



**Diploma in Engineering: Summer – 2015 Examinations**

**Subject Code : 17640 (MET)**

**Model Answers**

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**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 may try to assess the understanding level of the candidate.
- 3) The language errors such as grammatical, spelling errors should not be given more 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 may give credit for any equivalent figure drawn.
- 5) Credits may 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.
- 6) In case of some questions credit may be given by judgement 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.



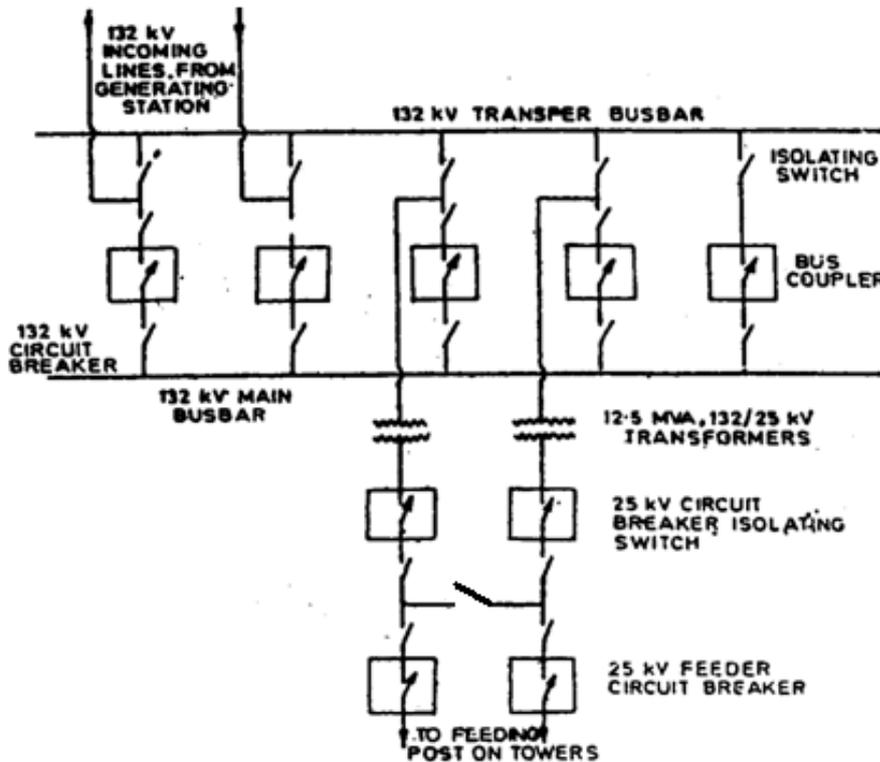
1 (A) Attempt any **THREE** of the following:

12

1 (A) a) Draw neat labeled layout of traction substation.

1 (A) a) Ans:

Layout of Traction Substation.



Fully Labeled 4 marks, partially 3 to 2 marks,

Unlabeled 1 mark

1 (A) b) State miscellaneous equipment at control post or switching substations and their use.

1 (A) b) Miscellaneous equipment at control post or switching substations & functions:

1. Lightning arrestor: protection against over voltage./ voltage surges
2. Auxiliary transformer: provides 230 V 50 Hz, supply to operate battery charger, remote control equipment, signally and lighting.
3. PT: provides continuous indication regarding the condition of supply.
4. Battery : for operation of RC equipment and interrupter.
5. Battery charging equipment: charge batteries at the control post.

½ mark for name max. 2 marks, ½ mark for functions max. 2 marks

1 (A) c) Explain with neat sketch the three aspect colour light signaling.

1 (A) c) Ans:

For color light Signals:-

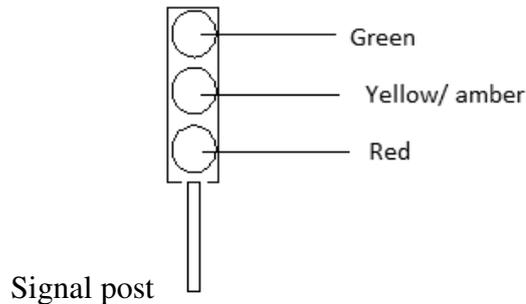
In three aspect signal; (R → Red, Y → Yellow and G → Green)

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

1 mark

1 mark

1 mark



1 mark

OR

For Semaphore signals:-

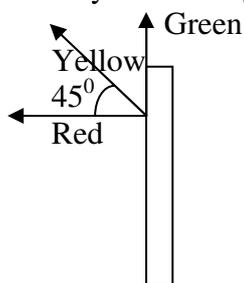
- i) Horizontal arm- Red light – OFF - STOP,
- ii) Arm  $45^\circ$  above horizontal - Yellow light- PROCEED WITH CAUTION,
- iii) Arm vertical up - Green light – ON- Proceed.

