



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



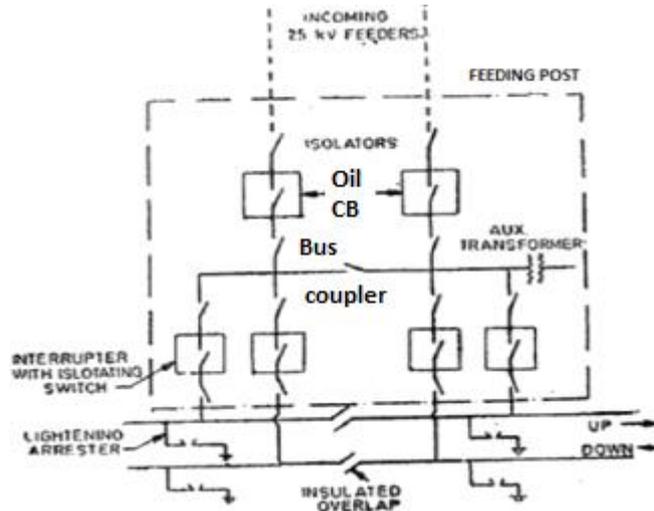
1 A) Attempt any three of the following

12

1 A) i) Draw a neat labeled diagram of feeding post

Ans:

Feeding post:



Completely labeled 4 marks, partially labeled 2 to 3 marks, unlabeled 1 mark.

1 A) ii) State any four miscellaneous equipment at control post with their function.

Ans:

Miscellaneous equipment at control post and their functions:

- 1) Lightning arrestor: Provide protection against lightning over voltages.
- 2) Auxiliary transformer: provides 230 V 50 Hz, supply to operate battery charger, remote control equipment, signally 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.

1 mark each for any four = 4 marks

1 A) iii) State any four advantages of automatic weight tensioning and temperature compensation.

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 propagation of waves in contact wire which is greater than that of unregulated OHE.
6. Due to fixed tension, fluctuations in the height are minimized.

1 mark each for any four = 4 marks

1 A) iv) Compare DC and AC track circuits on:

- i) Length of circuit
- ii) Application
- iii) Effect of stray currents



iv) Maintenance

Ans:

Comparison between DC and AC Track Circuits:

Parameter	DC Track Circuit	AC Track Circuit
Length of circuit	Short length	Longer length 3 to 5 km
Application	Used for non-electrified lines	Used where tracks are electrified
Effect of stray currents	Cause voltage drops in the un-insulated rail thus limiting the length of the circuit	Stray currents have no effect on AC track circuit
Maintenance	Complex procedures and routines, costly.	Easier procedures and less expensive.

1 mark each
= 4 marks

1 B) Attempt any one of the following:

6

1 B) i) Draw symbols of any six signaling boards of OHE. Write the meaning of each.

Ans:

Signaling Boards of OHE:

Sr.No.	Signal board format	Meaning
1		These caution boards are provided for warning the Drivers of the unwired tracks taking off from wired tracks.
2		Point levers controlling the movement of trains from the wired track to the unwired track are fitted with warning tablets (Boards) painted yellow, to warn the cabin man not to admit electric locomotives on the unwired track
3		The point where locomotive circuit breaker is to be opened is indicated by this signal.
4		Indication that the neutral section has been passed and locomotive circuit breaker may be switched on again is given by another signal.

1 mark each
with meaning
any six = 6
marks,

else
proportionally
lesser marks to
be awarded



5		Indicates to the Driver that he is approaching a neutral section and should be in readiness to open locomotive circuit breaker, is fixed 250 m ahead of the neutral section.
6		Indicates to the Driver that he is approaching a neutral section and should be in readiness to open locomotive circuit breaker, is fixed 500 m ahead of the neutral section.
7		Occasionally it becomes necessary to lower the pantograph on certain sections when OHE is not properly adjusted so as to avoid damage to the pantographs. In such cases temporary warning boards are placed ahead of the section, facing the direction from which locomotives normally approach for this purpose. On reaching such a warning board, the Driver shall open locomotive circuit breaker and lower pantograph/s of his electric locomotive/s.
8		Driver may raise the pantographs after passing the section and reaching the signal provided for the purpose

1 B) ii) Define mimic diagram and explain how it enables TPC to visualize the whole of the power supply system.

Ans:

Mimic diagram:

Definition: The diagram that depicts the power supply arrangement for the overhead 25 kV traction systems in the remote control centre on a small scale in the traction power control centre.

