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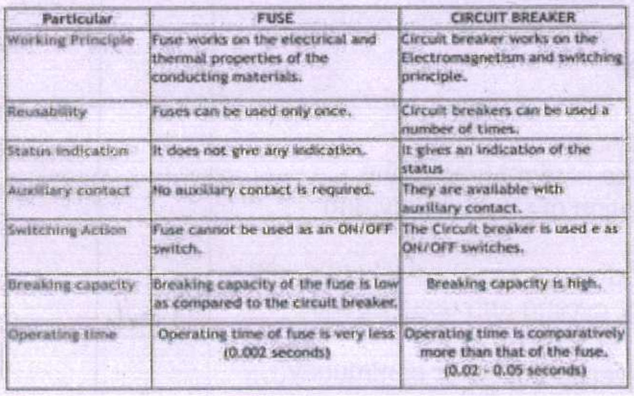
April - 2024

SCHEME OF VALUATION

Scoring Indicators

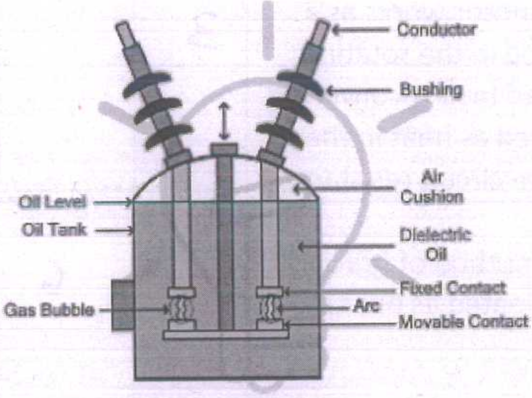
(Revision – 2015) **Course Code:**
6031

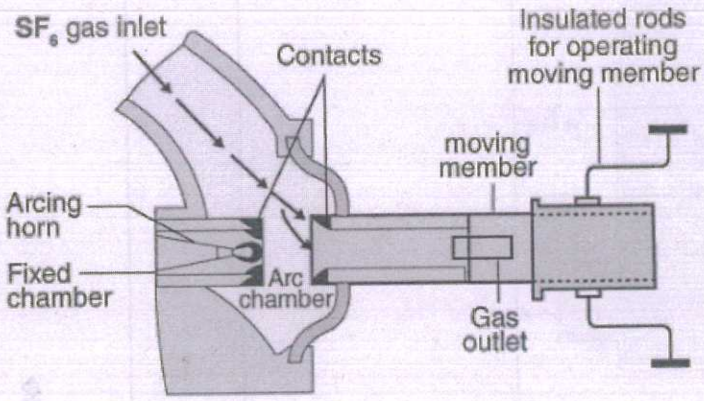
ELECTRICAL POWER UTILIZATION AND SYSTEM PROTECTION

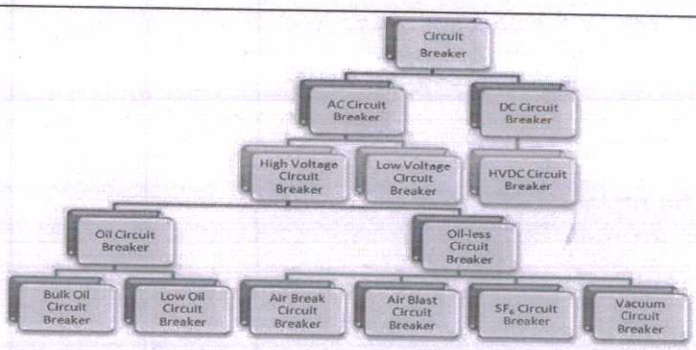
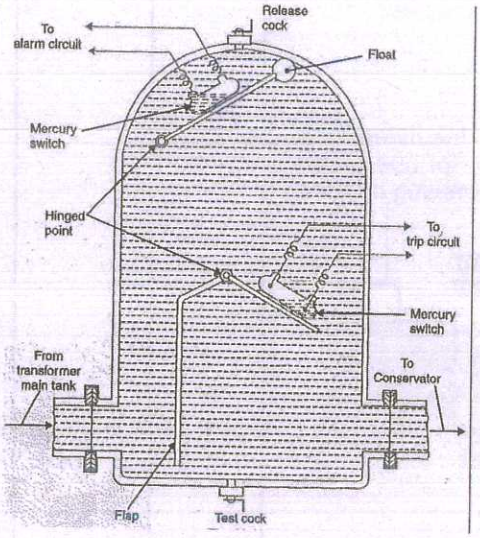
<table>
<tr><th>Q. No</th><th>Scoring indicator</th><th>Split up</th><th>Sub Total</th><th>Total</th></tr>
<tr><td>I</td><td>PART A</td><td></td><td></td><td></td></tr>
<tr><td>1</td><td>Low melting point , high conductivity, low cost</td><td>2</td><td>2</td><td></td></tr>
<tr><td>2</td><td>circuit breaker is an electrical switch designed to protect an electrical circuit from damage caused by over current/overload or short circuit</td><td>2</td><td>2</td><td></td></tr>
<tr><td>3</td><td>Nichrome, platinum, copper nickel</td><td>1ea</td><td>2</td><td></td></tr>
<tr><td>4</td><td>An electric drive is a device used to control the output of a motor used</td><td>1</td><td>2</td><td></td></tr>
<tr><td>5</td><td>Rheostatic, regenerative or plugging</td><td>each</td><td>2</td><td>10</td></tr>
<tr><td></td><td>PART B</td><td></td><td></td><td></td></tr>
<tr><td>II
1</td><td>The advantages of fuse are current limiting effect under short-circuit conditions, no maintenance, and cheapest type of protection.
The fuse element changes very easily. It needs zero maintenance.
It affords the current limiting effect under short circuit conditions.
The fuse operation is completely automatic and requires less time than circuit breakers, and no complexity exists</td><td>1 each</td><td>6</td><td></td></tr>
<tr><td>2</td><td>Comparisons between fuse and circuit breaker.