1 mark

1 mark

1 mark

Any suitable fig. showing these actions



1 mark

1 (A) d) Give purpose and location of un-insulated and insulated overlap.

1 (A) d) Ans:

Purpose and location of insulated & un-insulated overlap:

Insulated overlap:

- To isolate 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

Un-insulated overlap:

- Two contact wires belonging to two adjacent sub-elementary sections are run parallel to each other for at least one span and electrically connected to each other by means of jumpers. 1 mark
- To rectify faults in one contact wire of two running in parallel without affecting power to OHE. 1 mark
- Located at each sub elementary section.

1 (B) Attempt any one of the following:

6 marks

1 (B) a) With neat sketches list the various types of construction of polygonal OHE and give their scope of application.



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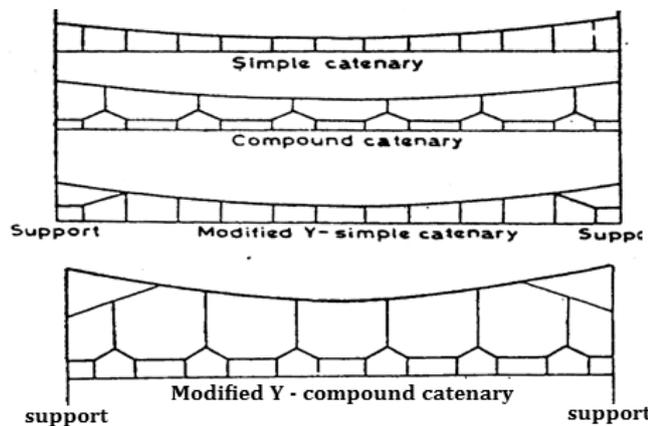
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1 (B) a) Various types of construction of polygonal OHE and Scope of application (speed ranges),

- 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 220 kmph

½ mark each  
for name  
½ mark each  
For speed



½ mark for  
each fig.

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

1 (B) b) Mimic diagram:

Definition: Depicts the power supply arrangement for the overhead 25 kV traction system in the remote control centre on a small scale in the traction power control centre. Indication lamps are provided for each section of catenary, so when voltage fails lamp in corresponding section lights up. Mimic diagram remains black under normal condition.

1 marks

- Mimic diagram is installed at each control centre to give actual visual position of electric supply system. It describes diagrammatically overhead system as well as various substations and control posts.
- Remote controlled equipments 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.,  
DS right angle to busbar – open position for CB
- Glowing of built in lamp of DS- discrepancy between position of DS and the actual position of the apparatus.
- Non remote controlled apparatus like substation isolators are represented by hand operated dummy switches.
- Electrified tracks represented by milky white Perspex strips

3 marks

The TPC gets a complete visual indication of the conditions of the various components of the system with following alarm indicating and supervisory



facilities:

- i) Milky white lamp lights up when alarm is received from any station in the panel. 2 marks
- ii) Green lamp lights up whenever impulse train is being transmitted from or received by remote control centre.
- 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) Explain the purpose of sectioning arrangements.

2 a) Purpose of sectioning arrangements:

- Power to the consecutive substations is fed from different phases in rotation as shown in figure to balance the energy load on the three phases. Avoid phase shifts. 1 mark
- Zones fed by adjacent substations are acting as a separate independent unit. 1 mark
- Neutral section is provided in between two adjacent substations.

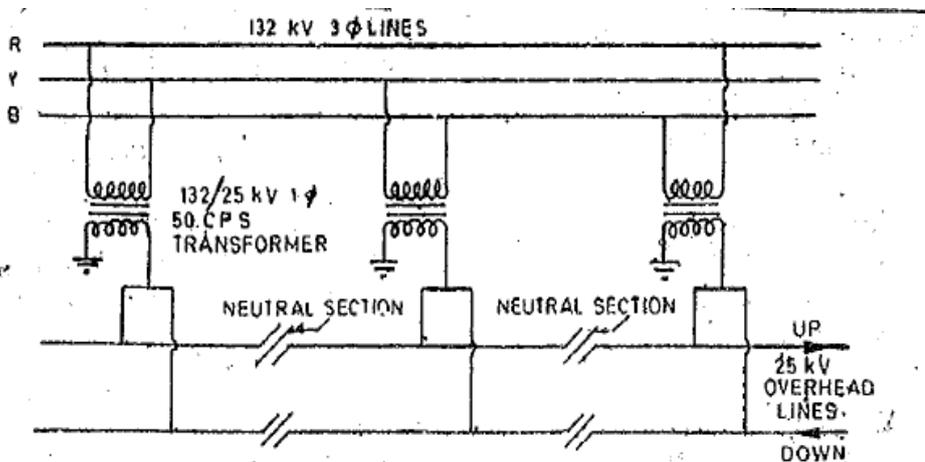


Figure 2  
marks

2 b) State any four advantages of automatic weight tensioning and temperature compensation.

