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.

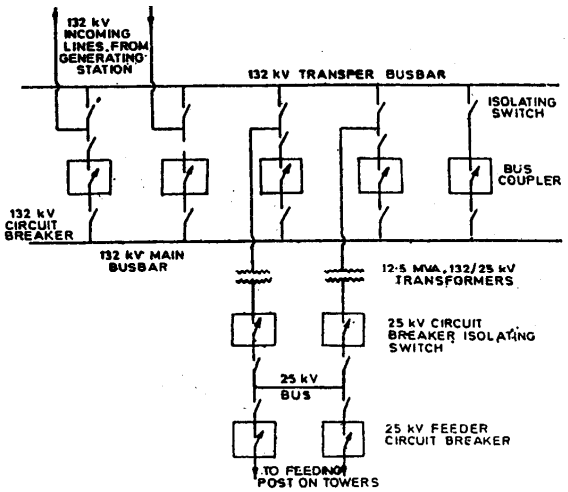
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.

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) i) Layout of Traction Substation.

Labeled sketch – 3 marks
Partially labeled- 2 marks

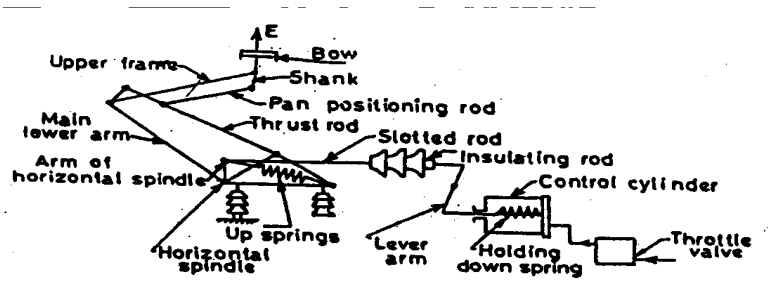


Function of isolating switch and bus coupler :
To enable maintenance of circuit breakers and bus bars while maintaining the continuity of supply for traction purpose.

Function- 1 mark

1 a) ii) Faively type pantograph

Labeled sketch – 3 marks
Partially labeled- 2 marks



Merits:

Any two merits - 1 mark

-Reduced frictional forces , due to less no. of articulated joints.

-Require less maintenance and cheaper in cost.

-Light in weight and adequate transverse rigidity

-Satisfactory current collection with low contact pressure of 6.5 to 9 Kg.

1 a iii) End on generation

Definition- 1 mark

For providing more amenities to the passengers of deluxe trains, a mobile generator car is provided at the end of train. This is called as 'end on generation'.

Method to provide electric power:

Description

In this system electric power to the train is supplied from diesel generating set at 400V, 3 phase, 50Hz, a.c. generation. 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 a.c. Heating, cooling loads in the car are provided with 415/230V a.c. -3 marks

1 a iv) Essential requirement of ideal signaling system

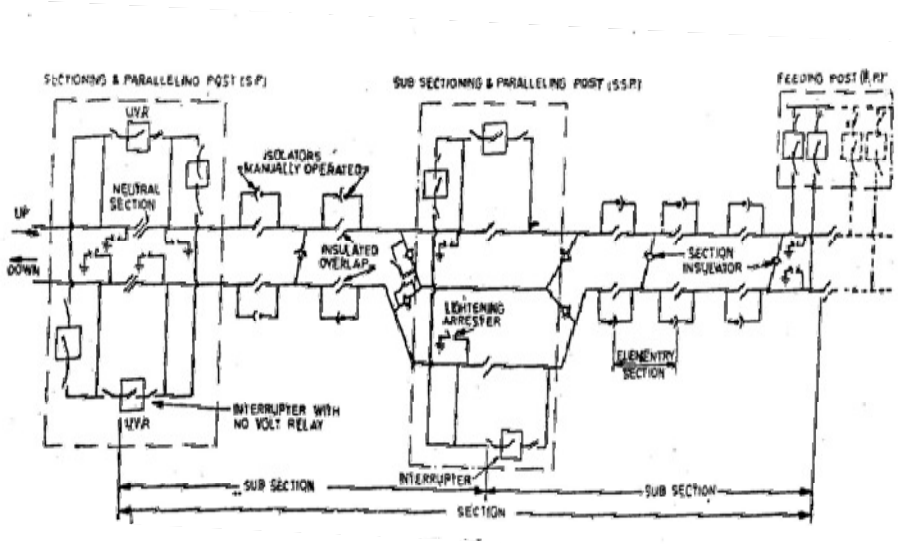
- Unless the whole section of the track governed by the signal is clear and safe, it should not be possible to display 'safe' indication.
- Failure of any component of signaling scheme should give danger indication.
- There should be provision of automatic operation of brakes to the train, if the driver ignores the danger indication of the signal.

