Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner should assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given importance (Not applicable for subject English and Communication Skills).
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner should give credit for any equivalent figure/figures drawn.
5) Credits to be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer (as long as the assumptions are not incorrect).
6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept

1 **Any five:** **(5×4=20)**

1 a) State any four points of differences between circuit breaker and an interrupter.

Ans:

Difference between Circuit breaker and Interrupter:

Sr.No.	Circuit-breaker	Interrupter
1	It is a switching device which offers manual on-off and also automatic opening in the event of fault in the system.	It is a switching device which offers manual on-off operation only.
2	It is provided with protective relay for automatic tripping (opening).	It is not provided with protective relay.
3	It is automatic circuit breaker.	It is non-automatic type circuit breaker.
4	It is installed on both sides of transformer and also on the feeder.	It is installed at feeding, sub-sectioning and paralleling posts.

1 mark for each of any four points = 4 marks

1 b) State the necessity of employing MHO relay in the protection scheme for 25 kV OHE.

Ans:

Necessity of employing MHO relay in the protection scheme for 25 kV OHE:

Protection system for 25 kV OHE has to fulfill some special requirements.

i) It has been observed that the maximum load current is more than the farthest end short-circuit fault current. Therefore, over-current protection based on the current peak discrimination will not be suitable for protecting the OHE from short circuit faults. — 2 marks

ii) Similarly, it has been also observed that the working impedance is less than the short-circuit impedance, hence plain impedance relay will also not be suitable for protection of OHE. — 2 marks

iii) The phase angle of traction load lies in between 40° to 60° and that for short-circuits lies in between 70° to 90°. Therefore, relay making use of impedance phase angle will be successful in obtaining proper discrimination and effective protection. Since Mho relay makes use of impedance phase angle for fault detection and providing protection, it is necessary.

1 c) i) List two limitations of third rail system.

Ans:

Limitations of Third rail system:

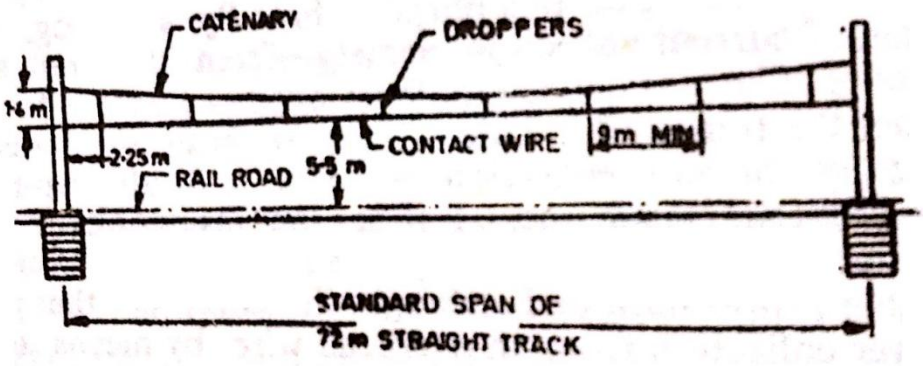
1) There is possibility of electric shock hazard close to ground.
2) Resistive losses are more.
3) Applicable only for low voltage applications below 1500 V.
4) Less safe.
5) Applicable to slow speed trains.

1 mark for each of any two limitations = 2 marks

1 c) ii) Draw labeled diagram of typical single catenary construction.

Ans:

Typical Single Catenary Construction:



Typical Single Catenary Construction

2 marks for labeled diagram

1 mark for unlabeled diagram

1 d) i) List any two factors which are to be considered while designing height of contact wire.

Ans:

Factors to be considered while designing height of contact wire:

1) Rolling stock gauge
2) System voltage
3) Span length
4) Location of contact wire e.g below bridge, tunnel or open.
5) Type of current collecting equipment.
6) Environmental conditions.

1 mark for each of any two = 2 marks

1 d) ii) What is encumbrance? State its value.

Ans:

Encumbrance: 1 mark

It is the axial distance between catenary and contact wire.

Its value is maintained at 1.4 m except at turn outs, overlaps and in the vicinity of overline structure. 1 mark

1 e) i) Give any two advantages of remote control system.

Ans:

Advantages of remote control system:

1) As substations and control posts are unattended (due to remote controls) there is considerable savings due to less manpower.
2) Central control station houses the complete info of the route (supervision of all individual posts is simple) hence coordination is very good.
3) As oral instructions are very less, human error based problems are minimized, otherwise oral instructions given over phone may lead to errors.
4) Correct and rapid supervision is possible.
5) Switching operations are carried out safely, quickly, and economically.
6) Maintenance cost is low.

1 mark for each of any two advantages = 2 marks

1 e) ii) State the significance of mimic diagram.

