

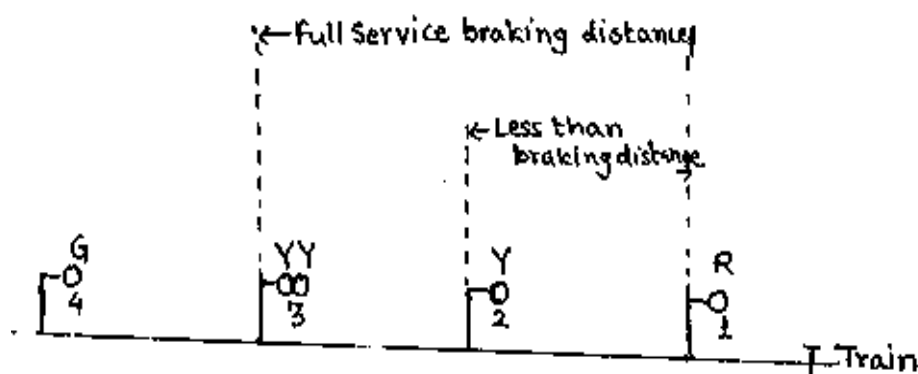
Model Answer
Winter – 2018 Examinations
Subject & Code: Modern Electric Traction (17640)

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.

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- 1 Attempt **any five:** **20**
- 1 a) Give any four 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. 1 mark for each of any four advantages = 4 marks
 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 b) Give the purpose and location of neutral section and section insulator.
- Ans:**
Purpose of Neutral section:
Passing of pantograph under insulated overlap will cause short circuit between two phases, damaging OHE & pantograph. To avoid this bridging, a neutral section is inserted between them. 1 mark for each purpose = 2marks
- Location:** Located between two substations.
- Purpose of Section insulator:**
Section insulators are provided to insulate OHE of one elementary section from the OHE of another adjacent elementary section. 1 mark for each location = 2marks
- Location:** Located at cross over from one track to other, from main line to siding.
- 1 c) With neat sketch explain the four aspects of colour light signalling.
- Ans:**
Four aspects of colour light signaling:
- 4th aspect is attention aspect given by 2 yellow lights in vertical fashion interpreted as “prepared to pass next signal at restricted speed”. 1 mark
 - Signal-1 & 2 located less than braking distance apart. Signal- 3 shows attention aspect, when signal-2 is at caution. 1 mark
 - A driver sighting signal-3, must pass signal-2 at restricted speed, stop has to be made at signal-1. 1 mark



1 mark

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1 d) State the classification of locomotive.

Ans:

Classification of Locomotive:

A) Based on the types of service rendered:

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.

2 marks

B) Based on the gauge of railway:

1. Broad gauge (W)
2. Meter gauge (Y).

1 mark

C) Based on the type of supply used:

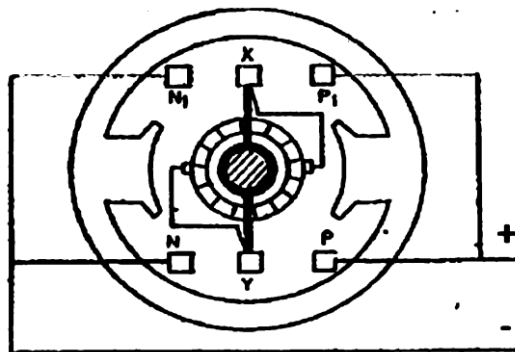
1. Alternating current (AC)
2. Direct current (DC)

1 mark

1 e) With the help of neat diagram, explain the method to obtain unidirectional polarity in train lighting.

Ans:

Method to Obtain Unidirectional Polarity in Train Lighting:



2 marks for figure

1 mark for clockwise and
1 mark for anticlockwise

Dynamo has rocker arm mounted on the shaft, friction tight. When the direction of rotation of the shaft is clockwise, terminal X (positive) touches P₁ while terminal Y (negative) touches N. Thus, giving the output polarity as shown in figure. When the direction of rotation is anticlockwise, X (negative) terminal of the rocker arm will now touch to N₁ brush and Y (positive) terminal of the rocker arm will touch to P. Thus, the output polarities will be obtained as shown in figure. Thus, unidirectional polarity is obtained.

1 f) List any 8 equipment used in auxiliary circuit of electric locomotive.

Ans:

Equipment Used in Auxiliary Circuit of Electric Locomotive:

1. Batteries
2. Compressor
3. Blowers
4. Exhausters
5. Pumps
6. Cab ventilating fans
7. Locomotive heating (if any)
8. Transformer oil cooling radiator

1/2 mark for each of any eight equipment
= 4 marks

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- 9. Head light
- 10. Flasher light
- 11. Marker light
- 12. Engine Horn

1 g) Explain the following - 1) Encumbrance 2) Span length.

Ans:

Encumbrance:

It is the axial distance between catenary and contact wire.

Its value is maintained at 1.4 m as per rules except at

- i) Turn outs,
- ii) Overlaps
- iii) In the vicinity of over line structure.

2 marks

Span length:

It is the distance between two adjacent traction mats, generally this distance is in multiples of 4.5 m and vary from 27 m to 72 m. This can be facilitates the erection of OHE with standard dropper length and avoid mistake in erection.

The span length 72m as per standard, which allows eight droppers at the spacing of 9m from each other.

2 marks

The span length depends various factors like:

- i) Wind pressure
- ii) Curvatures
- iii) Current collection point of view etc.

