



Diploma in Engineering: Winter – 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.



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1 (a) Attempt any THREE of the following:

12

1 (a) i) List various miscellaneous equipment at control post. State use of each.

1 (a) i) Ans:

Miscellaneous equipment at control post or switching substations & functions:

1. **Lightening arrester:** protection against 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 remote control equipment and interrupter.
5. **Battery charging equipment:** charge batteries at the control post.

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

1 a) ii) State use of any four relays for the protection of traction transformer.

1 a) ii) Ans:

Relays for the protection of traction transformers:

- 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 mark each
any four = 4 marks

1 a) iii) State the meaning of various terms of OHE labeled in fig no 1. Give their normal values.

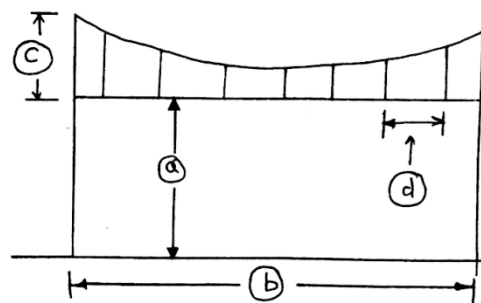


Fig. No. 1

1 a) iii) Ans:

- a → Mid span height of contact wire – 5.5 m
b → Span length -- 72 m
c → Encumbrance -- 1.4 m
d → Dropper spacing -- 9 m

½ m for each meaning & ½ m for each value



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1 a) iv) Give purpose and location of following signals,

1) Warner: 2) Co-acting: 3) Shunt: 4) Detonating:

1 a) iv) Ans:

1) Warner signal - When in 'on' position, it indicates that the signal ahead is at danger and driver must be prepared to stop at next signal. When in 'off' position it indicates that the signal ahead is in proceed position and driver can take the train speed. It is the first signal for train entering the station.

½ m each for
purpose
Max 2

2) Co-acting signals- Where due to obstruction such as over bridge, arm or light of main signal does not remain in the view of driver, during whole time co-acting signals are provided. They are fixed below the main signal.

½ m each for
location
Max 2

3) Shunt signal - For controlling the shunting operations in the station yards shunt signals are used. They are mounted about 0.5m above ground or fixed on same post as departure signal.

4) Detonating signals- Are used in foggy weather to indicate the locality of a signal to the driver of approaching train. These are placed on the rails and explode when engine passes over them.

1 b) Attempt any ONE of the following:

6

1 b) i) 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.

1 b) i) 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
1 m each test
1 mark
1 mark

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

1 b) ii) Draw symbols of any six signaling boards of OHE, write meaning of each.

1 b) ii) Ans:



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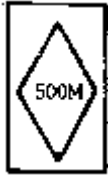
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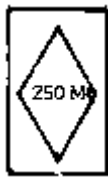
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1)



--- neutral section 500 m ahead

2)



--- neutral section 250 m ahead

½ m for each
symbol =
max 3 mark

3)



--- Switch OFF power before neutral section

½ m for each
meaning =
max 3 mark

4)



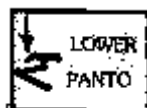
--- Switch ON power after neutral section

5)



--- Take UP Pantograph after neutral section

6)