1 point – 2 marks,

2 points – 3 marks,

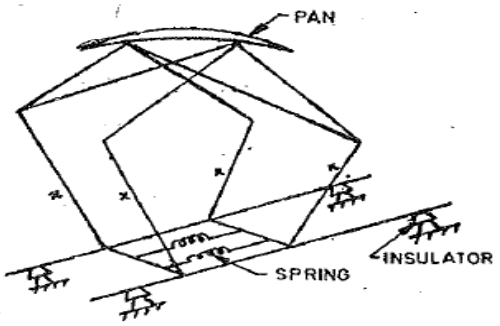
3 points– 4 marks

1 b i) Combined diagram of sectioning and paralleling post, sub-sectioning and paralleling post and feeding post.



Labeled sketch – 6 marks
Partially labeled- 4 marks
Partially drawn- 3 marks

1 b ii) Diamond type pantograph: Fig- 3 marks.



Methods of raising and lowering of pantograph

Air raised gravity lowered

Air raised spring lowered

Spring raised air lowered

Methods- 3 marks

2 a) Purpose of: 2marks for each

i) Lightening arrestor: protection against voltage surges.

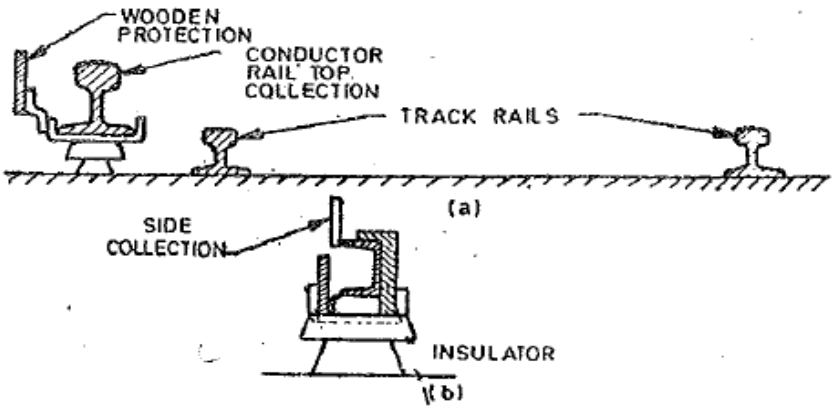
ii) Auxiliary transformer: provides 230 V 50 Hz, supply to operate battery charger, remote control equipment, signally and lighting.

2 b) Advantages of automatic weight tensioning and temperature compensation: 1 mark for each point. Any 4 points.

- 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 propogation of waves in contact wire which is greater than that of unregulated OHE.
- Because of fixed tension, fluctuations in the height are minimized.

2 c) Conductor rail system

Labeled 2marks unlabeled 1 mark.

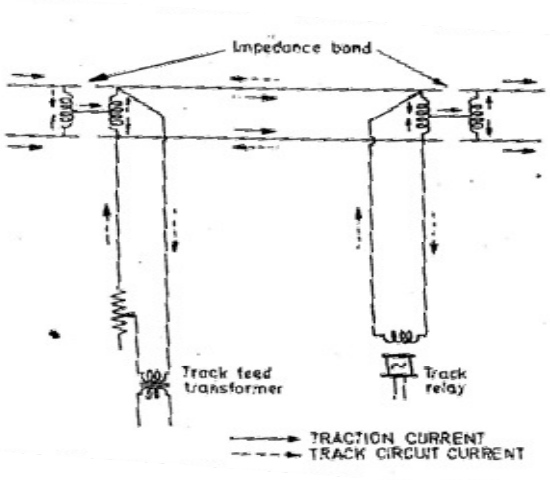


Merit:
Used in underground system of traction in large cities.
Demerit:
Low system voltages, heavy current collection (top contact system- voltages upto 750V and side contact system- voltages upto 1200V)

Merit- 1 mark.
Demerit- 1 mark.