2 b) Ans:

Advantages of automatic weight tensioning and temperature compensation:

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

1 mark for  
each point,  
any 4 points.  
= 4 marks.



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2 c) Explain the working of the single battery system. What are its disadvantages?

2 c) Single battery system:

Working (points to be covered)

- Above certain speed auto cut in switch operates and dynamo supplies light load and charges batteries through lamp resistance.
- At speed below cut out auto cut in switch disconnects dynamo and lamp resistance is shorted; battery supply load directly.

1 mark

Disadvantages:

- Resistance switching during auto cut in results in lamp flickering.
- Need of voltage regulators to control variations.
- Only one battery so total load on it.
- Continuous charging and discharging of battery.

1 mark ( any two )

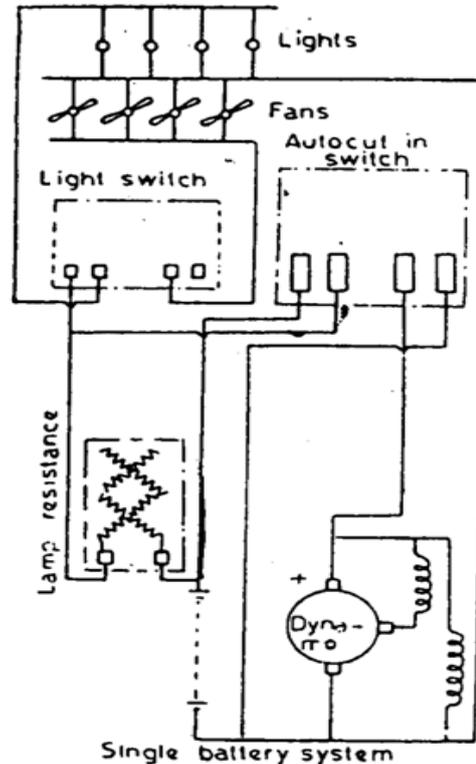


Figure 2 marks

2 d) State function of relay in electric locomotive. List different types of relays for the same with purpose.

2 d) Ans:

Function of relay in locomotives:

Control sequences of operation of components in power circuit in conjunction with auxiliary contacts on power switches. It is remotely controlled and electromagnetically operated .

1 mark

1. Overload relays:

- To sense overload and initiate action for protection as per setting.

2. Low or No voltage relays:

- To sense loss of supply or low voltage and initiate action for tripping of

½ mark each type, ½ mark its purpose



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relevant circuits as of motors etc. and reset their starting circuits.

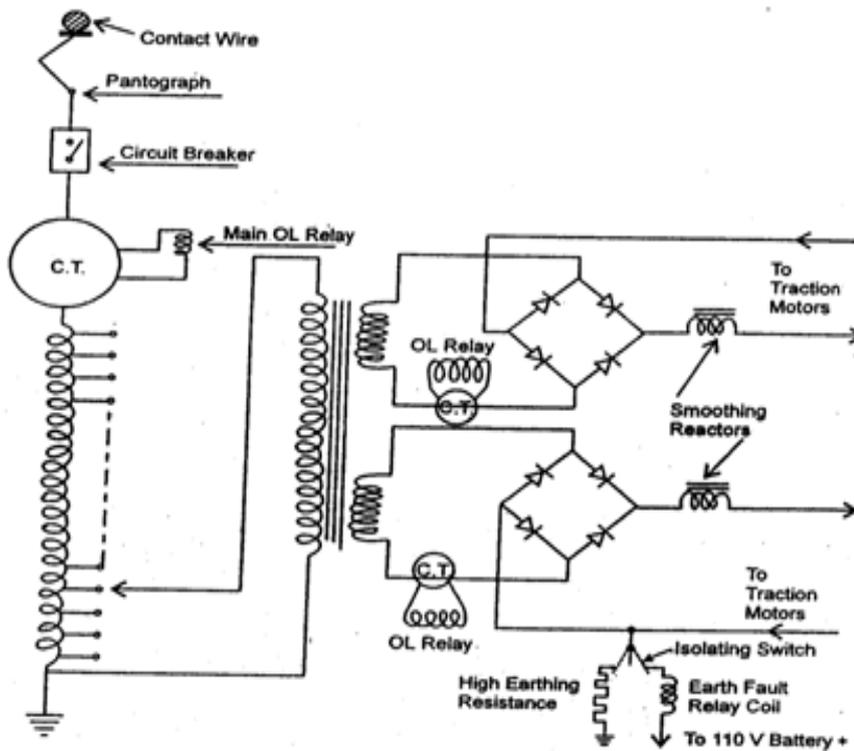
3. Current limiting relays:

- sense current values during the starting of motors and maintain them at limiting values during automatic acceleration of motors.

2 e) Draw schematic diagram showing placement of main and traction overload relays.