---- Take DOWN Pantograph before neutral section



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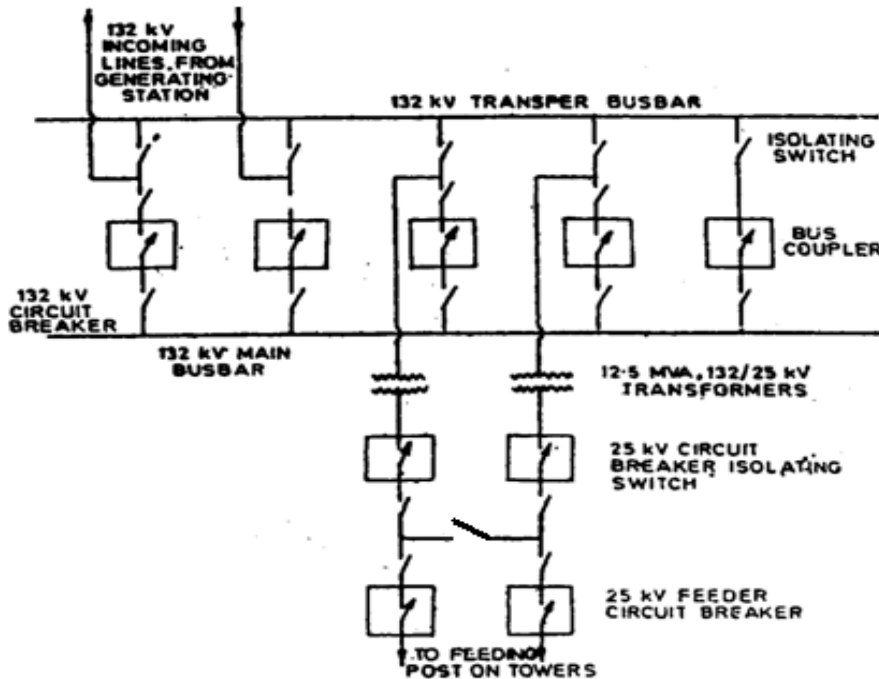
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2 a) Draw neat sketch of traction substation. Label various components of it.

2 a) Ans: Layout of Traction Substation.

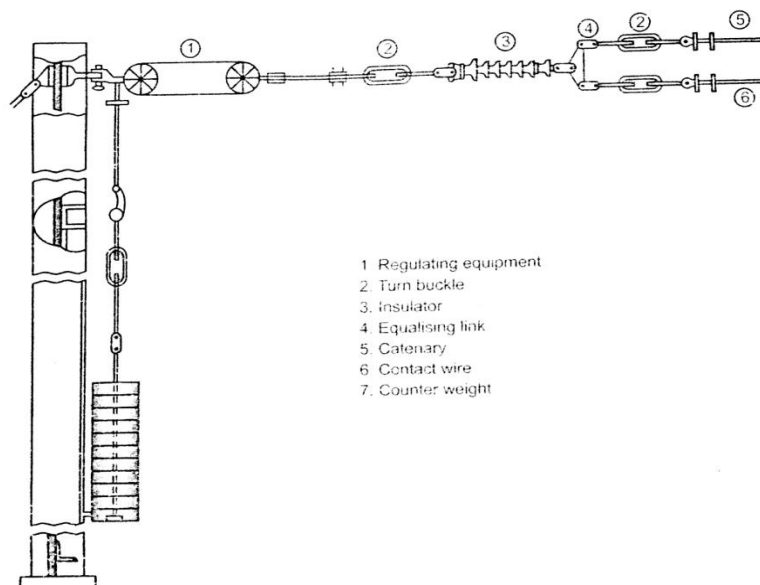


Fully
Labeled 4
marks,
partially 3 to
2 marks,

Unlabeled 1
mark

2 b) Draw a neat labeled diagram of Automatic Weight Tensioning and Temperature Compensation and give any two advantages of the same.

2 b) Ans: figure of automatic weight tensioning



Labeled fig.-
2 mark
unlabeled-
1 mark

Advantages of automatic weight tensioning and temperature compensation:

- Sparkless current collection at higher speeds.
- OHE becomes more dynamically stable under all atmospheric conditions.



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- 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.
- Advantages-
1 mark each
–max 2 mark

2 c) Write any four points that state how a traction transformer is different from ordinary transformer.

2 c) 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) Impulse 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

2 d) List any four advantages of multi aspect colour light signals.

2 d) Ans:

- 1) Economical
- 2) Simplicity of indication to drivers
- 3) Better ability to deal with traffic of varying speed
- 4) Simpler and easier in operation
- 5) Control on large signals at heavily worked stations
- 6) Provide increased line capacity

1 m for each
= max 4
marks

2 e) State the function of a contactor in a power circuit of locomotive. List different types of it and state one application of each.

2 e) Ans:

Contactors in power circuit of locomotive are used to connect relevant sections for operation. Connecting or disconnecting the power circuit at different conditions of operation and at different locations.

1 m for
function

They are classified by their methods of closing the movable contact –

- 1) electromagnetic 2) electro-pneumatic 3) cam & roller operated

½ m for each
type = max 1
½ m

Application :

- 1) Electromagnetic – used in the circuits carrying low currents such as taken by auxiliary motors.
- 2) Electro pneumatic – used to control heavy power currents.
- 3) Cam & roller operated – used for group switching.

