QUESTION BANK

ELECTRICAL DEPARTMENT

CENTRAL RAILWAY

MUMBAI DIVISION

राम करन यादव
महाप्रबंधक
Ram Karan Yadav
General Manager

सत्यमेव जयते

मध्य रेल,
छ.शि.म.ट. मुंबई - 400 001

Central Railway,
CSMT, Mumbai - 400 001

संदेश

मुझे यह जानकर प्रसन्नता हो रही है कि मुंबई मंडल के कार्मिक विभाग द्वारा कुछ विशेष कदम उठाए गए हैं जिसके अंतर्गत परिचालन, वाणिज्य एवं विद्युत विभाग की विभागीय परीक्षाओं के लिए 'प्रश्न-बैंक' पुस्तिका को प्रकाशित किया जा रहा है।

यह पुस्तिका डिजिटल पुस्तिका के रुप में **'cr.indianrailways.gov.in'** पोर्टल पर उपलब्ध करायी गयी है । यह 'प्रश्न-बैंक' पेपर रहित कार्यालय (Paperless Office) की संकल्पना को लागू करने की दिशा में उठाया गया एक सराहनीय कदम है। भविष्य में इसी तरह अन्य विभागों के 'प्रश्न-बैंक' पुस्तिका भी प्रकाशित हो ऐसी आशा करता हूं।

यह 'प्रश्न-बैंक' पुस्तिका सभी रेल कर्मचारियों को विभिन्न विभागीय परीक्षाओं की तैयारी के लिए लाभदायक होगी। मैं इसके सफल प्रकाशन के लिए कार्मिक विभाग, मुंबई मंडल को हार्दिक बधाई देता हूं।

शुभकामनाओं सहित!

25.1.24

(राम करन यादव)
महाप्रबंधक

भारत सरकार / Government of India
रेल मंत्रालय / Ministry of Railways
मध्य रेल / Central Railway

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संदेश

कार्मिक विभाग मुंबई मंडल निरंतर कर्मचारियों के हित मे विभिन्न योजनाओं के माध्यम से प्रयासरत रहा है। इसी प्रयास को जारी रखते हुए परिचालन, वाणिज्य एवं विद्युत विभाग के 'प्रश्नबैंक' एवं 'मास्टर सर्कुलर' का प्रकाशन मुंबई मंडल द्वारा किया जा रहा है। यह प्रश्न संच कर्मचारियों को विभागीय परीक्षा के अध्ययन के लिए अत्यंत सहायक होगा। किसी भी संगठन में पदार्पण करने के पश्चात प्रत्येक कर्मचारी को उस संगठन द्वारा दी जानेवाली सुविधा एवं संगठन के नियमों की संपूर्ण जानकारी होना आवश्यक है।

मुंबई मंडल द्वारा यह पुस्तिका 'cr.indianrailway.gov.in' पोर्टल पर उपलब्ध की गयी है जिस से कर्मचारियों को विभागीय परीक्षाओं के अध्ययन के लिए काफीसहायता होगी।

उक्त पुस्तिका का प्रकाशन के लिए मैं मंडल रेल प्रबंधक तथा कार्मिक विभाग, मुंबई को हार्दिक शुभकामनाएं देती हूं।

रेणु

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मंडल रेल प्रबंधक

Rajnish Kumar Goyal I.R.S.E.E.
Divisional Railway Manager

सत्यमेव जयते

मध्य रेल

संदेश

वर्तमान युग कड़ी प्रतिस्पर्धा का युग है जिसमें प्रत्येक व्यक्ति एक अच्छी नौकरी और अच्छे कैरियर के लिए हरसंभव प्रयास करता है। प्रत्येक व्यक्ति चाहता है कि वर्तमान पद से जल्द से जल्द उसे पदोन्नति के रूप में अपनी उन्नति हो जाए। इस पदोन्नति को प्राप्त करने हेतु वह विभिन्न प्रकाशन की पुस्तक–पत्रिकाएं एवं प्रश्न बैंक इत्यादि को मुख्य साधन के रूप में प्रयोग करता है।

मुंबई मंडल के विभिन्न विभागों के पदाधिकारियों तथा कर्मचारियों द्वारा अपने ज्ञान व अनुभव के आधार पर तैयार किया गया, यह प्रश्न बैंक रेल्वे के अंतर्गत विभागीय पदोन्नति परीक्षा से संबंधित सभी प्रकार के प्रश्नों का अनूठा संग्रह है। इसमें सामान्य ज्ञान, विभिन्न महत्वपूर्ण प्रश्न, नवीनतम अधिसूचना, गजट पत्रक, बजट संबंधी व अन्य आवश्यक जानकारियों का संकलन है जो न केवल कर्मचारियों के ज्ञान में वृद्धि कर उनकी तैयारी को सुदृढ़ करता है बल्कि उन्हें अन्य कर्मचारियों की तुलना में काफी आगे भी ले जाता है। मुझे विश्वास है कि इस प्रश्न बैंक की सहायता से कर्मचारीगण अपने ज्ञान मे तो वृद्धि करेंगे ही साथ ही परीक्षा में उत्तीर्ण होकर अपना लक्ष्य भी प्राप्त कर सकेंगे। मुंबई मंडल द्वारा यह पुस्तिका 'cr.indianrailway.gov.in' पोर्टल पर उपलब्ध करायी गयी है जिसका सभी रेल कर्मचारीगण लाभ उठा सकते हैं।

मैं डॉ. तुशाबा शिंदे, वरिष्ठ मंडल कार्मिक अधिकारी एवं समस्त कार्मिक विभाग, मुंबई मंडल को उनकी इस अनूठी पहल के लिए सराहना करता हूं और बधाई देता हूं।

शुभकामनाओं सहित!

रजनीश

(रजनीश कुमार गोयल)

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भारत सरकार / Government of India
रेल मंत्रालय / Ministry of Railways
मध्य रेल / Central Railway

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Sr. Divisional Personnel Officer

कार्मिक विभाग
मुंबई मंडल कार्यालय
मुंबई छत्रपति शिवाजी महाराज टर्मिनस
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Personnel Office,
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मनोगत

श्री राम करण यादव जी, महाप्रबंधक महोदय द्वारा परिचालन, वाणिज्य एवं विद्युत विभाग की विभागीय परीक्षाओं हेतु अतिरिक्त प्रश्न बैंक का विमोचन करके आपके करकमलों में सौंपने का मुझे गौरव प्राप्त हुआ, जिसके लिए मैं महाप्रबंधक महोदय का अत्यंत आभारी हूं।

मैं मुख्यतः हमारे प्रधान मुख्य कार्मिक अधिकारी, श्रीमती रेणु शर्मा महोदया का अत्यंत आभारी हूं जिनकी प्रेरणा एवं मार्गदर्शन में मैंने यह प्रश्न बैंक बनाने का कार्य पूर्ण किया है।

श्री रजनीश कुमार गोयल, मंडल रेल प्रबंधक का मार्गदर्शन हमारे लिए सदैव प्रेरणादायी होता है। इन पुस्तिकाओं के प्रकाशन में भी उनका अमूल्य मार्गदर्शन मिला है। इसके लिए मैं मंडल रेल प्रबंधक महोदय का आभारी हूं।

यह प्रश्न बैंक 'cr.indianrailway.gov.in' पोर्टल पर भी उपलब्ध कराया गया है ताकि इस प्रश्न बैंक का उपयोग संपूर्ण रेल कर्मचारीगण कर सकें व इसका लाभ उठा सकें।

धन्यवाद!

T Shinde 01/07/24

(डॉ. शिंदे तुशाबा)

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All staffs & Welfare inspectors of Mumbai Division

OSM (Outside maintenance

Multiple Choice Questions

1	As per I.E. rule low voltage is up to _____ volts. **A. 250 Volt** B.415V C.1500V D.750V
2	Jabalpur division is in _____ Railway. **A.West Central** B.Central railway C.Eastern Railway D.Western Railway.
3	Symbol for star connection is _____. **A. Ÿ** B.Ω C.ʊ D.Δ
4	_____ is used for measurement of illumination level. **A. Lux meter** B.Ammeter C. Voltmeter D.Energy meter
5	_____ Motor can work on A.C. or D.C. supply. **A. Universal** B.Induction C.Synchronus D.None of these.
6	30 % energy can be saved by using _____ in F.T. fitting. **A. Electronics Ballast** B.Resistance C.Inductance D.None of these
7	Minimum clearance in front of panel board should be _____ mtr. **A. 1 meter** B.1.5 meter C.2.0 meter D.None of these.
8	For 30 H.P., 400 Volt, 3 phase squirrel cage induction motor _____ typestarter is required. **A. Auto Transformer** B.DOL starter C.star delta starter D.None of these.
9	Megger of _____ volts rating should be used for measuring the insulation resistanceof house wiring. **A. 500 Volt** B.1000 Volts C.2000Volts D.250 Volts .
10	The minimum size of G.I. Earth wire should be _____ SWG. **A. 8SWG** B.10 SWG C.05SWG D.None of these.
11	_____ is provided in ceiling fan for starting torque. **A.2.5 mfd Capacitor** B.3.5 mfd Capacitor C.25 mfd Capacitor D.None of these.

12	_____ gas is used in window type Air conditioner. **A.F-22** B.F12 C.R134 D.None of these.
13	Megger is used for measurement of_____. **A.Insulation resistance** B.Earth resistance C.Voltage D.Current.
14	Copper is a good _____ of electricity **A.Conductor** B.insulator C.semi conductor D.resistor.
15	_____ is measured by ammeter. **A.Current** B.voltage C.resistance D.specific gravity.
16	_____ type of motor is generally utilized for Air-cooler. **A.Shaded Pole** B.DC series C.Induction D.Synchronus.
17	Minimum height for fencing of sub-station is_____ meter. **A.1.8 Meter** B.2.8 Meter C.2.5 Meter D.None of these.
18	The rating of Secondary of CT is: _____ Ampere. **A.5 Ampere** B.10 Ampere C.15 Ampere D.None of these.
19	One Ton of Refrigeration is equal to :_____ BTU per hour. **A.12000 BTU** B.15000BTU C.14000BTU D.None of these.
20	Solapur division is comes under _____ Railway. **A.Central railway** B.West Central C.western Railway D.South central Railway.
21	For 10 H.P., 400 Volt, 3 phase squirrel cage induction motor _____ type starter is required. **A.Star-Delta** B.DOL C.Auto Transformer D.All of these.
22	The declared frequency in India is _____ cycle per second. **A.50 Cycle/second** B.60 Cycle/second C.100 Cycle/second D.None of these.
23	As per I.E. rule, permissible variation for low & medium voltage is up to _____%. **A.±6%** B.±2.5% C.±10% D.None of these.
24	_____ Color light is obtained from HPSV fitting.

	A.Yellow B.White C.Blue D.None of these.
25	_____ is used in breather of Transformer. **A.Silica Gel** B.Transformer oil C.Bucholz Rela D.None of these.
26	In LT overhead _____type of insulator are utilized. **A.Pin Type** B.Suspension type C.Schakle Type D.None of these
27	Air velocity is measured by _____. **A.Anemo Meter** B.Hydro meter C.Muti meter D.Baro meter.
28	When the CT's are in circuit it's terminal should not be _____. **A.Open** B.Close C.Reverse D.None of these.
29	_____are used for improvement of power factor. **A.Power Capacitor** B.Resistace C.Inductance D.None of these.
30	_____ Pump is used for deep bore well. **A.Submersible** B.Mono block C.Centrifugal D.None of these.
31	The Color of good silica gel is _____. **A.Blue** B.Yellow C.Pink D.White
32	In LT overhead _____type of conductor are utilized. **A.ACSR** B.Copper C.Steel D.Silver.
33	Current is measured by _____. **A.Ammeter** B.Anemo Meter C.Megger D.None of these.
34	For safety purpose in each circuit _____ is provided. **A.Fuse** B.contactor C.Bulb D.None of these.
35	In Energy Meter _____ error is permitted. **A.3 %** B.5 % C.7 % D.10 %,
36	_____ Color light is obtained from Metal Halide fitting. **A.White** B.Blue C.Yellow D.None of these.
37	Voltage is measured by _____.

	A.Voltmeter B.Ammeter C.Anemo Meter D.Megger
38	_____ is the weakest portion of circuit. **A.Fuse**, B.Energy Merter, C.Contactor, D.None of these.
39	The earth resistance of small substation should not be more than _____Ω. **A.2 Ω,** B.2 MΩ, C.2K Ω, D.20Ω
40	At Cut-pole in 11 KV systems _____ insulators are utilized. **A.Disc,** B.Pin, C.Schakle, D.None of these.
41	Insulation resistance is measured by _____. **A.Megger**, B.Voltmeter, C.Ammeter, D.Anemo Meter
42	If Transformer oil is non-operational then it should be _____. **A.Replacement**, B. Cooled, C.Circulated, D.None of these.
43	In Auto Transformer _____ winding is available. **A.Single**, B.Double, C.Tertiary, D.None of these.
44	Megger of _____ volts should be used for measuring the insulation resistance of low voltage installation. A.1000 Volt, B. **500 Volt**, C.1500 Volt, D.2000 volt.
45	_____is used for automatic operation of air conditioner **A.Thermostat**, B. fuse, C.MCB, D.None of these.
46	Current, Voltage and Resistance is measured by ---------- A. Hydrometer, B. **Multi meter** C.Insulation tester, D.None of these.
47	For 2 H.P., 400 Volt, 3 phase squirrel cage induction motor _____ type starter is suitable. **A.DOL,** B. Star-Delta, C.Auto Transformer, D.All of these.
48	_____ gas is used in refrigerator. A.R22, B.F-22, **C. F-12** D.None of these.
49	_____ is called the language of engineers. **A.Drawing,** B.Painting, C.English, D.None of these.

50	_____ Fitting is the latest source of light. **A.L.E.D,** B.LCD, C.CFL, D.Incadecent.
51	For 3 H.P., 3 phase squirrel cage motor _____ starter is used. **A.DOL,** B.Star-Delta, C.Auto Transformer, D.All of these.
52	The head of the zonal Railway is ----------. **A.General Manger**, B.DRM, C.CEE, D.none of these.
53	Bhusaval division comes under ---------- zone. **A.Central Railway** B.West Central, C.western Railway, D.South central Railway.
54	Integral coach factory is situated at ----------. **A.Peramboor**, B.Kolkota, C.Kapurthala, D.Bhopal
55	Rail wheel factory is situated at ----------. **A.Bengaluru,** B.Peramboor, C.Kolkota, D.Kapurthala,
56	Voltmeter is connected in ---------- in a circuit. **A.Parallel**, B.Series, C.Series parallel, D.none of these.
57	Ammeter is connected in ---------- in a circuit. **A.Series**, B.Parallel, C.Series parallel, D.none of these.
58	M. C. B. means ---------- circuit breaker. **A.Miniature,** B.Moulded core, C.Main, D.none of these.
59	Safety clearance from OHE lines is minimum ----------meter. **A.2 Meter.** B.2.5 Meter. C.3 Meter. D.none of these.
60	Mumbai Division is in ---------- Railway zone. **A.Central Railway** B.West Central, C.western Railway, D.South central Railway.
61	In India Railway started in the year----------. A.1852, B.1952, **C. 1853**, D.1953.
62	In India first train was run between Boribunder and --------- stations A.Kasara**,** B.Kalyan, C.Kurla, **D.Thane**

63	The highest Official in Railway board is ---------- Railway board. A.Minister, B. Secretary, **C. Chairman**, D.Governer
64	For Electrical department member ---------- is available in Railway board. **A.Traction**, B.Rolling stock, C.Traffic, D.None of the above
65	In addition to Chairman Railway board there are --------members in Railway Board. **A.S Aix**, B.Five, C.Seven, D.Eight
66	In Electrical department Chief Electrical Engineer nominated as the ---------- **A. E.I.G.**, B. S.I.G, C. D.I.G, D. C.V.sC
77	Head quarter of Central Railway is ----------. **A.Mumbai**, B. Pune, C.Nagpur, D.Bhusawal
78	Diesel Modernization workshop is situated at ----------. **A.Patiala**, B.Latur, C.Bhopal, D.Chittaranjan
79	For jointing of lug in cable connection---------- tools used. **A.Crimping**, B.Stamping, C.pressing, D.jig
80	Electrical General Department works under ----------. **A.CESE**, B.CELE, C.CEGE, D.CEDE
81	-------- equipment is used in Laboratory and Research work. **A.Absolute**, B.Secondary, C.Solenoid, D.Standard
82	For daily use ---------- instrument is use. **A.Secondary,** B.Absolute, C.Solenoid, D.Standard
83	Facility of Holiday homes provide in ---------- schemes. **A.Welfare**, B.Rehabilitation, C.Liberalisation, D.Development
84	Any equipment kept in Laboratory setting with standard equipment is called----------. **A.Calibration**, B.Motorisation, C.Setting, D.none of these.
85	There are ----------use for smallest to smallest errorless measurement. **A.Micrometre**, B.Millimeter, C.Centimeter, D.Tensometer.
86	Voltmeter is ---------- type instrument.

	A.Indicating, B.Testing, C.Reading, D.none of these.
87	Ammeter is connected in----------with the load. **A.Series**, B.Parallel, C.Across, D.End
88	Kilowatt hour meter is ---------- type instrument. **A.Integrated**, B.Isolated, C.Derivated, D.None of these
89	-------- is the equipment to measure R.P.M. of rotating machines. **A.Tachometer**, B.thermometer, C.galvanometer, D.anemometer
90	Weight should be lifted according to --------- of the crane. **A.Capacity**, B.Potential, C.Load, D.Pull lift.
91	In open circuit no ------ flows. **A.Current**, B.Resistance, C.Impedance, D.none of these.
92	The unit of electrical power is ----------. **A.Watt**, B.Volts, C.Ampere, D.Watt hour
93	The transformer is a ---------- device. **A.Static,** B.Rotating, C.Bimetallic, D.Cruciform
94	There are ---------- types of Instrument transformers. **A.Two Types,** B.One types, C.Three types, D.Four types
95	Instrument transformer is used for ---------- instrument. **A.Measuring**, B.Indicating, C.Testing, D.Reading
96	In Multimeter and ammeter ---------- transformer is used. **A.Current**, B. Step up, C.Step down, D.Potential
97	In ---- connection there is no any neutral point. **A.Delta**, B.Star, C.Delta star, D.None of the above
98	The process of extracting heat from any place to reduce the temp.is called -------.

	A.Refrigeration, B.Condensation, C.Evaporation, D.None of these
99	Transformer is working on ---------- induction principle. **A.Mutual**, B.Static, C.Capactive, D.None of these
100	Voltage between two phases is called---------- voltage. A. Under, B.Phase, C.Over, **D.Line**
101	B.T.U. is the unit of ----------. A. Current, **B.Heat**, C.Voltage, D.Cold.
102	In overhead line conductor is tied on ------. **A.Insulator**, B.Conductor, C.Semiconductor, D.none of these
103	AAC stands for all ------- conductor. **A.Aluminium**, B.Copper, C.steel, D.None of these
104	------- Wire is provided below overhead line conductors for safety. **A.Guard**, B.Phase, C.Neutral, D.Guy.
105	FL stands for ------- lamp. **A.Fluorescent**, B.flash, C.float, D.none of these
106	------ wire is used for earth conductor. **A.Galvanized iron**, B.Copper, C.Aluminium, D.none of these
107	------ is connected in series of the ceiling fan to control the speed **A.Regulator**, B.Rectifier, C.Invertor, D.capacitor.
108	The machine which converts electrical energy in to mechanical energy is called ------. **A.Motor**, B.Generator, C.Alternator, D.Transformer
109	There is no any difference in construction of DC motor and ------motor. **A.Universal**, B.Induction, C.servo, D.Synchronous.
110	---------- Relay is provided to protecting motor against overCurrent. **A.Overload**, B.Overvoltage, C.differential, D.none of these

111	Back ----- is generated as soon as motor picks up speed. **A.EMF**, B.Current, C.capacitance, D.Impedence.
112	PILC cable is called paper ----- lead covered cable. **A.Insulated**, B.integrated, C.inverted, D.isolated.
113	Disc of single phase energy meter rotates due to torque created by two ---- **A.Electromagnet**, B.Induction, C.capacitance, D.None of these
114	There is -------- coil and potential coil in single phase energy meter. **A.Current**, B.Resitance, C.Capacitance, D.None of these
115	Generally --------- inch sweep ceiling fans are most commonly used. **A.Sweep 48"** B.Sweep 36" C. Sweep 44" D.Sweep 55"
116	Earth -------can be reduced by using coal and salt and increasing moisture content in soil. **A.Resistance**, B.Inductance, C.Capacitance, D. Impedance
117	For three phase machines/equipment's ------ earths are essential. **A.2**, B.1, C.3, D.4
118	Choke is provided in ------ with the circuit of gas discharge lamp. **A.Series**, B.parallel, C.series parallel, D.None of these
119	--------- voltage is required for starting of gas discharge lamp. **A.High**, B.Low, C.Medium, D.None of these.
120	-------- should be provided in substation. **A.First-aid Box**, B.wheel chair, C.both, D.none.
121	Service line shall be taken from the point of ----------. **A.Support**, B.centre, C.end, D.top.