Ans:

Significance of mimic diagram:

The mimic diagram provides the operator with an overview of the status of the power supply arrangement for overhead 25 kV system. The dynamic data shown

on the mimic is updated automatically with telemetered, calculated and manually updated data from the database. The mimic diagram can also accommodate analog meters, digital displays, directional power flow indicators and chart recorders. The mimic diagram control equipment, mimic controller is used together with dedicated software, normally residing in the application servers, as the mimic driver unit. The mimic diagram shows and overview comprising static and dynamic information about equipment in station. The static information shows devices such as transmission lines, bus-bars and transformers. The dynamic information shows the current state of the devices such as circuit-breakers, interrupters, etc. The circuit-breaker, interrupter etc. are represented by control Discrepancy switch (DS). The tele-command for closing or tripping of circuit-breakers is transmitted by actuating the discrepancy switches.

4 marks for correct answer

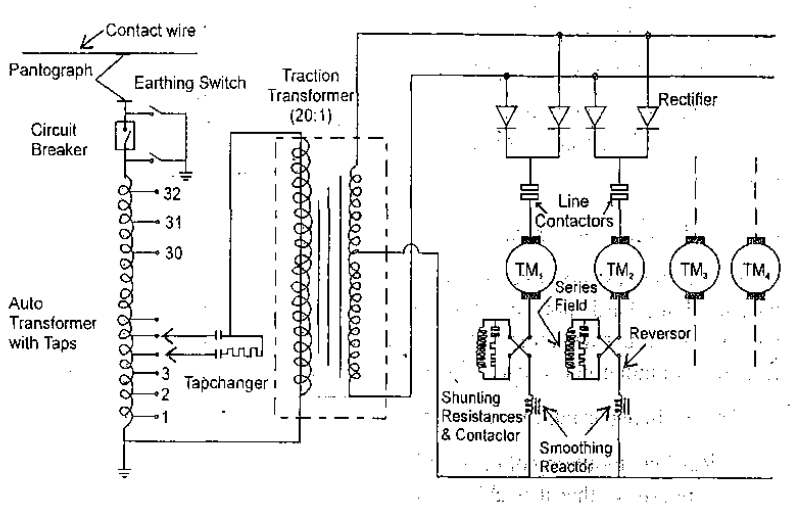
Benefits:

•The operator is able to scan the overall status of the complete system at a glance.
•The mimic diagram provides a pictorial view of the system network.

1 f) Draw the labeled diagram of power circuit of electric locomotive.

Ans:

Power circuit of electric locomotive:



Schematic arrangement of power circuit

4 marks for labeled diagram

3 marks for partially labeled diagram

2 marks for unlabeled diagram

1 g) List two types of defects that may occur in electric locomotive and the methods by which they can be eliminated.

Ans:

Types of Defects in Electric Locomotive:

Defects are classified by their causes –

1) Out of defective design , material or workmanship by the manufacturer
2) Out of inadequate maintenance due to the negligence on the part of maintenance staff.
3) Out of the lacuna in maintenance schedules which may necessiate change in the periodicity of inspection.

1 mark for each of any two types = 2 marks

Methods of Elimination:

i) To eliminate the defects under (i) above , appropriate action is to be taken by the manufacturer and
ii) The defects under (ii) & (iii) can be minimised by resorting to the ideal

1 mark each = 2 marks

maintenance practice.

2 Any two: 16

2 a) In relation with control posts of traction SS list;
i) Four major equipments
ii) Four miscellaneous equipments.
State the function of each of them.

Ans:

i) Major equipments and their functions:

1) Single phase transformer: steps down the high voltage to 25 kV,
2) Transformer circuit breakers: rarely operated under normal conditions (they are normally closed) but trip the transformer circuit open on the occurrence of internal faults in transformers.
3) Feeder circuit breakers: Trip the respective feeder open on the occurrence of faults on the OHE.
4) Interrupters: Work as non-automatic type circuit breakers to interrupt the circuit at normal load currents, But capable of opening/closing the OHE by remote control by traction power controller.
5) Protective devices (relays): sense abnormal conditions in the respective sections of the system and give the trip / alarm signal to the circuit breaker / indicator panel.

½ mark for name + ½ mark for function =1 mark any four = 4 marks

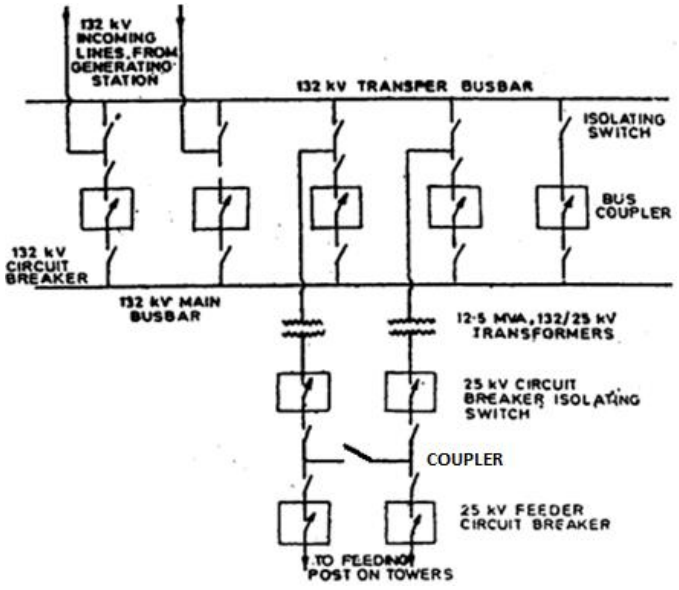
ii) Miscellaneous equipment at control post and their functions:

1) Lightning arrestor: Provide protection against lightning over voltages.
2) Auxiliary transformer: provides 230V, 50 Hz supply to operate battery charger, remote control equipment, signaling and lighting.
3) PT: measure HV and indicate its value at each sub sector of remote control centre.
4) Battery: for operation of Remote Control equipment and interrupters.
5) Battery charging equipment: Charge batteries at the control post.

½ mark for name + ½ mark for function =1 mark any four = 4 marks

2 b) Draw a neat layout of traction substation and discuss its main features.

Ans:



Fully labeled diagram = 5 marks, partial diagram or partially labeled reduced marks proportionally.

Features:

1) The HV to the substations is always maintained from two sources or double circuit incomers.
2) Normally one of the two transformers is in operation.
3) There are always two transformers to ensure continuity of power supply.
4) The main bus bar is connected to the incoming line of 132 kV through a CB and isolator set while the transfer bus through the isolator only.
5) The transfer bus is a sort of backup with respect to the main bus bar.
6) Function of all isolating switches and bus couplers: To enable maintenance of circuit breakers and bus bars while maintaining the continuity of supply for traction purpose.

Features: 1 mark each any three = 3 marks.

2 c) i) List any four advantages of automatic weight tensioning and temperature compensation arrangement in OHE.

Ans:

Advantages of automatic weight tensioning and temperature compensation arrangement in OHE:

1. Sparkless current collection at higher speeds.
2. OHE becomes more dynamically stable under all atmospheric conditions.
3. Reduction in wear of both contact wire and pantograph collecting strips.
4. Creep of conductors with passage of time is automatically taken up by the tensioning device.
5. Only one critical velocity of propogation of waves in contact wire which is greater than that of unregulated OHE.
6. Because of fixed tension, fluctuations in the height are minimized.

1 mark each any four = 4 marks

2 c) ii) Give any four difference between uninsulated and insulated overlap.

Ans:

Difference between uninsulated and insulated overlap:

1 point = 2 marks,
2 points = 3 marks,
3 points = 4 marks

Un-insulated	**Insulated**
Gap between the contact wires is less	-Gap between the contact wires is more
No isolation possible	-Isolation is possible for operation and maintenance of OHE
Electrically connected by means of jumpers.	-Electrical continuity by means of jumpers in series with isolators or interrupters.

3 **Any two**: **16**

3 a) Draw a neat labeled layout of feeding post and state the function of any four components present in it.

Ans:

Functions of components:

1) Incoming feeders: Each feeder has two condcutors: 25 kV and 3 kV for connection to busbar (25 kV) and connection to track (3 kV) for return current respectively.

2) Oil Circuit breakers: These connect the two incoming feeders to the two sets of busbars and operate (open the circuits) to protect the system under fault or

abnormal conditions in the system. These are switched on after the isolators on its two sides are closed.

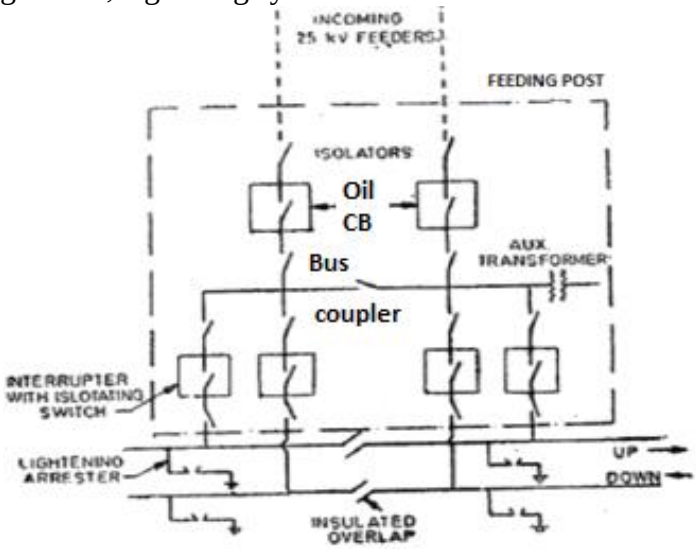
1 mark each component function any four = 4 marks

3) Isolators: Are placed on either side of the Oil Circuit breakers to isolate the CBs / busbars for maintenance or other works. These are double pole interlocked switches that are operated only on no load, that is when the CBs are opened.