2 d) i) A.C. track circuit

Labeled- 2marks unlabeled - 1 mark

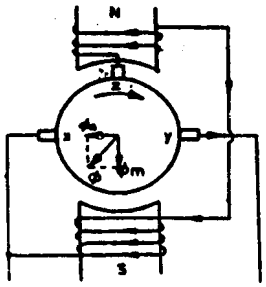


ii) Necessity of impedance bonds:

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

2marks. - Any 2 points.

2 e) Three brush generator — Fig. - 2 marks.



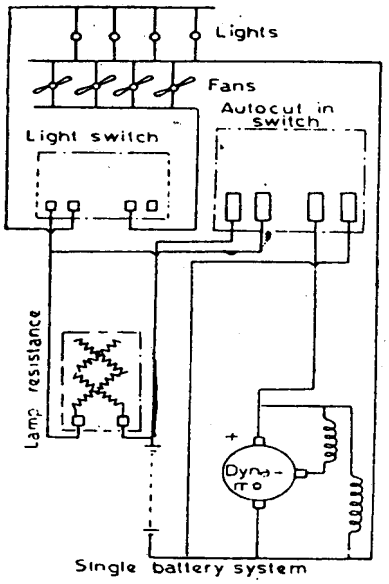
* — Working 2 marks.

Works on the principle that ,increase in emf generated is reduced with increase in the load current.

- field excited from one of main brush X and third brush Z fixed at 90 deg. With brush axis
- as load increases , armature reaction flux Øa increases
- more distortion in main flux
- resultant flux reduces

field excitation reduces hence emf across XY reduces

3 a) Single battery system: Fig. 2 marks.



- 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.

Working 2 marks.

3 b) Advantages of search light signals over long range signals:

- Due to compact design, it can be used where clearances are eliminated.
- Superior indication even with low wattage lamps due to superiority of optical system.
- No chance of false indications being given by external lights.
- Maintainace of outer lens and lamp is less.
- Different indications fall at most convinient height is with respect to driver's line of vision.

1 mark each Any four= 4 marks

3 c) Procedure of maintenance of pantograph:

- Check and correct sliding contact between contact wire of OHE and contact strips.
- Inspect vibration level and take corrective action.
- Check and adjust contact pressure to correct setting.
- Inspect joints in tubular framework.

1 mark each = 4 marks (other valid points can be considered)

3 d) Stagger :

Distance between contact wire and pantograph axis is called stagger of contact wire. — Definition- 1mark.

Factors affecting stagger: — Any one factor and points related with that- 3 marks.

a) Factors relating to track:
   i) Versine due to curvature of the track.
   ii) Depression of track due to low joints, loose packing and change of super elevation.

b) Factors concerning OHE:
   i) Blow off effect of contact wire due to wind and temperature.
   ii) Change of contact wire position between supports with respect to the axis of the track.
   iii) Mast deflection causing displacement of OHE.

c) Factors relating to rolling stock:
   i) Lateral oscillations of locomotive body.
   ii) Rolling and noising of locomotive.

3 e) Sequence of operation:

Sequence of closing- i)earthing switch, ii)isolator, iii) C.B. — 1½ marks

Sequence of opening- i)C.B., ii)isolator, iii)earthing switch. — 1½ Marks

Interlocks are electromagnetic switching controls such that the if the sequence of a particular operation is not followed the energization of the next device does not occur till the earlier scheduled action (switching) is completed. — 1 mark

4 a i) Pole collector:

Advantages: — Advantages any two- 1 mark for each.

- Simple in construction and used for tramways.
- Due to its swivelling action, can be used for trolley buses to enable them to maneouvre in traffic up to a distance of 4 to 5 metresfrom contact wire.

Dis-advantage: — Disadv. Any two- 1 mark for each.