\

STATE TRUE OR FALSE -

1	Overhead line is easy for maintenance than U.G. Cables **True**
2	Hydrometer is used for measurement of specific gravity of electrolyte of Batteries **True**
3	Terminals of current transformers can be kept open while in service **False**
4	Earth resistance of domestic installation shall not be more than 8 ohms **True**
5	Capacitors are used for improvement of power factor **True**
6	When conductor cuts the magnetic lines of force e.m.f. is generated. **True**
7	No capacitor is required for single phase shaded pole motor **True**
8	Never provide fuse in neutral conductor. **True**
9	Opposition to flow of current is called resistance **True**
10	V.T. Pump can be installed in deep bore well **False**
11	Different type of Vector Group of Transformer's is not eligible for parallel operation. **True**
12	As per I.E. rule, permissible variation for low & medium voltage is up to ± 6 %. **True**
13	Yellow Color light is obtained from HPSV fitting. **True**
14	Silica Gel is used in breather of Transformer **True**
15	In LT overhead Shackle type of insulator are utilized. **False**
16	Air velocity is measured by Anemometer. **True**
17	Shaded pole type of motor is generally utilized for Air-cooler. **True**
18	Minimum height for fencing of sub-station is 3 meter. **False**

19	The rating of Secondary of CT is 5 Ampere. **True**
20	One Ton of Refrigeration is equal to 12000 BTU per hour. **True**

21	As per I.E. rule low voltage is up to 250 volts. **True**
22	Bhopal division is comes under Central Railway. **False**
23	Lux-meter is used for measurement of illumination level. **True**
24	Universal Motor can work on A.C. or D.C. supply. **True**
25	Energy can be saved by using electronic Ballast in F.T. fitting. **True**
26	Minimum clearance in front of panel board should be one mtr. **True**
27	Megger of 500 volts rating should be used for measuring the insulation resistance of house wiring. **True**
28	For 10 H.P., 400 Volt, 3 phase squirrel cage induction motor rotor resistance type starter is required. **False**
29	Capacitor is provided in ceiling fan for starting torque. **True**
30	R-22 gas is used in window type Air conditioner. **True**
31	The declared frequency in India is 50 cycle per second.

	True
32	Minimum height for fencing of sub-station is 1.8 meter **True**
33	Commutator & Brushes are provided in DC machines. **True**
34	Vane relay is provided near canvas duct to prevent the fire. **True**
35	Volt-meter is used for measurement of illumination level. **False**
36	If more than one cell is connected in series then it is called Torch. **False**
37	For 30 H.P., 400 Volt, 3 phase squirrel cage induction motor Auto Transformertype starter is require **True**
38	First train in India was run between Boribunder & Thane. **True**
39	R134 a gas is used in new refrigerator. **True**
40	3 phase Induction motor is used for pumps. **True**
41	Minimum height for fencing of sub-station is 2.5 meter **False**
42	Commutator & Brushes are provided in AC machines. **False**
43	As per I.E. rule medium voltage is up to 650 volts. **True**

44	Chief Electrical Engineers Of Railways are also working as an Electrical Inspector to Government. **True**
45	If more than one cell is connected in series then it is called Battery. **True**
46	Energy can be saved by using electronic fan regulator in Fan circuit. **True**
47	Overhead line is preferred over U.G. Cable for transmission **True**
48	The Color of Silica Gel of breather of transformer is Yellow **False**
49	Transformer is a static device. **True**
50	Flemings Right Hand rule is applicable for Generators **True**
51	Maximum permissible Earth resistance of small substations is 12 ohms **False**
52	Motor is a machine which converts electrical energy in to mechanical energy **True**
53	If cells are connected in series its total voltage increases **True**
54	Transformer has primary and secondary windings. **True**
55	Unit of current is ampere **True**
56	Two separate earth should be provided for neutral

	True
57	To convert AC to DC rectifier is used **True**
58	There are three contactors in star delta starter **True**
59	BDV of transformer oil in use should not be less than 30 KV **True**
60	Lub oil of DG set should be checked before operation. **True**
61	First train in India was run between Ghodbunder & Thane **False**
62	Fuses are provided for protection in electrical circuits **True**
63	Resistance of conductor increases if temperature decreases. **False**

ABBREVIATIONS -

1	CWM **Chief Workshop Manager**
2	IRIEEN **Indian Railway Institute of Electrical Engineering, Nasik.**
3	RDSO **Research Designs and Standards Organisation**
4	MDB **Main Distribution Board**
5	CFL **Compact Fluorescent Lamp**
6	LA **Lightening Arrester**
7	VRLA **Valve Regulated Lead Acid**
8	VCB **Vacuum Circuit Breaker**
9	ACSR **Aluminium Conductor Steel Reinforced.**
10	DCP-**Dry Chemical Powder**
11	ELCB **Earth Leakage Circuit Breaker**
12	RPF **Railway Protection Force**
13	HRC **High Rupturing Capacity**
14	MCB **Miniature Circuit Breaker**
15	TRD **Traction Department**
16	DRM **Divisional Railway Manager**
17	IS **Indian Standards**
18	KWH **Kilo Watt Hours.**
19	CRB

	Chairman Railway Board
20	MOCB **Minimum Oil Circuit Breaker**
21	PVC **Poly Vinyl Chloride**
22	PT **Potential Transformer**
23	HPSV **High Pressure Sodium Vapour**
24	CESE **Chief Electrical Service Engineer**
25	CT **Current Transformer**
26	GI **Galvanised Iron**
27	ACB **Air Circuit Breaker**
28	MH **Metal Halide**
29	CEE **Chief Electrical Engineer**
30	OCB **Oil Circuit Breaker**
31	DG Set **Diesel Generating Set**
32	GM **General Manager**
33	ICF **Integral Coach Factory**
34	RCF **Rail Coach Factory**
35	BSL **Bhusaval**
36	JBP **Jabalpur**
37	SDEE **Sr. Divisional Electrical Engineer**
38	CSTM

	Chhatrpati Shivaji Terminus Mumbai
39	WCR **West Central Railway**
40	CR **Central Railway**
41	EHV **Extra High Voltage**
42	OVP **Over Voltage Protection.**
43	SPP **Single Phasing Preventer**
44	SWG **Standard Wire Gauge**

Answer in one sentence

1	Which meter is used for measuring voltage? **Volt-Meter**
2	What is filled in the transformer breather? **Silica Gel**
3	Which fire extinguisher is suitable for electrical fire? **Dry Chemical Powder**
4	What is meant by CT? **Current Transformer**
5	What is meant by LA? **Lightening Arrester**
6	How many zones are in Indian Railways? **17**
7	Who is the highest Official in Railway board? **Chairman Railway Board**
8	Where is the Head quarter of West-Central Railway? **Jabalpur**
9	Where is the Head quarter of Central Railways? **CST Mumbai**
10	Where is the Integral Coach Factory is situated ? **Peramboor**
11	Where is the Diesel Locomotive works situated? **Varanasi**
12	Which tools is used for jointing of lug in cable connection? **Crimping**
13	Who is the Head of Electrical General Department? **CESE**
14	Which instrument is use for daily use? **Secondary**
15	What is used for ensuring tightness of nut-bolt? **Torque Wrench**
16	In which schemes Facility of Holiday homes provided? **Welfare**
17	What is called for setting of any equipment with standard equipment kept in Laboratory? **Calibration**
18	While cutting with chisel in which direction one should cut?

	Opposite
19	Voltmeter is which type of instrument? **Indicating**
20	What is used for measurement of Level of light? **Lux meter**
21	How the Ammeter is connected with the load for measurement? **Series**
22	What safety should be taken while working on heighted place? **Safety belt & Helmet**
23	The quality of insulation is reducing due to? **Moisture**
24	Germanium and silicon are which type of material? **Semi- Semiconductor**
25	What is provided to protect electrical circuit from short circuit? **Fuse**
26	What do you mean by ELCB? **Earth Leakage Circuit Breaker**
27	In which condition the Isolator is operated? **Only off Load**
28	PTW stands for? **Permit to work**
29	For which type of fire, Dry chemical powder type fire extinguisher is used? **Electrical**
30	In which circuit current is same? **Series**
31	What is same in parallel circuit? **Voltage**
32	What is the unit of electrical power? **Watt**
33	How much kilowatt is equal to1000 watt? **One**
34	How much watt is equal to One HP? **746 Watt**
35	What is called the path of conductors arranged for flow of current? **Circuit**
36	What is the work of Diode? **Rectifier**
37	What is the total resistance of the circuit if all the resistances are connected

	in series? **Addition of all the resistances**
38	Write down the name of magnet poles? **North & South**
39	What is other name of secondary cell? **Storage**
40	What is name of Lamp filament's metal? **Tungsten**
41	What do mean by MMF? **magneto motive force**
42	Generally which grade of Pencil is used in drawing? **H**
43	What is called if more than one cell are connected in series/ parallel? **Battery**
44	In ammonia print which lines are formed on white background? **Blue**
45	What is the temperature limit of Y class insulating material? **90 °C**
46	What is called to the transformer? **Static**
47	What are the types of Instrument transformers? **2**
48	In which connection there is no any neutral point? **Delta**
49	What is same in delta connection? **Phase & Line voltage**
50	Which type of transformer is used for Multimeter and ammeter? **Current**
51	Which type of transformer is used In generating station? **Step Up**
52	What is working principle of Transformer? **Mutual Induction**
53	What is the voltage in between phase and neutral In star connection? **230 Volt**
54	What is the unit of capacity of cells? **Ampere-hour**
55	Which types of conduit are used for wiring? **PVC /Metal**

56	How the heat does flows? **Higher temp. to lower temp.**
57	What is called that heat required for changing the state from liquid to gas at constanttemp? **Latent heat**
58	ACSR stands for? **Aluminium conductor steel reinforced.**
59	What is the starting current of motor? **6 to 8 times of running curren**
60	What is the unit of Cooling capacity of AC unit? **Refrigeration ton**
61	Which type of fittings is provided on tower? **Flood Light**
62	What are the main parts of motor? **Stator & Rotor**
63	In which type of fan regulator losses are less? **Electronic**
64	What is called that machine which converts electrical energy in to mechanicalenergy? **Motor**
65	What are the types of conductor? **3types**
66	Which relay is provide D.to protect motor against overload? **Overload relay**
67	Which coil is provided in starter for starting purpose? **No volt Coil**
68	What is used in star delta starter for automatic operation? **Timer**
69	Which type of starter is used For Motors up to 5 hp? **D.O.L**
70	Which type of motor can works on both supply i.e AC&DC? **Universal**
71	PVC stands for? **Polyvinyl chloride cable**
72	What for XLPE stands? **Cross linked polymer extruded cable**
73	How much coils are working in single phase energy meter?

	2 coils
74	Generally which sweep of ceiling fans is most commonly used? **48" sweep**
75	Insulation resistance of house wiring is measured by which Megger? **500 volt**
76	Where the switches should be provided in house wiring? **Phase**
77	What is the codal life of House wiring? **10 years**
78	What is used for getting high voltage for starting of gas discharge lamp? **Choke**
79	What is provided to safeguard the Big buildings from lightening? **Lightning arrester**
80	Which pump is used for bore wells? **Submersible**
81	Which type of pump is generally used for open well? **Centrifugal**
82	Which type of submersible pump is used for open well? **Mono-block**
83	Which protection is essential for submersible pump? **Dry-run**
84	Which conductor shall have permanent identification mark? **Neutral**
85	Which type of board shall be displayed in English and local language at the place of medium and high voltage? **Danger**
86	What precautions to be take while working on overhead line? **Earthing**
87	What should be provided in substation to extinguish the fire? **Fire extinguisher**
88	How much horizontal clearance is required from building for low and medium voltage line? **1.2 meter**
89	What is used for measurement of velocity of air? **Anemometer**
90	What is precaution to be taken on high voltage line for prevention of access

	to unauthorized persons? **Anti-climbing device**
91	What is called that power station using coal? **Thermal power station**
92	What is called for Power station using water turbine? **Hydroelectric power station**

Match the Pair.

A)

Part A	Part B
1. Electrical Inspector to Government.	A. Silica Gel
2. Breather	B. CEE
3. Yellow Light	C. Safety Device
4. Helmet	D. Dry Sand
5. Fire Bucket	E. HPSV Lamp
6. Ceiling Fan	F. DCP Type
7. Fire Extinguisher	G. 2.5 MFD capacitor
8. Line Voltage	H. Priming
9. Centrifugal Pump	I. Self-Starter
10. DG set	J. Voltage between 2 phases

B)

Part A	Part B
1. Transformer	A. R-134a
2. Refrigerator	B. Explosion Vent
3. Sulphuric Acid testing	C. Refrigerant Leakage
4. Metal Halide	D. H2 SO4
5. Soap Solution	E. White Color Light

C)

Part A	Part B
1. Transformer	A. 2 Volts
2. Window AC	B. For Automatic Operation
3. Voltage of Cell	C. AMF Panel
4. Thermostat	D. For Cooling of Room
5. D.G.Set	E. Bucholz Relay

D)

Part A	Part B
1. Starting capacitor	A. Step up or step down voltage
2. Transformer	B. Ceiling fan
3. Submersible Pump	C. 50 cycles per second
4. Low voltage	D. Up to 250 volts
5. Declared frequency in India	E. Deep bore well

E)

Part A	Part B
1. Porcelain	A. Electrolyte
2. Transformer	B. Yard Lighting
3. Battery	C. Overload Relay
4. High Mast Tower material	D. Insulating
5. Motor Starter	E. Neutral

F)

Part A	Part B
1. Tachometer	A. Measurement of SPG
2. Multimeter	B. Measurement of IR
3. Lux meter Speed	C. Measurement of
4. Megger	D. Measurement of Voltage, Current & Resistance
5. Hydrometer	E. less maintenance

Answers For Match the Pair.

A) 1 – B 2 – A 3 – C 4 – E 5 – D 6 - G 7 - F 8 - J 9 - H 10 - I
B) 1 – B 2 – A 3 – D 4 – E 5 – C
C) 1 – E 2 – D 3 – A 4 – B 5 –
D) 1 – B 2 – A 3 – E 4 – D 5 – C
E) 1 – D 2 – A 3 – E 4 – B 5 – C
F) 1 – C 2 – D 3 – E 4 – B 5 – A

TL\AC (Train Lighting \ Air Conditioning

Fill in the blanks

1	The pressure which maintains current is called _____. **A.Voltage** B.Impedence C. Capacitance D. None of these
2	The measuring unit of electric power is _____. **A.Watts** B.Volts C.ampere D.Lux.
3	In coach wiring DC fan positive is _____in colour. **A.Red** B.yellow C. blue D.black
4	Ammeter is connected in _____ with supply. **A.Series** B.Series parallel C. Parallel D.none of these
5	Opposition to magnetic flux is called _____. **A.Reluctance** B. Resistance C. Impedence D.Capacitance
6	RMPU coach is equipped with alternator of _____KW capacity. **A.25 KW** B. 4.5KW, C. 2.5 KW D.15 KW,
7	One mega-ohm is equal to _____ ohms. **A.10 Lac** B.1 Lac C. 100 Lac D.10000
8	One ton of refrigeration is equal to _____ B.T.U.per hour. **A.12000 BTU** B.1200BTU C. 120 BTU D.120000 BTU.
10	Grade number of belt of normal nominal pitch length is given as _____. **A.50** B. 49 C. 51 D.52.
11	Cut in speed of 25 KW alternator is _____ RPM. **A.350 RPM** B. 300 RPM C. 400 RPM D.250 RPM.
12	Axle pulley of non A. C. coach is of _____ mm size. **A.572.6 MM** B. 562.6 MM C. 582.6 MM D.579 MM.

14	Capacity of 4.5 KW alternator is _____ amperes. **A.37.5 Amps** B. 32 Amps C. 35.5 Amps D.40 Amps .
15	There are 4 number of_____ belts in110 volts TL coach. **A.V-Belts** B. Flat belts C.Round bolts D.Toothed belts.
16	The measuring unit of mechanical power is _____. **A.Horse Power** B. Amper hour C. Hertz D. Volts.
17	In coach wiring fan negative is _____in colour. **A.Black** B.Red C. Yellow D.Blue
18	Rail Coach Factory is situated at _____. **A.Kapoorthala** B.Perambur C. Bhopal D.Varanasi.
19	AC Two tier coach has alternator of _____ KW capacity. **A.25 KW** B.4.5KW C. 2.5 KW D.15 KW,
20	_____ton of refrigeration is equal to 12000 B.T.U.per hours. **A.1** B. 2 C.3 D.4**.**
21	_____ is used for measurement of lux level. **A.Lux meter** B.Anemometer C. Voltmeter D. Hydrometer.
22	Integral Coach Factory is situated at _____. **A.Peramboor** B.Kapoorthala C. Bhopal D.Varanasi.
23	AC three tier coach has alternator of _____ KW capacity. **A.25 KW** B.4.5KW, C. 2.5 KW, D.15 KW.
24	Megger is used for measurement of _____. **A.IR** B.Current, C. lux D.frequency.
25	Specific gravity of fully charged lead acid cell is _____. **A.1220** B.1100, C. 1300 D.1000.

26	_____ Relay is operated if air delivery of blower is sufficient. **A.Vane relay** B. Overload Relay C. Differential Relay D. Thermostat.
27	3000 Kilo-Calorie per hour is equal to _____ton of refrigeration. **A.One** B. Two, C. Three D.half.
28	_____ is used for measurement of insulation resistance. **A.Megger** B.Lux meter C. Anemometer D.Voltmeter.
29	_____ Relay is provided to prevent fire near canvass duct. **A.Vane Relay** B.Overload Relay C. Differential Relay D.Thermostat.
30	Voltage of fully charged lead acid cell is _____volts. **A.2.3 Volt** B. 2.5 Volt, C. 3.0 Volt D.2.0 Volt.
31	Alternator pulley of AC coach is of _____ mm size PCD. **A.200 MM** B.180 MM, C. 220 MM D160 MM
32	Setting of TDR-1 in AC coach is _____ minutes. **A.2.5 second** B.1.5 second, C. 10 second, D.5 second
33	Single phasing _____ is provided to avoid damage from single phasing. **A.Preventer** B.Rectifier C. Inverter D. None of these
34	_____ Amp/Hr Battery is provided in TL coach. **A.120 AH** B. 70 AH, C. 1100 AH, D.800 AH
35	For conversion from AC to DC _____ provided. **A.RRU** B.INVERTER C.ALTERNATOR D.OVP
36	Escorting staff to be present on duty before _____ hour of train departure. **A.1 Hour** B.30 Mins C. 2 Hours D. 1 Hr 35 mins
37	In RMPU coach control circuit wires are of _____ colour.

	A.White B.Red, C. Yellow, D.Blue
38	Best class of insulation material is _____ class. **A.C Class** B.Y Class, C. A Class, D.F Class
39	Diode is also known by the name of _____. **Rectifier**
40	If contact No.13A is welded _____runs continuously **A.Compressor** B.Alternator, C. WRA, D.None of these
45	The illumination level is measured by _____ meter. **A.Lux meter** B.Anemometer, C. Voltmeter, D.Megger
46	In SG coach the emergency lamp will be burn after _____ circuit in input circuit. **Short - circuit.**
47	After destroying of Residual _____ output of Alternator is stopped. **A.Magnetism** B.Current, C. Voltage, D.None of these
48	The difference in between two alternators current of AC coach is not more than _____ Amperes. A.160 Amps B.50 Amps, **C. 25 Amps**, D.100 Amps
49	Dyno Drive test is carried out for _____ sharing. **Load**
50	Specific Gravity of Battery is measured by _____. A.Hygrometer **B. Hydrometer**, C. Volt meter, D.Tong tester
51	_____ is used for measurement of current. **A.Ammeter** B.Anemometer, C. Voltmeter, D.Megger
52	_____ KVA Inverter is used in RMPU AC coach. **A.5 KVA** B. 10 KVA, C. 15 KVA, D.None of these
53	Ammeter is provided with _____ for measurement of Load of AC Coach.

	A.Shunt B.Fuse, C. Resistance, D.None of these
54	Drawing is the _____of Engineers. **Language**
55	Line Voltage is = 1.732 times _____ voltage. **A.Phase** B. Neutral C. Open circuit, D.None of these
56	If Neutral is required then _____ connection must be done. A. Series B.Delta C. Parallel, **D.Star**
57	Electrolyte is prepared by adding _____Acid in water. **A.Sulphuric** B.Hydrchloric, C.Tartaric acid, D.None of these
58	In TL coach C_____ V-belts are used. A.120 **B.122** C. 118, D.132
59	In garib rath _____ system of train lighting is used. **A.EOG** B.HOG C. MOG, D.SG
60	Axle pulley of AC coach is of _____ mm PCD. A.550.6 MM B.562.6 MM C. 577.6 MM, **D. 572.6 MM**
61	Amount of current flowing In open circuit is _____. A. 100 amps B.Infinity **C. Zero**, D.10 amps
62	In RMPU coach _____ gas is utilized. **A.R-22** B. R134a, C. R134, D.R12
63	Diameter of Branch Circuit Wire is _____ of sq.mm in coach wiring. **A.16 Sq.mm** B.20 Sq.mm, C.25 Sq.mm, D.32 Sq. mm
64	Codal life of coach wiring is _____ years. A.12 Years B.20 Years, **C.25 Years,** D.2 Years
65	_____ KVA Transformer is used in AC coaches of LHB EOG system.

