 2 mm
- They contain hetropolar structure (alternate North & south poles of even no.)
- Excitation is essentially DC voltage (RMS)

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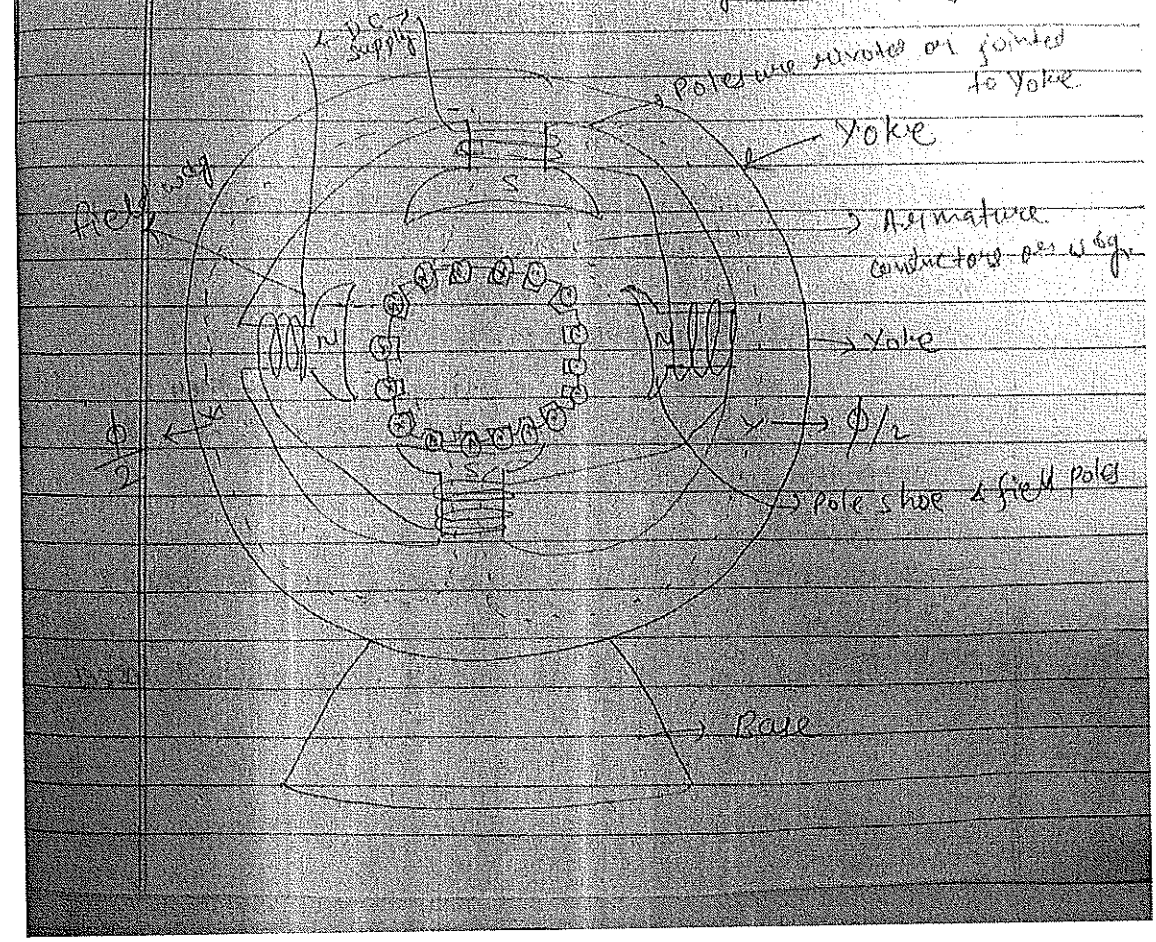
→ Yoke has 3 functions:-
- Act as a protective covering to entire m/c
- Support pole core
- It offers flux path completion (flux passing through yoke is half of the main field flux)

∴ Yoke should be of good material
⇒ For small m/c → it is cast iron
⇒ For Large m/c → it is fabricated steel

When DC m/c operating under power electronic converter circuit laminated yoke are preferred



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Poles:
Basic fun'. of poles is to produce working flux. Basic source of flux is permanent magnet flux is uncontrollable.
- So to control flux, electromagnets are used,
- DC is used to excite the field wdg & make them permanent pole electromagnets.

In order to produce definite poles (North or South) the polarity of pole depends upon two things -
→ Excitation
→ Orientation / sense of wdg. of field

* Electromagnets are used → for small m/c
* Permanent magnets " " → for large m/c

Armature core:
Cylindrical drum shaped structure with punching on its periphery known as slots, to hold armature conductor.
- Have high permeability.
- Made up of Si steel lamination of thickness 0.5 mm
- 3.5 to 4% Si added to steel to reduce eddy currents & hysteresis losses
- Si has low η coef. of I.C.
- Solid cores are not preferred as they encourage eddy current.
- Laminations are made to reduce eddy current loses.

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Commutator:-

No. of commutator segments = No. of coils required

Commutator is a split ring segmented through mica insulation of 0.8mm thickness & made up of copper. Commutator is also mounted on the same shaft.

Brushes:-

It is used to collect current from the rotating commutator & armature coils.

Material used are copper, carbon & graphite.

→ Carbon brushes improve commutation → For large m/c

→ Brushes are always placed on MNA (Magnetic neutral axis) for better results

→ Copper brushes → For small m/c

Ans. 2.