<table>
<tr><th>Particular</th><th>FUSE</th><th>CIRCUIT BREAKER</th></tr>
<tr><td>Working Principle</td><td>Fuse works on the elecrical and thermal properties of the conducting materials.</td><td>Circuit breaker works on the Electromagnetism and switching principle.</td></tr>
<tr><td>Reusability</td><td>Fuses can be used only once.</td><td>Circuit breakers can be used a number of times.</td></tr>
<tr><td>Status indication</td><td>It does not give any indication.</td><td>It gives an indication of the status</td></tr>
<tr><td>Auxiliary contact</td><td>No auxiliary contact is required.</td><td>They are available with auxiliary contact.</td></tr>
<tr><td>Switching Action</td><td>Fuse cannot be used as an ON/OFF switch.</td><td>The Circuit breaker is used e as ON/OFF switches.</td></tr>
<tr><td>Breaking capacity</td><td>Breaking capacity of the fuse is low as compared to the circuit breaker.</td><td>Breaking capacity is high.</td></tr>
<tr><td>Operating time</td><td>Operating time of fuse is very less (0.002 seconds)</td><td>Operating time is comparatively more than that of the fuse. (0.02 - 0.05 seconds)</td></tr>
</table></td><td>1 each</td><td>6</td><td></td></tr>
</table>

3	1. Selectivity 2. Speed 3. Sensitivity 4. Reliability 5. Simplicity 6. Economy Brief explanation needed	6		
4	Dielectric heating is used for drying purposes such as in the textile industry, drying of paper, drying of wood, etc. The sterilization of bandages, absorbent cotton, etc can be done by dielectric heating. For the treatment of certain pains and diseases, tissues and bones in the body are to be heated which can be done by dielectric heating. Heating general processing such as coffee roasting, chocolate industry, etc. Cooking seafood such as oysters without removing the outer shell. Dehydration of milk, eggs, fruits, etc. Defrosting of frozen foods such as meat and vegetables. For control of bacterial growth and production of germicidal reactions, the food products are heated, and to prevent the product from losing their flavor, they are dielectric heated. For the processing of chemicals, rubber, synthetic material	1 each	6	
5	improve road safety reduce the incidence of night time crime improve the perception of street safety and security increase leisure and commercial activity after dark encourage walking, cycling and use of public transport improve the effectiveness of other community safety measures such as closed circuit television (CCTV) and Automatic Number Plate recognition (ANPR) develop safer routes to schools	1 each		