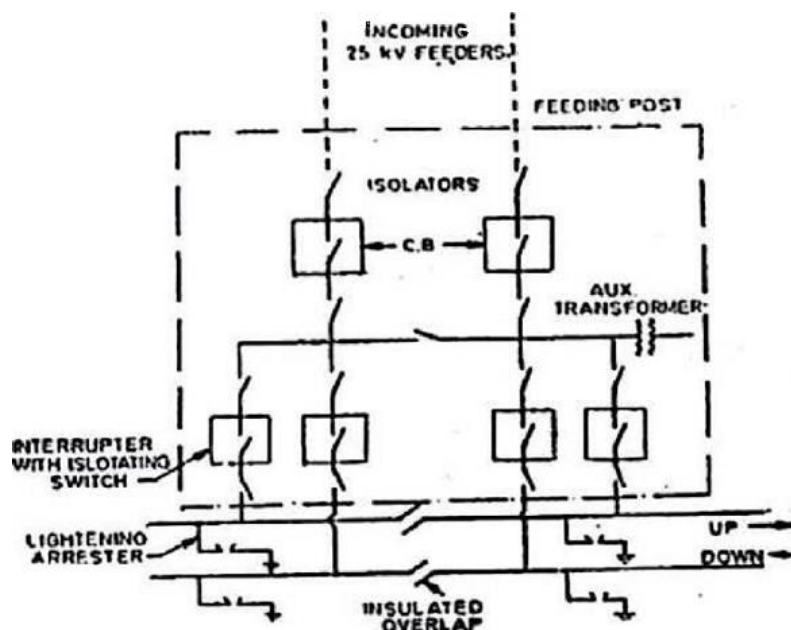
2 Attempt **any two**:

16

2a) Draw a neat labelled diagram of feeding post and write any four points related to it.

Ans:

Feeding Post:



4 marks for
labeled
diagram
3 marks for
partially-
labeled
diagram
2 marks for
unlabeled
diagram

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Points Related to Feeding Post:

1. Normally there are two feeders running in between substation and feeding posts. Each feeder has two conductors one insulated for 25 kV (connected to bus-bar) and other for 3 kV (connected to track for return current).
2. Cross-section of the conductor is 20sq.mm of copper or 400 sq.mm of A.C.S.R.
3. Located as near as possible to substation with maximum distance being 2 km.
4. Feeders connected to two sets of bus-bars which are used to maintain supply to OHE in case of failure of one of them or when under maintenance.
5. The 25 kV CB of feeding post are controlled from RCC of railway.
6. 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 for
each of any
four points
= 4 marks

- 2b) With neat sketch explain automatic weight tension and temperature compensation.

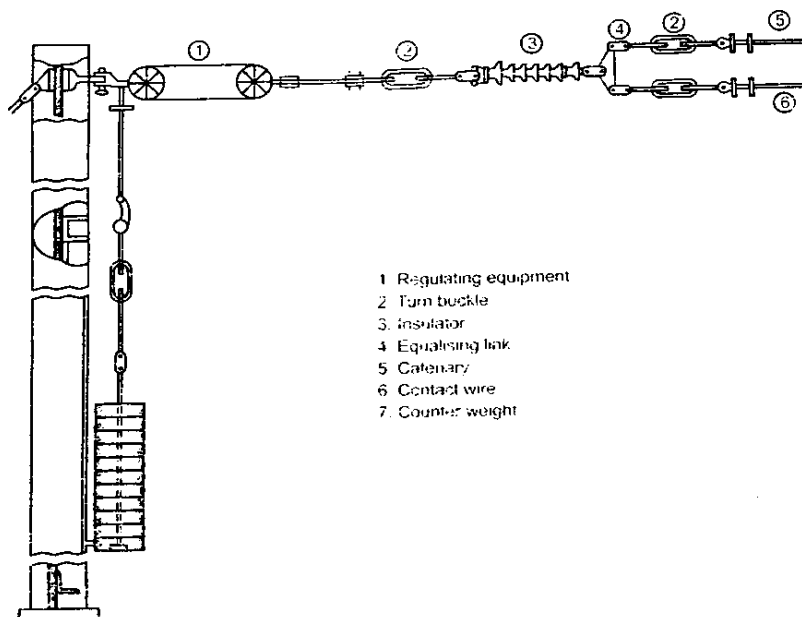
Ans:

Automatic Weight Tension and Temperature Compensation:

The tension in overhead lines in traction systems depends on the temperature. Higher temperatures lead to expansion of conductors and hence sag. It is therefore necessary to minimize the sag to least by giving more tension to the conductors. This adjustment of tension and sag is done automatically to facilitate spark less collection of current from the overhead lines by the current collectors mounted on the top of high speed loco. It works as follows:

4 marks for
explanation

The tensioning device consists of pulley block or a winch with suitable reduction ratio. This arrangement is made on the two sides of the tensioned catenary and contact wire. With variations in the temperature the tension in the contact wire and catenary are maintained due to the pull of the counter weights of around 400 kg shown in the figure. The tension in the contact wire and catenary is around 1000 kg.