No. of turns = 220

No. of conductors, $Z = 220 \times 2 = 440$

Conductor resist. of one conductor,

$$x = \frac{0.004}{2} = 0.002\ \Omega$$

Armature Resistance,

$$R_a = \frac{xZ}{A^2} = \frac{0.002 \times 440}{4 \times 4}$$

$$= \boxed{R_a = 0.055\ \Omega}$$

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Ans. 3.

Pole pitch $= \frac{Z}{P} = \frac{24}{4} = 6$ Z/pole

Avg. pitch, $Y_A = \frac{Y_b + Y_f}{2} = \frac{Z}{P}$ ⇒ Lap winding

$\frac{Y_b + Y_f}{2} = 6$

$Y_b + Y_f = 12$ — (1)

$Y_b - Y_f = 2M$ → multiplicity factor

M = 1 for simplex

$Y_b - Y_f = 2$ — (2)

$Y_b = \frac{14}{2} = 7$ & $Y_f = 5$

$Y_b = 7$ (first coil side ↓, 1st last coil side ←)	last $Y_f = 5$ (1st last coil side ↓, 2nd first coil side ←)
1 + 7 = 8	8 − 5 = 3
3 + 7 = 10	10 − 5 = 5
5 + 7 = 12	12 − 5 = 7
7 + 7 = 14	14 − 5 = 9
9 + 7 = 16	16 − 5 = 11
11 + 7 = 18	18 − 5 = 13

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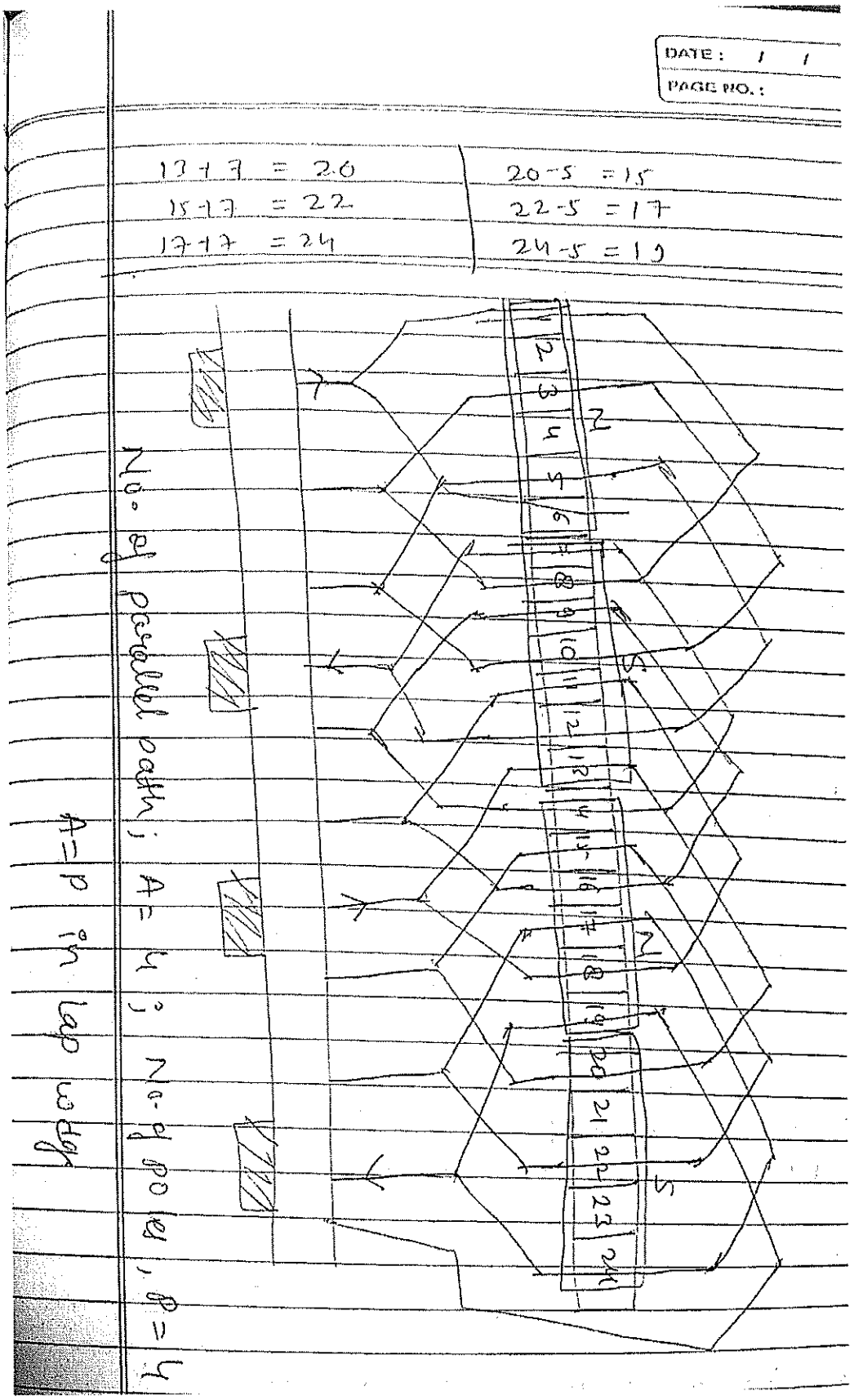