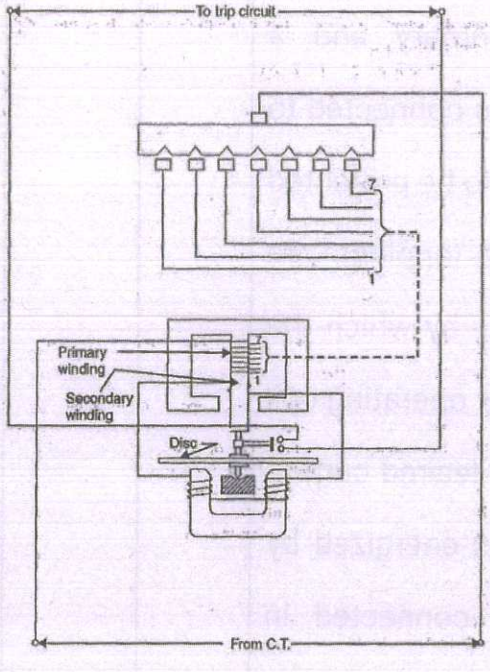
	create a quality environment for local people, business and tourism	6		
6	based on supply namely AC drives & DC drives. based on running speed namely Constant speed drives & changeable speed drives. based on a number of motors namely Single motor drives & multi-motor drives. based on control parameter namely stable torque drives & stable power drives.	2 each	6	
7	In this type of braking, the DC motor is disconnected from the supply and a braking resistor R_b is immediately connected across the armature. The motor will now work as a generator and produces the braking torque. During electric braking when the motor works as a generator, the kinetic energy stored in the rotating parts of the motor and a connected load is converted into electrical energy. It is dissipated as heat in the braking resistance R_b and armature circuit resistance R_a.	3		
	Dynamic Braking is an inefficient method of braking as all the generated energy is dissipated as heat in resistances.	3	6	30
	PART-C			
III a	An Oil circuit breaker aka OCB is a type of circuit breaker that uses insulating oil as a dielectric medium to quench the arc and break the circuit safely. The oil used is insulating oil used usually transformer oil that has better dielectric strength than air. The heat produced by the arc vaporizes the oil, producing a hydrogen gas bubble surrounding the arc. The pressure of the oil compresses the gas bubble			

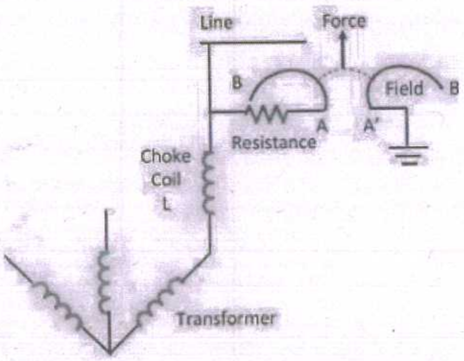
	increasing its dielectric strength which extinguishes the arc during the zero-crossing.Under fault conditions, the moving contact moves downward to separate from fixed contacts. During the contact separation, the separation gap increases. due to the high voltage difference, the oil starts to ionize and an arc is struck between the contacts	4		
	 **Bulk Oil Circuit Breaker**	4	8	
IIIb	Advantages • Clears both high and low fault currents. • Does not deteriorate with age. • Operates at high speed. • Provides reliable discrimination. • Requires no maintenance. • More cost-effective than other circuit interrupting devices with the same rating. • Ensures consistent performance.	4		

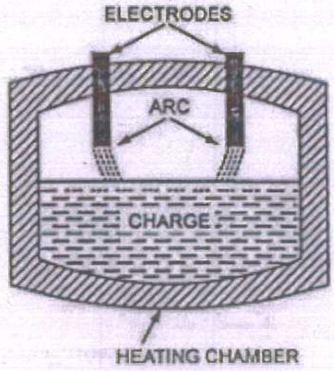
	• Fast fusing operation without noise and smoke. Disadvantages • They need to be replaced after each operation. • The heat produced by the arc may affect the associated switches.	3	7	15
IVa	**SF6 Circuit Breakers** SF6 is a sulfur hexafluoride circuit breaker in which sulfur hexafluoride is used as the arc extinguishing medium. The sulfur hexafluoride gas attracts free electrons. As the circuit contacts are opened, the gas flows through the chamber striking the arc. The free electrons are then absorbed by the SF6 resulting in immobile negative ions. For the arc to extinguish completely, the Insulating strength of the medium should be increased. Both the contacts, fixed and moving contacts are placed in the arc chamber along with the gas.	4		
		4	8	

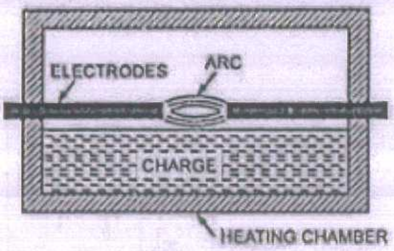
IVb		7	7	15
Va	Buchholz Relay is a gas-actuated relay installed in oil immersed transformers for protection against all kinds of faults. Named after its inventor, Buchholz, it is used to give an alarm in case of incipient (i.e. slow-developing) faults in the transformer and to disconnect the transformer from the supply in the event of severe internal faults. It is usually installed in the pipe connecting the conservator to the main tank as shown in Fig 	34 4	8	