2 marks

Use of the mimic diagram:

- Gives actual position of electric supply system visually. It describes diagrammatically overhead system as well as various substations and control posts.
- Remote controlled equipment in the mimic diagram are represented by a



control discrepancy switch (DS). The tele-command for opening and closing of C.B. and interrupter is transmitted by actuating the DS.

- DS is in line with the busbar- closed position for C.B.
- Glowing of built in lamp of DS- discrepancy between position of DS and the actual position of the apparatus. 2 marks
- Non remote controlled apparatus like substation isolators are represented by hand operated dummy switches.

The TPC gets a complete visual indication of the conditions of the various components of the system by following:

- i) Milky white lamp lights up when alarm is received from any station in the panel.
- ii) Green lamp lights up whenever impulse train is being transmitted from or received by remote control centre. 2 marks
- iii) Red lamp lights up when either send or receive channel fails.
- iv) Annunciation window indicates the nature of fault which is inscribed separately on each window.

2 **Attempt any four of the following:** 16

2 a) Give the purpose and location of the un-insulated overlap and insulated overlap.

Ans:

- i) **Un-insulated overlap:** To rectify faults in one contact wire (of two wires) running in parallel without affecting power to OHE. 1 mark

Located at two adjacent sub-elementary sections. 1 mark

- ii) **Insulated overlap:** To provide isolation for operation and maintenance of OHE if two lengths of OHE belong to two elementary sections. 1 mark

Located at feeding posts, sub sectioning posts and booster sections. 1 mark

2 b) Explain with neat sketch, the three aspect colour light signaling.

Ans:

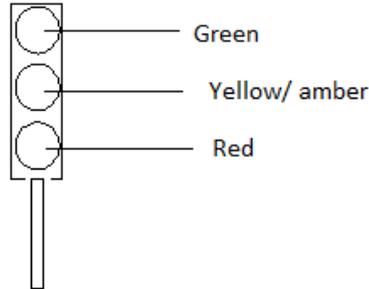
Points to be compulsorily covered:

In three aspect signal; (R → Red, Y → Yellow and G → Green)

- i) Red light ON indicates – STOP, 1 mark
- ii) Yellow or amber light indicates PROCEED WITH CAUTION, 1 mark
- iii) Green light ON indicates proceed. 1 mark



Signal post



1 mark for
Signal post
figure

2 c) Write any four important points related to construction of feeding post.

Ans:

Important points related to construction of feeding post:

- 1) Each feeder has two conductors one insulated for 25 kV (connected to busbar) and other for 3 kV (connected to track for return current).
- 2) Located as near as possible to substation with maximum distance being 2 km.
- 3) Feeders connected to two sets of busbars which are used to maintain supply to OHE in case of failure of one of them or when under maintenance.
- 4) The 25 kV CB of feeding post are controlled from RCC of railway.
- 5) The interrupters which are remotely controlled are supposed to operate only under normal current as they are not provided with protection for the same.

1 mark each
for any four
= 4 marks

2 d) State any four points by which traction transformer differs from ordinary transformer.