4) Interrupters: These are outdoor located, non-automatic, low oil content single pole switches whose function is to connect the diffeent sections of the OHE to the feeding post. They are operated only under normal load conditions and not under fault condition tripping.

5) Bus coupler: This connects the two sets of busbars to which the each of these feeders connect. In the case of failure of one of the feeders connected to one of the busbars the supply is continued to it by supplying through the bus coupler.

6) Auxiliary transformer: It's function is to step down the 25 kV to 230 V, 50 Hz for the operation of the substation LV equipment such as battery chargers, lighting arrangements, signalling systems etc.

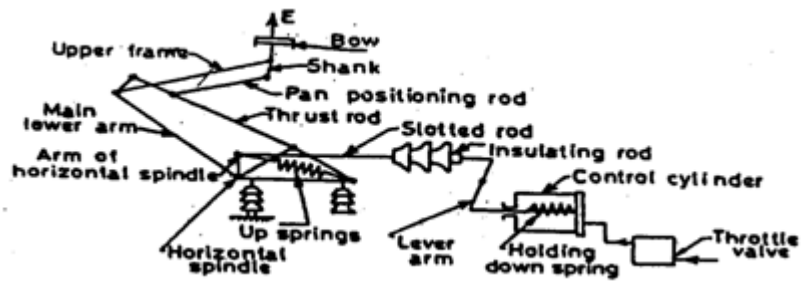


Labeled figure 4 marks else proportionally lower marks

3 b) For a faivelely type pantograph:
1) Draw its neat labeled diagram.
2) Explain its construction and working.

Ans:

1)



Labeled diagram 4 marks else proportionally lower marks

2) Construction and Working:

Construction:

Consists of a sub frame or base, articulated system, pneumatic control system including throttle valve, two raising springs and four insulators. The base is of welded sections (that houses ball bearings) which carries the articulated system, rubber stops provided to limit folding of articulated system. — 1 mark

Working:

When compressed air is admitted in the control cylinder, the piston compresses the holding down springs and slotted rod gets translatory motion which permits horizontal spindle to rotate under the action of up-springs. The pantograph then rises until the collector touches OHE. The articulated system then stops. Air motor plays no further role. The piston remains stationary. The pantograph is operated purely by up springs. Opening of control cylinder to atmosphere causes piston to return under the force of holding down springs. The slotted rod presses on the pin thereby lowering the articulated system. — Working 3 marks

Methods of raising & lowering the pantograph
i) Air raised, gravity lowered.
ii) Air raised, spring lowered.
iii) Spring raised, air lowered.

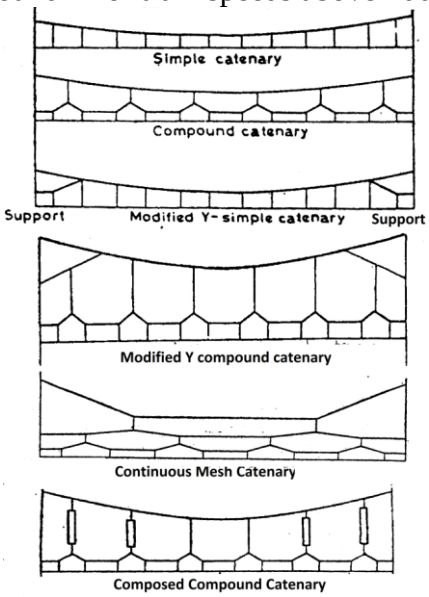
3 c) i) List four types of construction of polygonal OHE with their scope of application.

Ans:

Various types of construction of polygonal OHE and Scope of application (speed ranges): — 1 mark each type any four = 4 marks,

- Simple – for train speeds upto 120 kmph
- Compound - for train speeds between 190 to 225 kmph
- Stitched or modified Y simple - for train speeds upto 160 kmph
- Modified Y compound - for train speeds upto 200 kmph
- Continuous mesh - for train speeds upto 200 kmph
- Composed compound - for train speeds above 200 kmph

1 mark each scope of application any four = 4 marks.



Some students may draw labeled diagram instead of listing them. They must be evaluated on merit of the content keeping the spirit in mind.

3 c) ii) Explain why neutral section is required in ac traction system and not in dc traction system.

Ans:

Neutral section is required to be provided in between two adjacent sub-stations fed by two different AC phases of the supply system to facilitate the changeover of the supply to the locomotive from one phase to the other as: — 1 mark

- Adjacent traction substations tap different phases for even load on supply system.
- Momentary passing of pantograph under the insulated overlap will cause short circuit, between phases damaging equipment.
- Hence neutral section provided between sections fed by different phases. — 2 marks
- This results in smooth and sparkles passage of pantograph between sections.