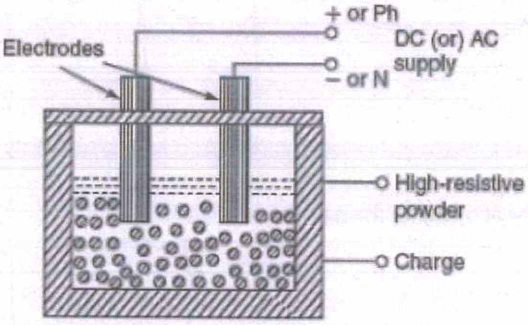
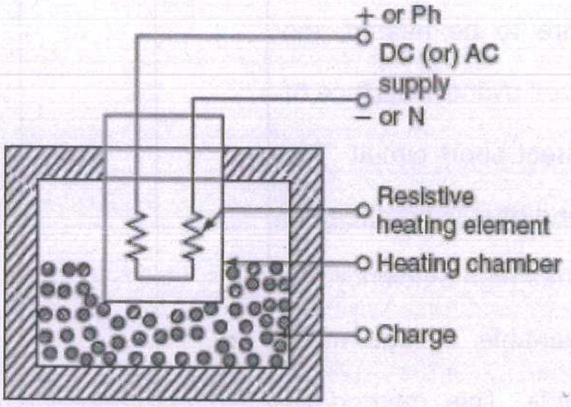
Vb	The methods commonly used for grounding the system neutral are 1. Solid grounding (or effective grounding) 2. Resistance Grounding 3. Reactance Grounding 4. Peterson-coil grounding (or resonant groundings) explanation	4 3	7	
VIa	Fig. shows the important constructional details of a typical non-directional induction type overcurrent relay. It consists of a metallic (aluminium) disc which is free to rotate in between the poles of two electromagnets. The upper electromagnet has a primary and a secondary winding. The primary is connected to the secondary of a C.T. in the line to be protected and is tapped at intervals. The tappings are connected to a plug-setting bridge by which the number of active turns on the relay operating coil can be varied, thereby giving the desired current setting. The secondary winding is energized by induction from primary and is connected in			

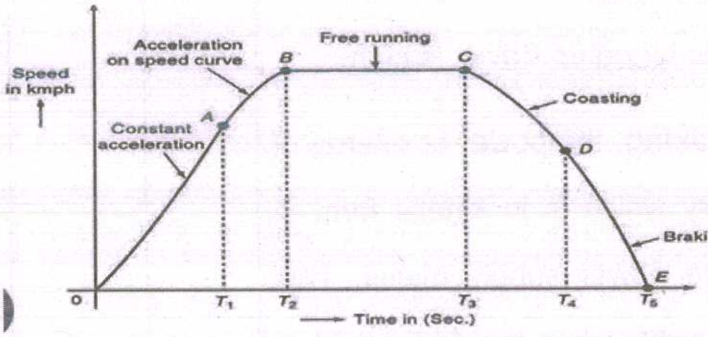
	series with the winding on the lower magnet. The controlling torque, is provided by a spiral spring. The spindle of the disc carries a moving contact which bridges two fixed contacts (connected to trip circuit) when the disc rotates through a pre-set angle. This angle can be adjusted to any value between 0° and 360o. By adjusting this angle, the travel of the moving contact can be adjusted and hence the relay can be given any desired time setting.	4		
		5	8	

VIb	This contains two horn-shaded pieces of metal. These two are separated by a small air gap and connected in a shunt between each conductor and earth. The distance between the two electrodes is optimum. This distance is filled with air that ionizes on fault current passage. Hence, the fault current is passed to the earth, and the inherent damage is stopped. 	4 3	7	15
VII a	In a direct arc furnace charge acts as one of the electrodes and the charge is heated by producing arc between the electrodes and the charge. Since in a direct arc furnace, the arc is in direct contact with the charge and heat is also produced by flow of current through the charge itself, the charge can be, therefore, heated to the highest temperature. In case of a single phase arc furnace two electrodes are taken vertically downward through the roof of the furnace to the surface of the charge and in a 3-phase furnace three electrodes put at the corners of an equilateral triangle, project on the			

	charge through the roof and three arcs are formed. The current passing through the charge develops electromagnetic field and necessary stirring action is automatically obtained by it. Thus uniform heating is obtained.	2		
		2		
	In this case an arc is formed between two electrodes above the charge, as shown in Fig. and heat is transmitted to the charge solely by radiation. In this case the temperature of the charge is, therefore, lower than that in case of direct arc furnace. Its construction limits the number of electrodes to two, so single-phase supply is required. The arc is produced by bringing the electrodes into solid contact and then withdrawing them. Power input is regulated by adjusting the arc length by moving the electrodes.	2		