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School of Electrical Skills
Session: 2019-20 (Summer Semester)
B. Voc. Program, 3rd Semester,
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Course Code: ELE 1303 **Time: 1 Hour**

Course Name: Electrical Circuit Analysis **Max. Marks: 20**

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

Section – A

05X01 = 05 Marks

1. The Thevenin equivalent voltage is:
   (a) The open circuit voltage (b) The same as the load voltage
   (c) Equal to the source voltage (d) None of these

2. In Superposition theorem, while considering a source, all other voltage sources are?
   (a) Open circuited (b) Short circuited
   (c) Change its position (d) Removed from the circuit

3. If source impedance is complex, then maximum power transfer occurs when the load impedance is _____ the source impedance.
   (a) Equal to (b) Negative of
   (c) complex conjugate of (d) negative of complex conjugate of

4. While computing the Thevenin equivalent resistance and the Thevenin equivalent voltage, which of the following steps are undertaken?
   (a) Both the dependent and independent voltage sources are short-circuited and both the dependent and independent current sources are open-circuited
   (b) Both the dependent and independent voltage sources are open-circuited and both the dependent and independent current sources are short-circuited
   (c) The dependent voltage source is short-circuited keeping the independent voltage source untouched and the dependent current source is open-circuited keeping the independent current source untouched
   (d) The dependent voltage source is open-circuited keeping the independent voltage source untouched and the dependent current source is short-circuited keeping the independent current source untouched

5. A network contains linear resistors and ideal voltage sources. If values of all the resistors are doubled, then voltage across each resistor is:
   (a) Halved (b) Doubled (c) Increases by 2 times (d) Remains same

Section – B

03X02 = 06 Marks

1. State Thevenin's theorem.
2. Given phasor A = 6.34 + j 13.59 and phasor B = 16.38 – j 11.47 write down the A/B in (i) rectangular form and (ii) polar form.
3. Given phasor A = 6.34 + j 13.59 and phasor B = 16.38 – j 11.47 write down the (A+B)/(A-B) in (i) rectangular form and (ii) polar form.

B

Registration No.: .....

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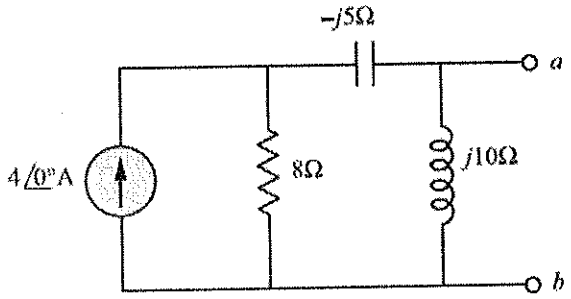
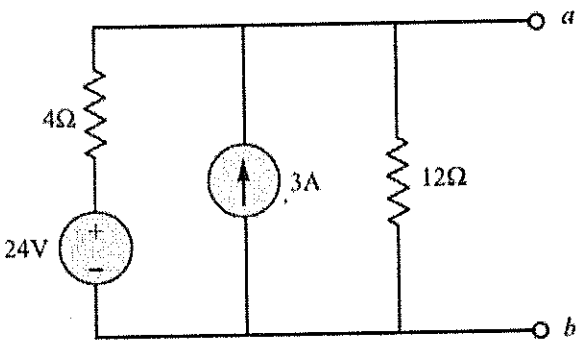
Section – C 03X03 = 09

Marks

1. A resistance of 50 ohm is connected in series with a pure inductor of 250 mH. The circuit is connected to a 50 Hz sinusoidal supply and the voltage across the resistance is 150 V. Calculate the supply voltage.
2. Find the Thevenin equivalent circuits at the terminals a-b for the circuit in.



3. Find the Norton equivalent for the circuit of Fig.



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School of Electrical Skills

Session: 2019-20 (Summer Semester)

B. Voc. Program, 3rd Semester,

2nd In-Sem. Examination

Course Code: ELE-1303 **Time: 1 Hour**

Course Name: Electrical Circuit Analysis **Max. Marks: 20**

Section – A

05X01 = 05 Marks

1. (c)
2. (b)
3. (c)
4. (c)
5. (d)

Section – B

03X02 = 06 Marks

Ans. 1.

Ans: "Any linear active bilateral two terminal network can be replaced across its terminals by a independent voltage source V_{th} in series with the single resistance R_{th}, where V_{th} is the open circuit voltage at the terminals and R_{th} is the equivalent resistance as viewed from the terminals when all the independent sources are reduced to zero i.e. leaving their internal resistances."

Ans. 2.

$$A/B = (15\angle 65°/20\angle -35°) = 0.75\angle 100° = 0.75\,[\cos(100°) + j\sin(100°)]$$
$$= -0.13 + j0.74$$

Ans.3.

Expressing $(A - B)$ in polar form gives

$$(A - B) = (-10.04 + j\,25.06) = 27\angle 111.84°$$

$$A + B = 6.34 + j\,13.59 + 16.38 - j\,11.47 = 22.72 + j\,2.12$$
$$= \sqrt{(22.72)^2 + (2.12)^2}\angle \tan^{-1}(2.12/22.72) = 22.82\angle 5.33°$$

Thus, $(A + B)/(A - B) = (22.8\angle 5.33°/27.0\angle 111.84°) = 0.85\angle -106.51°$
$= -0.24 - j0.81$

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Section – C

03X03 = 09 Marks

Ans. 1.