2 e) Ans:

Placement of main and traction overload relay:



**Schematic illustrating placement of main and traction circuit overload relays**

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

3 Attempt any FOUR of the following:

16

3 a) What strengths of LIM propelled railway traction system.

3 a) Ans:

Strengths of LIM 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

1 mark each,  
any four = 4  
marks



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in the height of bridges, diameter of tunnels along the route.

6) Avoidance of rotation of parts leads to low mechanical losses.

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

3 b) Give the different types of protection schemes used for traction transformers with a typical layout.

3 b) Ans:  
Protection schemes used for traction transformers:

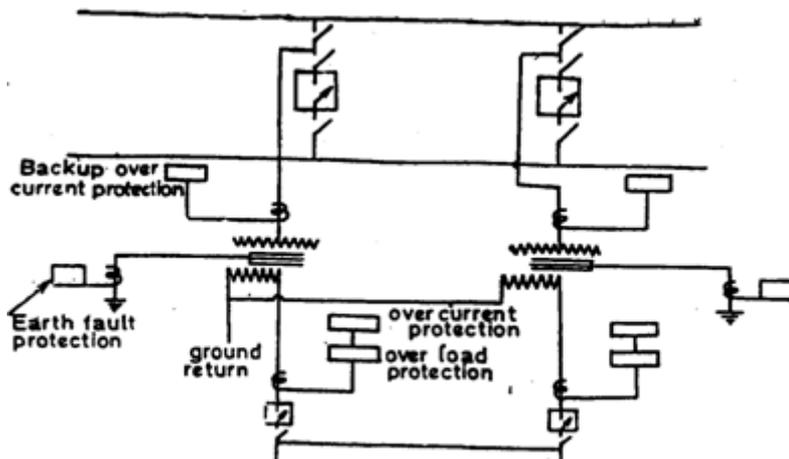


Diagram 2  
marks

Traction transformer protection:

- Inverse time over current relay as back up protection on primary (HV side) – over current protection of transformer and other equipment.
- over current relay on LV side – over current protection of transformer
- Overload thermal relay – protection against sustained overloads on transformer
- Earth fault relay – earth fault protection of transformer.
- Buchholz relay – protection from incipient earth or inter winding faults inside the transformer

1 each ( any  
two ) = 2  
marks

3 c) For conductor rail system used for current collection system:

- i) State its merit (any one) and demerit (any one).
- ii) What is done to reduce the voltage drop at joints?
- iii) Suitable system voltage.

3 c) Ans:

i) Merits: a) Compact than OH system. b) can be used with small diameter tunnels. c) less cost compare to OH

Merit 1 mark

Demerit: Current collection at higher speeds can lead to accidental contact & unsatisfactory current quality; only DC workable.

Demerit  
1 mark

ii) Copper bonds (between rails) provided either by rivetting or welding to reduce voltage drops at joints.

1 mark

iii) (Direct voltage) 750 V for top contact systems and 1200 V for side contact systems.

1 mark



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3 d) State any four factors by which traction transformer differs from ordinary transformer.

3 d) Ans:

- 1) Specially designed to withstand severe operating conditions.
- 2) Are required to have high short time peak capacity.
- 3) Class A insulation , specially reinforced to withstand frequent short circuits.
- 4) Can take overloads as- 50 % for 15 min , 100 % for 5 min , 120 % for instant
- 5) Inpulse withstand voltage nearly 5 times higher
- 6) To limit effect of SC impedance not less than 8.5 % for 10 MVA and 10 % for 12.5 MVA.

1 mark each  
any four = 4  
marks

3 e) What are various supply arrangements of feeding AC traction substation?

3 e) Ans:

Supply arrangement of feeding AC traction sub-station:

I) Supply authorities are responsible for following:

- Operation and Maintenance of 132/110 kV transmission line.
- Operation and Maintenance of Grid substations upto 25 kV outgoing terminals.
- The traction power controller controls 25 kV feeder circuit breaker from remote control centre.

1 mark each  
= 4 marks

II) Supply authorities are responsible for following:

- All 132 kV and 25 kV equipment are owned, installed operated and maintained.
- Railway authorities own, install, operate and maintain 25 kV CBs.

III) Supply authorities give only 132/110 kV supply at substation.

- Railway authorities install, operate and maintain all 132/110 kV equipment at substations.

IV) Supply authorities provide 3 phase supply at 132 kV at a point.

- The railway authorities distribute to the traction substations through own transmission lines.

4 (A) Attempt any THREE of the following:

12

4 (A) a) Describe the criteria for designing height of contact wire for OHE.

4 (A) a) Ans:

Height of contact wire is decided by considering the following:

- 1) Rolling stock gauge (Broad gauge, meter gauge etc.)
- 2) System voltage.
- 3) Location of the track such as in tunnels, on bridges, under bridges, level crossings, etc
- 4) Working at inspection pits, loco sheds

1 mark each  
( any four ) =  
4 marks



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- 5) Type of OHE: regulated or un-regulated.
- 6) Surrounding temperature

4 (A) b) Draw diagram of AC track circuit. State the necessity of impedance band, where AC track are to be used.