Ans:

Difference between Traction Transformer & Ordinary Transformer:

Point	Traction transformer	Ordinary transformer
Design	For very severe operating conditions	Normal conditions depends on requirement
Core	Always shell	Core or shell
Windings	Plain double or combination of double & auto.	Plain double.
Insulation	Class A, reinforced to withstand frequent short circuits.	Depends on requirement
Tappings	Mostly on LV side, Midpoint tap used.	May be on both sides, Not always mid point tap.
Impedance	Around 8% to 11 % to limit short circuit current.	As low as possible to have good voltage regulation (2 to 5%)
Type	Always step down	Step down & step up.
Size/ mountings	Always as compact as much as possible.	Depends on rating.
Operating requirements	High short time peak capacity	Normal

1 mark for
each of any
four
= 4 marks

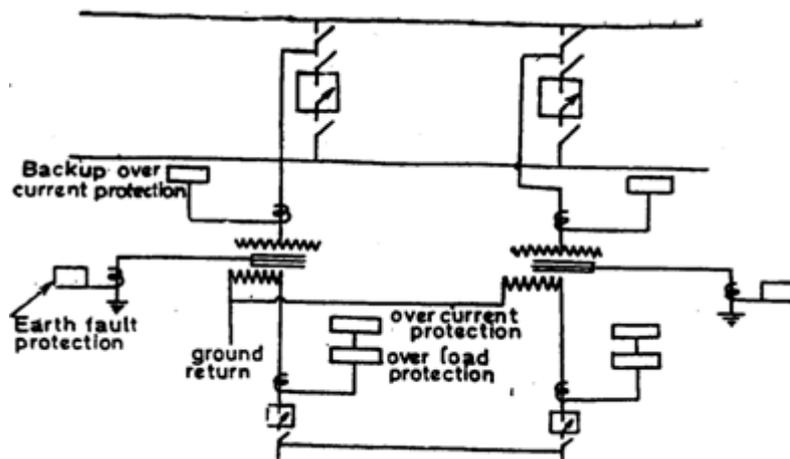


Overload capacity	50 % for 15 min , 100 % for 5 min , 120 % for instant.	Normally not above 20 to 30%.
Inpulse voltage withstand	5 times higher.	Normal

2 e) With neat sketch explain protection scheme used for traction transformer.

Ans:

Protection schemes used for traction transformers:



2 marks for
Diagram

- Back up (Inverse time) over current relay on primary (HV side) – over current protection of transformer and other equipment.
- Inverse time over current relay – over current protection of transformer on secondary side (LV) and catenary.
- Overload thermal relay – protection against sustained overloads on transformer.
- Earth fault relay – earth fault protection of transformer.

2 marks for
Explanation

3 **Attempt any four of the following:**

16

3 a) List two major equipment at traction sub-station, with their functions.

Ans:

Major equipment at traction substation:

- 1) **Transformer:** To step down the busbar voltage from 132 kV to 25 kV.
- 2) **Circuit Breaker:** To disconnect the circuit in case of fault. Transformer CB trips on internal faults of transformer. Feeder CB trips on occurrence of fault on OHE.
- 3) **Interrupter:** To disconnect the circuit in case of fault. It cannot operate automatically.

1 mark each
for any two
equipment
= 2 marks

1 mark for
function of
each above
= 2 marks

3 b) Describe the criteria for designing height of contact wire for OHE.

Ans:

Height of contact wire is decided by considering the following:

- Rolling stock gauge (Broad gauge, meter gauge etc.)



- System voltage.
 - Location of the track such as in tunnels, on bridges, under bridges, level crossings etc.
 - Working at inspection pits, loco sheds.
 - Type of OHE : regulated or un- regulated
 - Surrounding temperature
- 1 mark each for any four = 4 marks

3 c) List any eight equipment used in auxiliary circuit of electric locomotive.

Ans:

1) Batteries , 2) Compressor , 3) Blowers , 4) Exhausters , 5) Pumps , 6) Cab ventilating fans.7) Locomotive heating (if any) , 8) Transformer oil cooling radiator. 9) Head light , 10) Flasher light , 11) Marker light , 12) Engine Horn

½ mark each for any eight equipment = 4 marks

3 d) Explain the need of maintenance of electric locomotive.