Solution The current in the series circuit

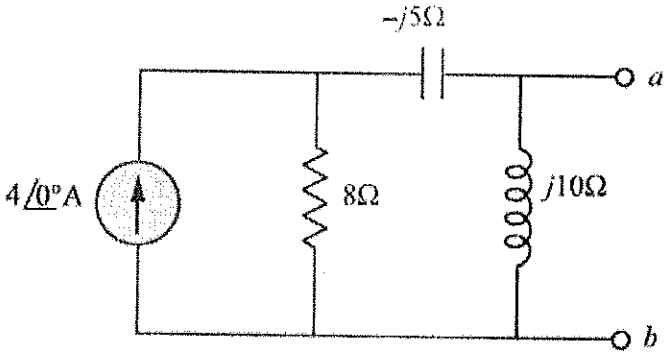
$$I = \frac{V_R}{R} = \frac{150}{50} = 3 \text{ A}$$

Now, $X_L = 2\pi fL = 2\pi \times 50 \times 250 \times 10^{-3} = 78.5\ \Omega$

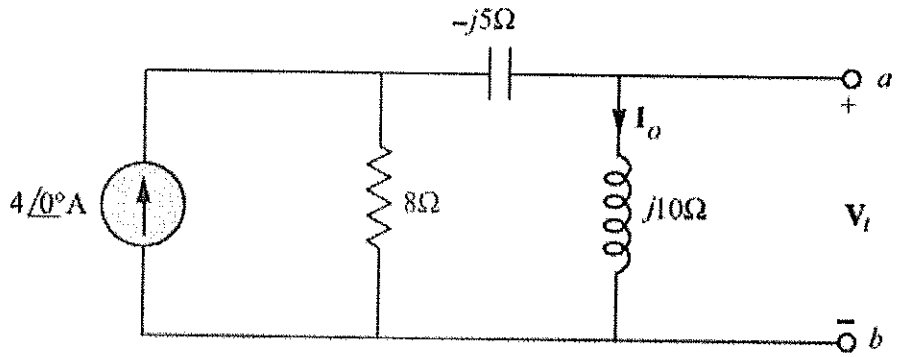
$V_L = I \times X_L = 3 \times 78.5 = 235.5 \text{ V}$

Then $V = \sqrt{V_R^2 + V_L^2} = \sqrt{150^2 + 235.5^2} = \sqrt{77{,}960.25} = 279.21 \text{ V}$

Ans. 2.



As a first step in the analysis, let us find Vt



Using the principle of current division,

$$I_o = \frac{8(4\angle 0^\circ)}{8 + j10 - j5} = \frac{32}{8 + j5}$$

$$V_t = I_o(j10) = \frac{j320}{8 + j5} = 33.92\angle 58^\circ \text{ V}$$

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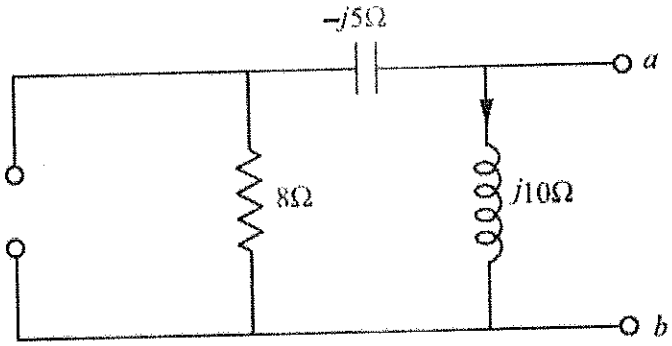
Using the principle of current division,

$$I_o = \frac{8\,(4\angle 0^\circ)}{8 + j10 - j5} = \frac{32}{8 + j5}$$

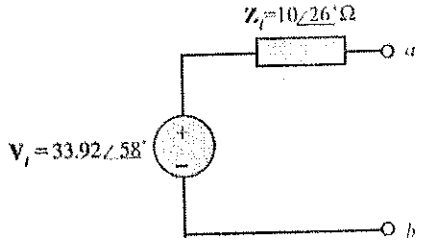
$$V_t = I_o(j10) = \frac{j320}{8 + j5} = 33.92\angle 58^\circ \text{ V}$$

To find Z_t, deactivate all the independent sources. This results in a circuit diagram as shown

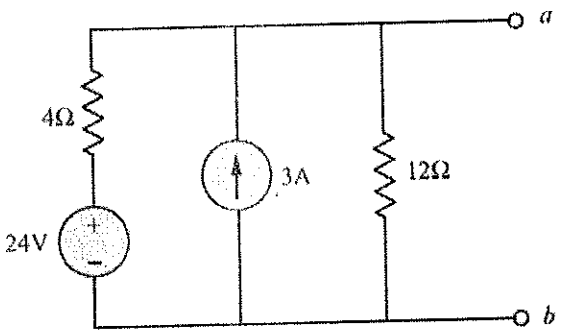


$$\begin{aligned} Z_t &= j10 \,||\, (8 - j5)\ \Omega \\ &= \frac{(j10)(8 - j5)}{j10 + 8 - j5} \\ &= 10\angle 26^\circ\ \Omega \end{aligned}$$

The Thevenin equivalent circuit as viewed from the terminals $a - b$ is



Ans. 3.