4 marks for
labeled
diagram
3 marks for
partially-
labeled
diagram
2 marks for
unlabeled
diagram

Model Answer

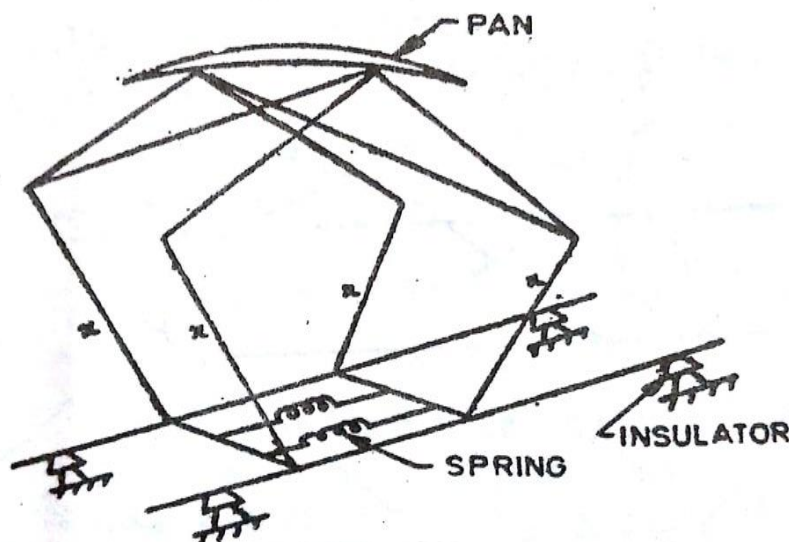
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- 2c) Draw and explain in brief construction of Diamond Pantograph. Write one advantage and one disadvantage of it.

Ans:

Diamond Pantograph:



3 marks for
diagram

Construction of Diamond Pantograph:

- 1) Diamond Pantograph consists of pressed steel channel sectional fitted with renewable collector strips and supported at the apex of Pentagonal tubular frame work as shown in above figure.
- 2) Collector strips are forced against the contact wire by upward action pantograph springs.
- 3) These strips slide along the bare metal of the contact wire as the train moves.
- 4) The collector strip material and the contact pressure are such as to ensure the minimum wear of the contact wire.
- 5) Metalized carbon strips are used for high current collecting capacity and to avoid use of lubricant.
- 6) Diamond Pantograph may be raised or lowered from cabin by following methods.
 - a) Air raised gravity lowered.
 - b) Air raised spring lowered
 - c) Spring raised air lowered

3 marks for
construction

Advantages of Diamond Pantograph:

1. Reversible operation.
2. Spark less Current collection.
3. Higher contact pressure.
4. Higher currents are handled.

1 mark for
any one
advantage

Disadvantages of Diamond Pantograph:

1. For given vertical range Diamond Pantograph requires lot of roof area.
2. Diamond Pantograph is heavier and bulky structure than Faiveley type.
3. It requires more maintenance than Faiveley type.
4. It is costlier than Faiveley type.

1 mark for
any one
disadvantage

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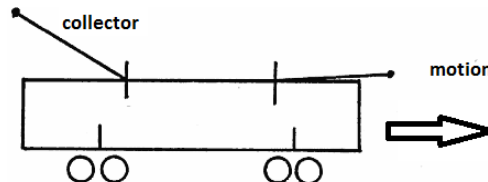
3 Attempt **any four**:

16

3a) Explain with neat diagram trolley collector for overhead system.

Ans:

Trolley Collector for Overhead System:



1 mark for figure

- This consists of a grooved gun metal wheel or grooved slider shoe with carbon insert carried attached to the end of a long pole provided on the top of the car.
- Other end of this pole is hinged to a swiveling base fixed to roof of vehicle.
- Necessary upward pressure for the pole and current collector is achieved by means of springs.
- As two trolley wires are required for a trolley bus a separate trolley collector is provided for each wire, the bases being mounted side by side.
- The pressure for wheel is approximately 10kg and for a carbon insert slider is approximately 17kg.
- The main drawback of trolley collector is that it has to be rotated through 180° for reversing the direction of motion of the vehicle.
- Another drawback is that there is poor contact between the wheel and trolley wire which gives rise to high current density.
- Suitable for comparative low speed (say 22 to 30 kmph).

+

1 mark for each point (any three)

3b) List any four weaknesses of LIM propelled railway traction system.

Ans:

Weaknesses of LIM Propelled Railway Traction System:

1. The system requires looping of all reaction rails all along the route. This considerably adds to the cost of track.
2. Since Al is relative expensive material, hence chances of theft of more, hence disruption of service
3. Due to more air gap in LIM than IM, 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 for each
= 4 marks

3c) List any four miscellaneous equipments at control post.State function of each.

Ans:

Miscellaneous Equipments at Control Post With Their Function:

1. **Lightning Arrestor:** Provides protection against over-voltages / surges.
2. **Auxiliary transformer:** Provides 230 V, 50 Hz, supply to operate battery charger, remote control equipment, signally and lighting at control post.
3. **PT:** Provides continuous indication regarding the condition of supply, for measurement and protection purposes.
4. **Battery:** For operation of control equipment and interrupter.
5. **Battery charging equipment:** For charging of batteries at the control post.