Ans:

Need of Maintenance of Electric Locomotive :

- To correct the effects of Wearing out.
- To correct the effects of deterioration of locomotive component during normal use.
- In the long run (aging) performance gets affected and finally beyond safe limit components may fail altogether.
- Increase the life of equipment.
- Maintain the proper quality of output of equipment.
- Maintain the efficiency of the equipment.

1 mark for each valid point any four = 4 marks

OR

Maintenance of Electric Locomotive is needed as it:

- Extends the useful life of parts / components of locomotive.
- Ensures proper availability of locomotive.
- Ensures reliability and operational readiness.
- Ensures safety by all means.

3 e) State four important features of LEM that differ it from normal electric motor.

Ans:

- 1) In LIM, primary & secondary or stator & rotor have longitudinal arrangement while normal IM has circular parts.
- 2) Air gap between stator & rotor is more in LIM as compared to IM.
- 3) Power factor is poor in LIM as compared to IM.
- 4) Linear relative magnetic field is produced in LIM and the rotary magnetic field is produced in IM.
- 5) Speed is measured in **m/sec** in LIM and in **RPM** in IM.
- 6) No speed limit for LIM while maximum speed of IM is 3000 RPM.
- 7) LIM has Less efficiency as compared to IM.
- 8) LIM is used in high speed levitated system while IM is used for rotary mechanical output.

1 mark each of any four = 4 marks,

(other valid points must also be considered on merit)

4 A Attempt any three of the following:

12

4 A) a) List different types of OHE supporting structures and describe any one of them.



Ans:

Types of OHE Supporting Structures:

Sr.No.	Name of structure	Short Description (expected)
1	Normal mast	Have single swiveling bracket and support one OHE.
2	Overlap intermediate mast	Have two swiveling brackets and support two OHE.
3	Anchor mast	In addition to one swiveling bracket to support one OHE it provides anchoring facility for other OHE as same happens to be at the end of tension length.
4	Anti-creep anchor mast	Anchor mast provided on both sides of anti-creep central mast.
5	Anti-creep central mast	Located in Centre of tension length.

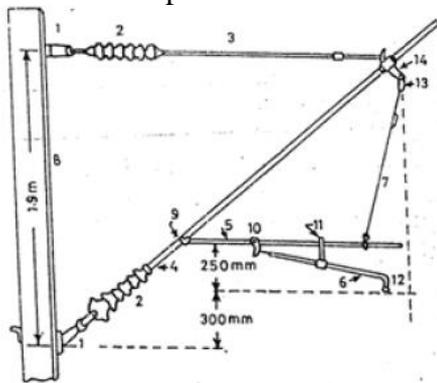
½ mark each
of any four
names
= 2 marks,

Short
description
covering as
given of any
one
= 2 marks.

OR

OHE supporting structures are :

- Single cantilever mast: independent for each track
- Portal (simple and knee): for 2-3 tracks , in the vicinity of points and crossings.
- Head span: for more than 4 tracks



- | | |
|-------------------------|---------------------------------|
| 1. Mast Fitting | 8. Mast |
| 2. Solid core insulator | 9. Register arm hook |
| 3. Telescopic stay arm | 10. Steady arm clamp |
| 4. Bracket tube | 11. Anti wind clamp |
| 5. Register arm | 12. Contact wire swivel clip |
| 6. Steady arm | 13. Suspension clamp |
| 7. Register arm dropper | 14. Catenary suspension bracket |

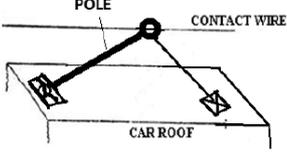
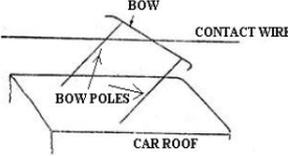
1 mark each
for any two
= 2 marks

Description
of any one
= 2 marks



4 A) b) Compare pole collector with bow collector (any 4 points).

Ans:

Points	Pole collector	Bow collector
Figure		
Construction feature	Simple in construction Grooved slider shoe attached to the end of long pole	Somewhat complicated Two collector poles on which light metal strip of 1 mtr
Speed	Low speeds up to 30 km/hr	High speeds up to 80 km/hr
Contact	Poor	Good
Current collection	Poor	Good
Reversibility	Has to be rotated by 180 for reversing the tram	Duplicate bows / arrangement for reversing bows for motion in reverse direction.
Position of supply contact wire.	Any position from track	Centre of track
Cost	Lower	Higher
Weight	Low	High
Application	Trolley bus	Tramway

1 mark for each of any 4 points
= 4 marks

4 A) c) State the meaning of end on generation. State any three advantages of end on generation.

Ans:

Meaning of End on generation:

- Scheme of providing diesel AC generator car at either end of train is end on generation.
- In this system electric power to the train is supplied from diesel generating set at 400V, 3 phase, 50Hz, ac.
- Coaches are provided with through wiring for transmitting 400V, 3phase supply from end to end.
- 5KVA transformers are used for light and fan at 110V ac.
- Heating, cooling loads in the pantry car are provided with 415/230 V ac.
- Fluorescent lighting is used.
- Fans with shaded pole motor are used.
- For improvement of PF static capacitors in generator car are used.

Advantages of End on generation :

- Almost 100% reliability.
- Use of fluorescent lighting improves illumination
- AC fans require no main

2 marks for explanation

+

2 marks for any three



- System is made theft proof.
- Less expensive & easy to maintain as compared to under frame.
- Economical in capital and running cost for 16 or more coaches.
- Weight of equipment in coaches reduced hence additional coaches can be used.
- More amenities to the passengers of deluxe trains can be provided.

advantages
= 4 marks

4 A) d) Draw and explain construction of Faiveley type pantograph collector.

Ans:

Explanation:

Construction of Faiveley type pantograph collector :

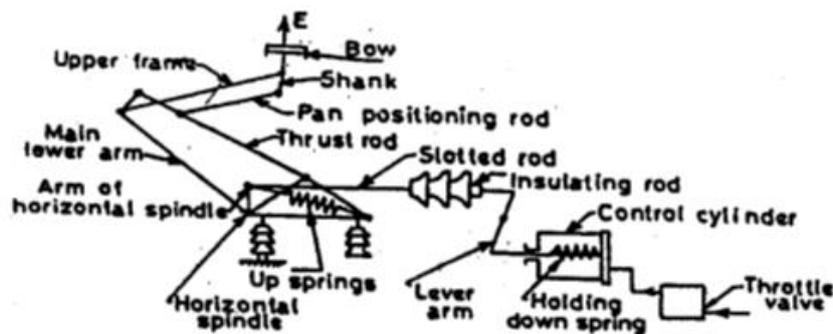


Diagram fully
labeled
2 marks,

- It consists of i) Sub frame or base, ii) Articulated system, iii) Pneumatic control system including throttle valve, iv) Two raising springs v) Four insulators.
- The base is made up of welded sections and houses two ball bearings on which is carried the articulated system.
- Rubber stops are provided to limit the folding of the articulated system at the lower part.
- Articulated system consists of:
 - Horizontal spindle turning into two ball bearings which are part of the base.
 - Lower arm integral with horizontal spindle and supporting at the upper end bearing on which are fitted two tubes of the upper frame.
 - Thrust rod articulated at lower end on fixed point of the base frame and on upper end on bearing housed in the yoke casting at upper end of lower arm.
 - Transversal tube rotating in the sleeves fitted on the tube ends of upper frame.
 - Positioning rod articulated on a pin fitted on the thrust rod and on one side & on the crank pin fitted to the shank as shown in the figure.
 - Bow consists of frame on which are bolted two connecting strips.
 - Whole pantograph is fitted on the roof of the vehicle by means of four insulators.

Partially
labeled
1 marks,

2 mark for
explanation

Working of Faiveley type pantograph collector:

- When compressed air is admitted in the central cylinder, 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 collector touches the OHE.
- The articulated system then stops and piston complete its stroke.
- Piston remains stationary during normal operation.
- The pin of horizontal spindle is permitted to move freely in the slot of slotted rod & pantograph is operated purely by the up springs.