½ m for each
application=
max 1 ½ m

2 (f) Give purpose and location of
i) Uninsulated overlap.
ii) Insulated overlap.



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- iii) Neutral section.
- iv) Section insulator.

2 (f) Ans:

- i) **Insulated overlap:** To isolate for operation and maintenance of OHE if two lengths of OHE belong to two elementary sections.
Located at feeding posts, sub sectioning posts and booster sections. ½ mark
- ii) **Un-insulated overlap:** To rectify faults in one contact wire of two running in parallel wires without affecting power to OHE.
Located at two adjacent sub-elementary sections. purpose of each
- iii) **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. and
- iv) **Section insulator:** Section insulators are provided to insulate OHE of one elementary section from the OHE of another adjacent elementary section.
Located at cross over from one track to other, from main line to siding. ½ mark
location of each

3 Attempt any four of following. 16

3 a) Write any four important points related to the construction of feeding post.

3 a) Ans:

Important points related to construction of feeding post:

- 1) 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) Located as near as possible to substation with maximum distance being 2 km.
- 3) 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.
- 4) The 25 kV CB are controlled from remote control center 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 four = 4
marks

3 b) Draw a neat sketch of stitched catenary. State the speed limit for

- i) 10 m Y ii) 20 m Y of this type

3 b) Ans:

- i) 10 m Y : 140 – 160 kmph
- ii) 20 m Y : beyond 160 kmph

Speed limit –
1 mark each

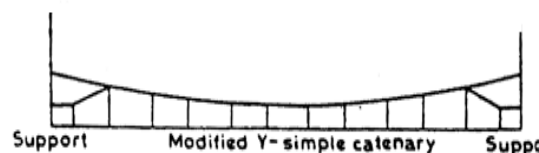


Figure –
2 mark

stitched catenary



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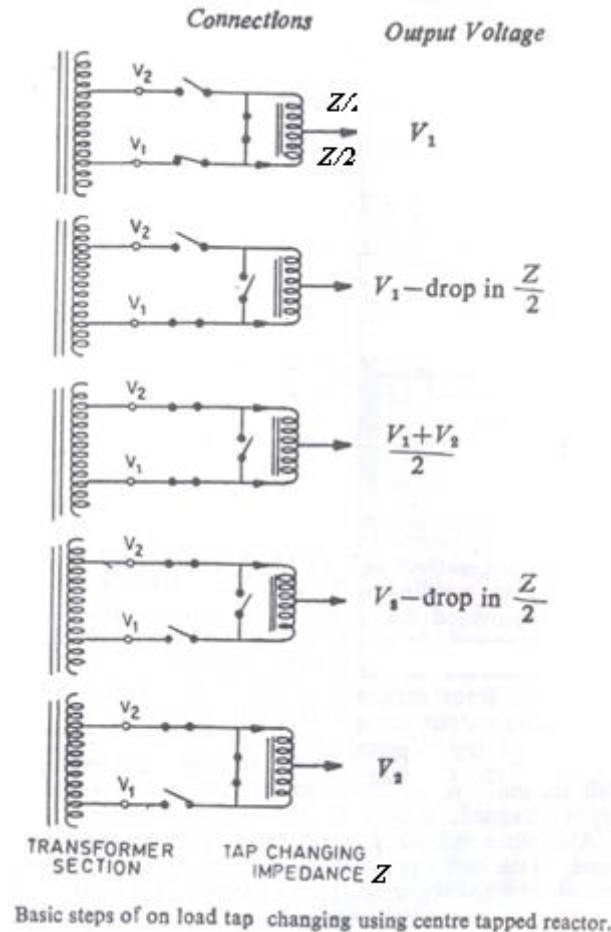
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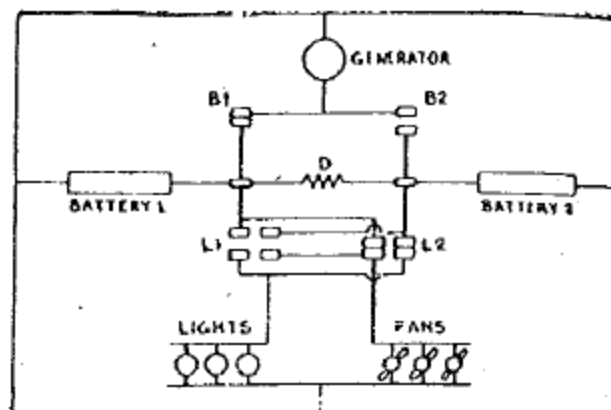
- 3 c) Draw schematic connections and state related output voltages in case of step by step on load tap changing using center tap reactor.