	A.60 KVA B.15 KVA, C.9 KVA, D.100 KVA
66	Capacity of precooling unit is _____ Ampere of AC coach. **A.200 Amps** B.100 Amps, C.300 Amps, D.500 Amps
67	AC mechanic should enter the faults encountered enroute in _____ book. **A.Log- Book** B.Diary, C. Notepad, D.None of these
68	In RMPU coach _____ motors are used. **A.3 Phase** B.1 Phase, C. DC, D.None of these
69	In 110 V TL coach main negative fuse is of _____amp. **A.40 Amps** B.16 Amps, C. 6 Amps, D.400 Amps
70	In RMPU coach _____ is provided in place of expansion valve **A.Capillary Tube** B.Accumulator, C.Drier, D.None of these
71	In case of Short circuit the amount of current will be_____. A. 10 Amps B.Zero, C. 100 Amps, **D. Infinity**
72	In 110 V TL coach RRU capacity of field fuse is_____ amperes. **A.6 Amps** B.16 amps, C. 35 amps, D.32 amps
73	In 110 V TL coach L-2 fuse is of _____amp. **A.16 Amps** B.32 amps, C. 35 amps, D.40 amps
74	In Rotary Junction Box there are total _____ switches. **A.Four** B. Three C. One D.Two
75	Battery of a TL coach is charged through _____. **A.BCT** B.Inverter C. EFT D.None of these
76	Head quarter of Central Railway is ----------. **A.Mumbai** B.Pune C. Bhusawal, D.Church gate
77	The ---------- value will increase by baking process of winding. **A.IR** B.Cooling C. Current, D.None of these

78	Germanium and silicon is ---------- material. A. Insulator B.Conductor C. **Semi- Conductor** D.None of theses
79	ELCB stands for earth---------circuit breaker. **A.Earth Leakage** B.Earth Level C. Earthing Load, D.None of these
80	-------- is the equipment to measure R.P.M. of rotating machines. A**.** Hydrometer B.Anemometer C. Barometer, D. **Tachometer**
81	In India Railway started in the year----------. **A.1853** B.1920 C. 1947, D.1857
82	Diesel Locomotive works situated at --------. **A.Varanasi** B. Kapurthala C. Peramboor D.Bhopal
83	Kilowatt hour meter is ---------- type instrument. **Integrated**
84	Diesel Modernization workshop is situated at ----------. A. Peramboor B.Varanasi C. Kapurthala, **D.Patiala**
85	If current is passed through the electrical winding made on core, the magnet formed is called-----. A. Magnetic B.Permanent Magnet C. Residual Magnet, **D. Electromagnet**
86	In Self generation Coaches ---------- cells are used. **A.Lead Acid** B.Nickel Cadmium C. Lithium Ion, D.Nickel Metal hydride
87	After attending desired speed in self-generation coach battery is charged by supply from ---------. **A.Alternators** B. BCT, C.Inverters, D.EFT
88	Heat required for changing the state from liquid to gas at constant temp.is called ---- heat.

	A.Latent B.Sensible C. Specific, D.None of these
89	--------- flows from higher temperature to lower temperature. A.Cold B.Current C. Water, **D.Heat**
90	From condenser liquid refrigerant goes to liquid ------. **Receiver**
91	One --------- heat is required to raise the temperature one kilogram of water by one degree centigrade **A.Kilo- calorie** B.Calorie C. Mega-calorie. D.Milli-calorie
92	After tightening the pulley marking should be done with ---- paint. **A.White** B.Black C. Red, D.Blue
93	Availability of nut, bolts, ------etc. of axle pulley should be ensured. **A.Split pin** B.Hair pin C. Spring pin, D.Taper pin
94	Shorting of free wheeling --------- is one of the reasons for defect in RRU. **A.Diode** B.IGBT C. JFET, D.MOSFET
95	After battery is discharged both plates are converted to -------. **A.Lead sulphate** B.Lead oxide C. Lead acid, D.Sulphuric acid
96	Time to time battery should be ------- charged if it is not in use. **A.Trickle** B.Boost C. Conventional, D.none of these
97	Cracks in ---------- is one of the defects noticed in a battery. **Container**
98	In battery reasons for most of the failures are low voltage and low ------ A.**Specific gravity** B. Specific current C. Load, D.None of these
99	If condenser is dirty or jammed -------- pressure will increased. **A.Discharge** B.charge C. semi-charge, D.None of these
100	In AC plant if quantity of refrigerant gas is less then suction pressure will be -------. **A.Low** B. High C. Unchanged, D.None of these
101	In AC coach if heater is 'on' without blower then as a warning.----- sounds.

	A.Hooter B.Message C. Whistle, D.None of these
102	------ is provided to fans for safety. **A.Guard** B.Terminals C. Blades, D.Electricity
103	From primary maintenance depot ------ feeding terminal is permitted to go in isolated condition. **A.Emergency** B.Electricity C. Energy, D. External

State True Or False

1	There are 10 accident emergency lights In one EOG coach. **False**
2	One kilo watt is equal to 1000 watts. **True**
3	Insulation resistance is measured by Megger. **True**
4	Electrolyte contains sulphuric acid and distilled water. **True**
5	In EOG system generation voltage is 750 volt three phase. **True**
6	Rating of RMPU coach compressor motor is 1.5 hp. **False**
7	Low voltage relay (LVR) is provided in conventional AC coach. **True**
8	LHB stands for Linke Hofmann Busch **True**
9	AC Generator is called Alternator. **True**
10	25 KVA inverter is provided in RMPU coach **True**
11	LHB coaches are comfortable as compared to other coaches **True**
12	Safety chain for alternator is provided for a show. **False**
13	End On Generation system is used in Rajdhanee Express **True**
14	Inverter converts DC in to AC. **False**
15	If field fuse is broken then alternator stops generation **True**
16	VRLA battery is also called as SMF battery. **True**
17	Unit of voltage is volt. **True**
18	Temperature is measured by Thermometer. **True**

19	There are two DG sets in a power car. **True**
20	Rating of RMPU coach blower motor is 1.5 hp. **True**
21	All motors of RMPU AC coaches are of 110 V DC. **False**
22	RRU converts AC in to DC. **True**
23	DC Generator is called Dynamo. **True**
24	02 Nos. brushes are provided in Brushless alternator. **False**
25	Two Nos. sealed compressors are provided in RMPU. **True**
26	Full load current of 4.5 kw alternator is 37.5 amperes. **True**
27	End on Generation system is used in Garib Rath **True**
28	If alternator belts are loose generation voltage will be low. **True**
29	Copper is good conductor of electricity. **True**
30	Inverter converts AC in to DC. **True**
31	Copper is better conductor of electricity than silver. **False**
32	Codal life of VRLA battery is 10 years. **False**
33	Unit of resistance is ohm. **True**
34	The unit of illumination level is lux. **True**
35	Both compressors of RMPU start at a time. **False**
36	NL stands for night light. **True**
37	Unit of resistance is soham. **False**

38	Main transformer of LHB coach is of 60 KVA. **True**
39	AC Generator is called Dynamo. **False**
40	10 Nos. brushes are provided in Brushless alternator. **False**
41	EFT stands for emergency feeding terminal. **True**
42	In AC three tier coach 1100 amp hour battery is used. **True**
43	Lux meter is used for measurement of temperature. **False**
44	The PCD of alternator pulley of AC coach is 200 mm. **True**
45	RRU is provided for conversion of AC into DC. **True**
46	Component number of LVR is 27 **True**
47	In Self generation system 3 phase brushless alternators are used. **True**
48	The heat load of one person in AC coach is taken as 400 BTU/hour. **True**
49	Accident emergency lights are provided in EOG coaches. **True**
50	100 KVA invertors are provided in RMPU AC coach. **False**
51	During good weather condition Insulation resistance value of TL coach wiring should not be less than 2 mega ohms. **True**
52	The unit of electrical current is amp. **True**
53	In 110 V TL coach 120 amp hour batteries is used. **True**
54	1 refrigeration ton is equal to 12000 BTU per hour. **True**
55	For measurement of velocity lux meter is used. **False**
56	The PCD of axle pulley of AC coach is 200 mm.

	False
57	1 refrigeration ton is equal to 2000 BTU per hour. **False**
58	C122 grade belts of 4 nos. Are provided in 110 volt TL coach. **True**
59	For measurement of Light intensity (Lux level), Lux meter is used. **True**
60	In SG Non-AC coach the Battery fuse is of 32 Amps. Provided. **True**
61	IR value of Coach is measured by 500 volt meger. **False**
62	Now 134a refrigerant Gas is utilized in Conventional coach. **True**
63	In refrigeration system the Vacuum pump is used for filling of water. **False**
64	Fresh Air dampers will be close during the pre-cooling test. **True**
65	SMI stands for special maintenance instructions. **True**
66	When more than one cell is connected in series, it is called battery **True**
67	MCB stands for mobile circuit breaker. **False**
68	If length of the conductor increases, its resistance increases. **True**
69	16 ampere fuse is used in L-1 circuit of 110 V TL coach. **True**
70	WRA stands for water raising apparatus. **True**
71	PTW stands for permit to work. **True**
72	Isolator is operated only on OFF load. **True**
73	The unit of current is resistance. **False**
74	Chittaranjan Locomotive works situated at Patiala. **False**

75	Head quarter of Central Railways is situated at Nagpur. **False**
76	The unit of electrical power is Watt.
77	In a magnet there are two poles East and South. **False**
78	Secondary cell is also called as Edison cell. **False**
79	Lamp filament is made up of tungsten. **True**
80	In VRLA cell, distilled water topping is not required. **True**
81	In dehydrator cum filter heat is absorbed from refrigerant gas. **False**
82	415 volt DC is converted to 415 volt A.C. by invertor. **False**
83	If discharge pressure exceeds the set value LP cut out trips the compressor. **False**
84	In RMPU coach OHP is provided for protection against overheating. **True**
85	In conventional AC coach capacity of each heater is 6 KW. **True**
86	Proper tightness of axle pulley should be ensured by striking with hammer. **True**
87	If residual magnetism is lost field should be flashed with the battery supply. **True**
88	For boost charging of battery charging current is triple than the normal. **False**
89	Storage place of battery should be airy and have sufficient light. **True**
90	For corrosion resistance grease is provided on the terminal of cells. **False**
91	If quantity of refrigerant gas in AC plant is less then discharge pressure will less. **True**
92	If air filter is dirty then suction pressure will be increased. **False**
93	Due to excess lub oil in AC system there will be sweating on compressor

	True
94	P.O.H. of AC coach is due after running of four lac Km. **True**
95	Sight Glass is provided on the open type compressor for checking oil level. **True**
96	Suction pressure is less if excess oil is charged in compressor. **True**
97	There should be one precooling cable in SG AC coach. **True**
98	From primary depot both alternator of AC coach shall be in working condition. **True**

ABBREVIATIONS -

1	SMI **Special Maintenance Instructions**
2	DC **Direct Current**
3	SMF **Sealed Maintenance Free**
4	RDSO **Research Designs and Standard Organisation**
5	RRU **Rectifier Regulator Unit**
6	EFT **Emergency Feeding Terminal**
7	VRLA **Valve Regulated Lead Acid**
8	CT **Current Transformer**
9	CESE **Chief Electrical Service Engineer**
10	MCB **Miniature Circuit Breaker**
11	WRA **Water Raising Apparatus**
12	SG **Self-Generation**
13	MOG **Mid-On-Generation**
14	PT **Potential Transformer**
15	CEE **Chief Electrical Engineer**
16	TDR **Time Delay Relay**
17	BCT **Battery Charging Terminal**
18	GM **General Manager**

19	BTU **British Thermal Unit**
20	DRM **Divisional Railway Manager**
21	EOG **End-On Generation**
22	CRB **Chairman Railway Board**
23	HRC **High Rupturing Capacity**
24	ICF **Integral Coach Factory**
25	RCF **Rail Coach Factory**
26	PCD **Pitch Circle Diameter**
27	FRP **Fire Retardant Paint**
28	PVC **Poly Vinyl Chloride**
29	H2SO4 **Sulphuric Acid**
30	BSL **Bhusaval**
31	JBP **Jabalpur**
32	SDEE **Sr. Divisional Electrical Engineer**
33	CSTM **Chhatrpati Shivaji Terminus Mumbai**
34	WCR **West Central Railway**
35	CR **Central Railway**
36	VCB **Vacuum Circuit Breaker**
37	EHV

	Extra High Voltage
38	FRLS **Fire Retardant Low Smoke**
39	HOG **Head-On- Generation**
40	OVP **Over Voltage Protection**
41	PELE **Portable Emergency Lighting Equipment Box**
42	FAC **First class air-conditioned coach**
43	ACFC **Air-conditioned First class with coupe**
44	WGSCNY **Vestibule self-generating second class 3tier sleeper**
45	GSCZAC **Self-generating AC chair car second class**
46	WGACCN **Vestibule self-generating air-conditioned 3tier sleeper**
47	WGFACCW **First class AC chair car (Executive chair car)**
48	RMPU **Roof Mounted Package Unit**
49	RJB **Rotary Junction Box**
50	DFB **Distribution Fuse Board**
51	LHB **Linke Hofmann Busch**
52	WBL **Wash Basin Light**
53	CFL **Compact Fluorescent Light**
54	LED **Light Emitting Diode**
55	CL **Cubical Light**

56	NL **Night Light**
57	AEL **Accident Emergency Light**
58	EL **Emergency Light**
59	BF **Bracket Fan**
60	POH **Periodical Over Hauling**

Answer in one sentence

1	What is measured by voltmeter? **Voltage**
2	What is the voltage of Megger used for measuring Coach wiring insulation? **500 Volt**
3	Now which refrigerant gas is used in conventional coaches? **R134a**
4	For what purpose vacuum pump is used in refrigeration system? **For Vacuum Creation**
5	What is used for finding out earth fault in 110 V TL coach? **Earth Tester**
6	How does vane relay operates? **By Air**
7	Which Train Lighting system is used in Garib rath trains? **EOG**
8	What is wattage of carriage fan in new AC two tier coaches? **40 Watt**
9	What is the colour of control circuit wire in AC three tier coaches? **White**
10	What is the colour of fan positive in 110 V TL coach? **Red**
11	What is the ampere rating of battery fuse in RMPU coach? **400 Amps**
12	Where does the magnetic amplifier used? **RRU**
13	How earth leakage is detected in 110 v TL coach? **Earth Tester**
14	What is the colour of light positive in 110 V TL coach? **Yellow**
15	What is the ampere rating of battery fuse in 110V TL coach? **16 Amps**
16	How many accident emergency lights are provided in one coach? **4 Nos**
17	Write name of the relay provided in AC coach whom operates on air? **Vane Relay**
18	How many safety chains are provided for 4.5 KW alternator? **2 Nos**

19	What is meant by MCB? **Miniature Circuit Breaker**
20	What is the work of RRU? **Conversion of AC to DC**
21	What is provided to raise the water in RMPU coach? **WRA**
22	How much the Half load current of 25 KW alternator? **97.5 Amps**
23	IR test of an alternator is carried out by which Megger? **1000 Volt**
24	What is provided for automatic operation in AC conventional coach? **Thermostat**
25	What is the situation of fresh air entry damper During precooling test? **Closed**
26	How much coaches manufactured in factory are put for Routine test? **All**
27	In which circuit electrical load is connected like garland? **Series**
28	The equipment is used for measurement of level of light? **Lux Meter**
29	Voltmeter is of which type of instrument? **Indicating**
30	By which tools the jointing of lug in cable connection is carried out? **Crimping Tool**
31	Facility of Holiday homes provide in which schemes? **Welfare**
32	Head quarter of West-Central Railway is situated at station? **Jabalpur**
33	How much zones in Indian Railways? **17 Nos**
34	Rail Wheel Factory is situated at station? **Bengaluru**
35	How the Ammeter is connected in circuit with the load? **Series**
36	What is measured by ohmmeter or multi meter? **Resistance**
37	Generally which grade of Pencil is used in Engg. Drawing? **H Type**

38	What is the work of Diode? **Rectification**
39	What is the diameter of Axle pulley in ordinary coach? **572.6 mm**
40	How much types of lead acid cells are used in Train Lighting? **3 Types**
41	What is the capacity of battery charger provided in SG AC coach? **200 Amps**
42	In SG TL coach what is the size of wire used for light & Fan wiring? **4 mm**
43	What is the capacity of four compressors of RMPU Coach? **3.5 Ton**
44	Why the Oil pressure cut out switch is provided? **Compressor**
45	What is the capacity of compressor motor of conventional type ac coach? **10 HP**
46	What is capacity of condensers motors provided in RMPU coach? **1 HP**
47	What is the capacity of blower motor provided in RMPU coach? **1.5 HP**
48	How much heat is required to raise the temperature of one pound of water by one degree Fahrenheit? **1BTU**
49	Which type of air should be used for cleaning of alternator during maintenance? **Compressed**
50	Which energy is converted in to electrical energy During battery discharging? **Chemical**
51	What is the capacity of emergency battery used in LHB coach? **70 AH**
52	What is the rate for boost charging of battery? **20 %**
53	What is the effect on polarity If cell is over discharged? **Reverse**
54	What is the Specific gravity of Battery grade sulphuric acid? **1835**
55	What is the capacity of HRC fuse of L1, L2 and fan circuit In SGTL coach? **16 Amps**

56	Which pressure will increase If condenser fan do not work? **Discharge**
57	What will happen if speed of the compressor motor is less then discharge pressure? **Less**
58	When expansion valve is choked up what is the condition of suction pressure? **Less**
59	What will happen if blower speed is decreased then suction pressure? **Less**
60	Which pressure of AC plant will increase if surrounding temperature is increased? **Discharge**
61	What will happen on compressors if blower does not work? **Sweating**
62	In which leakage coach should not be sent in service? **Positive**
63	When replaced V belts are to be retightened? **300 KM**
64	What is the scheduled P.O.H. of AC coach is due? **18 Months**
65	Which gas is charged in the system for leakage testing? **Nitrogen**
66	How much precooling cable to be required in power car? **2 Nos**
67	What is the Codal life of Mercury Thermostat? **5 Years**
68	What action to be taken of AC coach before taking to platform? **Precooled**
69	Which is working to be ensured for water supply to coach Before placement of train on platform? **WRA**
70	Where to be mentioned with signature the condition of AC coach and defects? **Log Book**

Match the Pair

A)

Part A	Part B
1. RMPU Coach	A. 3 Phase AC Motor
2. Sealed Type Compressor	B. RMPU Coach
3. Vane Relay	C. Operated by Air
4. Alternator	D. Safety Chain
5. Specific Gravity	E. Hydrometer

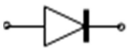
B)

Part A	Part B
1. Conventional Coach	A. RMPU
2. 25 KVA Inverter	B. 40 Ampere
3. Main Negative Fuse	C. 750 Volt
4. Battery Fuse	D. R 134 a
5. End-On-Generation	E. 40 Ampere

C)

Part A	Part B
1. Dry wooden stick	A. DM water + Sulphuric Acid
2. Sealed compressor	B. 2 Minutes
3. Electrolyte	C. Conventional Coach
4. Open Type Compressor	D. Electrical insulator
5. TDR -1 setting	E. RMPU

D)

Part A	Part B
1. Conventional Coach	A. Cut in Pressure 5 PSI
2. Water Raising Apparatus	B. Timer Setting 2.5 Second
3. Megger	C. Control Circuit of RMPU coach
4. Diode	D. Insulation Resistance
5. Control transformer	E. 

E)

Part A	Part B
1. Earth Tester	A. Proves that air is delivered by blower
2. Water Raising Apparatus	B. For measurement of earth resistance
3. Proving Relay	C. To change AC to DC
4. Diode Coach	D. To raise the water in
5. Alternator generation	E. For AC power

F)

Part A	Part B
1. AC carriage fan	A. C-122
2. Alternator 4.5 KW	B. Accident Emergency Lamp
3. RRU	C. 37.5 ampere current rating
4. AEL to DC	D. For conversion of AC
5. V Belt	E. less maintenance

G)

Part A	Part B
1. Color of light positive wire	A. Red
2. Color of fan positive wire	B. Yellow
3. Color of fan negative wire	C. Blue
4. Color of RMPU AC control wire	D. Black
5. Color of light negative wire	E. Black and white

Answers For Match the Pair

A)

1 – A 2 – B 3 – C 4 – D 5 – E

B)

1 – D 2 – A 3 – B 4 – E 5 – C

C)

1 – D 2 – E 3 – A 4 – C 5 – B

D)

1 – B 2 – A 3 – D 4 – E 5 – C

E)

1 – B 2 – D 3 – A 4 – C 5 – E

F)

1 – E 2 – C 3 – D 4 – B 5 – A

G)

1 – B 2 – A 3 – D 4 – E 5 – C

OSM (Out side maintenance)

Chapter 01

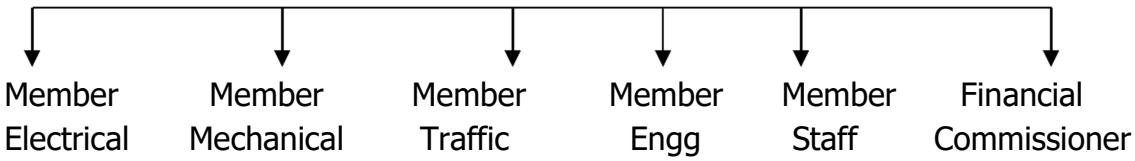
Lesson No. 1 Foundation

Sub-lesson - 1 Railway Administration.

Indian Railway is the biggest organization in Asia and second biggest in the world. Indian Railway is the biggest commercial organization run by Govt. of India in which approx. 16 lakhs of employees are working. The entire organization is in control of Railway Board. It is headed by Chairman Railway Board. Railway Board fuctions under Railway Ministry. The railway ministry is headed by Hon. cabinet Minister and and there are two Minister of state for Railways.

To improve the efficiency of Indian Railways, it is devided in to 16 different zones. Varios Divisions are working under Zonal Railways.

Chairman Railway Board



Various Directorates works under Railway Board for each department.
The Indian Rly is divided into 17 zones for better efficiency and administrative convenience. The zone is headed by General Manager andassisted by AGM and SDGM. For every department there is a Principal HOD. e.g. There is Principal CEE for electrical department.

In addition to these zones there are 7 production units and Metro Rail headed by GM also works under Railway Board.