1 mark for each of any four equipment
= 4 marks

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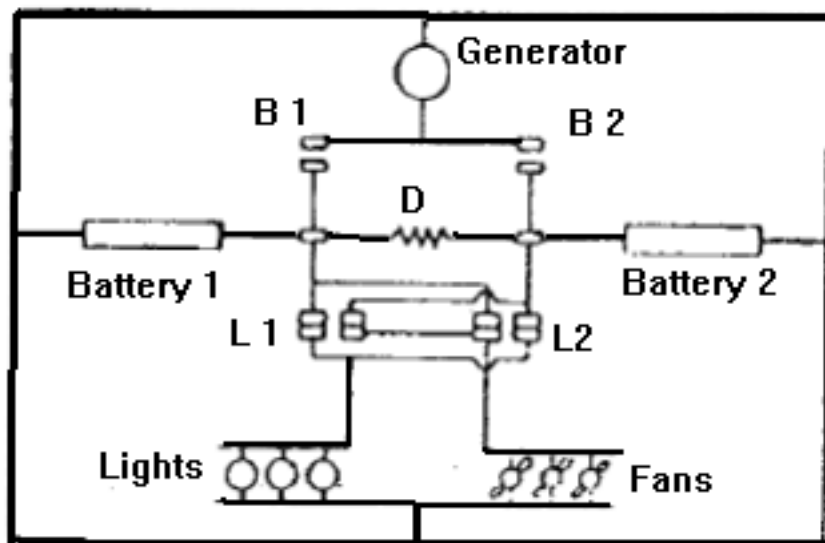
- 3 d) Explain with neat diagram the working of double battery parallel block system in train lighting.

Ans:

Working of Double Battery Parallel Block System in Train Lighting:

1. 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 following figure.

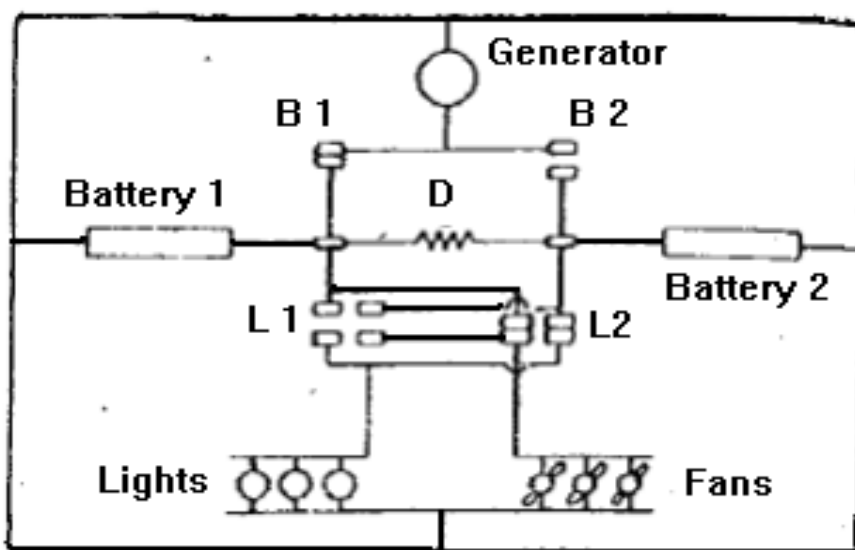
1 mark



1 mark

2. When train is in motion and lights on, generator is connected to battery 1 through closed contact B_1 and lighting load is connected to battery 2 through closed contact L_2 , as shown in following figure.

½ mark



1 mark

3. 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.

½ mark

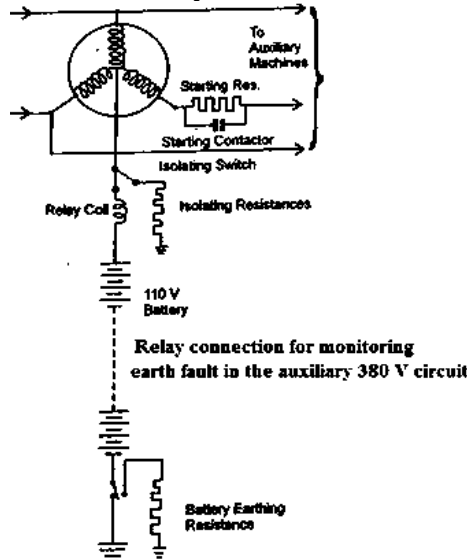
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- 3e) Draw a neat diagram of earth fault protection of auxiliary circuit.

Ans:

Earth Fault Protection of Auxiliary Circuit:



4 marks for
labeled
diagram
3 marks for
partially-
labeled
diagram
2 marks for
unlabeled
diagram

- 3 f) List any four current collectors for overhead system. State application of each.

Ans:

Current Collectors for Overhead System With Their Application:

1. **Trolley (Pole) collector:** It is used for trolley buses having speed range from 20kmph to 32kmph.
2. **Cable collector:** This system consist long cable and power driven reel is carried by locomotive. It is used where track route is exposed to dangerous gases, dust and chemical.
3. **Bow collector:** It is used for tramways having higher speed range.
4. **Pantograph collector:** It is used for main line service locomotives, urban trains, suburban trains etc. having higher speed range.

1 mark for
each
= 4 marks

- 4 a) Attempt **any two**:

12

- 4 a) i) State any four ideal requirements of signaling system.

Ans:

Ideal Requirements of Signaling System:

1. Unless the whole section of track governed by the signal is clear & safe, it should not be possible to display 'safe' indication.
2. Failure of any component of signaling scheme should give danger indication.
3. There should be provision of automatic application of brakes to the train, should the driver ignore the danger indication of the signal.
4. Electric lock should be provided on the lever working the home signal.
5. All traction signals are located on the left side of the track.
6. The signal units are so fixed that the height of the center line of the red signal shall be approximately 3.65m above the track.
7. No part of the signal without track indicator shall normally be higher than 5.2m above the track.
8. If signals are located between the tracks, no OHE structures shall be provided in the same track space for at least 600m in the rear of the signal.