4 B) Attempt any one of the following: 06

4 B) i) State one application each of technically feasible LEM propelled transport system based on suspension used (any Six).

Ans:

- 1) Steel wheel on steel rail --- surface transportation
- 2) Rubber wheel on road --- surface transportation
- 3) Flat surface on water --- crossing rivers
- 4) Levitation --- wheel less travel along pre-defined routs

1 mark each
for any two
points
= 2 marks

Applications related to technically feasible LEM propelled transport system based on suspension used should be considered

4 B) ii) For a traction transformer circuit breaker

- State:
- 1) Rated current and rupturing capacity
 - 2) Any two tests it should be capable of withstanding
 - 3) Overall tripping time and relay time.

Ans:

- 1) Rated current --- 750 A and
Rupturing capacity --- 500 MVA
- 2) Any two tests it should be capable of withstanding ---
Breaking test , Reclosing test , Endurance test (any two)
- 3) Overall tripping time --- 0.14 sec and
Relay time --- 0.04 sec

1 mark
1 mark
2 marks for
two tests
1 mark
1 mark

(Any other standard values written by candidate should be considered)

5 Attempt any two of the following: 16

5 a) i) Give any four important features of the moving primary and fixed secondary single sided LIM.

Ans:

Features of the moving primary and fixed secondary single sided LIM:

- 1) Name of motor as primary stator and secondary rotor.
- 2) A primary winding moving and securing a low cost secondary track per km.
- 3) Impose transferring full propulsion electric power.
- 4) Movable primary is placed above permanent magnet track with alternate polarity.
- 5) Magnetic field is static of fixed secondary.
- 6) In single sided repulsion forces levitate the moving rotor by pushing its conductor away.

1 mark for
each of any
four features
= 4 marks

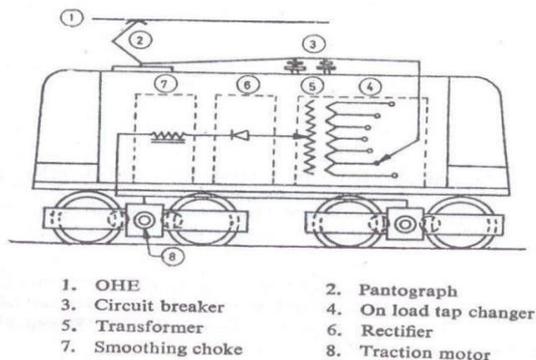


- 7) LIM principle of working on Transverse flux i.e. two poles placed opposite side by side.
- 8) Using longer poles speed and efficiency can be increased.

5 a) ii) Draw the labeled diagram of power circuit of AC locomotive.

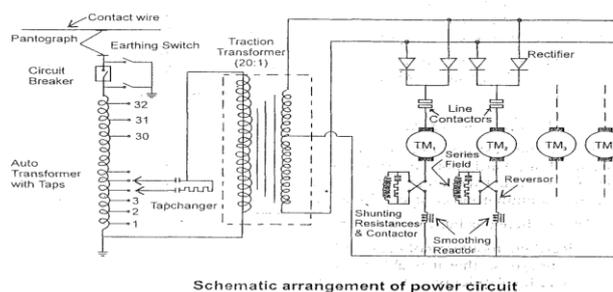
Ans:

Power Circuit of AC Locomotive:



2 marks for diagram

OR



+

2 marks for any four labels.