Every zone is further divided in to the divisions. The head of the Division is DRM. For General services Sr.DEE(G) is the branch officer assisted by DEE(G) and or ADEE(G).

For production units/factory GM is the head. Head of the workshop unden zonal railway is CWM.

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Sub-lesson- 2 :- **Various departments.**

Main departments-

1) Electrical engineering.
2) Mechanical engineering.
3) Engineering (civil)
4) Signal and telecommunications.
5) Commercial.
6) Operating.
7) Stores.
8) Accounts.
9) Personal.
10) Medical.
11) Security.
12)

Sub-lesson- 3 :- **Various fields of electrical works.**

1. General services-

a) **Out side maintenance (OSM)-** They look after operation andmaintenance of electrical installation at stations, service buildings, yards, quartes, pumping station, air conditioning, etc.
b) **Train lighting and air conditioning (coaching)-** They look after trainlighting and air conditioning of coaches.

2. Traction distribution (T.R.D.)-

a.Power supply installation.(PSI)
B.Over head equipments (OHE)
C.remote control equipments(RCE)

3. Traction rolling stock(TRS)-

Repairs and maintenance of electric locomotives.

4. Traction rolling operations(TRO)-

Movement of locomotives with running staff

Lesson No. 2 Portable and hand tools

Sub-lesson- 1 :- Crimping tools.

To have the tight and proper termination and joints crimping tool is used. There are various type of the crimping tools.

1. Hand press, crimping plass.
2. Hand operated multi purpose tool.
3. Hand operated multi purpose tool with dies.
4. Hand operated hydraulic pressure type portable tool.

Capacity- Up to 400 sqmm.

Sub-lesson- 2. Precautions while using the tools.

1.Do not keep sharp tools likeknife, screw driver, etc. in the pocket without cover.

2.Sharp and pointed tools shall be handed over to others from handle side.

3.While using chisel cutting should be done away from the user.

4. Before using tools ensure that the handles are tight and there is no oil or greese on it.
5. Use always new and proper size tools.

6. Do not keep tools on the top of the ladder while working on the highted place

7. Treatment should be done immediately if injured while working.

Sub-lesson- 3. Torque wrench.

Where tightness of the bolt is required accurately done in that case the torque wrench is used. The required value of torque is set and then the bolt can be tightened to the set kg-metre torque. With this the damage due to loose or over tightness are avoided.

Lesson- 3 Measuring tools.

Sub-lesson- 1 Scale/steel rule, caliper, vernier caliper, micrometer

Scale- It is a simple instrument used to measure the length, width, etc.Its accuracy is less. At one side cm and mm are calibrated on the other side inches and soot can be measured.

Caliper- With the help of inside and outside caliper, diameter of theround shape job like pipes can be measured. But it requires scale to know the measurements.

Vernier calipers- These sre used to measure the diamensions moreaccurately. It has two scales, one is called main scale and the other is known as vernier scale.

Micrometer- It is use to measure the diamensions with maximumaccuracy. The measurements can be done up to 1/1000 inch, 1/100 cm. the least count is up to 1/2000 or 0.0005.

Sub-lesson- 2 Least count, accuracy, calibration.

Least count-

It is the ratio of one division on main scale to the totalnumber of divisions on vernier scale. E.g. if main scale has minimum division of one and vernier scale has total 25 divisions then -

Least count = 1/25 =0.04

Accuracy:-

accurate measurement of a substance is not possible. It isaffected by the temperature, error in the instruments, human error, etc. If100 cm long object is measured by different persons at different time the readings may be different. One may take it as 99 cm, other 96.5 and so on. The reading with minimum error shall be recorded. Thus the ratio of actual reading obtained to the correct reading is called accuracy.

Calibration:-

when the instruments are in use regularly the error areincreased after some period. Its reliability is reduced. Thus to have the correct reading it has to be calibrated with respect to the standard instrument in the laboratory (Test room). This is called calibration which is done periodically.

Sub-lesson- 3 Measuring instruments, size and types.

Measuring instruments are of following types-

1. **Absolute instruments-** The instruments used in laboratories andreaserch work are absolute instruments.

2. **Secondary instruments-** These are most commonly used in day to daywork.

On the basis of working measuring instruments can be classified as –

i) Indicating type- It shows the instantaneous reading. E.g.voltmeter, ammeter, wattmeter, etc.

ii) Recording type- In this type the reading can be read directly aswell as it is recorded also to access afterwords. E.g. Thermometer, speedometer, etc.

iii) Integrated type- It shows resultant reading after integratingvarious elements together. E.g. KWH meter, Ampere hpur meter, etc.

Sub-lesson- 4 Use of Scale, vernier calipers, micrometer.

Scale- It is a simple instrument used to measure the length, width, etc.Its accuracy is less.

Vernier calipers- These sre used to measure the diamensions moreaccurately.

Micrometer- It is use to measure the diamensions with maximumaccuracy.

Sub-lesson- 5 **Voltmeter, ammeter, megger, multimeter and tachometer.**

Voltmeter- In electrical circuit voltmeter is used to measure the voltage. Itis connected in parallel in the circuit.

Ammeter- It is used to measure the current flowing in the circuit. It is connected in seies with the circuit.

Megger- It is used to measure the insulation resistance of the machine/equipments or installation.

Multimeter- Current, voltage, resistance, etc can be measured with the help of multimeter.

Tachometer- It is used to measure the speed of the machine in RPM.

Lesson- 4 Material handling and storage.

Sub-lesson- 1 **Types of material, class, and characteristic.**

Electrical material is classified as below:-

1. Conductor- The material in which there is negligible opposition to theflow of current is called conductor.

Conductors are of two types-

1. High conductivity material.
2. Low conductivity material.

High conductivity material- in this type the resistance negligible. It is used for winding wires, cables, etc. Example- silver, copper, alminium, etc.

Low conductivity material- The resistance of these material is considerable. These are used for making heater coils, load resistance, etc. Example- Tungusten, nichrome, etc.

2. Insulator-

To prevent the leakages in the electrical system insulatorsare use D. It is required in electrical machines, distribution systems,etc. it offers very high resistance to the flow of current.

Example- Porcelein, rubber, mica, PVC, dry wood, etc.

3. Semiconductor-

Its characteristics are in between conductor andinsulator. These are mostly used in the electronics circuits.

Example- germanium, silicon, etc.

4. Magnetic material-

The material which can be converted into magneteasily or offers very low reluctance to the flow of magnetic lines of force.

Example- iron, steel, nickel, etc.

Sub-lesson- 2 Shelf life, aging and baking cycle.

Shelf life/ aging- The life and quality of the material is affected with themethod of storage, season, physical and chemical properties. Due to moisture its insulation resistance is decreases. If temperature rises its insulation quality is deteriorated.

Insulation resistance can be tested by megger. If IR value is less it can be improved by baking ang applying varnish.

Sub-lesson- 3 Baking cycle.

It is the process of baking new or old winding in oven with the varnish at the temperature of 100 degree centigrade. Due to this process contact of air with the winding material is disconnected. Thus it becomes moisture free and its mechanical property is also improved. Due to baking -

1.IR value is increased.

2.Mechanical property is improved.

3.Life of the material is increased.

Sub-lesson- 4 Sources of insulating material.

1. Fibrous material
2. Mineral product- oil
3. Ceramic material- porcelain.
4. Rubber products.

5. Wax products.
6. Resin material.

Lesson - 5 Personal safety

Sub-lesson- 1 Use of Tools and other equipments.

1.While handing over the tools, it should be given handle side.

2.Do not keep sharp tools like screw driver, files, knife, etc in the pockets.

3.Use insulated tools while working on electrical appliances.

4.While working on rotating machines ensure that its supply is switched off and nobody else can switch it on accidently.

5.Do not work on live mains neither encourage others to do so.

Sub-lesson- 2 Use of Safety belts, helmet, ladders.

While working on highted places use safety belts and helmets. Do not keep any tool or material on the top of the ladder. The ladder should be hold properly by other person.

Sub-lesson- 3 Working on electrical equipments.

1.Do not play mischief with the electrical equipments.

2.Always switch off the before working.

Sub-lesson- 4 Insulated tools.

Always use insulated tools. Use rubber mat where ever voltage exceeds 60 volts.

Sub-lesson- 5 Earthing.

All the non current carrying metallic bodies of the electrical equipments shall be earthed to safeguard from electrical shock due to leakage current.

Sub-lesson- 6 Fuse, MCB.

To prevent the damage to electrical circuit from overload, short circuit, etc fuse and miniature circuit breaker (MCB) shall be used.

Sub-lesson- 7 Dealing with the electrical accident.

1.Switch off the electric supply immediately.
2.Remove the victim from the live electrical wires.
3.Give first aid and call doctor immediately.
4.Advice all concerned officers.
5.Use fire extinguisher where ever required.
6.In all installations fire extinguishers, sand buckets shall be available.
7.Staff should have the knowledge of operation/use of fire extinguishers.

Sub-lesson- 8 Fire extinguishers.

1.Sand buckets and chemical fire extinguishers shall be available.
2.Staff should have the knowledge of its operation/use.

Sub-lesson- 9 General safety rules.

1.Do not work on live electrical lines.
2.Use insulated tools, gloves, rubber mat, etc.
3.Do not pull the wire for removing pin from the plug. Hold the pin and pull it.
4.while replacing fuse element switch off the main switch.
5.Ensure that the earthing is proper and use three pin plugs.
6.All electrical connections should be tight.
7.Do not play mischief with the electrical equipments.

Lesson- 6 Safety in the electrified section.

Sub-lesson- 1 Induction effect on electrical lines.

There are two types of induction effect on electrical lines-

1. Electrostatic induction- This effect is produced due to high voltages.

2. Electromagnetic induction- This effect is due to current flowing in the overhead equipments (OHE).

Sub-lesson- 2 Precautions while working on LT line.

While woking on LT line in electrified section, the line should be earthed at both sides of the place of working. Every team working should ensure that the separate earth is used. (two earths per kilometre)

Sub-lesson- 3 Precautions while working on platforms and FOB.

While working on platform and foot over bridge there is apossibility of danger due to induction effect. The staff working should ensure that the line is earthed properly.

Sub-lesson- 4 Safety precautions at various work sites.

1. Working on crane-

During crane working in the section presence of authorized electrical staff Essential.

2. Working on isolator-

Isolators should be operated on no load.Thus load should be disconnected before operation of the isolator. These are provided in the yard. The key for the operation is kept with the station master. Register with the name of the authorized person to operate the isolator is available with station master.

3. Bonding-

In electrified section all the structures and masts Are connected with rails (Earth) by earting conductors is called bonding. It safeguards from the danger of leakage current.

4. Temporary jumper-

While replacement of the rails the returnpath of current should be kept undisturbed for temporary jumpers are used.

5. Permit-To-Work-

Before starting the work on OHE in section thestaff should obtain permit to work certificate. The duration of power block is mentioned in this PTW alongwith section location. After the work is completed it should be adviced to the TPC. Thereafter the line is charged by the TPC.

Lesson- 7 Fire fighting

Sub-lesson- 1 Types of fire extinguisher

Mainly these are of five types-

1.Soda acid type.
2.Foam type.
3.Carbon di-oxide type.
4.Dry chemical powder type.ü
5.Other means like- sand buckets, fire brigade.

1. Soda acid type-

In this type the nozzle is attached to the body ofcylinder. Cap is provided on the top plunger. This is suitable for dry fire. Inside water mixed sodium bi carbonate is formed. Its range is upto 20 to 25 feet. It is not usefull for electrical fire.

2. Foam type-

In this type nozzle is attached with the cap. There is alocking arrangement for the cap. It is useful in B class fire i.e. fire related with liquid and oil.The foam produced is conductor of electricity hence not useful in electrical fire. It can be used for A class fire.It's range is 20 to 25 feet.

3. Carbon di oxide-

Its shape is like the gas cylinder. There is a hornwith the discharge tube. Available in 3 to 15 pound capacity. Its range is from 8 to 10 feet. It can be used for local fires and it do not affect the material on which it is used.

4. Dry chemical powder type-

In this type there is a trigger valve in thedischarge tube. Pressing device is provided on the cap. It is used for the electrical fire. It can be used in all types of fires. The range is 4 metre and pressure 50 psi.

Mixture in form of powder is kept in the container- sodium bi carbonate 97%, magnesium sterate $1^1/_2$%, magnesium carbonate 1%, tri calcium phosphate 1/2%. Carbon di oxide gas container is kept inside.

5. Other devices-

a) Sand buckets- Buckets are filled with sand.Whenever required it can be used for throwing on the fire.

b) Fire brigade- There is a pump in the fire brigadeso that the water canbe sprayed on fire with very high pressure and from a distance of 50 to 100 feet. There are 2 to 3 feet high pipe stands and length of delivery hose pipe is 50 to 100 feet. At the end of the hose nozzle is fitted with valve.

Lesson - 8 First Aid

Sub-lesson- 1 Shock treatment

1) First of all switch off the main switch.
2) Remove patient from the contact of electric supply.
3) Take the victim to airy place having sufficient light.
4) Cover him with blanket to feel warm.
5) Encourage him.
6) If there is difficulty in respiration, give him artificial respiration.
7)

Sub-lesson- 2 Treatment of injury.

1) Apply bandage.
2) Try to stop the bleeding.
3) If the bone is fractured, do not move it.
4) Clean the wound with detol.
5) Massaj the patient body.
6) Give him tea.
7) Take him to Doctor immediately

Sub-lesson- 3 Treatment on burns.

1) Apply potato water/ burnol ointment/ coconut oil on the burns of the patient.
2) Prepare a mixture of ten gram soda in half litre water. Soak the cloth in this mixture and put it on the burns.
3) If the patient is unconscious try to bring him in conscious state

Lesson - 9 Material handling and operation of equipments.

Sub-lesson - 1 Types of Equipments.

Manual equipments-

1) Carrier- Box tray, hand trolley, etc.

2) Taking advantage of gravity on slope.

Mechanical equipments-

1) Lifting equipments.
2) To carry on road.

Sub-lesson- 2 Function of equipments.

Manual-

In this method the material is transported manually inboxes or trolleys. This consumes more time and requires more labour.

With the help of gravity- I

n this method with the help of slopematerial can be transported easily.

Mechanical device- In this method mechanical devices are usedfor transportation of material. The labour require is less and it consumes less time. These are available to move material horizontally as well as vertically. Devices- fork lift, truck, crane, hoist, etc.

Sub-lesson- 3 Lifting chain, wire rope.

1. Lifting chain and wire rope is used in crane for handling heavy material. Wire rope, lifting chain should be inspected periodically. Machine should not be overload

Sub-lesson- 4 Precautions.

1. Weight should be lifted according to the capacity of the machine.
2. Work should be carried out under the supervision of skilled person carefully.
3. Wire rope, lifting chain should be inspected periodically.
4. Machine should not be overloaded.

Lesson - 10 Environment and cleanliness of working place.

Sub-lesson - 1 Storage of material

1. Material should be kept at proper place.
2. Corridor, gallery, road, etc. shall be kept clean.
3. Anti corrosion arrangement shall be done.
4. Anti theft measures shall be adapted, material shall be secured properly.
5. Arrangement for prevention of fire shall be made.

If material is stored at proper place in proper way then the losses and accidents can be prevented more over service is improved.

Sub-lesson - 2 Cleanliness at place of working

1. Tray shall be used to avoid dust, dirt, oil spilling.
2. Stair case, benches, road, etc. of work place shall be cleaned every day.
3. Oily material and other waste shall be collected in the dust bin.
4. Every week the floor shall be cleaned.
5. Drainage shall be cleaned time to time.
6. Adequate illumination level and air shall be available at work place.
7. White washing shall be done once in a 14 months.
8. Painting shall be done once in a 5 year.

Chapter :- 02

Lesson - 1 Basic electrical technology and definitions.

Sub-lesson - 1 Electrical circuit, current, voltage, resistance.

Electrical cicuit- It is a path of conductors arranged for the flow ofcurrent. In a circuit load, wires, controlling devices, and protection equipments, etc. is provided.

Close circuit- It is a complete circuit in which normal current flows.

Open circuit- The circuit is not complete; there is a break in thecircuit. Thus current flowing in this circuit is zero.

Short circuit- In this the circuit is completed byepasing the load i.e. the positive and negative or phase and neutral of the supply cotacts each other without any resistance. Hence the abnormal current flows in the circuit. It damages the appliances/circuit.

Types of electrical circuit-

1. Series circuit
2. Parellel circuit

1. **Series circuit-** The circuit in which there is only one path for the flowof electric current is called series circuit.

2. **Parellel circuit-** The circuit in which there are more than one path forthe flow of electric current is called parallel circuit.

Difference in series and parallel circuit-

Series circuit	Parallel circuit
1. There is only one path for current.	There are more than one path for current.
2. load is connected in the form of Garland.	Load is connected in the form of ladder.
3.Voltage is divided as per the value of individual resistance.	Voltage is same across all resistances.
4. Current is same in all resistances.	Current is divided in branches. Current is different as per the value of load resistance.

5. Total resistance increases when connected in series.	Total resistance decreases when connected in parallel. Total resistance is less than the lowest resistance in the circuit.

Current- flow of electrons in a circuit is called current. Its unit is ampere.It is measured by the ammeter. Ammeter is always connected in series with the load.

Voltage- It is a potential difference between two points in a circuit. Itsunit is volts. It is measured by voltmeter. It is connected in parallel with the circuit.

Resistance- It is the property of the substance to oppose the flow ofcurrent through it. Its unit is ohms. It can be measured by ohm meter or multimeter.

Sub-lesson- 2 Work, Horse power, Electrical power

Work- It is a product of force and displacement.

Work = force x displacement

For example- If 10 lb weight is lifted at a height of 10 feet the work done will be = 10x10 = 100 Foot-l B.

Simillarly- when 10 Kg weight is lifted at a height of 10 metre then the work done will be =10x10 =100 Kg-metre.

Horse power- Rate of doing work is called power. Unit of mechanicalpower is Horse power.

550 ft-lb work per second is called one horse power.

or

33000 ft-lb per minute is equal to one horse power.

or

In MKS system 75 Kg-m per second is equal to one horse power.

Electrical power- Unit of Power is watts. It is the product of voltage andcurrent flowing in the electrical circuit.

Electrical power = voltage x current i.e. volt-ampere. It is known as aparant power. In pure resistive circuit power factor is unity so watts = volt-amperes.

1000 watt = 1 kilo watt, like wise 10,00000 (ten lakh) watt = 1 megawatt.
746 watt = 1 HP.
1.34 HP = 1 kilo watt

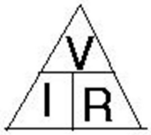
Sub-lesson- 3 Ohm's Law

Ohms law states the relation between current, voltage, and resistance in the electrical circuit.

In a closed circuit kepping temperature and physical properties constant the ratio of voltage and current of the circuit is constant, it is known as resistance of the circuit.

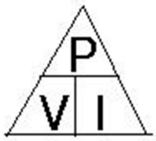
V/I = Constant.or R
V/I = R
V/R = I or I X R = V. where V = voltage in volts, I = current in amperes and R = resistance in ohms.

Ohms law triangle-



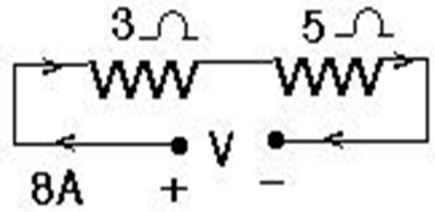
Likewise in DC circuit -

Power = voltage x current = wattsü,
Current = power/voltage = amperes (P/V = I)
voltage = power/current = volts (P/I = V)



Example- 1

Find out voltage of the circuit given below-



Ans:-

Voltage = Current X Resistance

Since resistance are in series, total resistance of the circuit

$R = R_1 + R_2$

$R = 3 + 5 = 8$

Now Voltage = Current X Resistance

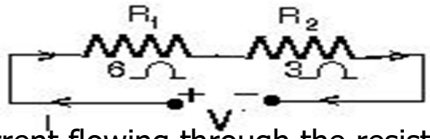
V = 8X 8 = 64 volt.

Ans-The voltage of the circuit is = 64 volts

Formulae to calculate power-

1. Power (P) = Currentü (I) X Voltage (V)
2. Current (I) = $\frac{\text{Power (P)}}{\text{Voltage (V)}}$
3. Voltage = $\frac{\text{Power (P)}}{\text{Current(I)}}$

When two resistances are connected in series-



1. Ammount of Current flowing through the resistance is same.

2. Voltage drop across the resistance is different.

When the resistances are connected in series the total resistance of the circuit is the addition of these resistances.

$R = R_1 + R_2$ü where R is the total resistance and R_1, R_2ü are the resistances in series.

Therefore R = 6 + 3 = 9 ohms

When two resistances are connected in parallel-

When two resistances are connected in parellel in a circuit then-

1. Current is divided according to the value of the resistance.
2. Total resistance of the circuit is less than the lowest resistance in the circuit. ÆüÖê •ÖÖŸÖÖ Æîü…
3. Voltage across the resistance in parallel is same.