- 3 c) Ans:
Only schematic of tap changing using center tapped reactor:



- 3 d) With the help of neat sketch of a double battery parallel block system, write sequence of operations for-
- i) One battery charging ii) Both batteries charging

- 3 d) Ans:



2 marks for sketch



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- i) One battery charging --
Train in motion -- Lights ON --
Generator connected to battery 1 through B1
Now battery 1 is charging
1 mark each for operation of each case
- ii) Both batteries charging
Train in motion -- Lights and other loads are OFF
L1, L2 open -- B1, B2 closed
Now both batteries are charging in parallel
- 3 e) For a pantograph write any two-
i) Types ii) Advantages iii) Methods of raising iv) Materials of collector strip
- 3 e) Ans:
- i) **Types –** ½ mark each
a) Diamond Type Pantograph b) Faiveley Type Pantograph
- ii) **Advantages –** ½ mark each
a) Reversible operation is possible b) current collection capacity is high
- iii) **Methods of raising-** ½ mark each
a) Air raised b) Spring raised
- iv) **Materials of collector strip-** ½ mark each
copper, copper steel combination, silicon manganese steel, aluminum steel, bronze, Metallized carbon or carbon (any two)
- 3 f) Compare AC & DC track circuits on-
i) Length of circuit
ii) Application
iii) Effect of stray currents.
iv) Maintenance
- 3 f) Ans:
- i) **Length of circuit** - a) AC track circuit is having long length upto 3 to 5 km
b) DC track circuit is having short length
- ii) **Application** - a) AC track circuit is used where electricity is available and track current is carried by both the rails
b) DC track circuit is used for non- electrified lines 1 mark each point
- iii) **Effect of stray currents** - a) Stray currents has no effect on AC track circuit
b) Stray current causes voltage drop in the un insulated rail .This limits the length of the circuit
- iv) **Maintenance** - a) AC track circuit has easier and cheaper maintenance
b) DC track circuit has complicated maintenance
- 4 Attempt any FOUR of the following: 16
- 4 a) List any four characteristics of efficient maintenance.



4 a) Ans:

Characteristics of Efficient Maintenance:

- 1) Planning of schedule.
- 2) Investigation of failures.
- 3) Repair facilities such as adequate staff, shed, plant and machinery.
- 4) Staff training facility such as training school, instruction manuals etc.
- 5) Proper inventory/optimum stocks of regular and emergency maintenance spares.
- 6) Good design and drawing office for the preparation of detailed working drawings and specifications for maintenance spares.
- 7) Inspection of stores purchased according to working drawings and specifications.

1 mark each
any four = 4
marks

4 b) Write a step by step procedure of obtaining constant output using three brush generator.

4 b) Ans:

Step by step procedure of obtaining constant o/p using three brush generator

- 1) The field is excited from one main brush X and third brush Z fixed at 90° electrical with normal axis of brushes X and Y
- 2) As the load on the generator increases the armature reaction flux ϕ_a increases. This is cross magnetising flux (crosses the main flux ϕ_m)
- 3) Main flux ϕ_m is distorted. The resultant flux ϕ_r at brushes 'ZX' reduces. The effect is that the e.m.f. generated across them reduces. The effect is the reduction in field excitation.
- 4) This further reduces the emf generated across the main brushes XY. The result is in controlling increased load and keeping o/p as far as possible as constant

1 mark each
point

4 c) State the necessity of feeding and sectioning arrangement in traction SS. Draw its sketch also.

4 c) Ans:

Need of feeding arrangement:

Feed the supply properly to the traction arrangement of over head lines & transformers (132 kV/25 kV) of each phase which in turn feed the up and down lines as shown in the figure.