		2	8	
VII b	1. High melting point. 2. Free from oxidation in open atmosphere. 3. High tensile strength. 4. Sufficient ductility to draw the metal or alloy in the form of wire. 5. High resistivity. 6. Low temperature coefficient of resistance.	7	7	15
VIII a	DIRECT RESISTANCE HEATING In this method, electrodes are immersed in a material or charge to be heated. The charge may be in the form of powder, pieces, or liquid. The electrodes are connected to AC or DC supply as shown in Fig. In case of DC or 1-φ AC, two electrodes are immersed and three electrodes are immersed in the charge and connected to supply in case of availability of 3-φsupply. When metal pieces are to be heated, the powder of lightly resistive is sprinkled over the surface of the charge (or) pieces to avoid direct short circuit. The current flows through the charge and heat is produced in the charge itself. So, this method has high efficiency. As the current in this case is not variable, so automatic temperature control is not possible. This method of	2		

	heating is employed in salt bath furnace and electrode boilers for heating water.  	2		
	INDIRECT RESISTANCE HEATING In the indirect resistance heating method, high current is passed through the heating element. In case of industrial heating, sometimes the heating element is placed in a cylinder which is surrounded by the charge placed in a jacket known as heating chamber is shown in Fig.	2		
	 	2	8	
VIII b	• Electroplating with metals. • Electrorefining of metals. • Extraction of metals.			

	- Purification of metals. - Electrolytic reduction of metals from their compounds. - Metal cleaning: dirty metals can be cleaned.	7	7	15
IXa	 	4		
	explanation of various time period	4	8	
IX b	*If* there is a fault in the main motor, then it causes the stopping of all the small machines. In group drives, the small machines have to be installed at places which are convenient for shafting. .In group drive, the speed control of individual small machine is not possible In case of group drive, a high amount of power is wasted in power transmission (in pulleys, etc.). In group drive, future expansion is not possible. When only a few machines are required to be operated, then the main motor operates with a very less capacity. Thus, its power factor and efficiency are poor.	7	7	15

	The layout of the group drive is fixed and cannot be changed. Also, the appearance of the layout is not good. Noise produced by group drives is high.			
Xa	In **Regenerative Braking**, the power or energy of the driven machinery which is in kinetic form is returned back to the power supply mains. This type of braking is possible when the driven load or machinery forces the motor to run at a speed higher than the no-load speed with a constant excitation. Regenerative Braking in DC Shunt Motors Under normal operating conditions the armature current is given by the equation shown below: $-I_a = \frac{V - E_b}{R_a}$ When the load is lowered by a crane, hoist or lift causes the motor speed to be greater than the no-load speed, the back EMF becomes greater than the supply voltage. Consequently, armature current Ia becomes negative. The machines now begin to operate as a generator.In the case of DC Series Motor an increase in speed is followed by a	4		

Xb	decrease in the armature current and field flux. The back EMF Eb cannot be greater than the supply voltage. Regeneration is possible in DC Series Motor since the field current cannot be made greater than the armature current. One commonly used method of regenerative braking of DC Series Motor is to connect it as a shunt motor. Since the resistance of the field winding is low, a series resistance is connected in the field circuit to limit the current within the safe value. Mechanical Requirements : Some of the important mechanical requirements of traction motors are, The weight of the traction motor should be less to increase the payload (carrying) capacity. A traction motor must be robust and capable to withstand continuous vibrations. The traction motor must be small in size to fit even in less space.	4 (any four) 4	8	

	The traction motor must be a totally enclosed type in order to protect it against dust, water, and mud electrical requirements of a traction motor are, Starting torque of the motor should be high to meet the train resistance and acceleration. The speed-torque curve should be such that starting torque is high and reduces as speed increases. The motor should be self-governing. When an up gradient is encountered the speed can be reduced such that the kilowatt loading gets controlled. The motor should protect itself from overload. If the speed-torque characteristic is such that speed is inversely proportional to torque, their product will always be constant. Therefore, hp which is proportional to the product of torque and speed is also constant. This gives motor self-protective property against overloads. The motor should have simple speed control. The motor should have a high power-to-weight ratio. The motor should have high mechanical and electrical efficiency.	(Any three) 3	7	15