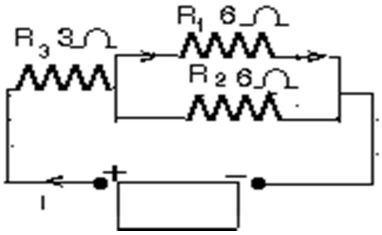
Therefore $R = \frac{R_1 \times R_2}{R_1 + R_2}$ (Applicable only if there are two resistances)

In the given circuit $R = \frac{6 \times 3}{6+3} = 18/9 = 2$ ohms

Or $1/R = 1/R_1 + 1/R_2$ i.e. $R = \frac{1}{1/R_1 + 1/R_2}$

$= \frac{1}{1/6 + 1/3} = \frac{1}{\frac{1+2}{6}} = \frac{1}{3/6} = 6/3 = 2$

When two resistances are connected in series and parallel-

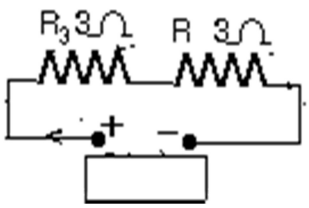


24 volt

First calculate total resistance of parallel circuit $R = R1 \times R2 / R1 + R2$

$R = \frac{6 \times 6}{6+6} = 36/12 = 3$ ohms

Now the circuit is reduced to-



24 volt

Now the resistances are in series hence R = R_1 + R= 3+3= 6 ohms If 24 volts is applied voltage of this circuit then find out the current

flowing in the circuit?

Total resistance of circuit is R = 6 ohms, voltage V= 24 volts, Therefore current I = V/R= 24/6 = 4 amperes

Power P = voltage (V) X Currentü (I) = 24 X 4 = 96 watt

Sub-lesson - 4 Magnetism, electromagnet, Ampere-turn, MMF.

1.Magnet- The property of the substance to attract or repel the iron orother magnetic material is called magnetism. And that substance is called magnet. Magnetic material- iron, nickel, cobalt, etC.

If a magnet is suspended freely in the air then its north pole rests in the north and south pole in the south direction.

If it is cut into any number of N S pieces, every piece will be a complete magnet having north and south pole.

Similar poles of the magnets repeleach other and the opposite poles attract each other.

Comparison between electrical circuit and magnetic circuit.

SrNo	Electrical circuit	Mgnetic circuit	
01	There is a flow of electrons called current (I)	There is a flux.	
02	There is electromotive force.	There is magneto motive force.	

	EMF	MMF	
03	There is a resistance.	There is a reluctance.	
04	There is a conductivity.	There is a permeability.	

Magnetic field- The area in which there is a effect of flux is called magnetic field.

Lines of Force- In a magnet Flux flows from north pole to south poleand south pole to north pole through air or other medium in the form of magnetic lines of force.

Magnetic Material- These are of three types.

1.Di-magnetic material.
2.Para-magnetic material.
3.Ferro-magnetic material.

1. Di-magnetic material- lead, gold, copper, mercury, etc. Thepermeability of these material is less than one.

2. Para magnetic material- platinum, oxygen, copper sulphate, etc.The permeability of these material is slightly more than one.

3. Ferro-magnetic material- iron, nickel, cobalt, etc. These material hasvery \ high permeability.

4.Electro magnet- When we pass the current in the winding made on theiron rod, it becomes the magnet. This is called electromagnet.When the flow of current is stopped, still some magnetic power remains in the iron. This is known as residual magnetism.

Application- 1.All electrical machines, 2.Measuring instruments and relays.

Magneto motive force-(MMF)- As EMF is essential to have the flow ofcurrent in the electrical circuit likewise The force which is essential to have the flux in the magnetic circuit is called MMF.

Ampere-turn- It is the unit of magneto motive force.

Ampere turn = current flowing in the coil X No. of turns in the coil.

Sub-lesson - 5 Cell, Alkaline cell.

Cell- It is a device which stores electrical energy in the form of chemical energy. Cells are of two types-1. Primary cell, 2. Secondary cell.

Primary cell- The cells which can not be recharged, thus once these areused it has to be thrown away. i.e. Dry cell, torch cell, deniel cell.

Secondary cell- These cells are charged with help of external source ofsupply. During charging it stores electrical energy in the form of chemical energy. Hence it is also known as storage cells or accumulators. During discharge the chemical energy is converted into electrical energy thus these are also called as secondary cells. When it is connected to load after desired time it gets discharged. It requires recharging to use again and again. Therefore after recharging again it is ready to use.

Types of secondary cells-

1.Lead acid cells.

2.Alkaline cells. a) Nickel iron cells, b) Nickel cadmium cells.

Battery-When more than one cells are connected in series or parallel iscalled battery. When the cells are connected in series then battery voltage increases. If these are connected in parallel then the battery capacity is increased.

Alkaline Cell-It was invented by the scientist Edison hence it is alsoknown as Edison cell. The container of this cell is of nickel plated steel. Positive plate is of nickel hydroxide ($Ni(OH)_2$ and the negative plate is of iron oxide (FeO). In this cell electrolyte is made up of 21% caustic potash (KOH) mixed with some lithium hydroxide (LiOH). Thes cell are very good as compared to lead acid cell. Cell voltage in fully charged condition is 1.4 volts. 1.2. volts on load and the cell is treated as discharged below 1.1 volts.

During discharge- $Ni(OH)_4+2K \rightarrow Ni(OH)_2+ 2KOH$ (+ plate), $Fe + 2OH \rightarrow Fe(OH)_2$ (- plate).

Sub-lesson - 6 Principle of Electrical motor and Generator.

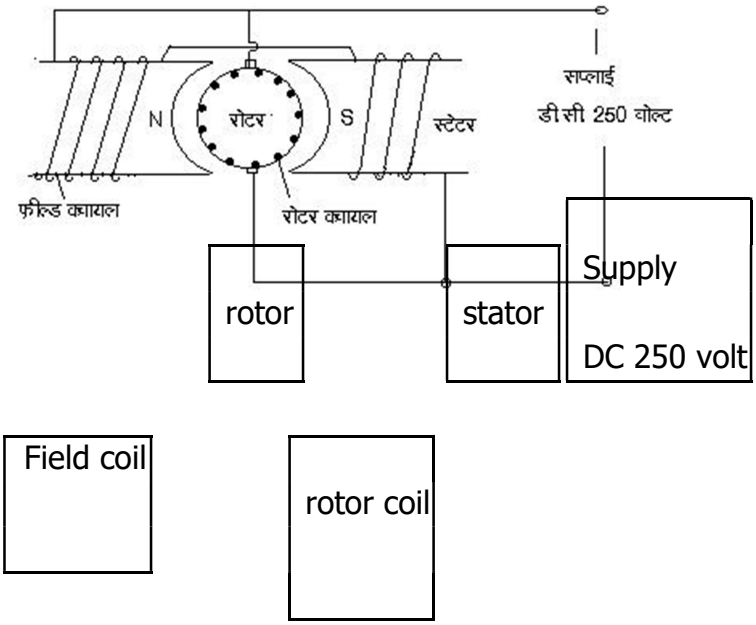
Electrical motor- The machine which converts electrical energy in tomechanical energy is called motor.

Priciple- When a current carrying conductor is situated in magnetic field,it is acted upon by a force which tends it to rotate. This the basic principle of the motor,

DC motor has two windings-

1. Stator winding.

2. Rotor winding.



When supply is given to both of these windings, due to current stator and rotor field is established. Diection of field is as per the direction of current. Due effect of these field force is acted upon a rotor and it rotates.

In 3 phase AC induction motors supply is given to only stator winding and the rotor is short circuited. Due to current in stator magnetic field is produced. The flux is alternating hence due to induction effect emf is induced in rotor. As it is short circuited current starts flowing in the rotor. Stator has rotating magnetic flux thus rotor starts rotating to oppose the cause of producing magnetic field in it.

In single phase AC motor stator field is not rotating type. There fore the starting winding is provided which creares starting torque to move the rotor in desired direction by placing this winding 90 degree apart from the running winding.

Generator-Machine which converts mechanical energy into electricalenergy is called Generator.

Principle- Generator works on the Farade law of electro magneticinduction.

First law states that whenever conductor cuts the magnetic flux, EMF is induced in it.

Second law states that the magnitude of EMF induced is directly proportional to the rate of change of flux linkage.

In stator field winding is fed DC supply to form the magnetic field. The main winding is on the rotor thus when rotor rotates it cuts magnetic flux and EMF is induced in the rotor winding. The supply is taken out with the help of carbon brush and slip rings in case of Alternator. In case of DC generator in place of slip ring commutator is used. Commutator converts AC supply to DC.

* * *

Chapter- 3

Lesson -1 Drawing, procedure to draw circuits and reading.

Introduction - Drawing is known as the language of engineers. Everything can not be communicated with the words. But with the help of drawing we can communicate every thing in detail alog with diamessions, shape, etc.

Sub-lesson -1 Lettering.

Lettering- It is used to write the title, diamenssions, and otherinformation in the drawing. Writing should be clear, neat, beutifull, and of proper size. The lettering is vertical or inclined type.
Types of lettering-

1. Single stroke letter-
This a very simple form of writing. Pointedpencil is used and letter is finished in one stroke thus letters are thin. For lettering generally capital letters are used. Size of the lettering is as given below-

a) Main title, drawing No, etc. - 6,8,10 andÓ 12 mm height.
b) Sub title - 3,4,5, andÓ 6 mm height.
c) Name of the material, diamenssions, and other notes - 2,3,4,5 mm height.

Example-

A B C D 1 2 3 4 Vertical

A B C D 1 2 3 4 70 degree Inclined

2. Gothic Letter-

If sigle stroke letter is made thicker then it can becalled as gothic letter. Thickness of all letters should be same. These type of letters are generally used to write the title of the drawing. Normally the thickness of letters should be between 1/5 to 1/10 th of the height of the letter.

Ratio of height and width should be 5:4 (except A,K,M,W. for these letters height and width shall be the same.)

C,D,G,O,Q letters in vertical form should be ofcircular shape and in inclined form it shall be of oval shape.

Example- **A B C D 1 2 3 4 (vertical**)

A B C D 1 2 3 4 **(70 degree inclined)**

Sub-lesson - 2 Different sizes of drawings.

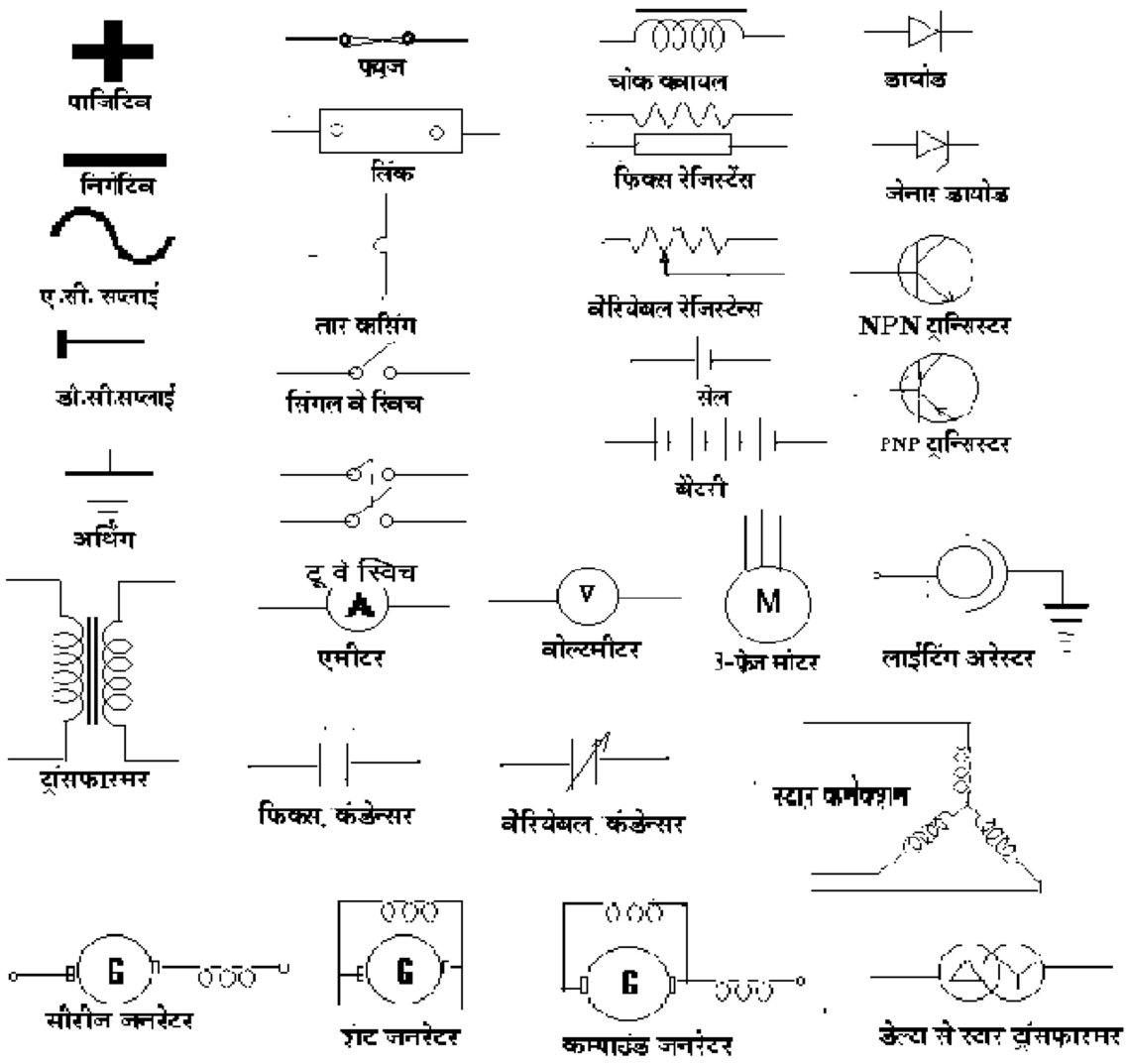
All parts and diamessions in the drawing should be clearly visible. For this it is drawn in three sizes.

1.Full size - When the drawing as per actual diamenssions isdrawn then it is called full size drawing. Object will look as it is.

2.Enlarge size - When the object is small then the then itsdiamenssions are increased in multiples so that it looks clearly. E.g. Scale = 1:10 or 1:100 etc.

3.Reduced size - when size of the object very big then it is drawnwith reduced diamenssions so that it can be easily accommodated in the drawing sheet. E.g. scale = 10:1 or 100:1 etc.

Sub-lesson -03 Symbols used in circuit drawing.



Sub-lesson - 4 Plan, Elevation, End view

1.Plan- The drawing of the object when viewed from the top is calledplan.

2.Elevation- úThe drawing of the object when viewed from the front side is called elevation.

3.End View- The drawing of the object when viewed from the side is called end view.

Sub-lesson- 5 Scale

For larger objects reduced scale drawing is prepared likewise for smaller objects enlarged drawing is prepared. The scale is chosen for this purpose having suitable representation factor.

$$\text{Representation factor} = \frac{\text{length of object in drawing}}{\text{Actual length of object}}$$

For enlarged drawing representation factor will be always greater than one. i. e. if 1 inch object is shown 5 inches in drawing then representation factor will be 5/1 = 5.

Plain scale- it has two divisions one is main division another is calledsub-division. Thus we can measure inches and soot or cm and mm in one scale.

Diagonal scale- in this scale with main division we get two sub-divisionse. g. metre, decimeter and centimeter.

Sub-lesson- 6 Drawing board, drawing material, and equipments.

Drawing board- It is rectangular board of seasoned soft wood planks of25 mm thick. On left side the ebonite edge is provided so that the TEE square can glide easily. It is available in the following sizes.

1. B-0, - 1250X900 mm
2. B-1 - 900X600 mm
3. B-2 - 650X500 mm
4. B-3 - 500X350 mm

B-2 and B-3 size drawing boards are most commonly used.

Drawing material- Material required is drawing paper, pencils, drawingclips, sand paper, eraser, etc.

1. Drawing paper- It should be ISI approved with sufficient and uniformthickness. Various sizes are as follows.

a) A-0 - 841X1189 mm
b) A-1- 594X841 mm

c) A-2 - 420X594 mm
dü) A-3 -297X420 mm

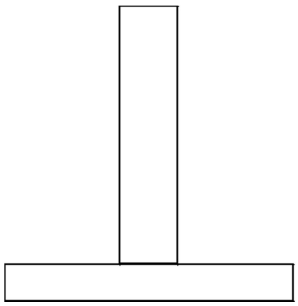
e) A-4 - 210X297 mm
fü) A-5 - 147X210 mm

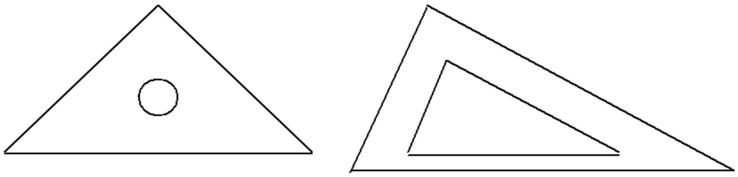
2. Drawing pencil- Grade of the pencil is printed on one end e. g. HB,H, 2H, 3H, etc. H means the hardness and B means the softness.

3. Drawing pin/clip-It used to fix the drawing sheet on drawing board.

4 .Sand paper block-It is used for sharpening of the pencil.

5. Tee square- It is made up of hard wood or plastic. It is in TEE shape.It is use to draw the parallel horizontal lines. It is also used alogwith set square to draw parallel lines of different angles.





Tee-square **Set-suare**

6. Set-square- One set square has 45,45 and 90 degree angles. Anotherhas 30, 60, 90 degree angles. These are made up of plastic or tin. Generally available in 25 cm and 20 cm size.

7. Mini drafter- It can function as TEE square, set square and protractor. It is fixed on drawing board at one place and used as per requirement.

8. Compass-It has two legs, one is pointed and another hasarrangement to fix the pencil. It is used to draw the the circles, arcs, etc.

9. Divider-It is used to divide lines in equal parts. To obtain themeasurement and transfer to another place.

10.Scale-It is used for conversion of objects measurements to suit thesize of drawing sheet.

These are made up of wood, steel, plastic or card board in different sizes. Generally 15 cm length 2cm width or 30 cm lenth and 3 cm width. Thickness is normally 1 mm.

11. Protractor - It is used to measure the angle. It is ade up oftransparent plastic.

Sub-lesson- 7 Copying of drawing.

Earlier chemicals were used to to copy the drawings from the tracing paper. In this process white lines on blue background used to emerge. Hence it was called as blue print.

1. Ferro print- white lines on blue background.
2. Ammonia print- blue lines on white background.
3. Xerox print- black lines on white background.

Original drawing is traced on tracing paper and preserved as negative of the photograph.

* * *

Chapter 04

Lesson- 1 Basic properties of Electrical Materials.

Sub-lesson – 1 Classification of material, types, characteristics and application.

Electrical material is classified in four categories as per their characteristics and applications-

1. Conducting Material.
2. Insulating material.
3. Semiconducting Material.
4. Magnetic material.

1. Conduting material :

a) High conductivity material,
b) Low conductivitymaterial.

High conductivity material- The resistance of high conductivity material is negligible. Current can pass easily through these materials. Characteristics of these materials is as below-

1. High conductivity.
2. Temperature coefficient of resistance is low.
3. Mechanically strong and should have flexibility.
4. High heat conductivity.

Conductors - These are basically used in the electrical circuits to carry the current. i.e. in distribution lines as cables, wires and for winding of the motors,etc.

Example:- Solid conductors- silver, copper, aluminium, lead, nickel, mecury, etc.
Liquid conductors- acid, alkalies, copper sulphate, sulpher nitrate,
Gaseous conductors- neon, mercury vapour, sodium vapour, etc.

Low conductivity materials- Its resistance is more than conductors but very low as compared to insulators. Therefore it is not a good conductor. Generally these are the alloys.

These are used in making heating elements, resistors, filaments, etc.
Example:- Tunguston, nickel chromium, nichrome, etc.

2. Insulating material- The material which offers very high resistance tothe flow of electric current is called insulating material. Normally it will not allow the flow of current. It has many applications in distribution,transmission, and utilization of electricity for most of the electrical appliances to reduce/prevent the leakage current.

Examples:- Solid- Mica, Ebonite, Glass, Marble,Slate, Porcelein, Rubber, silk,cotton, paper, asbestos.

Liquid- mineral oil, varnish, etc.
Gaseous- SF6(sulpher hexa fluoride), etc.

Insulating material should posses following properties-

1. Its insulation resistance should be high.
2. It should be mechanically strong.
3. It should not absorb moisture.
4. It should be good conductor of heat.

3. Semiconductors- These are neither conductor nor insulator. These areused in the electronics appliances like radio, rectifiers, etc.
Example- silicon, germanium, selenium.

4. Magnetic material- The material in which magnet is formed easily iscalled magnetic material. This is used in most of the electrical machines like motors transformers, measuring instruments, etc.

Magnetic materials are of three types-

1. Ferro-magnetic material- It has very high permeability.
   Example- Iron, cobalt, nickel, etc.
2. Para-magnetic material- It has medium permeability.
   Example- aluminium, platinum.
3. Di-magnetic material- It has very low permeability. Example- silver, copper, bismuth, hydrogen gas, etc.

Magnetic material used in machines should have very high permeability and very low iron losses.

Sub-lesson - 2 Shelf life of insulating material, thermal ageing, and Identification.

The life and quality of material depends on its mechanical, chemical, and thermal properties and also on method of storing, carefull maintenance, etc.

Insulation resistance is reduced due to moisture, temperature (heat), effect of adverse season, etc. The condition of insulation is checked by megger time to time. If the insulation resistance is less than the prescribed limit then the remedial measure is taken to improve it.

Classification of insulating material on the basis of temperature.

SrNo	Class	Max. Temperature	Example
01	**Y**	90°C	Cotton, silk, paper, etc.
02	**A**	105°C	Impregnated- cotton, paper, silk, etc.
03	**E**	120°C	Polyurethane, enamel, plastic, etc.
04	**B**	130°C	Mica, fibre glass, etc.
05	**F**	155°C	Mica, fibre glass, asbestos with varnish.
06	**H**	180°C	Mica, fibre glass, asbestos with silicon resin.
07	**C**	Above 180°C	Mica, fibre glass, porcelain, ceramic with high quality bonding material.