4 (A) b) Ans:

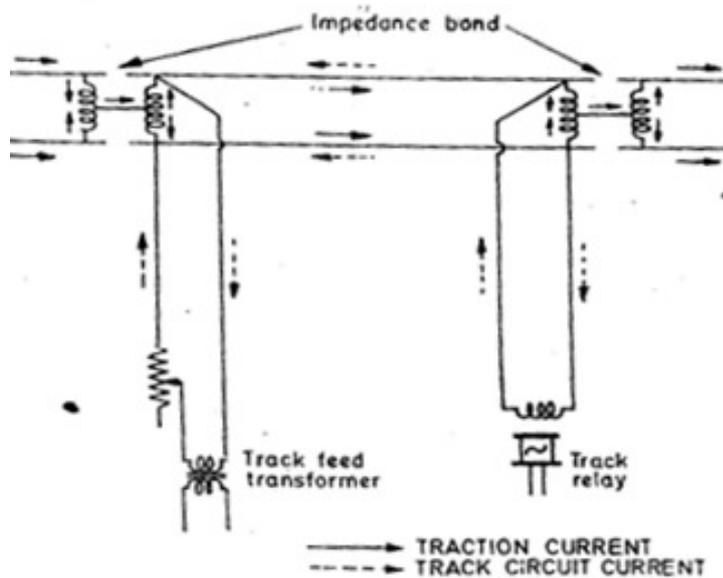


Diagram 2  
marks

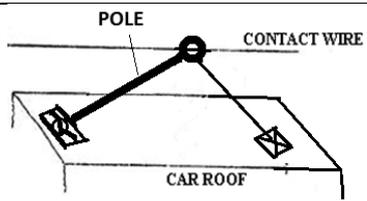
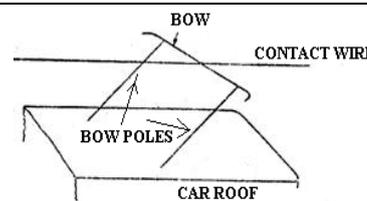
Need of impedance bonds:

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

Any two  
needs 1 mark  
each = 2  
marks

4 (A) c) Compare pole collector with bow collector.

4 (A) c)

Points	Pole collector	Bow collector
Figure		
Construction feature	Simple in construction Grooved slider shoe attached to the end of long pole	Some what 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

1 mark each  
any 4 points  
= 4 marks



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<b>Reversibility</b>	Has to be rotated by 180° for reversing the tram	Duplicate bows / arrangement for reversing bows for motion in reverse direction.
<b>Position of supply contact wire.</b>	Any position from track	Centre of track
<b>Cost</b>	Lower	Higher
<b>Weight</b>	Low	High
<b>Application</b>	Trolley bus	Tramway

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

4 (A) d) Ans:

	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  
any four  
names =  
2marks,

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

**OR**

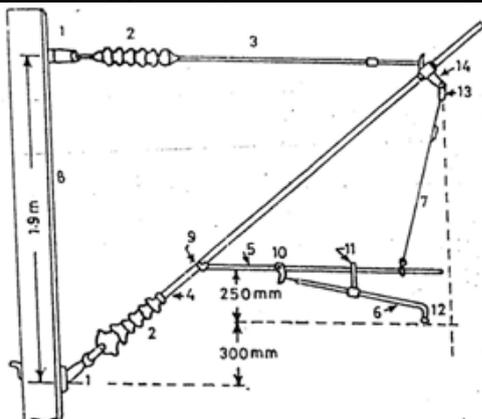
OHE supporting structures are :

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

OR

1 mark each  
for any two =  
2 marks

**OHE supporting structure for single cantilever system:**



- |                         |                                 |
|-------------------------|---------------------------------|
| 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 |

Description  
of any one =  
2 marks



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- Trouble on one track doesn't hamper other track working.
- Simple, easy for erection, economical and can be manufactured before work is carried out.

4 (B) Attempt any one of the following:

6

4 (B) a) Draw a neat labeled diagram of feeding post and state any four important features.