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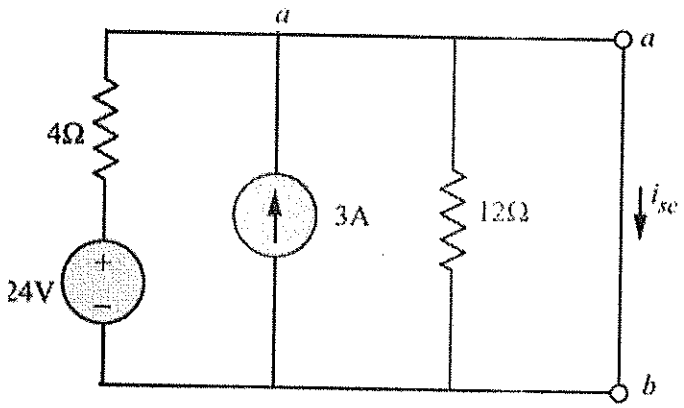
As a first step, short the terminals a-b. This results in a circuit diagram as shown in Fig.

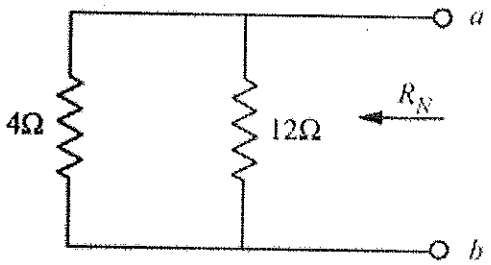


Applying KCL at node a, we get

$$\frac{0-24}{4} - 3 + i_{sc} = 0$$

$$\Rightarrow i_{sc} = 9\text{A}$$

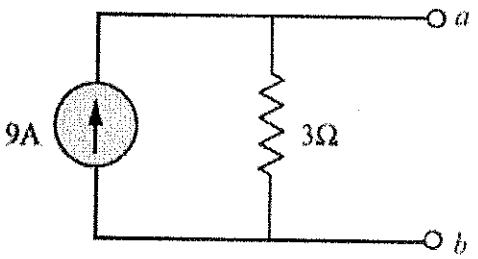
To find R_N, deactivate all the independent sources, resulting in a circuit diagram as shown



We find R_N in the same way as R_t in the Thevenin equivalent circuit.

$$R_N = \frac{4 \times 12}{4 + 12} = 3\ \Omega$$

Thus, we obtain Nortion equivalent circuit as shown in Fig.



Registration No.: .....

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

School of Electrical Skills
Session: 2019-20 (Summer Semester)
B. Voc. Program, 3rd Semester,
2nd In-Sem. Examination

Course Code: ELE 1304 **Time: 1 Hour**
Course Name: Electrical Measuring Instruments **Max. Marks: 20**

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

Section – A

05X01 = 05 Marks

1. Which instrument has the highest accuracy in the prescribed limit of frequency range?
   (a) PMMC (b) Moving iron (c) Dynamometer (d) Both (a) and (b)
2. Moving iron instruments when measuring voltages and current:
   (a) Indicates the same values of the measurement for both ascending and descending values
   (b) Indicates higher value of measured for ascending values
   (c) Indicates higher value of measured for descending values
   (d) None of the above
3. Frictional losses in dynamometer type instruments are:
   (a) Higher (b) Lower (c) Constant (d) Exponential
4. The range of ammeter and voltmeter with high precision in dynamometer instruments is:
   (a) 50A, 600V (b) 100A, 600V (c) 10A, 500V (d) 10A, 600V
5. Which instrument has narrow slot opening?
   (a) PMMC (b) Dynamometer type
   (c) Moving Iron (d) Any of the above

Section – B

03X02 = 06 Marks

1. Differentiate between accuracy and precision.
2. What are the advantages and disadvantages of PMMC instruments?
3. A PMMC instrument has a coil of dimensions 15 mm × 12 mm. The flux density in the air gap is 1.8×10^{-3} wb/m2 and the spring constant is 0.14×10^{-6} N-m/rad. Determine the number of turns required to produce an angular deflection of 90° when a current of 5 mA is flowing through the coil.

Section – C

03X03 = 09 Marks

1. Prove that the deflection torque is directly proportional to the current passing through the coil for PMMC instruments?
2. State advantages and disadvantages if dynamometer type instruments.
3. Derive the torque equation in moving iron instruments.

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School of Electrical Skills
Session: 2019-20 (Summer Semester)
B. Voc. Program, 3rd Semester,
2nd In-Sem. Examination

Course Code: ELE 1304 **Time: 1 Hour**
Course Name: Electrical Measuring Instruments **Max. Marks: 20**

Section – A

05X01 = 05 Marks

1. Which instrument has the highest accuracy in the prescribed limit of frequency range
   Ans. (c) Dynamometer
2. Moving iron instruments when measuring voltages and current
   Ans. (c) Indicates higher value of measured for descending values
3. Frictional losses in dynamometer type instruments are
   Ans. (a) Higher
4. The range of ammeter and voltmeter with high precision in dynamometer instruments is
   Ans. (d) 10A, 600V
5. Which instrument has narrow slot opening
   Ans. (c) Moving Iron

Section – B

03X02 = 06 Marks

1. Differentiate between accuracy and precision.

Accuracy: is the capacity of a measuring instrument to give RESULTS close to the TRUE VALUE of the measured quantity.

- Accuracy is measured by the absolute and relative errors
- The measurement value (which is sometimes referred to simply as the measurement) is the value given by a measuring instrument and the true value is the actual value of the property being measured.