Sub-lesson - 3 Baking Cycle.

Insulation resistance of machine winding is improved by varnishing and baking it in the oven. With this not only IR value but mechanical strength is also improved and prevents entry of moisture.

Baking cycle description-

1. Clean the old winding.

2. keep it in the oven and heat up to 100 to 110 °C so that all the moisture goes away.

3. Deep it in the varnish for 2 hrs so that all air is removed and varnish reaches to every where.

4. Take it out and allow the excess varnish to drip in the tank.
5. Bake it in the oven at 110 °C for 4 hrs.

Sub-lesson - 4 Sources of insulation material.

Sources of insulating material are as below-

1. Fibres material- Asbestos, wood. Paper, card-board, cotton, Empire cloth, etc.

2. Mineral Products- Mica, marble, slate, mineral oil,etc.

3. Vitrous and ceramic material- Glass, quartz, silica, porcelain, etc.

4. Rubber and its products- VIR, Ebonite, Gutta-percha, etc.

5. Waxes & Compounds- Paraffin wax, Bitumen compound.

6. Synthetic resin product- plastic, backelite, PVC, polythene, varnish, enamel, etc.

Sub-lesson - 5 Expected qualities of material.

All material should have good mechanical, thermal, and chemical properties i.e.-

1. High conductivity, high resistance, and low di-electric loss. Low weight.
2. Good heat conductivity, good viscosity.
3. It should be non inflammable and fire retardant.
4. It should not be affected by oils, acid, alkalies.
5. It should not be affected by any chemicals or metals mixed in the soil.
6. It should not absorb moisture.
7. It should be mechanically strong to sustain vibrations.
8. It should be capable to work on higher temperatures.
9. It should be easily available.
10. It should have sufficient flexibility.

Sub-lesson - 6 Choice of material.

Following points shall be remembered while selection of material-

1. It should be capable to fulfill requirements like voltage rating, current rating, di-electric strength, etc.
2. It should be easily available.
3. It should have maximum good qualities.
4. For special material evaluation of cost at various stages. Easy to manufacture/produce.
5. It should be reliable and durable.
6. It should be cheaper.
7. It should have good electrical, physical, mechanical and chemical properties.

* * *

Chapter - 5

Lesson No.-1 Name and location of Maijor power supply equipments

Sub-lesson -1 Types of transformers and uses

Transformer- Transformer is a static device which transforms electricalpower from one circuit to another without changing its frequency.This is the function of transformer.

Principle of a transformer :- Transformer works on mutual inductionprinciple. i.e. if two coils are placed side by side and AC supply is given to one coil an EMF is induced in the second coil and it is proportional to the number of turns of the coil.

In generating stations(Power House) transformer is used to step up the voltage of AC supply and thus current is reduced without change in frequency and power. At distribution substation the transformer is used to step down the voltage sutaible for distribution and utilization.

Transformer has two windings-

1. Primary winding- which is connected to the incoming supply.

2. Secondary winding- Load is connected on this winding. Both of these windings are placed on the same magnetic core.

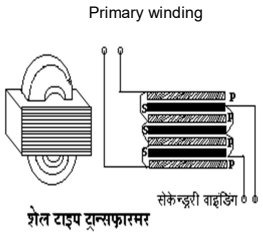
Types of transformers-

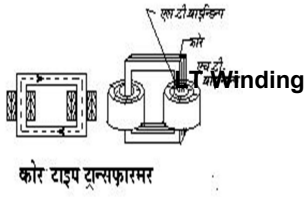
1. Based on construction.
2. Based on application.
3. Based on winding connections.
4. Based on type of cooling.

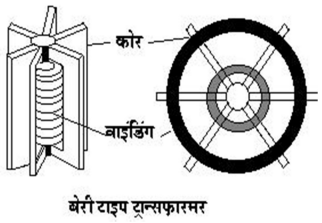
1. Based on construction- ü1) Core type 2) Shell type 3) Berry type

i) Core type- In this type as shown in picture (A) there is only one path for magnetic lines of force. Their efficiency is low. These are used in the small equipments.

ii) Shell type- In this type there are two paths for the magnetic lines of force. Thus efficincy is more as compared to core type as shown in the picture (B).
iii)
iv) Berry type- In this type there are many magnetic paths as shown in the picture (C) thus it is efficient than or and shell type. These are used for high capacity.







2. Based on the application-

i) Power transformer

ii) Distribution transformer
iii) Instrument transformer

1. Power transformer- Transformers above 200 KVA capacity installed ingenerating stations, factories, and both side the transmission lines are called power transformers. These are available in single phase or three phase. These are put into service as per the requirement. When there is no load the transformers are switched off. Thus thse are designed for maxmimum efficiency at full load. Leakage reactance of these transformers is kept higher than the distribution transformer since voltage regulation is not important. These are designed to keep minimum copper loss.

2. Distribution transformer- Generally transformers up to 200 KVA usedthe substations to step down distribution voltage (11 KV) to standard service voltage (415 V) are called distribution transformers. These are connected in service for round the clock whether the load is available or not. Thus all the while there is iron loss. Hence these are designed to keep iron loss minimum. Normally in General services 11/0.433 KV transformers are used and these are installed at the load centre.

3. Instrument transformer- These are used with the measuringinstruments and protective relays.

a) Current transformer (CT)- Where huge current is to bemeasured it can not be handled by normal ammeter. CT reduces it to 5 ampere so that the small ammeter can measure it e.g. to measure 400 amperes current CT of 400/5 A ratio is used. Secondary of the CT should not be kept open while it is installed on busbar or cable. Otherwise it will burnt out.

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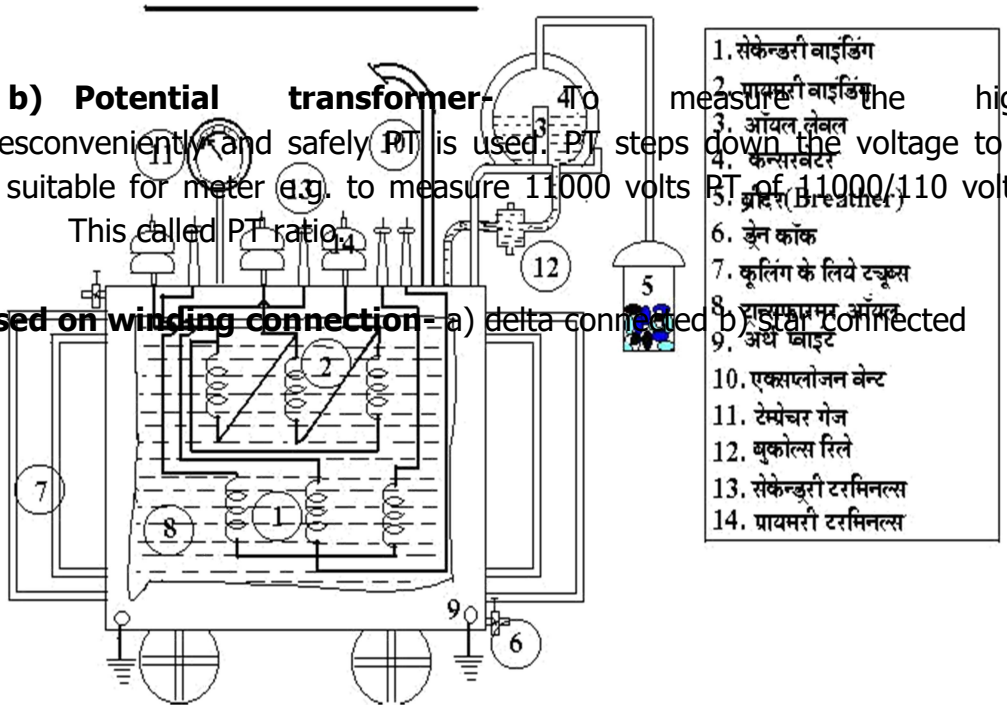


b) Potential transformer- To measure the higher voltagesconveniently and safely PT is used. PT steps down the voltage to the range suitable for meter e.g. to measure 11000 volts PT of 11000/110 volts is used. This called PT ratio.

3. Based on winding connection- a) delta connected b) Star connected

a) star connection- In this type of connection either starting endsor finishing ends of all the tthree phases are joint together and supply can be connected or taken through free ends. The lead brought out from joint is called neutral and free ends called phases.

In this connection line voltage is root three times the phase voltage i.e. Vp x 1.732 thus if voltage between phase and neutral Vp is

230 volts then voltage between phase 1 and phase 2 (line voltage) V will be 230 x 1.732 = 400 volts. To have the advantage two different voltages on secondary side distribution transformers are always delta-star connected i.e. primary winding delta and secondary winding star.

4. Basd on type of cooling- Teemperature of the transformer rises while itin service. To improve efficiency and ensure proper working various cooling methods are employeed. Most commonly used are given below. a) natural air cooled transformer (AN)

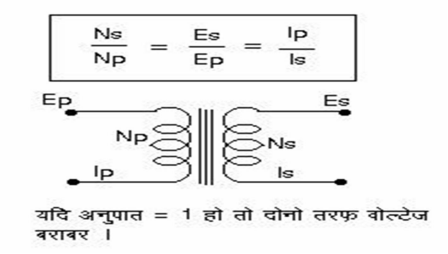
b) oil filled natural air cooled transformer (ONAN)
c) oil filled air blast cooled transformer (OB)

Transformation ratio- when ac supply is given to the primary windingcurrent flows and it creates alternating flux. This induces EMF in winding which opposes the applied voltage thus it is called back EMF. It is due to self inductance. This EMF is approximately equal to th applied voltage.

The EMF induced in secondary winding is due to mutual induction.It also opposes the vary cause producing it.

If primary voltage = Ep secondary voltage = Es
Primary current = Ip secondary current = Is
No. of primary turns = Np No. of secondary turns = Ns

Then transformation ratio = K=



यदि अनुपात = 1 हो तो दोनो तरफ़ वोल्टेज बराबर ।

K is the transformation ratio. If K is more than 1 the transformer is called step up and if K is less than 1 then it is called step down.

Relay- Relay is a combination of set of contacts which makes or breaksthe circuit as per the controlling sensing eliment. It has normally open (NO)or normally close (NC) contacts.ü

What happens when current flows in relay coilü- when current flows in arelay coil condition of both contacts is changed. i.e. NO closes and NC opens. This are used in the control circuit to open or close the circuit as desired.This effect is due to formation of magnet in relay coil with the flow of current through it which operates the relay. Types of relays are-

1. Current relay
2. potential relay
3. thermal relay

Contactor:- contactor is a magnetically operated switch. It has fixed andmoving contacts. These are mounted on a contact carrier. Position of contact carrier is cotrolled by a) spring set b) and electromagnet. When the coil is not magnetized contact carrier remains in off position because of spring tension. When no volt coil get energized force is acted against spring tension and and carrier is attracted and NO moving contacts makes contact with the fixed contacts. Thus circuit is close D. Position of NC contacts exactly opposite of this.

This are used in the motor starters. Starting current of the motor is about 6 to 8 times the normal current. Thus the contactors are made to handle this current for making and breaking the circuit. Whle making and breaking the circuit, there is sparking at fixed and moving contacts. To suppress this arcing arc schutes are provided.

Coil should be chosen as per requirement other wise it affects the life of the contactor. These are manufactured to operate on +10% ÃÖê - 15%ü of the declared voltage.

Sub-lesson -2 Layout of Sub-Station

Transmiossion voltage is to step- down to low voltages as per the requirement of the consumer load for which sub-stations are essential. Distribution sub-stations are of three types.

1. Pole mounted sub-station- It is sutaible where space is less and the load is also less. In this type the transformers are installed on yhe pole itself. Incoming HT supply is connected through AB switch.

Controlling swiches are provided on outgoing side for the feeders. These type of sub-stations are preffered upto 200 KVA capacity.

2. Outdoor type sub-stations- Where the transformer capacity is above 250 KVA these sre installed on the plinths in open place and protection.

3. In-door type sub-station- In factories, etc transformers are installed in the covered or buildings. This is called in-door type sub- station.

Name of the equipments used in the sub-stations

1. 4-pole / 6-pole structure with bus-bar
2. HT metering
3. HT circuit breaker / AB switch
4. Lightening arrester
5. transformer AB switch
6. Drop-out fuses
7. Main transformer and stand-by
8. LT cable
9. LT control panel
10. safety equipments as per IE rules
11. Schematic diagram of sub-station
12. Emmergency lighting

Gang operated switch -

It is a manually operated off load switch provided in HT supplyü. Generally it has three poles operated in a gang. All poles should be opened or closed at atime. These are available in 200 and 400 amps rating.

Sub-lesson -3 **Over-head line.**

Transmission and distribution of supply- Transmission line is used totransmit huge electrical power with EHV to the distannt locations. In India there are 66, 132, 220, and 400 KV transmission lines for which over-head lines are used.

11KV an 33 KV lines are brought from main substations to small sub-stations to step-down voltage to 440 volts for distribution to consumers for which over-head lines are used.

Electrical power can be transmited and distributed with thetwomethods-

1. Over-head system- In over-head system iron 0r concrete poles areerected. With the help of cross arm and insulator conductors are strengthened. The bare conductors of copper or aluminium of various capacity according to load current are used in this system. As per IE rule No.85 the maximum length of span for low and medium OH line shall not exceed 65 meters without the permission of EIG.

2.

Main parts of the OH line-

1. Supports or poles- To maintain the clearance between ground and conductor which is known as vertical clearance supports are Required. 1/6 th part of its lngth is normaly burried in the ground with the foundation of 1:3:6 ratio concrete.

Minimum Clearances are maintained as per IE rule.

place	For low and medium voltage	For high voltage	For extra high voltage
At road crossing	5.8 m	6.1 m	6.1 m + 0.3 m for every 33 KV or part thereof
Along the road	5.5 m	5.8 m	6.1 m + 0.3 for every 33 KV or part thereof
At other places	uninsulatedü 4.6 m insulated 4.0 m	5.2 m upto 11 KV	6.1 m

2. Cross arms- acts as a support for insulator.

3. Insulator- It supports and provide insulation between conductor andearth.

4. Conductor- It carries the current. Normally in LT line all aluminiumconctors (AAC) are used. In HT lines aluminium conductor steel reinforced (ACSR) conductors are used.

5. Stay rod- It is provided to secure supports in position.

6. Stay wire- It is also provided to secure supports in proper position.

7. Guard wire- Guard wire is provided below the conductors to preventit from falling down in case it breaks.

8.Stay tightener- It is provided to facilitate the re-tightening of the stayto maintain proper tension.

Advantages of OH line-

1. It is cheaper.
2. Inspection and and fault finding/rectification is easy.
3. It is asy to tap the connection.
4. Enhancement of capacity is easy according to demand of load.

Disadvantages of OH line-

1. It is incovinient in highly populated area.
2. It is prone to short circuits and fire.
3. Line losses are more due to induction effect.
4. Maintenance is more.
5. It can damage due to lightening surges.

Sub- lesson - 5 Battery capacity, life and electrolytes specific gravity

Battery capacity- Battery capacity is given in Ampere-Hours. It indicatesthat how many amperes can be supplied to load for specific period. In other words amount of current required for charging the battry in specified period. This is called the capacity of the battery.

i.e. the product of rate of discharge current and the period for which it can deliver that current is the capacity of the battery.

Example:- 10 ampere is the discharge current rate for 9 hours it means that the Capacity= Ampere x No. of Hours

= 10 x 9

= 90 ampere-hours (AH)

Efficiency of the battery = Discharge AH / Charging AH x 100

= 90x100/100

= 90 %

It means that charging time will 10 hours but discharging time will be 9 hours.

Electrolite- The mixture of acid or alkali and distilled water used in cellThrough which when current is passed chemical reaction takes place is called Electrolite.

Specific gravity- Hydrometer is used for measurement of specificgravity. It is made up of glass tube and a bulb. Scale is provided on the tube. It is kept inside the another glass tube. When it is filled with the eletrolite the inside tube floats at the level proportionately to the acid content. Thus the specific gravity can be read on the scale provided on the glass tube. When battery is discharged the electrolyte is dilute and therefore inside tube will sink in the electrolyte more, Exactly the case is reverse when cell is charged and electrolyte is strong.

Specific gravity of lead acid cell is more than 1210. when specific gravity is reduced to 1180 the cell is treated as discharged. It requires charging immediately. Life of lead acid cell is 4 years.

Sub-lesson-6 Street light fittings

Required Ilumination level - 2 to 5 lux

Lux = lumens per square meter. It is the unit of illumination level.

Type of Fittings (luminaires)-

1. FL - fluroscent lamp.
2. HPMV- high pressure mercury vapour lamp
3. LPSV- low pressure sodium vapour lamp
4. HPSV- high pressure sodium vapour lamp
5. CFL - compact fluroscent lamp

Sub-lesson- 7 Yard Lighting

Types of yard lighting-

1. Tower lighting or high-mast tower lights.
2. Distributed lighting.
3. Gantry lighting.
4. Combined system (combination of all three types)

Sub-lesson- 8 Types of conductors

There are three types of conductor-

1. solid conductor
2. Liquid conductor
3. Gaseous conductorü

Solid conductor- it is the conductor in solid form and offers very lowresistance to the flow of current. E.g. silver, copper, aluminium, brass, lead, nichrome, tunguston, etc.

Liquid conductor- it is the conductor in liquid form which offers very lowresistance to the flow of current. E.g. mixture of sulpher nitrate,dilute sulphuric acid,copper sulphate. Etc.

Gaseous Conductor- in physical condition it is in the gaseous state and offers very low resistance to the flow of current. E.g. neon gas, organ gas, mrcury vapour, sodium vapour, etc.

Sub-lesson - 9 Common conductors

Common conductors are-

1. all aluminium conductorü
2. aluminium conductor steel reinforced (ACSR)
3. cadmium copper conductor (usefull for long spans)
4. galvanized iron conductorü (G.I. Wire)
5. all aluminium alloy conductorü (AAAC)

Types of insulators- There are following types of conductors whichoffers very high resistance to the flow of current.

1. Pin type insulator
2. Suspension type or disc insulator
3. Shackle insulator
4. Reel or bobbin insulator

Sub-lesson - 10 Types of wiring

Types of wiring are as given below-

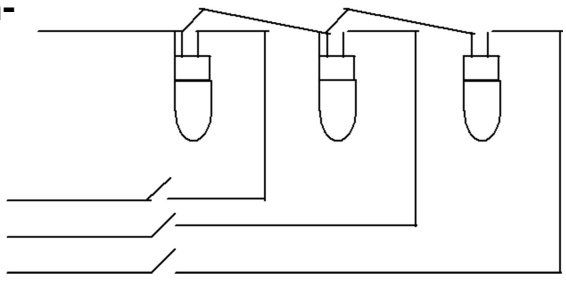
1. Cleat wiring
2. Wooden casing caping
3. PVC casing caping
4. Wooden batton wiring
5. Metal conduit wiring
6. PVC conduit wiring

Systems of wiring- These are of three types-

1. Loop in loop out
2. T Type
3. Ring type

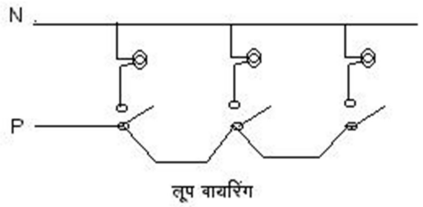
1. **Lop in loop out wiring-** wires are cut by looping it different circuitsare made. Further by looping new circuits are made. This is loop in loop out method.

Diagram-



Loop in loop out

2. **T wiring-** in this type phase is taken through switches and neutralthrough bulb holders.
   diagram-



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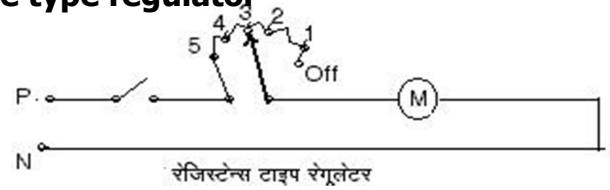
Sub-lesson-11 Fans and regulators

Motor of ceiling fans are permanent capacitor type in which there is no centrifugal switch required. Capacitor is directly connected in series with the starting winding. It always remains in the circuit. In this typ of motors starting an running torque is low an its winding wire for starting and running winding is nearabot similar. Rotor is of squirrel cage type. Regulator is connected in series with the fan for speed control.

Types of regulators-

1. resisrance type
2. transformer type
3. electronic type

Diagram- resistance type regulator



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Sub-lesson- 12 Types of reflectors

1. all steel reflector, vitrous enameled white inside.
2. open defusing glass globes.
3. polished metal reflectors.
4. chronic enameled iron shed white inside.
5. double faced mirror stripped type.
6. parabolic reflector with mirror glass or polished metal.
7. vitrous enameled steel sheet (pvc reflector)

Sub-lesson- 13 **Types of DC Motors**

Machine which converts electrical power in to mechanical power is called motor. Where DC supply is used for motors they are called DC motors.

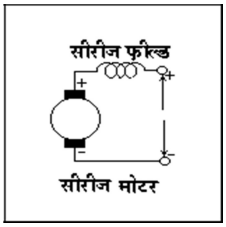
Working principle of motor- whenever a current carring conductor is placed ina magnetic field it is acted upon by a force which tends it to rotate. Fleming left hand rule is applied to find out the direction of rotation. Place first finger, middle finger and thumb perpendicular to each other (90 degrees), if middle finger shows the direction of current then first finger will show the direction field and thumb shows the irection of motion.

Main parts- 1. stator (field) - stator is a stationary part and it has windingcalled field winding.