4 (B) a) Ans:

Features 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 FP 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  
any three = 3  
marks

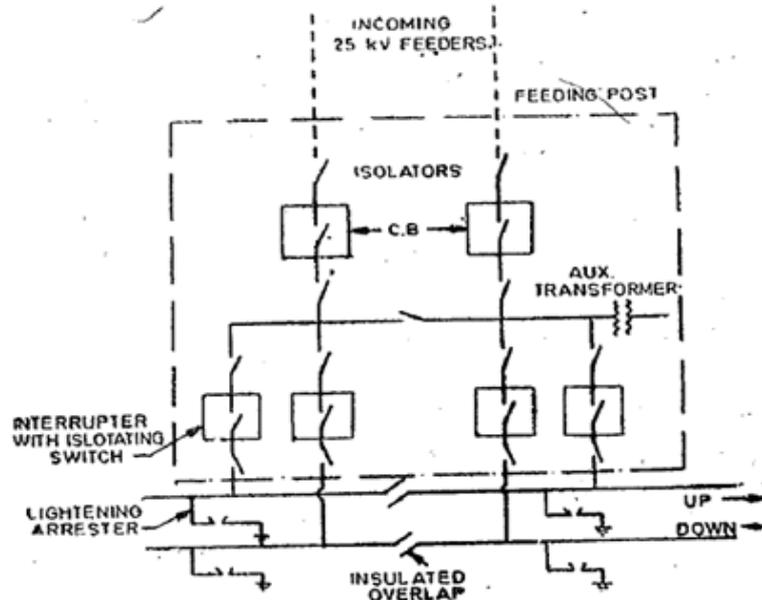


Diagram 3  
marks

4 (B) b) Draw a neat sketch of moving primary fixed secondary double sided LIM and give two advantages & disadvantages for the same.

4 (B) b) Ans: **Moving primary fixed secondary, double side LIM**

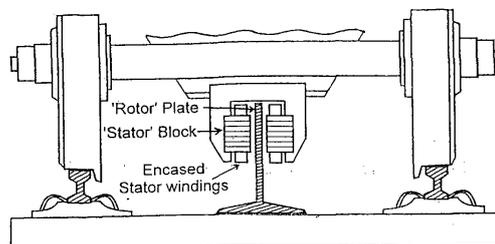


Diagram  
2 marks

Moving-primary fixed-secondary double-sided LIM



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Advantages:

- No Need of backing of iron along the track as laminated core is used in each primary.
- Uniform air gap maintained.
- Higher thrust/force.
- Better magnetic circuit performance.
- Better power factor.

Any two 1  
mark each =  
2marks

Disadvantages:

- Problem of maintaining uniform clearance between secondary Al plate and two primaries all along the track, particularly at points and crossing.
- Costly due to AL plate all along the track .
- Overall dimensions and weight higher
- Increases the risk of accidents result from change in gap due to sudden production of lateral forces on the moving vehicle.

Any two 1  
mark each =  
2marks

5 Attempt any TWO of the following:

16

5 (a) What is end on generation? Explain how it is used in modern trains. Why it is required?

5 (a) **Important points to be covered:**

**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

1 mark each  
for any four  
points  
= 4 marks

**Its required due following:**

- Almost 100% reliability.
- Use of fluorescent lighting improves illumination
- AC fans require no maintenance
- 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 equipments in coaches reduced hence additional coaches can be used.
- more amenities to the passengers of deluxe trains can be provided.

1 mark each  
for any four  
= 4 marks



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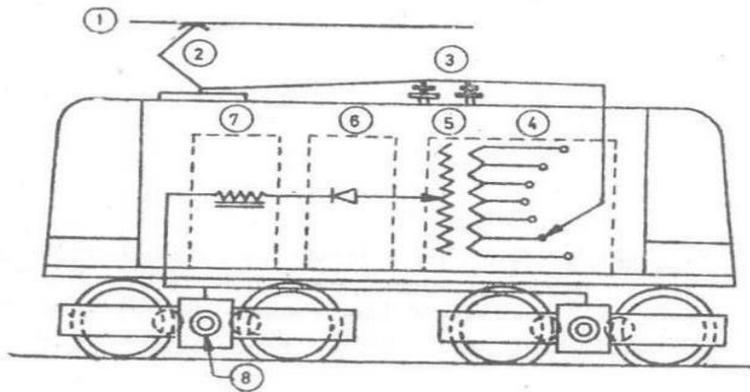
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5 (b) Draw the schematic arrangement of power circuit of AC locomotive. Explain briefly the functions and main features of equipment in power circuit.

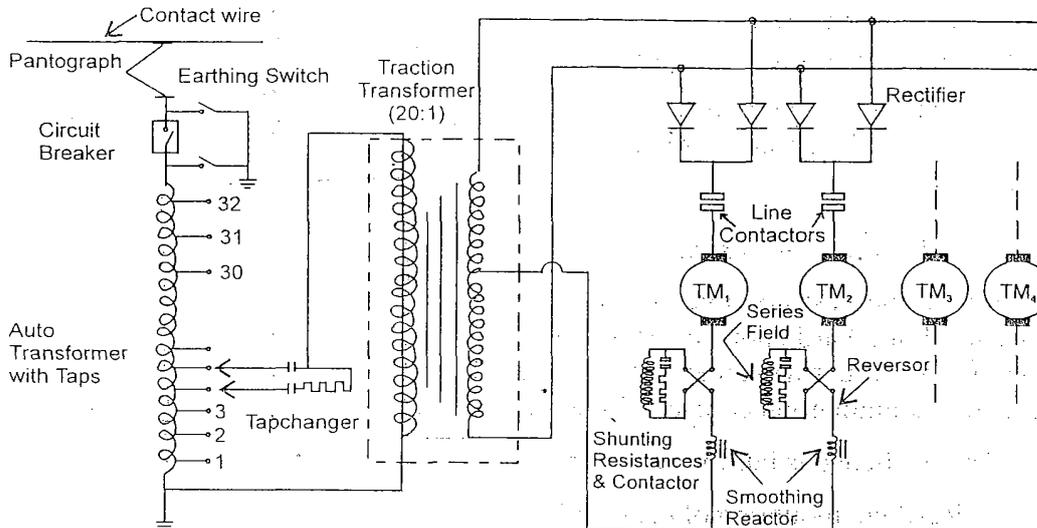
5 (b) Ans:



- |                    |                        |
|--------------------|------------------------|
| 1. OHE             | 2. Pantograph          |
| 3. Circuit breaker | 4. On load tap changer |
| 5. Transformer     | 6. Rectifier           |
| 7. Smoothing choke | 8. Traction motor      |

Diagram fully labeled  
4 marks,  
partially labeled 2 to 3 marks,  
unlabeled 1 mark

**OR**



**Schematic arrangement of power circuit**

Functions & main features of equipment:

- 1) circuit breaker: disconnects the locomotive equipment from the supply in the event of fault .
- 2) On load tap changer, used to control the voltage to the traction motors through the rectifier for speed control.
- 3) Traction transformer, steps down the voltage to the suitable value for the traction motor. It has a ratio of 20:1 .
- 4) Rectifier: converts input AC to DC for further use by series traction motors.

Any four 1 mark each = 4 marks



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- 5) Smoothing reactor/choke: smoothen out the ripples in the DC output current of rectifier .
- 6) Traction motor: operates as per the required operating characteristics to take on the traction load.
- 7) Earthing switch to be closed before working for maintenance. for energizing loco equipment at 25 kV it is opened.

5 (c) i) Give any four important features of moving primary & fixed secondary single sided LIM.

5 (c) i) Ans:

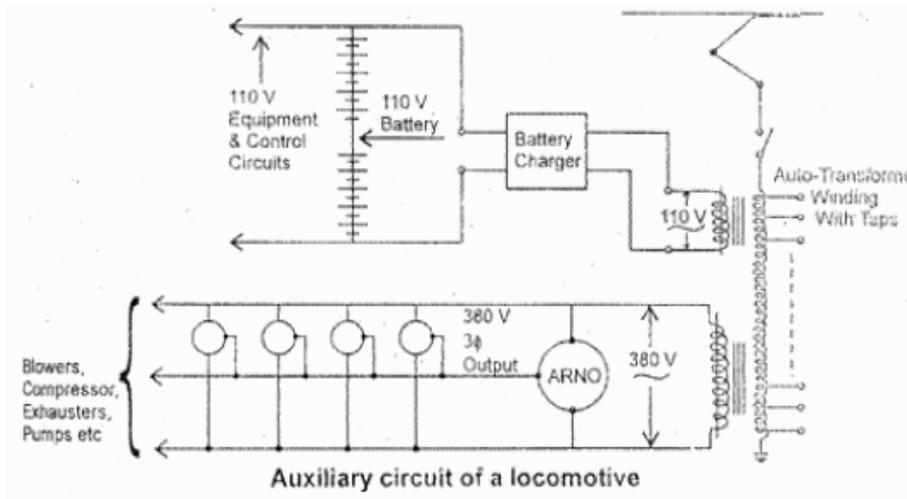
Important features of moving primary and fixed secondary single sided LIM:

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

Any four 1  
mark each =  
4 marks

5 (c) ii) Draw the labeled diagram of auxiliary circuit of a AC locomotive.

5 (c) ii) Ans:



Fully labeled  
4 marks,  
partially  
labeled 2 to 3  
marks,

Unlabeled 1  
mark

6 Attempt any TWO of the following:

16

6 (a) Explain the purpose of following equipments in AC locomotive:

- (i) Circuit breaker & earthing switch.
- (ii) Tap changer
- (iii) Head light
- (iv) Marker light.