Precision: is the capacity of a measuring instrument to give the same reading when repetitively measuring the same quantity under the same prescribed conditions.

- Precision implies agreement between successive readings, NOT closeness to the true value.
- Precision is related to the variance of a set of measurements.
- Precision is a necessary but not sufficient condition for accuracy.

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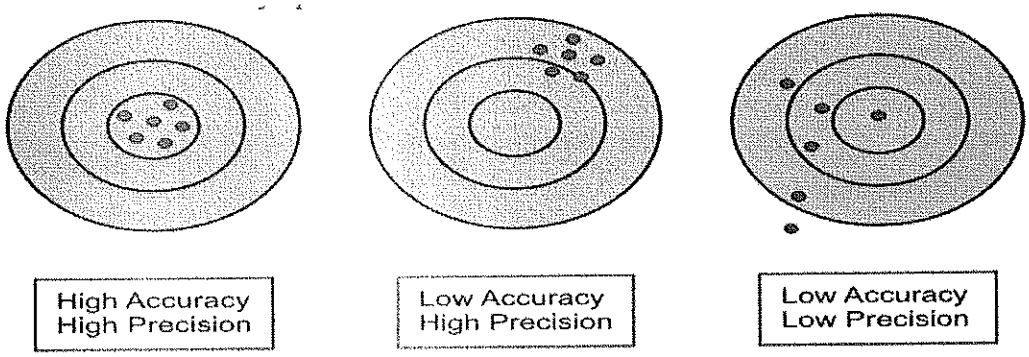

2.

Ans.

Meter Type	Control	Damping	Suitability	Application
PMMC	Spring	Eddy current	D.C.	Widely used for d.c. current and voltage measurements in low and medium impedance circuits.
Moving Iron	Spring or Gravity	Air friction	D.C. and A.C.	Used for rough indication of currents and voltages. Widely used for the indicator type instruments on panels.
Electrodynamometer	Spring	Air friction	D.C. and A.C.	Used mainly as wattmeter. Also may be used as ammeter or voltmeter. Widely used as a calibration instrument and as a transfer instrument.

3. A PMMC instrument has a coil of dimensions 15 mm × 12 mm. The flux density in the air gap is 1.8×10^{-3} wb/m2 and the spring constant is 0.14×10^{-6} N-m/rad. Determine the number of turns required to produce an angular deflection of 90° when a current of 5 mA is flowing through the coil.

Ans.

Solution Total deflecting torque exerted on the coil,

$$T_d = BilnB \text{ (N-m)}$$

$$= 1.8 \times 10^{-3} \times 5 \times 10^{-3} \times 15 \times 10^{-3} \times 12 \times 10^{-3} \times n$$

The control torque of the springs is

$$T_C = k_s \times 6$$

$$= 0.14 \times 10^{-6} \times 90 \times \pi/180$$

At equilibrium, $T_d = T_C$

$$1.8 \times 10^{-3} \times 5 \times 10^{-3} \times 15 \times 10^{-3} \times 12 \times 10^{-3} \times n = 0.14 \times 10^{-6} \times 90 \times \pi/180$$

$$n = \frac{0.14 \times 10^{-6} \times 90 \times \pi/180}{1.8 \times 10^{-3} \times 5 \times 10^{-3} \times 15 \times 10^{-3} \times 12 \times 10^{-3}} \approx 1.36$$

Section – C

03X03 = 09 Marks

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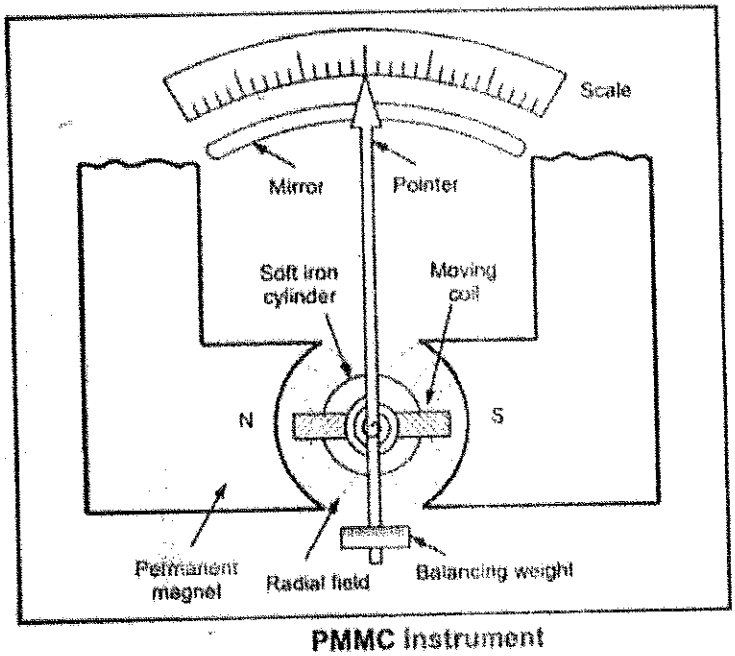
1. Prove that the deflection torque is directly proportional to the current passing through the coil for PMMC instruments?

Ans.