5 b) **List any four constituents of supply system for traction.**

Ans:

Constituents of Supply System for Traction:

- 1) Substation: It has 132kv,50c/s three phase double circuit input supply and Output of 25 kv 50 c/s single phase double circuit
- 2) Feeding posts: A double circuit line between substation outputs to feeding post at tracks as Protected and controlled feeder line.
- 3) Feeding and sectioning arrangements: The arrangement is used to avoid unbalance in loading of three phase power system.
- 4) Sectioning and paralleling posts: It is an arrangement of power system feeding for two parallel rail track Supply lines between feeding post and neutral section.
- 5) Sub sectioning posts: Each subsection again further divided in one or more sections and parallel posts. They are normally 10-15km in length.
- 6) Elementary section: Subsection of 10-15 km in length is too large for repairs and maintenance point view so for fast isolation of faulty part subsection is further divided into elementary section.

2 marks for each of any four = 8 marks

5 c) With the help of neat labeled diagram explain the working of Double battery



parallel block system for train lighting.

Ans:

Double Battery Parallel Block System for Train Lighting:

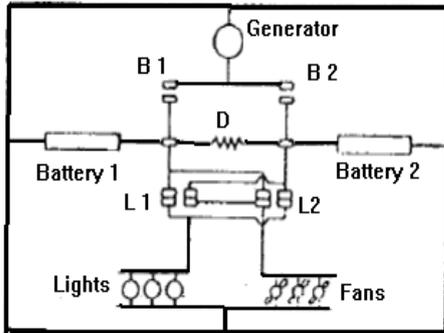


Fig a

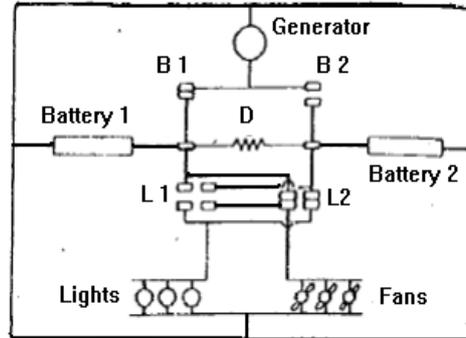


Fig b

- When train is in motion and lights on, as shown in fig(b), generator is connected to battery 1 through closed contact B₁ and lighting load is connected to battery 2 through closed contact L₂.
- When train is in motion and lighting and other loads are switched off, switches L₁ and L₂ are open, lamp resistance D is short circuited when both generator contacts B₁ and B₂ are closed and both batteries will then be charged in parallel.

2 marks for
each labelled
diagram
= 4 marks

2 marks for
explanation of
each
= 4 marks

6 **Attempt any two of the following.**

6 a) i) What are the advantages of VF signaling over DC signaling for remote control operation.

Ans:

Advantages of VF signaling over DC signaling for remote control operation:

- 1) Large number of circuits can be easily derived over a single pair of wires (single pair can control 18 stations).
- 2) Signal attenuation can be compensated by use of repeater stations.
- 3) No interference and cross talk over adjacent conductors.
- 4) Can be used over long distances.
- 5) Can be used where large number of equipment's can be controlled.

1 mark for
each of any
four
= 4 marks

6 a) ii) Explain with necessary diagram the earth fault protection of auxiliary circuit of locomotive.

Ans:

Earth fault protection of auxiliary circuit of locomotive:

Detection of any earth fault in auxiliary circuit of Loco is a very important element of the protection strategy. Since earth fault should not lead to dangerous condition till another fault occurs, this protection is provided with facility of isolation.

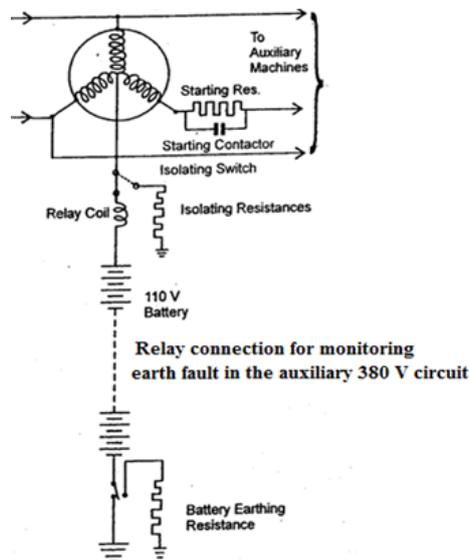
Function of relay: The earth fault occurring anywhere in the auxiliary circuit gets monitored by the relay which acts to trip the main CB. For monitoring

2 marks for
explanation



earth fault in the auxiliary circuit is connected to the star point of the Arno as shown in figure. An earth fault occurring anywhere in the auxiliary circuit gets monitored by the relay which acts to trip the main CB.