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- 6 (a) (i) Circuit breaker & earthing switch:  
Circuit breaker: disconnects the locomotive equipment from the supply in the event of fault . 1 mark  
Earthing switch to be closed before working for maintenance. for energizing loco equipment at 25 kV it is opened. 1 mark
- (ii) Tap changer: On load tap changer, used to control the voltage to the traction motors through the rectifier for speed control. precise control. LV or HV tap changing is used. 2 marks
- (iii) Head light: located at centre near roof level, provide powerful vision support for drivers over the track ahead. The headlights work on 32 V ac and can be dimmed if needed at 16 V ac. They beam up to a distance of 800 m if powerful enough. 2 marks
- (iv) Marker light: located on lower section on both sides (front and rear). Markers have a switchable lens so they can have one of two colours -- red or white. Normally the marker lamps are white in front (at the leading face of the loco). The rear marker lights are lit, and red in colour, when the loco is travelling alone red marker indicates parking light. 2 marks
- 6 (b) i) What is need for maintenance and policy of obsolescence of locomotive?
- 6 (b) i) Ans:  
Need for maintenance & policy of obsolescence of locomotive: All points covered 4 marks, proportional reduction if less coverage, (Other valid options may also be considered)
- Maintenance must be continuously so planned and carried out to maintain the fitment (of various) of parts replaced with respect to one another.
  - Enough stock of critical parts is maintained.
  - Schedule of maintenance planned to minimize loss.
  - Replace obsolete parts with current equivalent alternatives.
  - Take rational decisions through adverse minimum of defender (existing equipment) with adverse minimum of challenger (new option available) for replacement.
- 6 (b) ii) Explain means to improve reliability of locomotive.
- 6 (b) ii) 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 method of trouble shooting and repairs: remedy effective with correct diagnosis, complete and systematic investigation has to be made, provide



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filters with clear instructions in the trouble shooting chart.

3. Technical investigations: important part is to learn the root cause of failure, every cause is studied to improve, modification or changes in design.
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. Tests and trials: reliability can be improved if behavior of certain components is known, test and trials carried out at shed are useful for reframing future specifications

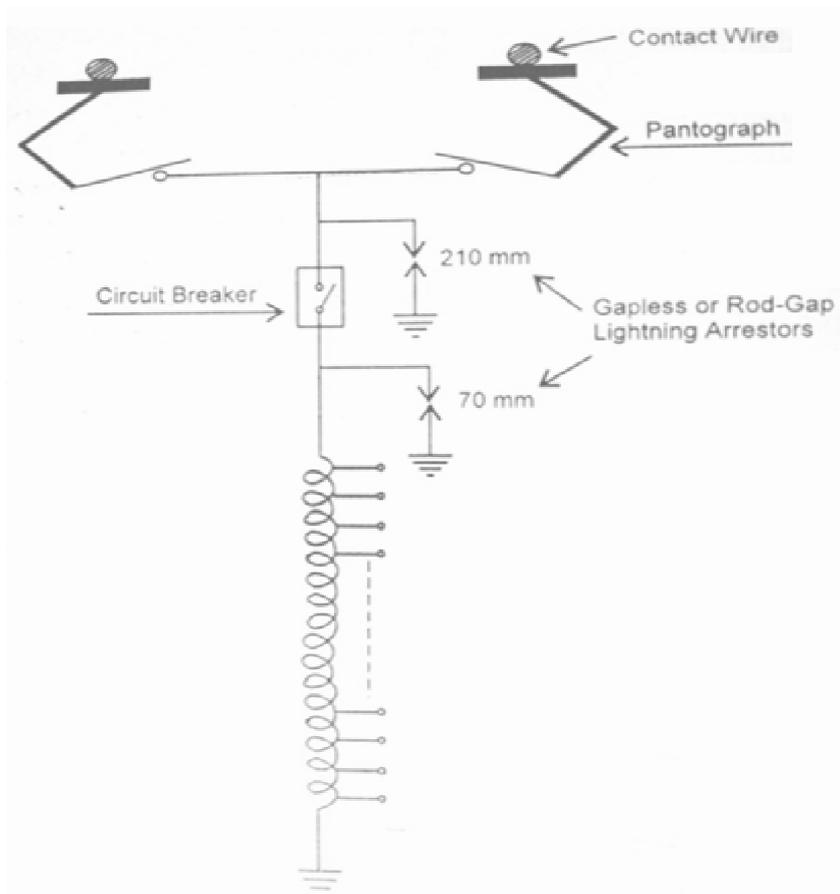
Any four points ½ mark each for means and ½ mark each for its explanation= 4 marks.

6 (c) i) Explain with neat sketch protection of locos against lightening surges.

- 6 (c) i) Locomotives are protected against lightning surges by spark gaps or gapless LA. Performance of gaps affected by climate variations , swarm of insects and dust. Rod gap setting changes due to melting and globule formation. When gap breaks the current is interrupted by tripping of CB. Now a day gapless lightning arrestors are used. They discharge the surge without interrupting the circuit and are not affected by atmospheric conditions such as storm, rain etc.

2 mark

Equivalent diagram may be considered. Fully labeled 2 marks, partially/unlabeled 1 mark





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**Model Answers**

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6 (c) ii) What are the advantages of VF signaling over DC signaling for remote control operations.

6 (c) ii) Advantages of VF signaling over DC signaling for remote control operations:

1 mark each  
( any four ) =  
4 marks

- 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 equipments can be controlled.
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