2.Armature (Rotor)- as its name indicates it is a rotatingpart on which armature winding is place D. To feed current to the armature arrangement is made with the help of comutator and brush-gear. Basically there is no difference in the construction of DC motor and generator.

Types of DC motors- DC motors are of three types-

1. DC series motor, 2. DC shunt motor, 3. DC compound motor.ü



1. **DC series motor-** field of this type of motorhas less number of turns of thick wire which is connected in series with the armature

winding. Thus current in the armature and field winding is same. Due to this the starting torque is high. On no load speed of this motor is abnormal and hence it is never started without load.
Applications- cranes, tram, traction, trolley car etc

2. **DC shunt motor-** In this type of motor field winding is of thin wirehaving more number of turns. Therefore its resistance

is high. It is connected parallel to the armature winding. Speed of these motors is almost constant. The starting torque is 1.5 to 2 times. Speed control of this motor can be easily done with the help of shunt regulator.

Aplications- e.g. pump, lathe m/c, drill m/c, printing m/c, etc.

Torque - By the term torque meant the turning or twisting moment ofa force about an axis. It is measured by the product of the force and the radius at which this force acts.

Therefore Torque T = force (f) x radius (r)

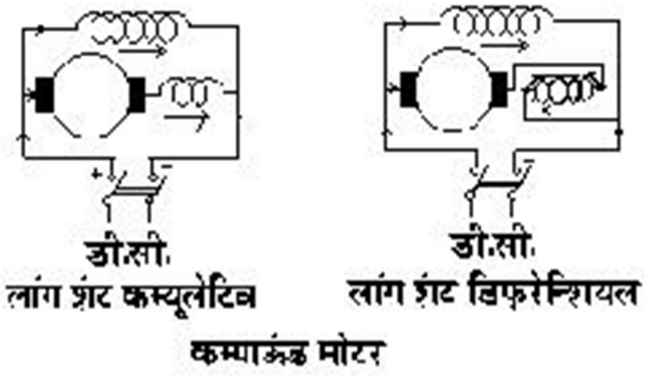
The unit of torque is Newton-metres.

3. Compound Motor- in this type of motor speed is constant and thestarting torque is also more. It has two field winding known as series field and shunt field.

Applications- compressors, pumps, punching m/c, press m/c, crusher, etc.

These motors are further classified in to two types on method of field connections-

1. Cumulative Compound motor
2. Differential Compound motor



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1. Cumulative compound motor- In this type the seriesfield winding is connected in such a way that it assistsshunt field.

With this connection

a) if load is more the starting torque will be more and speed is reduced.

b) if it is off-loaded then shunt winding prevents overspeed.

Applicatios- tool m/c, coal crusher, etc.

2. Differential compound motorü- In this type the series field winding isconnected in such a way that it opposes the shunt field. With this connection speed is contant. Before starting this motor series field is shorted. This prevents the excitation of series field prior to shunt field to avoid the starting of motor as a series motor.

Sub-lesson-14 **AC motors**

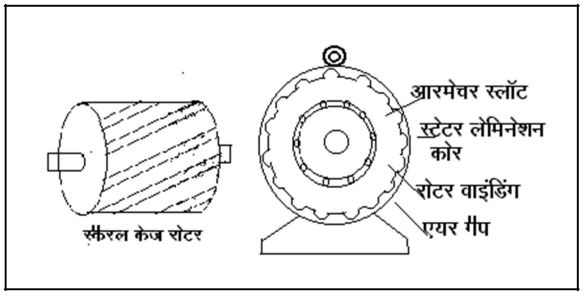
Motors working on AC supply are called AC motors.

1. Single phase AC motors
2. Three phase AC motors

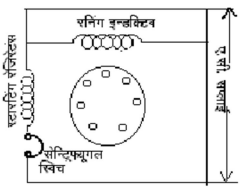
1. Working of single phase motors- Construction of single phase motor is also like a three phase motor, only difference is it has two windings in stator called starting winding and running winding. With only one winding pulsating field is formed. Due this motor is unable to start unless you move its rotor in any one direction. In order to avoid this rotating magnetic field is required. To have the rotating magnectic field second winding is essential.

Typeas of single phase motors-

1. Split phase motor
2. Shaded pole motor
3. repulsion motor
4. universal motor
5. Capacitor start induction run motor
6. Permanent capacitor motor
7. Capacitor start and capacitor run motor



Capacitor start induction run motor- In this type a capacitor is provided



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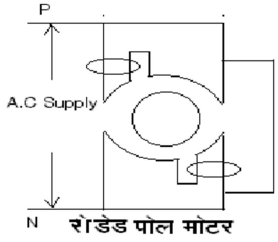

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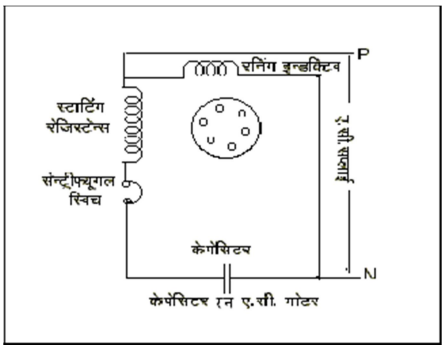
in series with the starting winding. Due to this starting torque and p.f. is improved. The centrifugal switch is provided in starting winding which opens it

at about 75 % speed of motor is attained. Rotor is of squirrel cage type which rotates because of rotating field produced by both the winding. After the centrifugal switch is opened it conues to work running winding field only.

Universal motor- field of this type of motor has less number of turns ofthick wire which is connected in series with the armature winding. Thus current in the armature and field winding is same. Due to this the starting torque is high. On no load speed of this motor is abnormal and hence it is never started without load.Speed of this motor is reduced if load is increased.

3. Capacitor start and capacitor run motorü- In this type of motor thereare two capacitors connected in series

with the starting winding. One is called running capacitor and another is called starting capacitor. Starting capacitor remains in circuit only at the time of starting the motor for fraction of second and then it is disconnected from circuit with help of relay. Thus the starting and running torque of these motors is high.



Applications- Air conditioners, compressors, etc

Sub-lesson-15 Motor starters

Why starter is required- Rsistance of squirrel cage winding is very lowand at stand-still position it will appear as atransformer with short circuited secondary. Threfore if it directly connected to the supply then it draws heavy current at starting. This will have effect on the supply voltage. It will drop abnormally and may affect other installations particularlly the effect will be more in case of motors above 5 HP.

Fuctions of motor starters-

1. To facilitate to start and stop the motor.
2. To limit the starting current.
3. To prevent restarting of motor in case of supply failure and restoration without knowledge.

4. To prevent failure of motor due to overloads, undervoltage,etc.

Therefore starter is essential for the motors. For motors upto 5 HP Direct on line (DOL) starter starter is provided. For motors above 5 HP star-delta or auto-transformer starter is provided which limits the starting current of the motor. Once the motor pick-up the speed back EMF is produced which opposes the applied voltage. Thus the current is reduced and motor draws its rated current.

Example:- Suppose resistance of winding is 5 ohms and voltage Applied is 100 volts.ü

Therfore starting current = V/R = 100/5

= 20 amperes

After starting attaining speed if back EMF = 80 volts

Then current = $\frac{E - E_b}{R} = \frac{100 - 80}{5} = \frac{20}{5} = 4$ amps

Thus at starting since back EMF is zero current is high which is decreased when back EMF is developed as motor picks up the speed.

Types of starters-

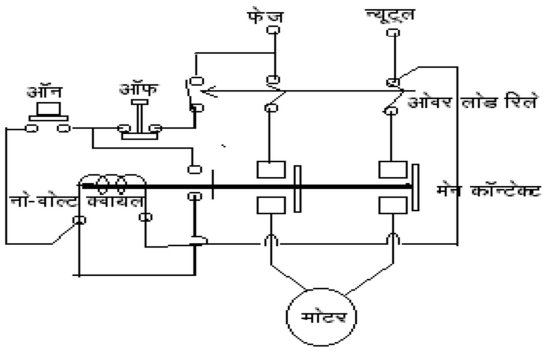
Srarters for squirrel cage induction motor-

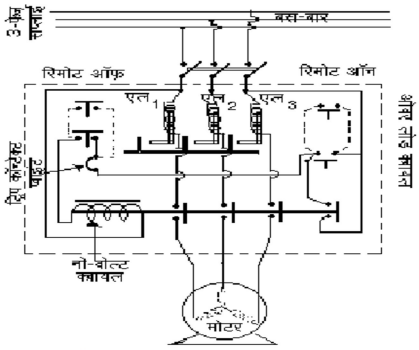
1. **Direct on line starter (D.O.L.)** The starter which connects motor tosupply mains without limiting current is called DOL starter. These are of two types single phase and three phase. There is no much difference in single and three phase starter except the number of pole of the contactor. In three phase 3 poles and in single phase 2 poles are required.

   In DOL starter when 'on' button is pressed one phase reaches to no volt coil of the starter. Neutral or second phase is directly connected to the another terminal of the no volt coil. The magnet is formed in the coil and it attracts pluger inside on which main and auxillary contacts are mouted. Since main contacts are close supply is passed through over load relay from L1, L2 and L3 to the motor contacts M1, M2 and M3 and it starts.úIf due to any reason motor is over loaded then it draws more current than its rating. It heats up the the bi-metalic strips of relay and

as per seting O/L relay breaks one phase of the no volt coil and cotacts are opened. Thus it prevents motor from damages. This type of starter is used upto 5 HP. Starting current is approx. 6 times the full load current.

Starters connection diagram-





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2. **Star delta starter-** This type of starters are generally used formotors above 5 HP and up to 15 HP. When starter is switched on, the motor winding is star connected and the starting current is limited to starting current divided by under-root 3 i.e. 1.732. The current is further controlled as the speed increases the back EMF also icrease.

After attaining full speed in star position the starter is switched over to delta position thus motor gets full voltage and it picks up designed full speed and work normally.

Applied voltage is 400 volts but in star it is = $\frac{400}{\sqrt{3}}$ = 230 volts

These are of three types manual, semiautomatic and fully automatic. Thermal over-load realy having bi-metalic strips are provided for the protection of motor from over-loads. Capacity of overload relay is approx. 60% of the rated current since it is provided in the branch circuit where load current is divided in to two paths. For automatic change-over from star to delta FASD starter timer is provided its setting should be done as given below-

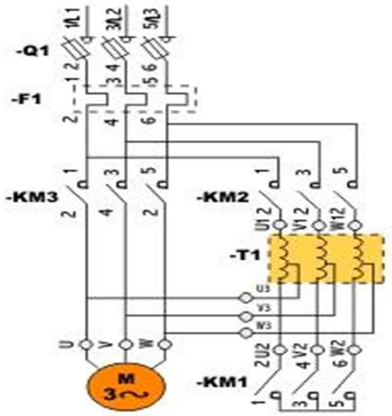
First keep the setting at maximum position.

Start the motor and allow it to run to full speed. Note this time.

Stop the motor reset the timer for the noted time.

3. **Autotransformer starteru-** In this type the starting voltage applied to motor is stepdown to desired value by autotransformer and thus the current also reduces. Whe nmotor pick-up the speed and back EMF is produced the full voltage is applied to motor changing the tap of the transformer.

No volt coil holds handle of starter in position and releases in case of power failure. Over-load relay protects motor from damage due to over-load.

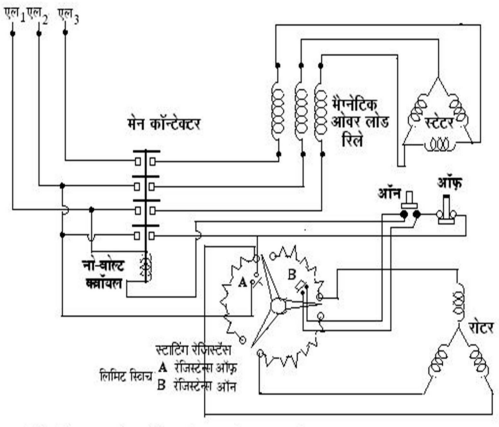


Auto-transformer starter

Soft starter- With the electronic device the reduced voltage isapplied to motor at starting and gradually and very smoothly it is increased to full voltage. Due very smooth starting the life of motoralso increases. It is energy efficient but its cost is very high and thus rarerly used in railways.

Starter for slip-ring induction motor-

Rotor resistance type starter- This is used for slip ring inductionmotor. The rotor os this motor has winding and three leads of this winding are connected to slip-ring provided on rotor shaft. With help carbon brushes mounted on slip-ring external resistance is connected in thr rotor winding at starting. This limits the starting current of the motor to desire value. Gradually as motor picks-up the speed it is reduced and finally it is bypassed and motor starts working on full speed. Initial torque of this motor high.



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Sub-lesson-16 **Cable**

Types of cables-

1. L.T. cable
2. H.T. cable
3. supper tension cable
4. Extra high tenssion
5. Oil/gas filled pressurized

On the basis of insulating material

1. Paper insulated lead covered (PILC)
2. Poly vinylle chloride insulated (PVC)
3. Cross linked polymer extruded (XLPE)

On the basis of conductor- copper or aluminium.

Laying of underground cable- Cable trench of 40 to 60 cm width and 1 mtr depth is made. Dry sand layer of 15 cms is provided at bottom. Cable is layed and covered with the sand and warning covers or bricks are provided. Then the trech is filled with the soil. C.I. cable route markers are provided to identify the route of the cable in future.

Single phase energy meters- Disc of single phase energy meterrotates due rotating field created by current coil and pressure coil. These are placed at electrically 90 degrees apart.

Construction**-** In this meter two coils are placed on one core as shown in the picture. Current coil made up of less number of turns of thick wire. Pressue coil is of more number of turns with thin wire. Disc rotates due rotating field created by current coil and pressure coil. These are placed at electrically 90 degrees apart.

The field of current coil is proportional to the current passing through it and pressure coil field is proportional to voltage. Thus torque produced is proportional to yhe power. If time factor is applies it gives the energy consumed and it is recorded with help of gear train.

Three phase energy meter- There are two current coils and twopressure coils in this meter. Torque produced by these coils act on a single disc. In some meters there are two discs on same spindle. To measure energy in unbalanced circuit three current coils and three pressure coils are provide D. Rest of the feature are similar to single phase energy meter.

Chapter-6

Maintenane of major electrical supply equipments

Lesson- 1 Defects in starters

Sub-lesson- 1 Defects in starters

A) Awitched on but motor does not start-

i) Supply fuses are blown.
ii) Open cicuit in no volt coil or wiring
iii) Tripping of single phasing preventor.
iv) Connection of motor is wrong.
v) Contact of contactor is carbonized.

B) When push buton is pressed motor starts but stops if hand is taken away-

i) There is a carbon on auxiliary contacts or open circuit.
ii) Over load relay is defective or setting is not proper.
iii) Mecanical load is more.

C) Motor starts in star and trips in delta-

i) There is earth fault.
ii) Mechanical load is more.
iii) Timer defective or improper setting.
iv) No volt coil of delta contactor burnt.
v) Motor connection is wrong.
vi) Carbon in NO/NC contacts.

D) Motor rotation is reverse-

i) Phase sequence is altered.

E) Contactor switching on and off-

i) Loose conection in wiring.
ii) Supply voltage is low.
iii) Pole shading ring broken.
iii) Contact strip burnt.

iv) Contactor capacity is less.
v) Surface of contactor not proper.
vi) Cotactor spring tension is less.

Sub-lesson-2 AC and DC motors

Maintenance and overhauling Points to be noted during maintenance-

i) General cleaning with compressed air having 80 to 10 psi pressure.
ii) Check air gap with air gap filler gauge.
iii) Check oil and Greece.
iv) Check insulation resistance of winding.
v) Check slip-rings, commutators, etc.
vi) Check carbon brushes and brush gear.
vii) Check motor current.
viii) Check motor terminal connection.
ix) Check vibration.
x) Check starter and control gear.

Schedule-

i) Daily
ii) Fort-nightly
iii) Half yearly
iv) Once in a 5 year complete overhauling.

Method of overhauling-

i) Primary inspection.
ii) Stripping out (opening and cleaning)
iii) Replacement of defective parts or repairs.
iv) Varnishing of windings with baking
v) Assembly test/final inspection

1. Primary inspection-

1. Read out machine reports carefully and check al parts.
2. Before opening check IR value and air gap.
3. Prepare connection diagram of armature, field winding, etc.

2. Stripping out/cleaning-

1. Open all parts.
2. Replace wornout bearing and part.
3 Clean oil/greese stick up to windings.
4 After varnishing baking to be done.

3. Assembly inspection-

1 check field connection,etc
2 Measure IR value of winding with 500 volts megger it should be minimum 2 mega-ohms.
3 Carry-out armature drop test.
4 Check motors full load current as per rating and voltage.
5 Check starting current, sparking, temperature of bearing, etc.
6 Full load temperature rise test of winding for 6 hours.
7 High voltage test for new coils.

Sub-lesson- 3 **To identify bearings noise**

a) Reasons for abnormal noise in al bearings-

i) Lubrication oil/greese dried.
ii) Balls worn-out.
iii) Due to vibratons ball range damaged.

b) If spare motor is kept on a place where there is vibration its bearings can be damaged.

Sub- lesson - 4 **Cleaning of reflectors**

Due to dust, dirt, etc illumination level reduces by 30% in a three months and 60% in 12 months. Therefore reflector should be cleaned once in a three month with soap water wet cloth.

Sub-lesson- 5 **Ceiling fans**

Al check nuts, split pins, suspension arrangement, capacitor should be checked. Air flow should be measured with the help of Anemometer

Sub-lesson- 6 **Wiring**

In addition to monthly inspection it should be thourolly checked once a year.

Annual inspection-

1. Service connection
2. Main switch board
3. wiring and its isulation
4. Earth and bonding
5. Swiches and fuse size
6. appliances
7. Fire prevention items.

Service connection (building)-

1. clearance from the building
2. capacity of service line fuse
3. polarity i.e. whether fuse is provided in the phase or otherwise
4. Wire size, condition of insulation,etc.

Main switch board-

1. Check voltage on peak load. Adjust transformer tap changer if it is less than 220 volts.
2. Main switch shall be available near all buildings.
3. Sufficient working clearance should be available near main switch.
4. Check fuse size of the main switch. If wires are damaged replace them.
5. Check IR with 500 volt megger between line and earth. It should not be less than 50 divided by number of outlets or 1 mega-ohm whichever is more
6. Line to line IR value should not be less than 5 mega-ohm.
7. Check earth resistance and continuity with earth tester. Itshould be maximum 8 ohms.If it is more take measures to improve the same.

Switch and fuse-

1. Clean the contacts of switch.
2. Switch should be always in phase line. Check for over heating and fuse size.
3. Check portable appliances like table fan, press, table lamp and its cable.Check if there is any leakage.

Improvement in earth resistance-

If earth resistance of the domestic installation is found more than 8 ohms then-

i) Clean the earth connetion.
ii) Put charcoal and salt in the earth pit.
iii) Connect more than one earth electrode in parallel.
iv) Whichever wire seems to be damaged replace it.
v) Rewiring should be done after 10 years.

Sub-lesson - 7 Maintenance of overhead line

In order to ensure un-intrupted power supply it essential to carry out preventive maintenance of the O/H line periodically. It is done as given below-

1. Preventive maintenance to ensure safety.
2. Pre-mansoon special inspection-
   i) With this inspection problable breakdown due to mansoon can be avoided.
3. When there is a breakdown on line emergency patrolling Should be carried out to find out the fault location, its nature and to decide the restoration process.

Routine maintenance-

1. Patroling of live line should be done once in a month.

2. Points to be checked –
   i) Metal supports- inspect the foundation of the supports/masts. Take necessary measure to prevent it from falling or tilting.
   ii) Wooden support-
   1. check that it is in vertical position.
   2. check foundation.
   3. check the bottom portion of pole whether it is in sound condition or not.

iii) cement poles-
iv) check for any cracks.
v) Cross arms- check for rusting and see that it is in proper position.

3. Insulators and fittings -

a) check for broken insulator.
b) Tilting of insulator from its position.
c) Check formation of dust,dirt due to pollution.
d) Rusting of its fittings.
e) Check for any hot spots, sign of burns, etc.

After arranging shut-down all the short-comings should be attended.

4. Conductor and earth wire -

Check whether the clearances are as per IE rules or not. Adjust if not correct. Remove any foreign objects like nest of the birds, pieces of hanging wires from the conductors.

5. Conductor fitting/joints-

i) Check the binding wires are in place or not.
ii) Check whether conductor is in proper position or slipped from insulator seat.
iii) Check that the strands of the conductor is not broken.
iv) Check the burnt jumpers loose clamps, if noticed replace them.

6. Stays and its accessories-

i) check for slackness.
ii) broken stay insulators.
iii) Loose or broken stay earthing.
iv) Guy Anchoring.

7. Clearance from trees-

If the branches of trees are imfringing the clearance it should be cut.(2 mtrs clearance).

Sub-lesson- 8 **Defects in battery and maintenance**

Defects-

1. broken container- due to mis-handling, carelessness, vibrations.
2. cell sulphation- If kept discharged for longer duration.
3. Internal short circuit- Due to overheating, over charging, charging voltage is more.
4. Buckling- Due to over charging
5. Reverse polarity-Over discharging of cell
6. Low electrolite level- leakage, container broken, not topped up in Time, ovr charging.
7. Terminal burnt- Lose connection, dirty.
8. Low specific gravity and low voltage- spilling of electrolyte, no proper charging.

Points to be checked during maintenance of battery-

1. Battery should be kept in dry palce.
2. Battery room should be airy.
3. Do not take any flame near battery.
4. Do not keep any tols on the cell.
5. Use hand-gloves and safety goggles while working on battery.
6. While preparing electrolyte dot not add water in to the acid, but acid should be added in water slowly.