PMMC Instrument

The equation for the developed torque can be obtained from the basic law of the electromagnetic torque. The deflecting toque is given by,

$$T_d = NBAI$$

where
T_d = deflecting torque in N-m
B = flux density in air gap, Wb/m^2
N = number of turns of the coil
A = effective coil area m^2
I = Current in the moving coil, amperes

$$\therefore \quad T_d = GI$$

where $G = NBA$ = constant

The controlling torque is provided by the springs and is proportional to the angular deflection of the pointer.

$$T_c = K\theta$$

where
T_c = controlling torque
K = spring constant, Nm/rad or Nm/deg
θ = angular deflection

For the final steady state position,

$$T_d = T_c$$

$$\therefore \quad GI = K\theta$$

$$\therefore \quad \theta = \left(\frac{G}{K}\right)I$$

or

$$I = \left(\frac{K}{G}\right)\theta$$

Thus the deflection is directly proportional to the current passing through the coil. The pointer deflection can therefore be used to measure current.

2. State advantages and disadvantages if dynamometer type instruments.

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Advantages of Electrodynamic Instruments

1) As the coils are air cored, these instruments are free from hysteresis and eddy current losses.
2) They have a precision grade accuracy.
3) These instruments can be used on both a.c. and d.c. They are also used as a transfer instruments.
4) Electrodynamometer voltmeters are very useful where accurate rms values of voltage, irrespective of waveforms, are required.
5) Free from hysteresis errors.
6) Low power consumption.
7) Light in weight.

Disadvantages of Electrodynamic Instruments

1) These instruments have a low sensitivity due to a low torque to weight ratio. Also it introduces increased frictional losses. To get accurate results, these errors must be minimized.
2) They are more expensive than other type of instruments.
3) These instruments are sensitive to overloads and mechanical impacts. Therefore care must be taken while handling them.
4) They have a non-uniform scale.
5) The operating current of these instruments is large due to the fact that they have weak magnetic field.

3. Derive the torque equation in moving iron instruments.

1.8.3 Torque Equation of Moving Iron Instruments

Consider a small increment in current supplied to the coil of the instrument. Due to this current let $d\theta$ be the deflection under the deflecting torque T_d. Due to such deflection, some mechanical work will be done.

$\therefore$ Mechanical work $= T_d\, d\theta$

There will be a change in the energy stored in the magnetic field due to the change in inductance. This is because the vane tries to occupy the position of minimum reluctance hence the force is always in such a direction so as to increase the inductance of coil. The inductance is inversely proportional to the reluctance of the magnetic circuit of coil.

Let
I = initial current
L = instrument inductance
θ = deflection
dI = increase in current
$d\theta$ = change in deflection
dL = change in inductance

In order to effect an increment dI in the current, there must be an increase in the applied voltage given by,

$$e = \frac{d(LI)}{dt}$$

$$= I\frac{dL}{dt} + L\frac{dI}{dt}$$ as both I and L are changing.

The electrical energy supplied is given by,

$$e\,dt = \left(I\frac{dL}{dt} + L\frac{dI}{dt}\right)dt$$

$$= I^2\,dL + L\,dI$$

The stored energy increases from $\frac{1}{2}LI^2$ to $\frac{1}{2}(L + dL)(I + dI)^2$

Hence the change in the stored energy is given by,

$$= \frac{1}{2}(L + dL)(I + dI)^2 - \frac{1}{2}LI^2$$

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Neglecting higher order terms, this becomes, $\Pi \cdot di + \frac{1}{2} I^2 \cdot dL$

The energy supplied is nothing but increase in stored energy plus the energy required for mechanical work done.

$$\therefore \quad I^2 dL + \Pi \cdot di = \Pi \cdot di + \frac{1}{2} I^2 \cdot dL + T_d \cdot d\theta$$

$$\therefore \quad T_d \cdot d\theta = \frac{1}{2} I^2 \cdot dL$$

$$\therefore \quad T_d = \frac{1}{2} I^2 \frac{dL}{d\theta}$$

While the controlling torque is given by,

$$T_c = K\theta$$

where K = spring constant

$$\therefore \quad K\theta = \frac{1}{2} I^2 \frac{dL}{d\theta} \qquad \text{under equilibrium}$$

$$\therefore \quad \theta = \frac{1}{2} \frac{I^2}{K} \frac{dL}{d\theta}$$

Thus the deflection is proportional to the square of the current through the coil. And the instrument gives square law response.

Registration No.: .....

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

School of Electrical Skills

Session: 2019-20 (Summer Semester)

B. Voc. Program, 3rd Semester,

2nd In-Sem. Examination

Course Code: ELE 1305 **Time: 1 Hour**

Course Name: Introduction to Power System **Max. Marks: 20**

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

Section – A

05X01 = 05 Marks

1. In overhead transmission lines the effect of capacitance can be neglected when the length of line is less than:
   (a) 200 km (b) 160 km (c) 100 km (d) 80 km.

2. Skin effect depends on:
   (a) size of the conductor (b) frequency of the current
   (c) resistivity of the conductor material (d) all of the above.

3. Which of the following is usually not the generating voltage?
   (a) 6.6 kV (b) 9.9 kV (c) 11kV (d) 13.2 kV.

4. In short overhead transmission line (up to 80 km), we may neglect
   (a) Series resistance (b) Shunt conductance
   (c) Shunt capacitance (d) Both shunt conductance and capacitance

5. When alternating current passes through a conductor
   (a) it remains uniformly distributed throughout the section of conductor
   (b) portion of conductor near the surface carries more current as compared to the core
   (c) portion of conductor near the surface carries less current as compared to the core
   (d) entire current passes through the core of the conductor.