In DC traction there is no phase changeover required at regular intervals. — 1 mark

4 **Any two**: **16**

4 a) i) With the help of circuit diagram, explain the working of the dc track circuit. 5

Ans:

DC track circuit:

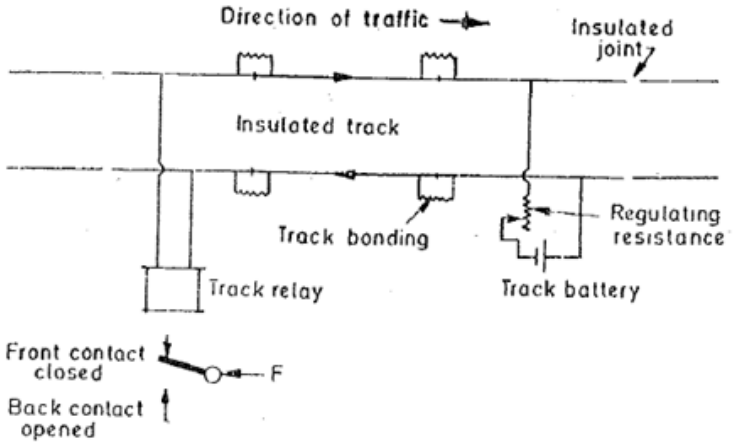


Diagram 3 marks

Working:

- Insulated rail joints are obtained by placing fiber pieces in between abutting rail ends. In the insulated section, continuity between the adjacent rails is kept by bonds to keep the track resistance low. The two rails of the insulated track are insulated from each other by wooden sleepers.
- Track relay is connected across two rails of insulated track at the start end and dc source along with the regulating resistance across the very same rails at the other end.
- When the track is not occupied, circuit is completed through track relay and current flows, thereby functions on the required signal are carried out.
- When the track is occupied by the train a circuit parallel to the relay coil is established by the vehicle wheels and axles due to which the relay current falls below the hold up value of the relay to give the required indication.

Explanation 2 marks

- It is used for non-electrified track lines.

4 a) ii) Give the functions of the impedance bond present in AC track circuit. 3

Ans:

Functions of impedance bonds:

i) To provide path of low resistance for traction currents to pass through insulated track.
ii) To provide path of high impedance for AC signaling currents between two rails of track.
iii) To keep signaling currents restricted to the insulated track circuits.

1 mark each = 3 marks

4 b) With the aid of neat diagram, explain the working of the Double Battery Parallel Block system.

Ans:

Double battery parallel block system for train lighting:

- When train is stationary or runs slowly, generator contacts B_1 and B_2 are open and both batteries supply the load through closed contacts L_1 and L_2, short circuiting lamp resistance D as shown in Fig (a).

2 marks each diagram + 2 marks each description / explanation = 4 + 4 = 8 marks

Fig a:

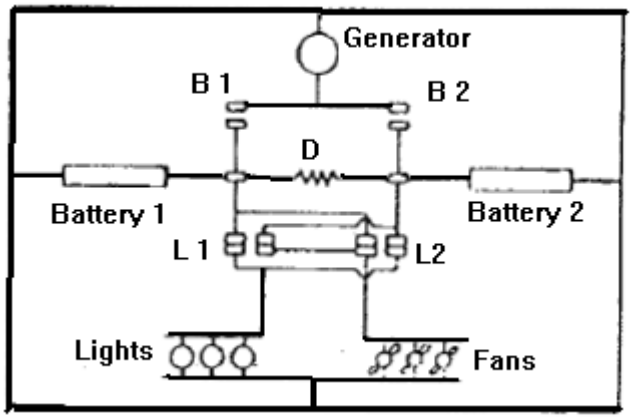
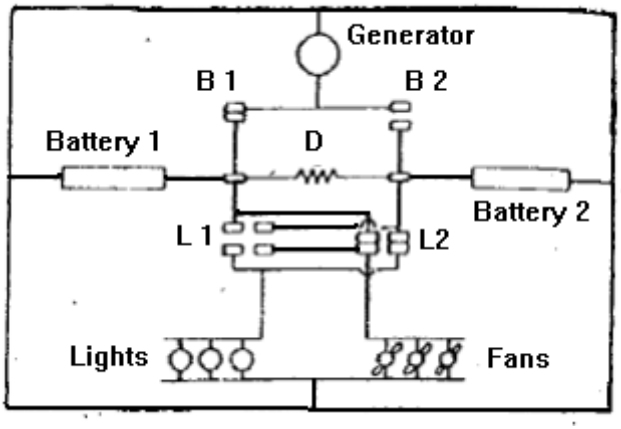


Fig b.



When train is in motion and lights on, as shown in fig(b), generator is connected

to battery 1 through closed contact B_1 and lighting load is connected to battery 2 through closed contact L_2.

When train is in motion and lighting and other loads are switched off, switches L_1 and L_2 are open, lamp resistance D is short circuited when both generator contacts B_1 and B_2 are closed and both batteries will then be charged in parallel.