1 mark for
each of any
four
requirements
= 4 marks

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- 4 a) ii) Give any four advantages of voice frequency signaling over DC signaling system.

Ans:

Advantages of Voice Frequency Signaling Over DC Signaling System:

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 can be controlled.

1 mark for
each of any
four
advantages
= 4 marks

- 4 b) i) State any four relays used for catenary protection. State function of each relay.

Ans:

Relays Used for Catenary Protection:

1. MHO relay: Wrong coupling protection.
2. MHO relay: Over current protection at farthest point.
3. Over current relay: Over current protection against faults near substation
4. Under voltage relay: Protection against faults far away from substation.

1 mark for
each
= 4 marks

- 4 b) ii) Write down the circuit breaker with their rating used in traction substation. Explain any one.

Ans:

Circuit Breaker With Their Rating Used in Traction Substation:

Rated capacity of a circuit breaker is 750Amps at 25 kV, 500MVA. Its overall tripping time is 0.14 seconds composed of 0.04 seconds for relay operation and 0.1 seconds for opening of breaker contacts.

4 marks

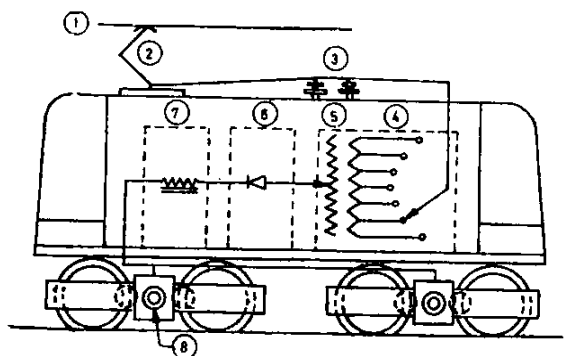
There are various types of circuit breakers are available according to the type of arc extinction medium but in case of traction substation application, mostly Minimum Oil Circuit Breaker (MOCB) is preferred.

OR Equivalent Answer

- 4 c) Draw neat labeled diagram of 1- ϕ AC locomotive showing its various equipment of power circuit and give the function of each equipment used in power circuit.

Ans:

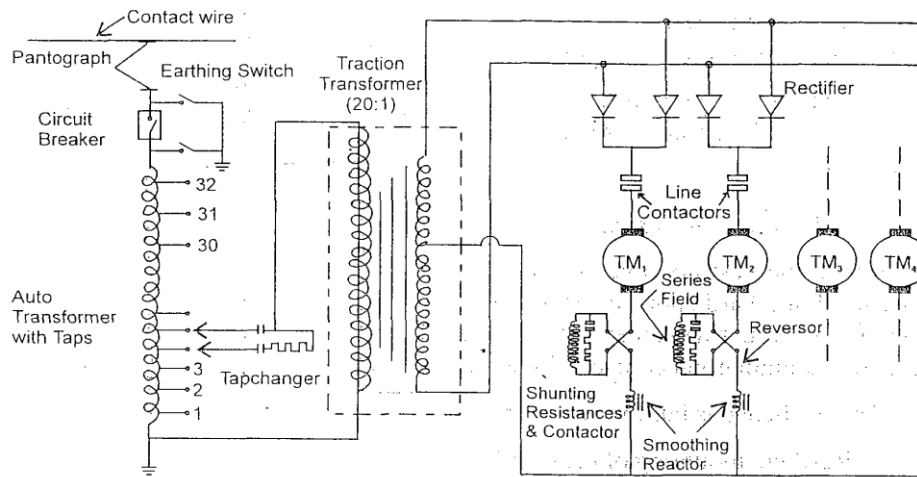
Diagram of 1- ϕ AC Locomotive:



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

4 marks for
labeled
diagram
3 marks for
partially-
labeled
diagram
2 marks for
unlabeled
diagram

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OR



Schematic arrangement of power circuit

Functions of Equipment:

1. **Circuit Breaker:** Disconnects the locomotive equipment from the supply in the event of fault in the equipment / loco.
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.
5. **Smoothing reactor/choke:** Smoothen out the ripples in the DC output current of rectifier.
6. **Traction motor:** Operates as per the requirement to take the traction load.

4 marks

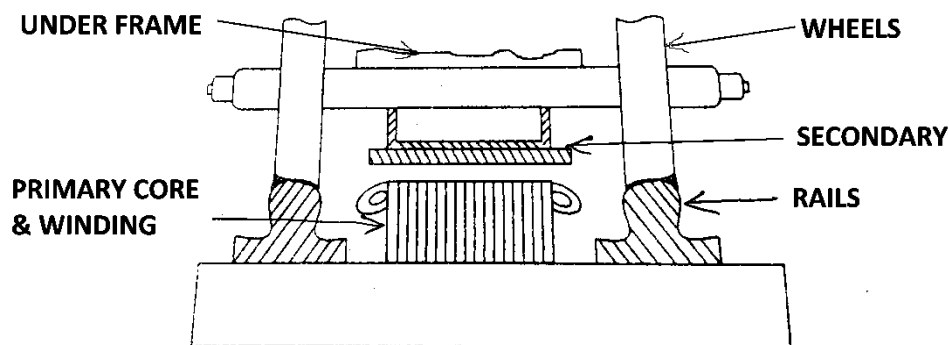
5 Attempt any four:

16

5a) Draw neat sketch of moving secondary fixed primary single sided LIM.