Function of isolating resistance: Since earth fault is not dangerous, the locomotive can be worked temporarily by isolating the relay which connects the star point to earth through a high resistance so that the relay operation is avoided.



2 marks for diagram

- 6 b) List any four types of faults that may occur on electric locomotive with their causes.

Ans:

Types of faults on electric locomotive with their causes:

- 1) **Mechanical faults and causes:** Faulty operation, Changes in mechanical loading conditions, Wear & tear, aging & deterioration of important mechanical parts of an equipment.
- 2) **Electric faults and causes:** Changes in the conditions of overloading leading to tripping, burning of tap changer or failure of insulation. External influences of abnormal nature - Like voltage surges, lightning, short circuits elsewhere leading to operation of lightning arrester, breaker, overheating, burning of tap changer etc.
- 3) **Faults due to Environment condition:** Changes in the operating environments such as temperature, moisture, dust etc. leading to failure of insulation, over- heating.
- 4) **Faults due to Improper operation:** Like bad maintenance either due to lack of attention which should have been given or much attention which should have not been given.

1 mark for each type of fault
= 4 marks

1 mark for two causes of each above
= 4 marks

- 6 c) Explain in brief the purpose of following equipment in AC locomotive:

- i) Circuit breaker
- ii) Tap changer
- iii) Smoothing reactor



iv) Transformer

Ans:

i) Circuit breaker:

- Used for protection of traction power circuits from faults, Located at various places for various circuits.
- They are classified by HV Air blast circuit breaker for traction motor protection faults but it has complex control block and arc extinguishing during breaking of faults current.
- Vacuum circuit breaker for used for same purposes it has simplified control blocks and self containing interruption facility.
- Compare to ACB it has longer life, reduced size and weight and higher rating too.
- During maintenance of power circuits and equipments circuit breaker helps in its operations

ii) Tap changer:

- Types: On-load and Off-load Tap changers.
- On load Tap changers are capable to change tap without interrupting the flow of current.
- It is provided on 25 kV regulating winding of locomotive transformer.
- Its operation accompanied by servo mechanism.
- For precision adjustments oil filled selector switch with transition resistance are used.
- On locomotive currently tap changers need more maintenance when locos are used for max speed changing requirements.
- Sometime flashover at tap changers affects the locomotive reliability.
- To avoid problem off flash over thyristor converters and silicon diode rectifiers are used

iii) Smoothing reactor:

- It is pair of choke coils connected at output of rectifier.
- Its function is to make pure DC output which is given to DC series traction motor.
- The function of choke coil is to remove AC ripple present in output of rectifier.
- The smoothened DC given to switch gear of line and combined control of traction motor.

iv) Transformer:

- Traction transformer is special designed transformer.
- Used for traction in loco and at substation.
- They required to stepping down from 220kV/132kV/110kV three phase 50c/s at substation to single phase 25kV, 50 c/s at substation.
- Some others type like Auto transformer, booster transformer also used in track line voltage regulation purposes.
- Traction transformers are normally oil immersed and air cooled with forced



oil circulation cooling.

- The magnetic circuit with 3 rd limb in core and winding on it used for power supply to auxiliary circuit of traction.
- Rating of main traction transformer-Single phase 50c/s,
Primary -4170KVA,Max 27.5kV, Nominal 25kV, Min. 22.5kV,
Secondary -3900KVA, Max. 1058V, Min 865V. Rated current of 2250 Amp.
Auxiliary- 270KVA, Oil immersed and forced oil circulation cooling system.
Impedance voltage:10% \pm IEC Referred to Secondary 865V and Primary 22.5kV