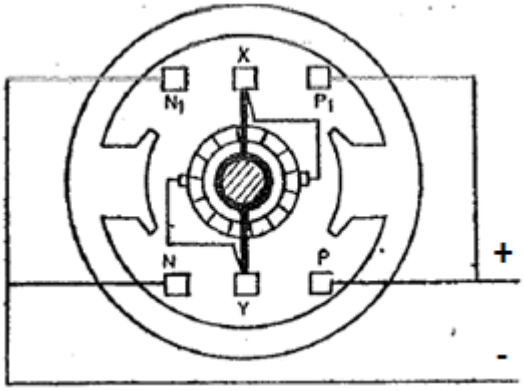
4 c) i) With the help of circuit diagram, explain the method of obtaining unidirectional polarity in case of train lighting. — 4

Ans:

Method of obtaining unidirectional polarity in train lighting:

Dynamo has rocker arm mounted on the shaft, on friction tight. When the direction of rotation is anticlockwise, X terminal of the rocker arm will be connected to N_1 brush and Y terminal of the rocker arm will be connected to P brush. Thus, the output polarities will be obtained as shown in figure.

Diagram 2 marks, explanation 2 marks total = 4 marks



When the direction of rotation of the shaft is clockwise, terminal X now touches P_1 while terminal Y touches N. Thus, giving the output polarity as in previous case, i.e. as shown in figure.

Thus, unidirectional polarity is obtained in train lighting.

4 c) ii) List four special features of train lighting dynamo. — 4

Ans:

Special features of train lighting dynamo:

1 mark each feature, any four = 4 marks

1) Robust construction for the conditions in which it is used,
2) Constant polarity irrespective of direction of motion of train,
3) Nearly constant output at varying speeds,
4) As it is in parallel with the batteries charging them, it is inherently self regulating,
5) It has two field windings namely: main field (weaker) between the positive and negative brushes, and the aid field (stronger) between the positive and third brush.

5 Any two: — **16**

5 a) i) List four types of electric locomotives according to type of services. — 4

Ans:

The classification of electric locomotives based on the types of service rendered by them are as follows:

1 mark each any four = 4 marks

1) Freight service: for transportation of goods only.

2) Passenger service for transportation of passengers.
3) Mixed traffic service (goods and passenger transportation).
4) Shunting service at stations and sheds.
5) Banking service to bank the coaches at proper locations.

5 a) ii) State the reason for employing air blast type circuit breaker in electric locomotive. — 4

Ans:

The main function of any circuit breaker is to operate under normal and abnormal circuit conditions as per the requirements of the electrical machines/equipment by switching or for protection purpose. As the AC electric locomotive is powered by a 25 kV overhead line, it is necessary to have a proper switching device that will provide the above mentioned facilities. — 2 marks

Also the overhead line is in open air where the pantograph makes contact with it and draws power. The air blast circuit breaker is placed between the pantograph and the transformer which is in the locomotive. Also the circuit breaker has to isolate the locomotive whenever there is a voltage change or phase change point in the path. Thus the breaker used here has to operate frequently. Oil or other types of breakers (other than air blast) will need more frequent maintenance or replenishment of oil etc. hence air blast breakers are employed. — 2 marks

5 b) i) List two types of contactors used in electric locomotive with their scope of application.

Ans:

Types of contactors and their applications in electric locomotives:

These contactors are named after the methods by which the moving contact in them is operated (closed and opened). — 1 mark each for names /description and 1 mark each for application any two = 4 marks

1) Electromagnetic contactor:

In this the moving contact mounted on the electromagnetic plunger is operated (closes the contacts) by the magnetic force produced due the magnetization of coil that have several hundreds or thousands of turns of wire carrying currents. These contacts open when the moving contact falls back with its plunger due to the loss of magnetization of the coils (the currents are interrupted). The moving contact is sufficiently insulated from its electromagnetic plunger mounting.

Application: power low current devices, such as auxiliary motors.

2) Electro-pneumatic contactor:

As the name goes the pressured air on the piston or similar component sets the moving contact in motion to close it. When the pressure of the compressed air is removed the moving contact moves back to its open position due to the restraining force on it. The moving contact is sufficiently insulated from its piston mounting.

Application: power heavy current devices such as traction motors etc.

3) Cam-roller operated contactor:
The cam shaft rotation sets the roller in motion through the cam. The link on which the roller is mounted has the moving contact at its other end. When the cam operates the roller the moving contact gets actuated through the common link and closes. Proper insulation is provided between the moving contact and the link on which it is mounted.

Application: group switching of devices and timing them to achieve efficient sequential operation.

5 b) ii) State the function of earthing switch and tap changer in electric locomotive.