Ans:

Moving Secondary Fixed Primary Single Sided LIM:



MOVING SECONDAY FIXED PRIMARY SINGLE SIDED L.I.M.

4 marks for labeled diagram
3 marks for partially-labeled diagram
2 marks for unlabeled diagram

Model Answer

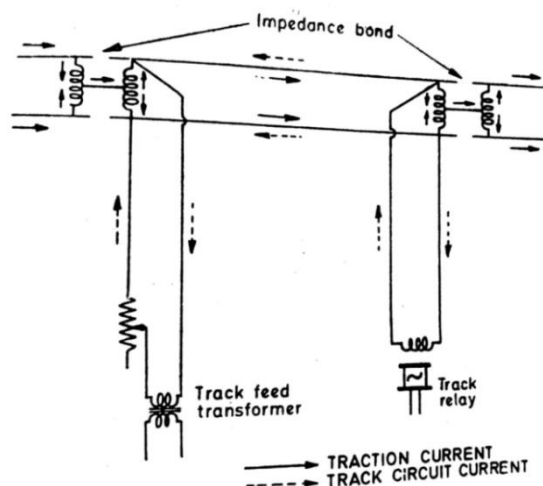
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- 5b) Draw neat labeled diagram of AC track circuit. Also give two advantages of AC track circuit.

Ans:

AC Track Circuit:



2 marks for
labeled
diagram

Advantages of AC Track Circuit:

1. Free from effects of stray currents.
2. Track circuit is up to a long length of track in one section length up to 3km to 5 km.
3. Cheaper in costs as compared to DC track circuit.
4. Easy to install than DC track circuit.

2 marks for
any two
advantages

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

Ans:

Need of Maintenance of Electric Locomotive:

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

1 mark for
each of
any four
= 4 marks

OR

Maintenance of Electric Locomotive is needed as it:

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

- 5d) State four important features of LEM that differ it from normal electric motor.

Ans:

Important Features of LEM That Differ it From Normal Electric Motor:

1. In LEM, primary & secondary or stator & rotor have longitudinal arrangement while normal electric motor has circular parts.
2. Air gap between stator & rotor is more in LEM as compared to normal electric motor.

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3. Power factor is poor in LEM as compared to normal electric motor.
4. Linear relative magnetic field is produced in LEM and the rotary magnetic field is produced in normal electric motor.
5. Speed is measured in **m/sec** in LEM and in **RPM** for normal electric motor.
6. No speed limit for LEM while maximum speed of normal electric motor is 3000 RPM.
7. LEM has Less efficiency as compared to normal electric motor.
8. LEM is used in high speed levitated system while normal electric motor is used for rotary mechanical output.

1 mark for
each of any
4 features
= 4 marks

- 5e) Give protection scheme used for 25kV catenary protection for AC traction.

Ans:

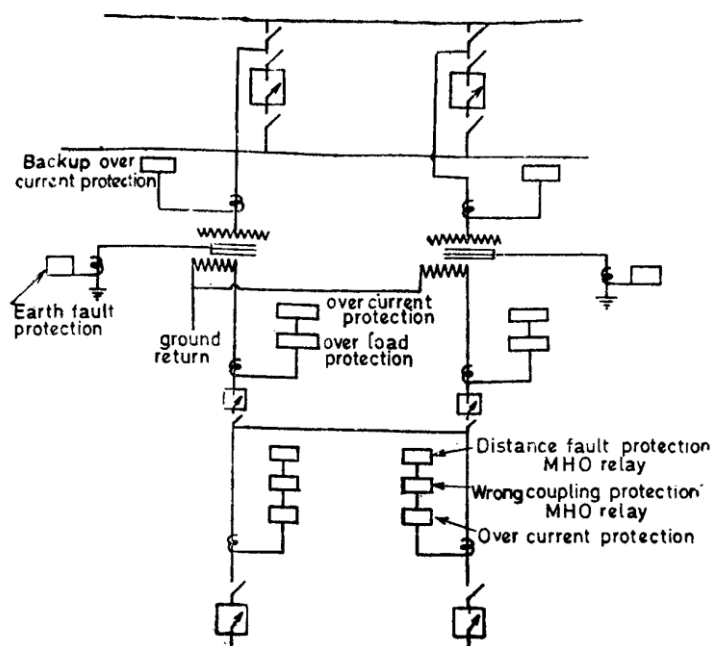
Protection Scheme Used for 25kV Catenary Protection for AC Traction:

As shown in the figure below the scheme consists of

- 1) MHO relay that makes use of the impedance phase angle to get proper discrimination for distant faults on it. It consists of PT, CT on 25 kV catenary and variable capacitors for phase angle adjustment.
- 2) Over current relay.
- 3) Under voltage relay for low voltage protection.

1 mark

25 KV catenary protection.



3 marks

- 5f) List different types of signals. State application of each.

Ans:

Different Types of Signals:

- 1) **Flag signals:** This is shown by signalman if green flag is raised; it means to proceed with caution. Green flag shown down, it means there is track defect; the train should not go ahead.
- 2) **Denoting signals:** These signals are used in foggy / cloudy weathers to indicate the positions of a signal to the drivers of approaching locomotive. They are placed across the tracks and explode when the engine pass over them, which makes aloud sound and attracts the attention of driver.
- 3) **Warner signals:** 'ON' position indicates the signal ahead is at danger and

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driver can pass signal with caution and be prepared to stop at the next signal. 'OFF' position indicates A signal ahead is to proceed position and driver can take the train at speed.