- Has to be rotated by 180^{o} before tram car can have motion in reverse direction.
- Suitable for low speeds upto 22 to 30 Kmph beyond which it runs the risk of jumping off the contact wire.

4 a ii) Supervisory and alarm facilities provided with the control desk for TPC: — 1 mark each point= 4 marks

- Catenary voltage supervision.
- Supervision of battery and ac mains supply at the controlled post.
- Signaling channel supervision.
- Supervision for perfect fidelity of transmitted signal.

4 A iii) 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:

- 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 mark

4 A iv) Purpose of sectioning arrangement:

- Power generation and transmission systems of supply authorities are of 3 phase type.
- Electric traction needs single phase supply. If all traction load is taken on one phase only, it would bring unbalanced conditions. — 1 mark
- Besides inconvenience to other consumers, causes lot of rotor heating in alternators due to double frequency currents. — 1mark
- To avoid this power to consecutive sections is fed from different phases of 3-ph supply in rotation as shown in fig. — 1 mark
- Zones fed by adjacent substations are acting as separate independent unit and neutral section is provided in between them.

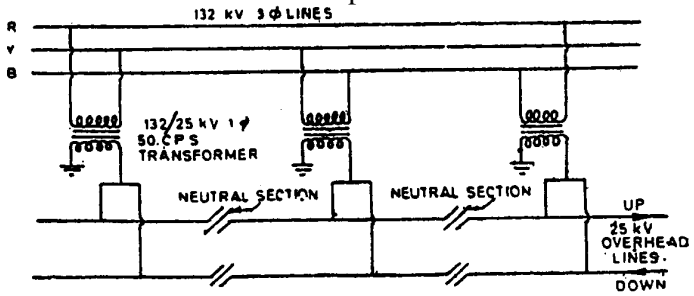


Fig.- 1 mark

4 b i) Merits of single rail d.c. track circuit:

- Simplicity and cheapness due to only one rail being insulated.
- Extensively used on the a.c. electrified tracks.
- Provision of 'interval discharge' safeguards against any danger to signaling circuit arising out of falling of catenary or contact wire on insulated rail.

Merits- 3 marks

Demerits of single rail d.c. track circuit:

- In case of failure of any one insulated rail joint, track circuit zone will be extended and interfering with zones of adjacent track circuits.
- Return traction currents or stray currents cause longitudinal voltage drop to be developed in the un-insulated rail, which limits the length of track circuit.
- Any broken rail on traction return path cannot be easily detected.

Demerits- 3 marks

4 b ii) Mimic diagram:

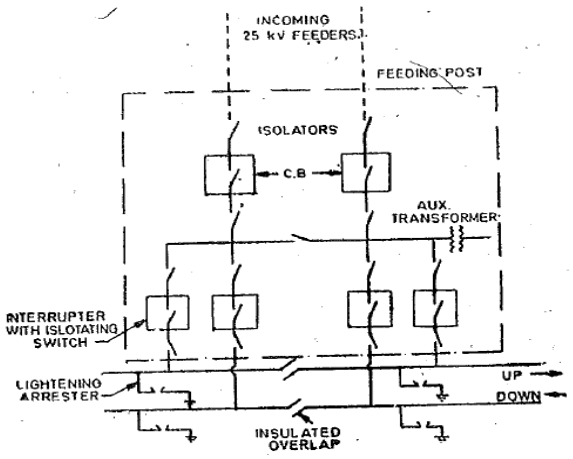
Power supply arrangement for the overhead 25 kV traction system is shown in remote control centre on a small scale on what is called mimic diagram. — 2 marks

1) Milky white lamp- lights up when alarm is received from any station in the panel. — 1 mark
2) Green lamp lights- up whenever impulse train is being transmitted from or received by remote control centre. — 1 mark
3) Red lamp- lights up when either send or receive channel fails. — 1 mark
4) Annunciation window- indicates the nature of fault which is inscribed separately on each window. — 1 mark

5 a) Special features of traction transformer: — 2 marks for each point. Any four points.