Ans:

1) Earthing switch: Earthing switch (has a number of electromagnetic and electro-pneumatic interlocks with the HT areas in the locomotive) is to be closed for safety to discharge the line charge to earth before working for maintenance. Also the doors of these unsafe areas do not open for maintenance unless the earthing switch is operated. The switch has to be opened before energizing the locomotive equipment at 25 kV when the safety doors lock. — 2 marks

2) Tap changer: Used to control the voltage to the traction motors through the rectifier for speed control. LV or HV side tap changing is precisely done. Due to the variable voltage available from the tap changer, the smooth speed control is possible without losses in rheostatic devices leading to efficient running of the locomotives. — 2 marks

5 c) i) Explain the need of maintenance of electric locomotive.

Ans:

Need for maintenance of electric locomotives:

- Make the operation cost effective.
- Extend the useful life of assets.
- Ensure proper availability of locomotive.
- Ensure reliability and operational readiness.
- Ensures safety by all means.
- To correct the effects of wearing out and deterioration of locomotive component during normal use.
- In the long run (aging) performance gets affected and finally beyond safe limit components may fail altogether.
- Maintain the proper quality of output of each equipment.
- Maintain the efficiency of all the equipment.
- Avoid accidents or similar dangerous situations.

½ mark each any eight = 4 marks (other valid answers must assessed on merit)

5 c) ii) List four factors by which reliability of electric locomotive can be improved.

Ans:

Means to improve reliability of locomotive:

1. Proper inspection: failures of locos are due to defects such as wear of

components, lack of lubricants, effective way is to prevent these with timely inspection.

2. Proper methods of trouble shooting and repairs: effective remedies with correct diagnosis, complete and systematic investigations, providing clear instructions in the trouble shooting chart.
3. Technical investigations: important part is to reach the root cause of failure, every cause is studied to improve, modification or changes in design can be done on this basis.
4. Suitable repairs facilities in the sheds: good job can be done with good tools, special equipments for lifting track, pinion extractors, grease guns, vacuum cleaners, filtering plant, testing bench, measuring instruments are required in sheds.
5. Trials and tests: reliability can be improved if behavior of certain components is known, test and trials carried out at shed are useful for reframing future specifications.

1 mark each any four = 4 marks

6 Any two: 16

6 a) i) List four characteristics for efficient maintenance of electric locomotive. 4

Ans:

Characteristics of efficient maintenance:

1) Proper planning of maintenance schedule.
2) Deep and proper investigation of failures.
3) Providing proper and adequate repair facilities such as staff, shed, tools, plant and machinery.
4) State of art staff training facilities at training schools with proper instructional materials etc.
5) Proper inventory/optimum stocks of regular and emergency maintenance spares.
6) Good and well equipped office setup for the preparation of detailed working drawings and specifications for maintenance spares.
7) Inspection of stores purchased according to working drawings and specifications.

1 mark each any four = 4 marks

6 a) ii) Explain with diagram the earth fault protection of power circuit. 4

Ans:

When any earth fault occurs in the traction power circuit the fault current flows through the relay coil as the battery negative is also earthed. This trips the main CB. The relay can be temporarily isolated by connecting the faulty traction circuit through a high earthing resistance to earth so that the locomotive need not be halted immediately but carry on till next stop in case of emergency for maintenance.