- 4) **Fixed Signals:** Each section (or block section as it is often called) is protected by a fixed signal placed at its entrance for display to the driver of an approaching train. If the section is clear, e.g. there is no train in it, the signal will show a "Proceed" indication. If, however, the section is occupied by a train, the signal will show a "Stop" indication, usually a red aspect.
- 5) **Two-aspect colour-light signals:** In this, each signal has two lamps (one above the other). The higher of the two is a green lamp, and the lower one is a red lamp. The green lamp when lit indicates clear (the proceed indication), and when the red lamp is used for STOP indication.
- 6) **Three-aspect colour-light signals:** – In this, each signal has three lamps arranged vertically. The top one is green, the middle one yellow, and the bottom one is red. The red and green lamps indicate indications as in the 2-aspect system, and the yellow lamp shows the caution indication.

1 mark for each of any one with application = 4 marks

OR Equivalent Answer

6 Attempt any two:

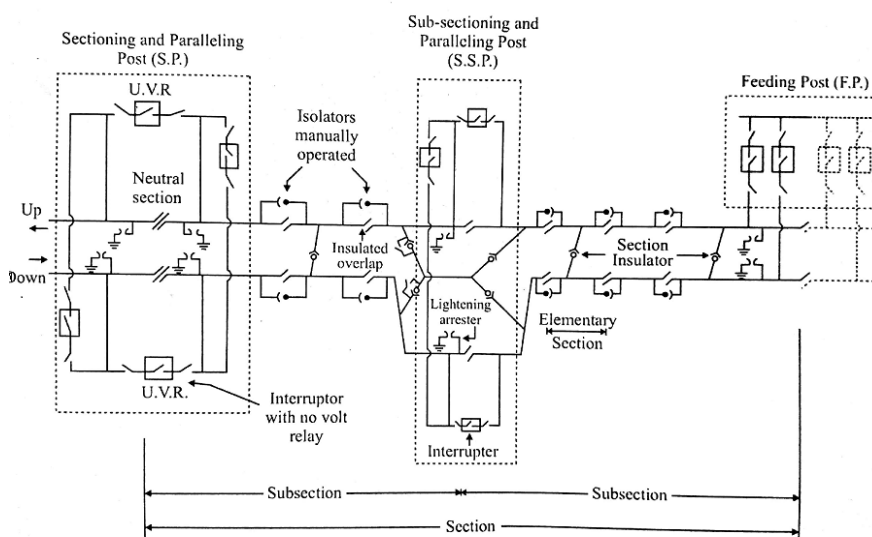
16

6 a) Explain with neat diagram

- i) Sectioning and paralleling post
- ii) Sub sectioning post

Ans:

i) **Sectioning and Paralleling Post:**



4 marks for labeled diagram
3 marks for partially-labeled diagram
2 marks for unlabeled diagram

OR Equivalent Diagram and Answer

(NOTE: In above diagram both posts are shown so combined or separate diagram should be considered)

Explanation of Sectioning and Paralleling Post:

1. The power supply arrangement is as shown in above figure for two track lines between feeding posts and a neutral section.
2. Sectioning and paralleling post consists of two paralleling interrupters used

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- to parallel OHE of up and down tracks, one on the side of neutral.
3. Bridging interrupters is normally kept open unless emergency feed is required. It should only be closed after taking special precautions to warn the drivers to drop the pantograph when passing the feeding post up to which feed is extended.
 4. Each substation feeds two sections.
 5. Supply to each section is therefore controlled by one CB.

2 marks

Explanation of Sub Sectioning Post:

1. As shown in above figure each section is subdivided by the provision of one or more sub sectioning posts normally at a distance of every 10km to 15km.
2. This facilitates isolation of faulty section.
3. At some stations with large yards change over switch is sometimes provided so that supply may be divided either from OHE of one subsection or the other.
4. There is no interrupter for paralleling the up and down track line.

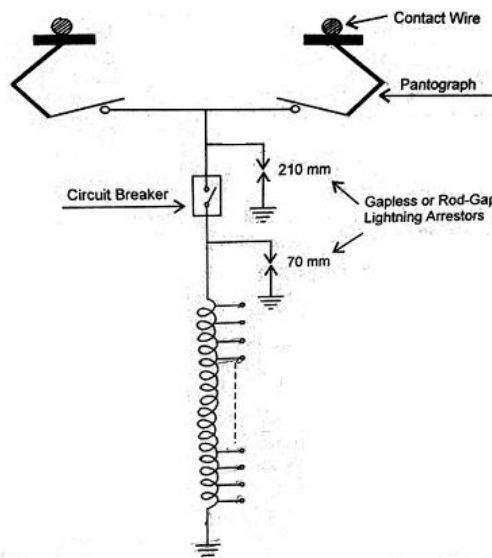
2 marks

6b) Explain the surge protection of electric locomotive from

- i) Direct lightening stroke
- ii) Switching surges

Ans:

i) Protection of Electric Locomotive From Direct Lightening Stroke:



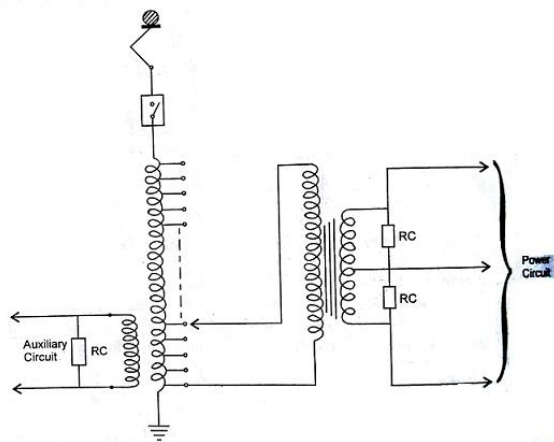
2 marks for diagram

1. The direct lightning strokes may strike on the overhead conductor on the roof of the locomotive.
2. To protect the locomotive from lightning strokes lightning arrester 1 (LA1) is provided it is generally a Rod gap type having the gap length of 210mm.
3. The lightning arrester provides a low resistance path for high voltages and high resistance path for normal power frequency working voltages. The lightning stroke is thus diverted towards earth via lightning arrester.
4. The transformer is critical and costly equipment hence lightning arrester 2 (LA2) is provided along with LA1. The gap of LA2 is 70mm so that its operation time is less.

2 marks for explanation

ii) Protection of Electric Locomotive From Switching Surges:

Model Answer
Winter – 2018 Examinations
Subject & Code: Modern Electric Traction (17640)



2 marks for
diagram

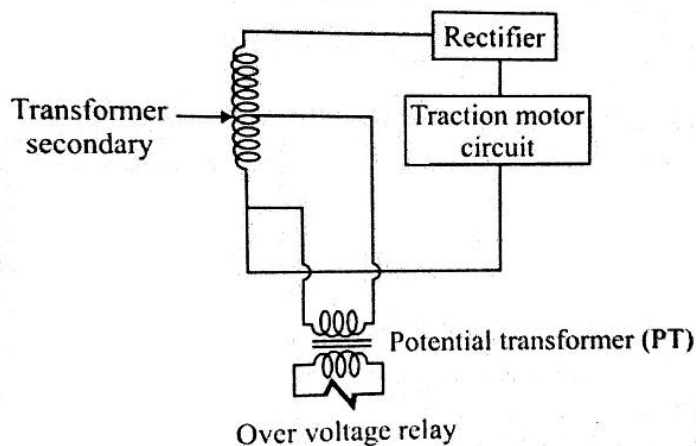
1. The strategy adopted for protection against switching surges is to connect the R-C networks as shown in the above figure.
2. Sometimes the surges of transmission system could find their way to the traction and auxiliary circuits through capacitive coupling at the bushings.
3. These surges get absorbed by the R-C networks which reduce the steepness of the wave front and also help to absorb the energy in the resistance.

2 marks for
explanation

6c) i) Explain protection of locomotive from overvoltage and under voltage.

Ans:

Protection of Locomotive From Overvoltage and Under Voltage:



2 marks for
diagram

1. For protection against over voltages the over voltage relay which is basically a potential transformer (PT) is used.
2. The potential transformer (PT) is connected across secondary of main transformer and the over voltage relay is connected across secondary of the potential transformer.
3. When over voltage occurs due to abnormal condition, the voltage across secondary of transformer increases hence PT voltage also increases and over voltage relay operates sending trip signal to CB which disconnects the circuit.
4. Under voltage is not desirable for efficient working of auxiliary circuits as Arno may not start, the under voltage is monitored through a relay triggering an alarm, which enables the power controller to react and take corrective

2 marks for
explanation

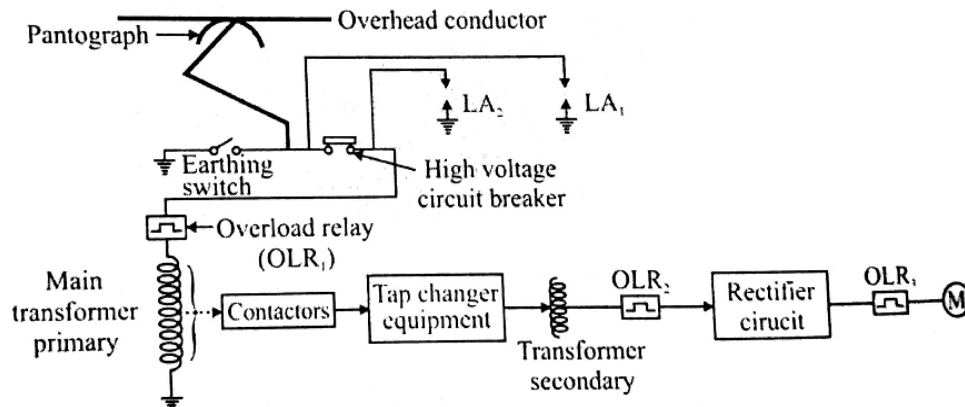
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measures.

6c) ii) Explain with neat sketch overload protection for power circuit of locomotive.

Ans:

Overload Protection for Power Circuit of Locomotive:



2 marks for
diagram

1. To protect the main power circuit from overload, the thermal overload relays are used.
2. The overload is sensed by the overload relay which gives tripping signal to CB on occurrence of overload and the circuit is disconnected.
3. The overload relays and CB are provided in different sections of power circuit as shown in the above figure.
4. The overload relay OLR₁ operates for overload on transformer side due to shorting of turns or any abnormal reasons.
5. The overload relay OLR₂ operates for overload fault due to failure of diodes.
6. Similarly the overload relay OLR₃ operates for overload fault on traction motor due to the flashover of traction motors.

2 marks for
explanation