1 mark

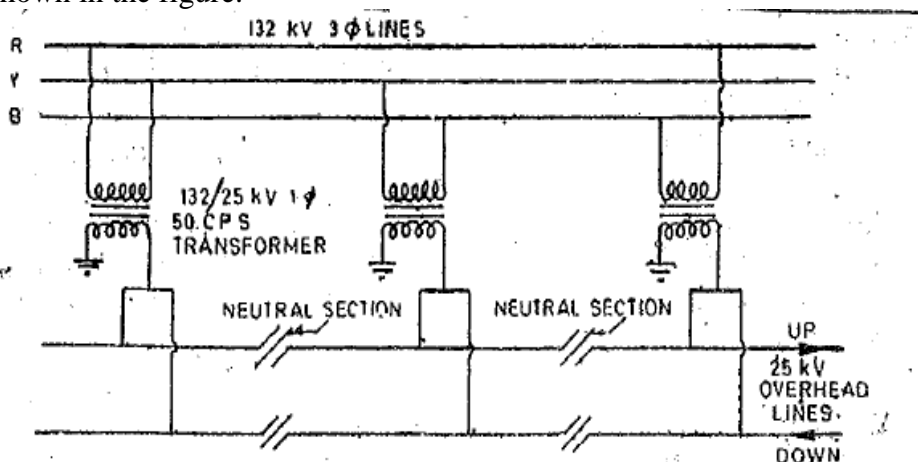


Figure 2
marks



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Need of sectioning arrangements:

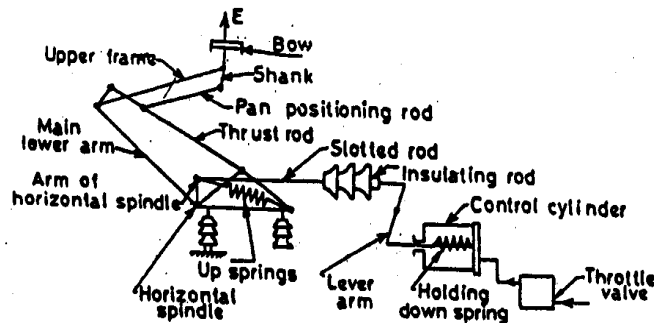
Power to the consecutive substations is fed from different phases in rotation as shown in figure to balance the energy load on the three phases. Avoid phase shifts. Zones fed by adjacent substations are acting as a separate independent unit. Neutral section is provided in between two adjacent substations.

1 mark

4 d) Draw a neat labeled sketch of faiveley type pantograph.

4 d) Ans:

Faiveley type pantograph: _____



Fully
Labeled 4
marks,
partially 3 to
2 marks,

Unlabeled 1
mark

4 e) State any four reasons of failure of under frame generation equipment.

4 e) Ans:

Reasons for failure of under frame generation equipment:

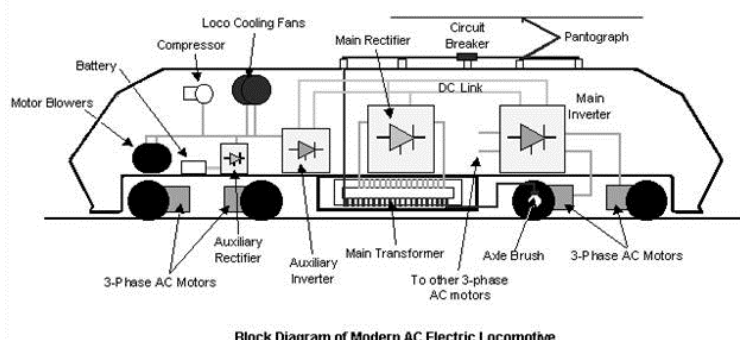
- 1) Generator belts falling off or becoming loose.
- 2) Poor quality of generator brushes, sticking in brush boxes and commutator getting dirty.
- 3) Generator fuses blowing off.
- 4) Generator solder running out.
- 5) Defective cells.
- 6) Propeller shaft becoming loose.
- 7) Axle pulley becoming loose.

1 mark each
any four = 4
marks

4 f) Draw a neat sketch of power circuit of three phase locomotive.