Explanation 2 marks

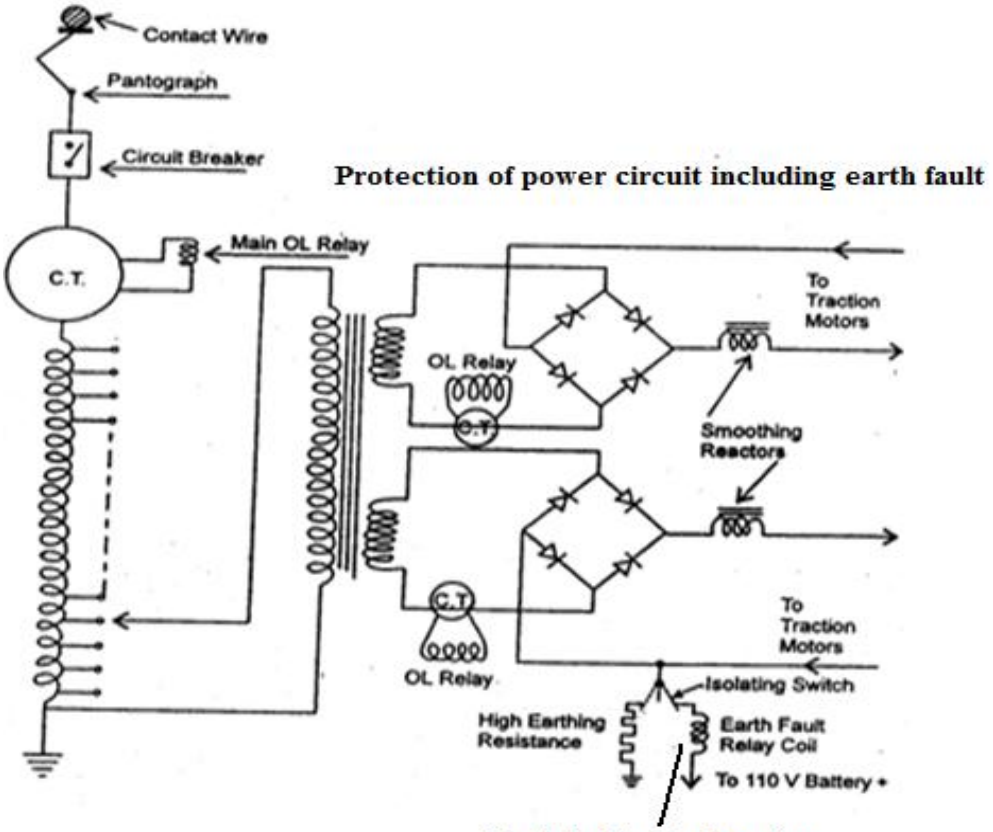
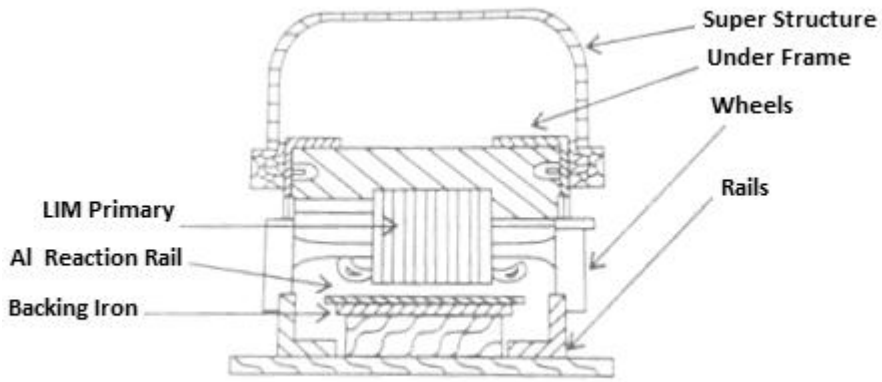


Diagram showing earth relay connection 2 marks

6 b) i) Explain with diagram the construction of linear electric motor. (Moving primary, fixed secondary single sided LIM).

Ans:



2 marks labeled diagram, otherwise proportionally lesser marks,

Constructional features of moving primary and fixed secondary single sided LIM:

- Simplest form of all types
- Primary on moving coach and secondary (Al reaction rail) laid down all along the track.
- Secondary (Al reaction rail) faces primary on upper side only.
- Primary laminated.
- Backing iron needed for completion of magnetic path with minimum

Explanation 2 marks

reluctance.

- Maintaining uniform minimum mechanical clearance between secondary Al plate and primary is easier at all locations compared to other configurations.

6 b) ii)Compare LEM with IM on four points.

Ans:

Features	LEM	Induction motor
Construction	Longitudinal arrangement of primary (armature) & secondary rotor. (primary is flat magnetic core with transverse slots laid with coils & secondary is sheet aluminum with iron backing)	Circular stator & rotor
Materials used	Electromagnetic laminated iron/steel core, normally aluminum rail as secondary..	Electromagnetic laminated steel/iron core, normally copper or aluminum as (secondary) rotor conductor materials.
Air gap and its control	Difficult to go to very low values.	Can be kept very low.
Working	Flux moves linearly & linear relative motion is produced between the linear armature and secondary.	Flux rotates in air gap & rotor / secondary moves (rotates) in the air gap in which rotating field is produced by stator armature winding.
Areas of Applications	Areas such as high speed, linear motion allowed, very low mechanical loss, higher comfort locomotives.	Drives for machine systems that need rotary input mechanical power such those in factories etc.

1 mark for each comparison any four = 4 marks

6 c) In reference with linear electric motor list;
i) Four strengths
ii) Four weaknesses.

Ans:

i) Strengths of LEM propelled railway traction:

1) Pull produced for propelling the system is independent of adhesion between the wheels of motorized coach and rail.
2) No driving wheels and hence no associated adhesion problem. This feature permits negotiation of steeper gradients.
3) Two wheels fixed to an axle can rotate independent of each other and hence curve negotiating property improves.
4) System does not require gears therefore reduction in the associated noise level and cost of maintenance.
5) Floor height above the rail level is substantially reduced. This results in reduction in the height of bridges, diameter of tunnels along the route.
6) Avoidance of rotation of parts leads to low mechanical losses.

1 mark each any four = 4 marks

7) Useful for high speed levitation trains due to absence of gears and adhesion.

ii) Weaknesses of LIM propelled railway traction:

1) The system requires looping of Al reaction rail all along the route. This considerably adds to the cost of track.
2) Since Al is relative expensive material, hence chances of theft are more, hence disruption of service.
3) Due to more air gap in LIM than RIM, power factor is poor and increased motor losses.
4) Due to discontinuity in the magnetic and electric circuits at entry and exit ends of motor, poor motor efficiency.

1 mark each any four = 4 marks