- Specially designed to withstand severe operating conditions
- Traction transformers have to withstand peak capacity for short time hence windings require class 'A' insulation.
- The windings are specially designed to withstand the stresses of frequent short circuits on 25KV OHE.
- In order to limit the effect of short circuit, impedance of transformer is not less than 8.5% for 10MVA capacity and 10% for 12.5MVA capacity.
- Transformers are not provided with on load tap changers.

5 b) Feeding post



Labeled diagram 4 marks,

partially labeled 2 marks, unlabeled 1mark,

5 b) ii) 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 200 kmph
- Continuous mesh - for train speeds upto 200 kmph
- Composed compound - for train speeds above 200 kmph

½ mark-type, ½ mark-appli. (any four)

5 c) i) Essential requirement of current collection gear

1. Under no circumstances, it should leave the contact of OHE.

2. Depending upon speed of electric vehicle, collection gear has to rise and fall in order to maintain the contact with OHE.

2 marks for each point= 4 marks

5 c) ii) Factors influencing contact pressure between OHE and pantograph:

- Concerning OHE including its dynamic behavior.
- Concerning pantograph design including its dynamic behavior.
- Concerning track- track irregularities
- Concerning vehicle suspension- lateral forces due to body rolling, bouncing and pitching

1 mark each= 4 marks

6 a) Method of obtaining unidirectional polarity in train lighting:

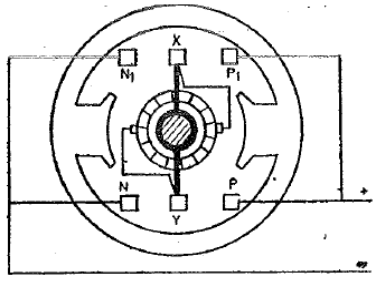


Fig 4 marks

Dynamo has rocker arm mounted on the shaft, on friction tight. When the direction of rotation is anticlockwise, X terminal of the rocker arm will be connected to N1 brush and Y terminal of the rocker arm will be connected to P brush. Thus, the output polarities will be obtained as shown in figure.

2 marks

When the direction of rotation of the shaft is clockwise, terminal X now touches P1 while terminal Y touches N. Thus, giving the output polarity as in previous case, i.e. as shown in figure.

2 marks

Thus, unidirectional polarity is obtained in train lighting

6 b) iii)

Four aspects of colour light signal:

- 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
- signal1 & 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

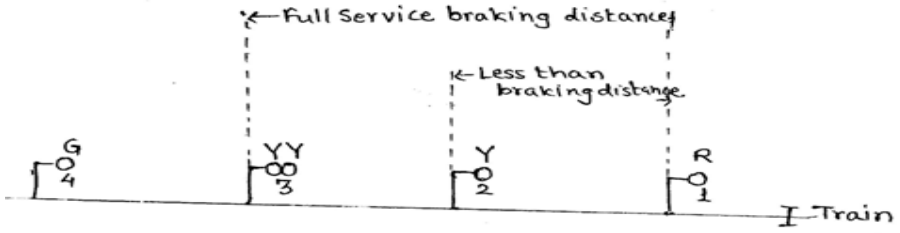


Fig 1 mark.

6 b) ii) Requirements of air conditioning in railway coaches: — 1 mark each= 4 marks

- Supply fresh clean air at the required comfort temperature.
- Cater to changing passenger nos.
- Provide proper heating & cooling for travel in differing climates.
- Operation of equipment from power generated, stored and controlled on train.

6 c) i) Height of contact wire at two different temperatures:

5.75 m for 4°c to 65°c and — 1 mark

5.65 m for 16°c to 65°c — 1 mark

6 c) ii) Maximum permissible slope at the speed of more than 100 Kmph of the train: — 1 mark

3 mm /m

Maximum permissible slope at the speed of less than 100 Kmph of the train: — 1 mark

4 mm /m

6 c) iii) Encumbrances.

- Axial distance between catenary and contact wire. — 1 mark
- Maintained at 1.4 m except at turn outs, overlaps and in vicinity of over-line structure. — 1 mark

6 c) iv) Maximum span length at two different wind pressures:

Max 72 meters on straight tracks and wind pressure of 88 kg/ m^2 and — 1 mark

is 67.5 m for wind pressure of 98 kg/m^2 — 1 mark