4 f) Ans:

Power circuit of three phase electric locomotive:



*Or Any other
equivalent
Circuit
Diagram*

4 Marks fully
labeled,
2-3 Marks
partial label,
1 mark
unlabeled.



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- 5 Attempt any four of the following 16
- 5 a) State any four limitations of arno converter.
- 5 a) Ans:
Limitations of Arno converter:
1. Unbalanced current in the 3-phase of stator winding
 2. Undue heat produced in the winding.
 3. Voltage fluctuation and voltage unbalance. Output voltage obtained from Arno converter fluctuates from 290 V to 460 V. 1 mark each
any four = 4 marks
 4. When output voltage of Arno converter raises to 460 V, because of excessive magnetizing current, p.f. is poor
 5. Stator winding carries single phase motoring current and 3ϕ generating current.
 6. Motoring phases carry both motoring and generating currents, resultant current is small where as generating phase carries only generating current, its magnitude is higher than motoring phases.
 7. Negative sequence torque has pronounced effect on starting torque.
 8. Problem in starting
- 5 b) List any four strengths of LIM propelled railway traction.
- 5 b) 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. 1 mark each
any four = 4 marks
 - 3) Two wheels fixed to an axle can rotate independent of each other and hence curve negotiating property improves.
 - 4) System does not require gears therefore reduction in the associated noise level and cost of maintenance.
 - 5) Floor height above the rail level is substantially reduced. This results in reduction in the height of bridges, diameter of tunnels along the route.
 - 6) Avoidance of rotation of parts leads to low mechanical losses.
Useful for high speed levitation trains due to absence of gears and adhesion.
- 5 c) Draw a neat sketch of earth fault protection of auxiliary circuit of electric loco. State the function of relay and isolating resistance.
- 5 c) Ans:
Earth fault protection for auxiliaries in Loco:
- Function of relay: 1 mark
The earth fault occurring anywhere in the auxiliary circuit gets monitored by the relay which acts to trip the main CB.
- Function of isolating resistance: 1 mark
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.

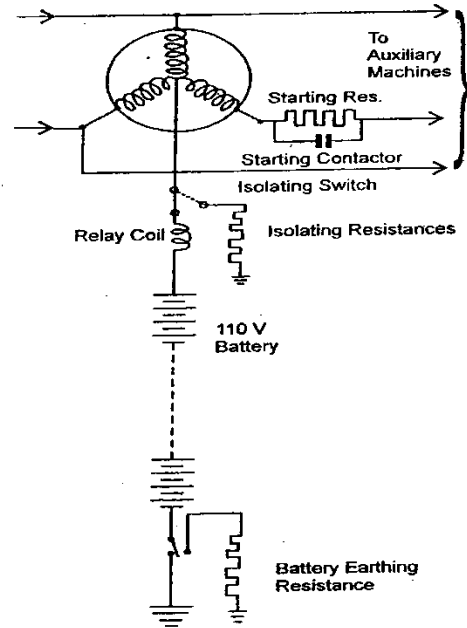


Figure 2
marks

**Relay connection for monitoring the earth fault
in the auxiliary 380 volt circuit**

- 5 d) State the function of following auxiliaries used in electric locomotive,
i) Batteries ii) Compressor iii) Blower iv) Exhauster

5 d) Ans:

- 1) **Batteries** – supply to run baby compressor which supplies air for initial raising of pantograph and closing of air blast circuit breaker.
- 2) **Compressor** – supply air for operation, control and application of brakes.
- 3) **Blowers** – cooling purpose as transformer blower, reactor blower, SCR blower, traction motor blower etc.
- 4) **Exhausters** – for vacuum brakes.

1 mark each

- 5 e) Write any four advantages of VF signalling over DC signalling.

5 e) Ans: **Advantages of VF signaling over DC signaling:**

- 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 each
any four = 4
marks



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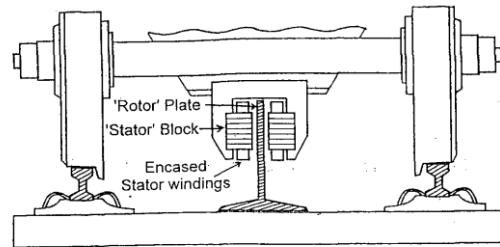
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- 5 f) Draw a neat sketch of moving primary fixed secondary double sided LIM. Write one advantage and one disadvantage of it.

5 f) Ans:

Moving primary fixed secondary, double side LIM



Moving-primary fixed-secondary double-sided LIM

Fig 2 marks

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 one = 1
mark

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 one = 1
mark

- 6 Attempt any THREE of the following:

12

- 6 a) i) State the following,

- 1) Position of head light
- 2) Supply voltage for flasher light
- 3) Colours used for marker light
- 4) Frequencies for engine horn.