Section – B

03X02 = 06 Marks

1. Define Proximity effect.
2. Describe the corona effect.
3. Write the advantages of AC transmission system over DC.

Section – C

03X03 = 09 Marks

1. Compare HVDC and HVAC transmission system.
2. Draw and explain the single line diagram of power supply system.
3. What are different components of HVDC Transmission system? Explain any three in detail.

B

BHARTIYA SKILL DEVELOPMENT UNIVERSITY
School of Electrical Skills
Session: 2019-20 (Summer Semester)
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Course Code: ELE 1305 **Time: 1 Hour**
Course Name: Introduction to Power System **Max. Marks: 20**

SOLUTION

Section – A

05X01 = 05 Marks

	Objective type questions, each questions carries 01 marks
	1. (d) **2. (d)** **3. (b)** **4. (d)** **5. (b)**

Section – B

03X02 = 06 Marks

	Short answer type questions, each question carries 02 marks.
(1)	Define Proximity effect?
Ans	When the conductors carry the high alternating voltage then the currents are non-uniformly distributed on the cross-section area of the conductor. This effect is called proximity effect. The proximity effect results in the increment of the apparent resistance of the conductor due to the presence of the other conductors carrying current in its vicinity.
(2)	Describe the corona effect.
Ans	The phenomenon of ionisation of surrounding air around the conductor due to which luminous glow with hissing noise is rise is known as the corona effect. Air acts as a dielectric medium between the transmission lines. In other words, it is an insulator between the current carrying conductors.
(3)	Write the advantages of AC transmission system over DC.
Ans	• The alternating voltages can easily be stepped up and down, which is not possible in DC transmission system. • Maintenance of AC substation is quite easy and economical compared to DC.

Section – C

03X03 = 09 Marks

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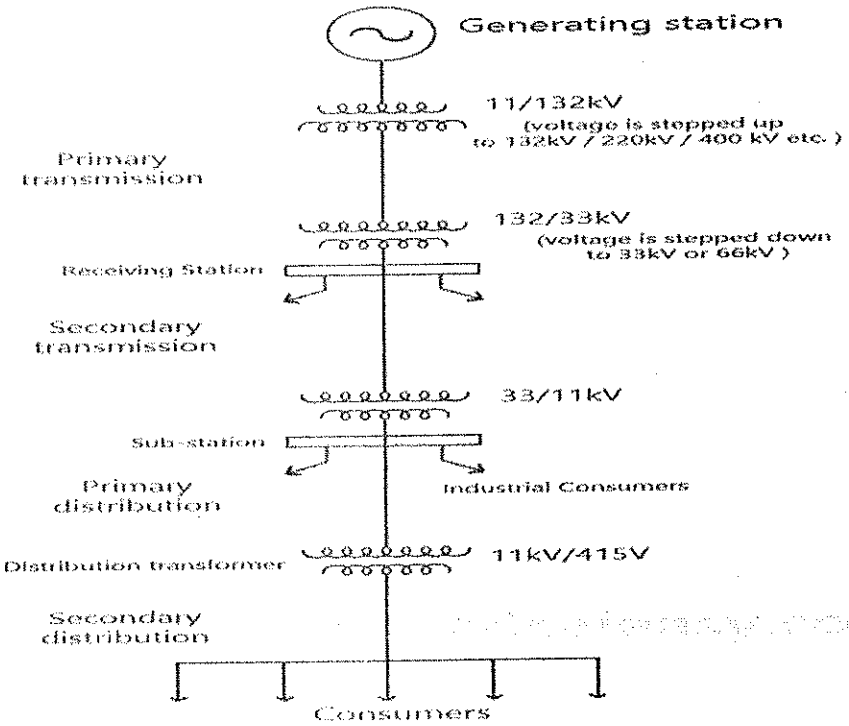
	Essay type questions, each question carries 03 marks.
(1)	Compare HVDC and HVAC transmission system.
Ans	**COMPARISION OF HVAC & HVDC SYSTEMS** • HVAC transmission is having several limitations like line length , uncontrolled power flow, over/low voltages during lightly / over loaded conditions, stability problems, fault isolation etc • The advantage of HVDC is the ability to transmit large amounts of power over long distances with lower capital costs and with lower losses than AC. • Asynchronous operation possible between regions having different electrical parameters . • Facilitate power transmission between different countries that use AC at differing voltages and/or frequencies • Reducing line cost: ▪ fewer conductors ▪ thinner conductors since HVDC does not suffer from the skin effect
(2)	Draw and explain the single line diagram of power supply system.
Ans	
(3)	What are different components of HVDC Transmission system? Explain any three in detail.

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Ans

1. Converters
2. Smoothing reactors
3. Harmonic filters
4. Reactive power supplies
5. Electrodes
6. DC lines
7. AC circuit breakers

Converters

- They perform AC/DC and DC/AC conversion
- They consist of valve bridges and transformers
- Valve bridge consists of high voltage valves connected in a 6-pulse or 12-pulse arrangement
- The transformers are ungrounded such that the DC system will be able to establish its own reference to ground

Smoothing reactors

- They are high reactors with inductance as high as 1 H in series with each pole
- They serve the following:
  - They decrease harmonics in voltages and currents in DC lines
  - They prevent commutation failures in inverters
  - Prevent current from being discontinuous for light loads

Harmonic filters

- Converters generate harmonics in voltages and currents. These harmonics may cause overheating of capacitors and nearby generators and interference with telecommunication systems
- Harmonic filters are used to mitigate these harmonics