- 6 a) i) Ans:

- 1) Position of head light:
Head light is located at center near roof level.
- 2) Supply voltage for flasher light:
Nominal 110 V. dc, range 70 V to 140 V.
- 3) Colours used for marker light:
Normally the marker lamps are white in front and the rear marker lights are red, when the loco is travelling alone, red marker indicates parking light
- 4) Frequencies for engine horn:
For HT horn – 660 Hz
For LT horn – 330 Hz

1 mark each



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- 6 a) ii) State the nature of protection provided for following types of faults;
1) Over voltage 2) Under voltage 3) High air pressure in air circuit 4) Low air pressure in air circuit
- 6 a) ii) Ans:
1) **Over voltage:** Controlled through tap changing, only an alarm needs to be provided for attention of crew.
2) **Under voltage:** voltage below 17.5 kV is not desirable. A no volt relay is provided which trips the CB and calls for resetting of power and auxiliary circuits. 1 mark each
= 4 marks
3) **High air pressure in air circuit:** Safety valve / PRV (pressure release valve) is fitted in the compressed air circuit to protect against high pressure.
4) **Low air pressure in air circuit:** Relay senses low pressure in air circuit and trips the relevant CB.
- 6 a) iii) State one application each for technically feasible LEM propelled transport system based on suspension used (any four).
- 6 a) iii) Ans:
1) Steel wheel on steel rail --- surface transportation 1 mark each
2) Rubber wheel on road --- surface transportation
3) Flat surface on water --- crossing rivers
4) Levitation --- wheel less travel along pre-defined routes
- 6 a) iv) Give meaning of the term defect. State effects of it. Also give classification of it and methods to eliminate them.
- 6 a) iv) Ans:
Defect - Failure in a genral sense can be regarded as a defect 1 mark

Effects of Defect -Defect results in the reduction of speed or load capacity of the locomotive or which detables the locomotive altogether for some length of time 1 mark

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

Methods of Elimination-
Above defect (1) can be eliminated by appropriate action taken by manufacturer 1 mark
Defects(2) and (3) can be minimised by restoring to the ideal maintenance practice
- 6 b) Attempt any ONE of the following 6
- 6 b) i) State the function of following components related to mimic diagram.
1) PL 2) OPL 3) CHL 4) GCK 5) LTK 6) ARK



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- 6 b) i) Ans :
- 1) **PL**-Milky white lamp called pilot lamp is provided which lights up when alarm is received from any section in that panel
 - 2) **OPL**-Green lamp called operation in progress lamp lights up whenever impulse train is being transmitted from or received by the remote control centre
 - 3) **CHL**-Red lamp called channel failure lamp lights up when either send or receive channel fails or underground P and T cable develops a fault
 - 4) **GCK**- General check key is provided for each controlled post to verify the exact position of all the apparatus at the controlled post
 - 5) **LTK**- Lamp test key is provided to carry out a test to ensure that all the indication lamps on each mimic panel are in good condition
 - 6) **ARK** -Alarm reset key is provided to enable the traction power controller to acknowledge and cancel any alarm tele signals arriving at the control centre
- 1 mark each

- 6 b) ii) Give broad classification of maintenance with meaning of each type. State the factors on which ideal maintenance of electric rolling stock is judged. Give any two means to improve any one factor of these.

6 b) ii) Ans:

Classification:

- 1) Running repairs – carried out when the equipment has actually failed.
 - 2) Trouble shooting – involves rectification of the defects by making temporary repair so that equipment is made get going on.
 - 3) Preventive maintenance - advance actions have to be taken to ward off the future failure.
- 2 mark
(any two)

Factors on which ideal maintenance judged :

- 1) Reliability of locomotive
 - 2) Availability of locomotive
 - 3) Overall cost of loco maintenance
- 2 mark
(any two)

Means to improve reliability

Proper inspection, proper method of trouble shooting & repairs , proper technical investigation , suitable repair facilities

OR

Means to improve availability

Inspection schedule , co-ordination between maintenance and operating staff , co-ordination of work at shed , availability of standby and quality spares

2 mark
(any two)