Battery maintenance-

1. Charge battery as soon as it is discharged.
2. Keep cell terminals clean and tight. Use petroleum jelly as anticorrosive.
3. Top up distilled water time to time. Float level should be maintained properly.
4. Do not allow temperature of the cell to rise above 45 degree centigrade.

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Chapter- 7

Sub-lesson- 1 Testing, erection, and commissioning

Election of Poles :

First plan the route of the O/H line. Decide the length of span. Keep the treches for ready and collect the material for foundation at site. Crow bars, shovels, ropes, pulley, pick-axe, etc is required for pole erection. Lineman with team will bring the pole to pit. With the help of Derrick for heavy poles and deadman method for light poles it is erected. Ropes are tied on all four sided and wooden ladder is used for safe erection of poles.

Sub-lesson-02 Focusing

Before erection of lluminaire its focus is adjusted and the protetive cover provided on the reflector is removed. Otherwise the efficiency of of the fitting will be affected.

Sub-lesson-03 Connection of choke and condenser.

Functions of choke-

1. For gas discharge lamp it requires high etriking voltage. The choke is used for this purpose. It is provided in series with the circuit. It also drops the voltage once the tube is striked and suitable reduced voltage is applied across the tube.
2. In rectifiers and chargers it is used as a filter.

Fuctions of condenser-

i) In single phase motor it is used to create phase difference. And it is connected in series with the starting winding.

ii)It is also used for power factor correction and connected across the load.

iii) It is used in the timer.

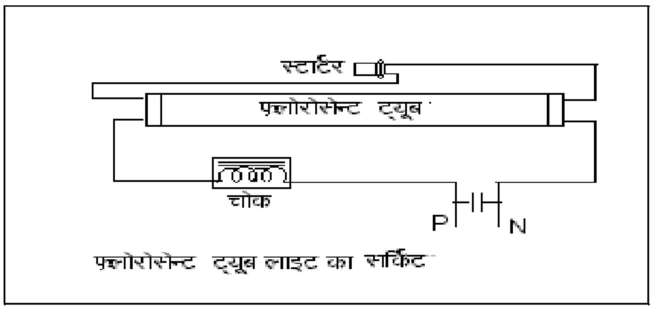
iv) It is connected in parrellel I DC circuits as a filter.

v) Used in gas discharge lamps-

a) Fluoroscent lamp.

b) organ gas lamps
c) mercury vapour lamps.

Diagram-



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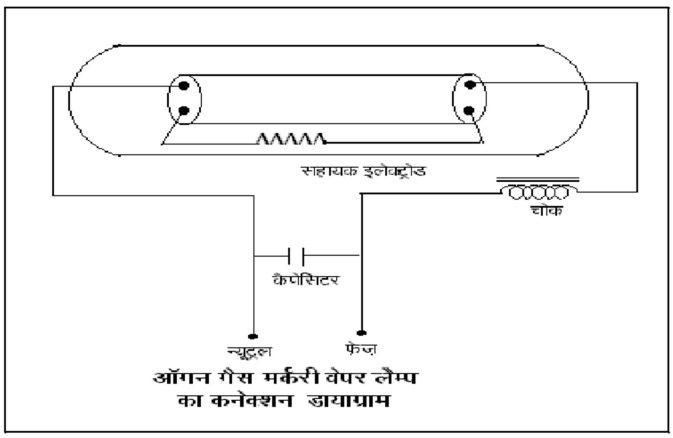

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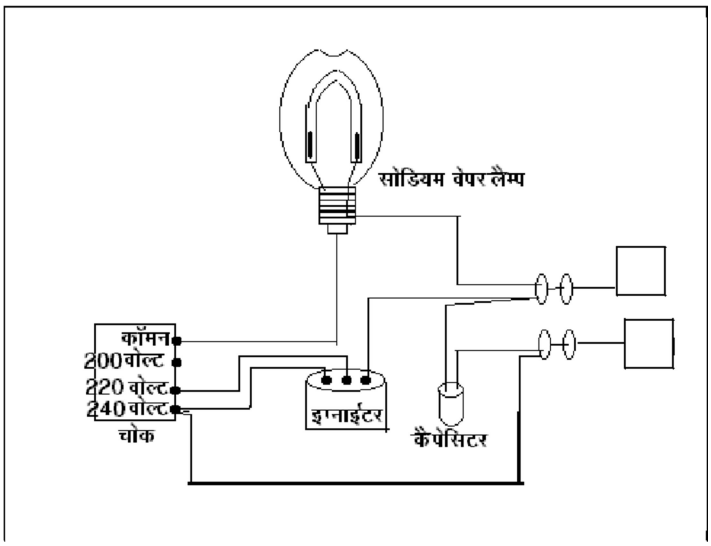


Connections in home appliances.

Sub-lesson-6

1. All non current carrying metallic parts should be earthed.
2. Sockets should be of three pin type only.
3. For pertable appliances connection should be given by three core cables.
4. conducror should be flexible type with good insulation.
5. Swiches shall be of suitable capacity. And fuse size should be appropriate.

Sub-lesson-7 **Insulation resistance of wiring.**

A) Wiring should be checked with the help of 500 volts megger. The value should not be less than 50 idivided by number of outlets or 1 mega-ohms whichever is higher.

B) Earthing- At 2.5 mtr to 3 mtr depth earth electrode is buried in the ground is called earthing. Lead of GI or copper wire is connected to the earth electrode and taken to the installation to be earthed. Eaths potential is treated as zero. When any metallic non current carrying body, cover, etc. is connected to the earth with this lead then it is said to be earthed. Good earthing is that which diverts fault current to earth safely.

C) Why earting is necessary-

1. If there is leakage current in any appliance with arthing arrangement it is diverted to earth and fuse is blown. The installation thus becomes safe.
2. Earting also safeguards the big buildings from lightening.

3. It safeguards the installation/equipments connected to O/H line from lightening surges.

4. To earth the transformer neutral. It prevents the dangerous variation in voltage due to un-balanced load.

Why separate two earths are required for three phase machines- With two earths in parallel it offers low resistance path for fault current and if any one lead is disconnected the other provides the safety.

D) Earthing procedure- Mainly there are two types most commonly used-

a. Pipe earting

b. Plate earthing

Maximum permissible earth resistance-

a) Power station - 0.5 ohms
b) Major sub-station - 1.0 ohms
c) Small sub-stations - 2.0 ohms
dü) Other places - 8.0 ohms

E) How to improve the earth resistance- Earth resistance depends Upon the size and length of the electrode, moisture content in the soil, Type of conection and temperature. It can be improved by-

1. increasing size and length of the electrode.
2. putting charcoal and salt in earth pit alogwith water.
3. connecting more than one electrode in parallel.
4. cleaning and reconnection of earthing terminals.

Fuction of megger- for testing of insulation resistance of installationmegger is used.

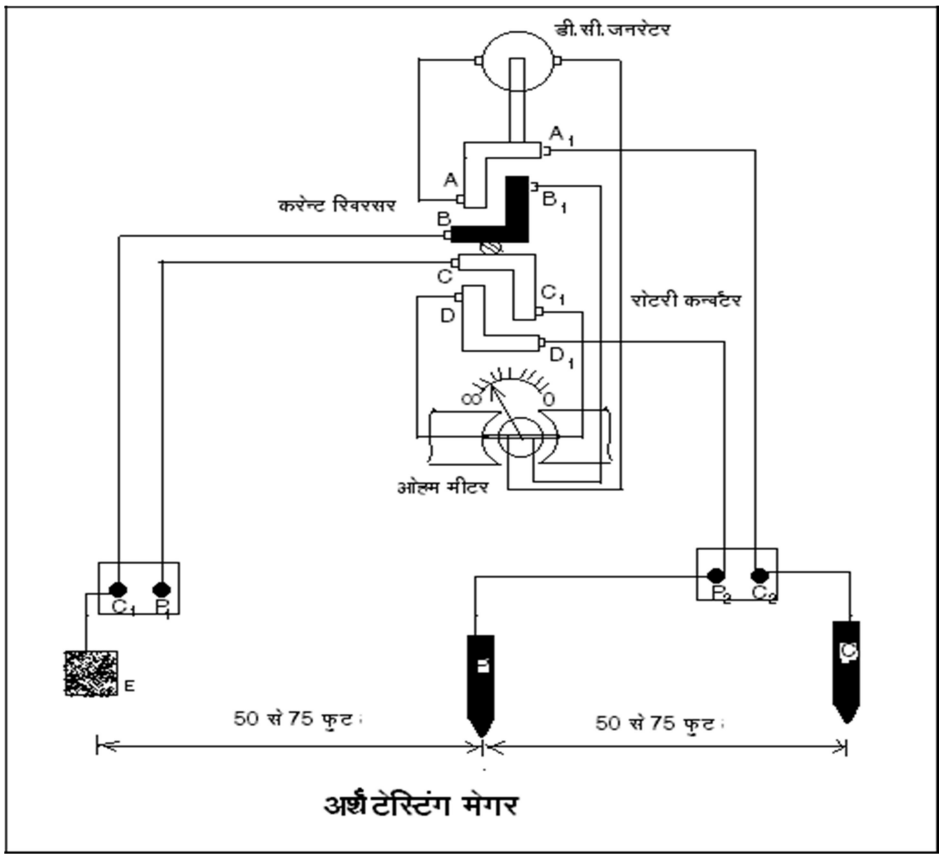
Working principle of megger- A megger insulation tester comprises a DChand driven generator and and a direct reading, two element, permanent magnet, moving coil type indicator mounted in one case as shown in figure. The indicator movement contains no control spring, but the restraining force is provided by a potential coil connected across DC generator in series with a fixed resistance. The poiter, therefore,takes a definite position only when the generator handle is turned. The deflecting force is produced by a current coil which is connected across the generator through the external resistance under test, and opposes the force created by the voltage coil. When there is infinite resistance between L and E then only pressure coil will produce torque and thus needle will move to infinity. Where as if the resistance is zero then only current coil will produce maximum torque and needle rests on zero.

Megger reads the resistance in thousands of ohms and mega-ohms.

What is earth tester- Earth tester used to test the earth resistance. It hasfollowing parts-

1. Hand driven generator, 2. Rotory current reverser, 3. Synchronous rotor, 4. Rotating rtifier, 5. ohm meter

Method of earth testing digram- To measure the earth resistance two \ ironspikes are driven in to earth at suitable distance.(Distance between each other is approx. 25 mtrs. From electrode under test.) P1 and C2 is shorted. When generator is turned directly the reading in ohms can be read.



अर्थ टेस्टिंग मेगर

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Diesel Generator Set

D.G.set- It is used to produce electrical power. Basically it is used asstand-bye since the cost of generation is more. Earlier Railways had its own power houses using steam turbines. But one by one they were shut down because they were un-economical. Generator converts mechanical energy in to electrical energy.

Working principle- Diesel ios used as a fuel in diesel engines. It is a four stroke engine. These are 1. suction stroke, 2. compression stroke, 3. power stroke and 4. exhaust stroke.

During suction stroke air is entered in the cylinder, then it is compressed during compression stroke. The temperature is rised due to compression sufficient for ignition of fuel. Thus when fuel is injected in cylinder it burns. This exerts force on piston thus power is generated,so this stroke is called power stroke.

Working principal of alternator – Alternator works on the principle of Farade's Law of electro-magnectic induction. It is coupled with the diesel engine. When engine rotates it drives alternator in turn alternator converts mechanical energy into electrical energy.

Advantages of DG set-

1. It can be put into service immediately.
2. Losses are low.
3. No skilled operator is required.
4. Maintenance is low.
5. Worn out parts can be easily replaced.
6. Life can be enhanced with little investment.
7. It can be easily provided at load centre thus cost of connections is less.
8. These are available in lower capacities also.
9. Less space is required.
10. consumption of water is less.
11. Maintenance and storage of fuel is easy.
12. It can be procured and installed easily.

Disadvantages-

1. sufficient crude oil is not available in our country. Hence foreign exchange is require for import.
2. There is sound pollution due to DG set.

Other Applications of DG set-

1. In accident relief train.
2. Mid on and end on geration power cars.
3. Accident relief medical equipment van.

Main parts of DG set-

Diesel engine.
a)Piston
b) cylinder head
c) valve/ports
d) connecting rod
e) bearings
f) supporting arrangement
g) fuel pump
h) crank shaft
i) fly wheel Alternator-

a) Rotor
   i) Salient pole type
   ii) Smooth cylinder type
b) stator
c) Excitor

Maintenance of DG set-

1. Daily
2. Weekly
3. Monthly
4. Half yearly
5. Annual
6. Once in a two year
7. Once in a four year

1. Daily-

Engine-

1. Check the log-book and carry-out the work accordingly.
2. Check water content in separator. Drain it through drain cock.
3. Check for any leakage of fuel, lubricating oil, water or exhaust smoke.
4. Check water level of radiator, fill it if required, by chromate solution of 3500 ppm. Put the cap of radiator properly.
5. Check the oil in the air filter. Replace if required. Check for intake air leakage.
6. Start the engine and check LOP. It should be 50 to 70 psi on desired speed. If it is less then stop the engine and find out the reasons.
7. Lubrication oil level should be checked after 20 minutes when engine is stopped. Top up if necessary.

Electrical system-

Battery

1. clean it with dry cloth.
2. Retighten the connections.

Swtch gear

1. Check self starting switch is working properly or not.
2. check for any abnormality.
3. check phase indicator and panel.

Alternator

1. Check if there is any abnormality.
2. check for the free passage of cooling air.

2. Weekly- In addition to daily schedule check the following items-

Engine-

1. Check engine and governor oil. Top up if required.
2. Check for contact heater working.
3. Check coolent for antifreezing and viscosity.
4. Check belt tension.
5. Check dust in the precleaner.

6. Check obstructions in air filter.
7. Check vibratios.

Battery-

1. Check electrlite level.
2. Check specific gravity and voltage.
3. Check for abnormal heating and any other abnormality in the cells.
4. Check container.
5. Check charging arrangement and charging current.

3. Half yearly-

1. Replace engine oil.
   Replace lubrication oil filter.
2. Clean the breather of main fuel tank.
3. Check coolent pH it should be between 8.5 to 10.5.
   Chromet concentration should be 3500 ppm.
4. Replace water filter element.
5. Check throttle joints.
6. Remove delivery hoses of air compressor and clean it.
7. Replace crank case breather element.

Reconditioning of battery and switch-gear. Alternator-

1. Check terminal box, junction box, insulation, etc. Clean withdry cloth.
2. Check the condition of cooling fans.

Pumps.

Pump- pump is the machine which lifts the water/liquid from one level to another.

Types of pumps used in Railways-

1. **Centrifugal pump**- In a centrifugal pump the liquid is admitted to the cetre of the rotor called eye and whirled through a shaped impeller, which imparts it a high velocity and energy as it moves towards the periphery. This happens due to centrifugal force. The water then passes thrugh volute chamber where the highvelocity is converted in to pressure smoothly. According to construction there are following types of centrifugal pumps.
   1. horizontal shaft CF pump/ Monoblock CF pump
   2. Vertical turbine pump
   3. Submersible pump (for bore well)
   4. Monoblock submersible pump. (for open well)

2. Jet pump- These are used where the space is limited, less discharge is required with high suction head. The basic principle of this pump is that when a liquid under pressure is released in front of the mouth of an orifice,a partial vacuum is created in the immediate xicinity of the jet and the surrounding water is sucked in to the orifice.

3. **Screw pump/ gear pump**- It is called positive displacement pump. These pumps are mainly used in machines as a oil pumps for lubrication, etc.

4. **Diaphragm pump**- a diaphragm pump consists of a thin, flexible diaphragm of rubber or ruberised canvas stretching across a chamber, the cetre of which is moved up and down or to and froby the operating device.

1. maintenance schedule of centrifugal pumps

A. Daily-

1. Check leakage through packing.
2. Check bearing temperature.
3. Check for vibrations and abnormal noise.
4. Check pressure, voltage and current reading.

B. Half yearly-

1. Check stuffing box glang.
2. Cleaning of gland bolts and oiling.
3. Check packing.
4. Check alignment of pump and drive.
5. Check greese/oil of the bearings.

C. Anual-Complete overhauling painting and out put test.

2. Maintenance schedule of vertical turbine pump

A. Genaral -

1. It should be installed in dry,dustfree and airy place.
2. It should be cleaned daily.
3. Oil lubricator oil level should checked and topped up and constant flow be ensured during working.

4. Check vibrations, discharge head level and belt tension where ever applicable.

B. Lubrication of pump unit-

1. For oil lubricated pump clean oil as recomded by manufacturer should be used.
2. Check oil level in reservoir and top up if required.

3. Submersible pump-

Reasons for failure of submersible pump-

Main reason for failure of submersible pump is failure of winding (burt) of motor. The reasons are-

1. Due to insulation failure.
2. Due to over-load.
3. Due to voltage fluctuation.
4. Due to single phasing.
5. Frequent starting of motor.
6. Wrong handling, repairs, and water-tight connection.

* * *

Chapter- 8

Sub-lesson-1 Indian Electricity Rules 1956

It is known as Indian Electricity Rules 1956. It is applicable to all installations pertaining to Generation, Transmission, Distribution and Utilisation of electrical energy. Its main object is to ensure safety in Generation, Transmission, Distribution and Utilisation of electrical energy and to prevent the thefts. To review these rule Central Electricity Board is constituated. Members are selected from experts from State government, public sector, Industrial Institutions, etc.

Electrical Inspector to Govt. (EIG)- He carries-out the periodicalinspections of the electrical installations under his jurisdiction and ensures the compliance of IE Rules. It is essential to obtain the sanction of EIG before charging the new HT installation. For Railways CEE of the respective zone is nominated as EIG.

Extract of I.E.Rules

Rule - 2: Classification of voltages

upto 250 volts	- Low voltage
Above 250 V uptoü 650 V	- Medium voltage
Above 650 V upto 33000 V	- High voltage
Above 33000 V	- Extra high voltage

Rule- 32 : neutral conductor should be marked such that it should be easily distinguished from phase conductors.

Rule-34 : Whenever bare conductor is terminated on a building, it should not be easily accessible without the aid of mechanical device.

Rule-35 : At every medium and high voltagedistriburion places Danger board should be provided in English or hindi and local language. E.g. s/stations, motors, pumps, transformers, neon signs, etc.

Rule-36 : Work should not be carried out on line without switching offthe supply. After ensuring that the supply is switched off the line shall be earthe D. Neutral link should be open.

Rule-43 : At sub-stations and switching stations suitable fireextinguishers

shall be provided in addition to the fire buckets filled with the sand. First aid box shall be kept upto date and in every shift first aid trained staff should be available.

Rule-44 : In every s/station, generating station, etc. shock treatmentchart in English or hindi and local language should be provided at conspicuous place.

Rule-48 : Installations insulation resistance shold be measuredperiodically. For low and medium voltage installation it should not be less than 1 mega-ohm with 500 volts megger. For HV installation it should not be less than 5 mega-ohm with 2500 volts megger.

Rule-51 : At the entry of the service line main switch shall be providedat the easily accessible location.

1. There should be minimum 1 metre clearance in front of the panel board.
2. Maximum 22.5 cms clearance can be kept behind the panel board. If there is an opening for panel board at the back side in that case minimum 75 cms clearance should be provided and entry should be avaible from either side of minimum 1.8 metre height.

Rule -54 : Permissible voltage variation from declared voltage-

Low and medium voltage	6 %
High voltage	+ 6, -9 %
Extra High voltage	+10, -12.5 %

Rule -55 : Permissible variation in declared frequency- 3%
In India declared frequency is 50 Hz, therefore frequency variation from 48.5 to 51.5 is permitted.

Rule -57 : Permissible variation in Trivector meter, KWH meter at 10% to 100% load should not be more than 3%.

Rule -61 : All metallic parts should be earthed properly.

Rule- 68 : Height of substation shall not be less than 1.8 mtrs

Rule-70 : For static condensers automatic discharging device shall \

Be provided.

Rule-77 : clearance between O/H line and ground.

Place	Low & medium voltage	High voltage	Extra high voltage
At Road crossing	5.8 m	6.1 m	6.1 + 0.3 m for every 33000 volts or part there of
Along the road	5.5 m	5.8 m	5.2 + 0.3 m for every 33000 volts or part there of

At other places up to 11 KV - 4.6 m and if it is insulated line then 4.0 m.
Above 11 KV and high voltage - 5.2 m

Rule -79 & 80 : Clearance from building

Voltage	Above building	From building
Low and medium	2.5 m	1.2 m
Upto 11 KV	3.7 m	1.2 m
Above 11 KV upto 33 KV	3.7 m	2.0 m

Rule -85: Maximum legth of span for low and medium voltage shallnot be more than 65 m.

Rule- 88 : Where continuity of guard wire breaks it should be earthed. The breaking strength of guard wire shall not be less than 635 Kg.

Rule- 89 : Service line should be tapped at point of support.

Rule- 90 : i) In every one kilometer of Over head line at least three at equal distance shall be provided.

ii) Stay insulator shall be provided at minimum three metres height. If stay insulator is not used then it should be permanently earthed.

Rule- 91 : i) Safety device to break the supply in case OH line breaksshould be provided in order to prevent the accident.

ii) Anti-climbing devices should be provided to to prevent access to un-authorised persons.

Rule - 92 : i) Lightening arrester shall be provided to protect OH linefrom lightening surges

ii)Earth wire of LA should be connected to earth electrode directly without any bends.

Recommended Maximum earth resistance is-

Power stations	- 0.5
Major substations	- 1.0
Small substations	- 2.0
At other places	- 8.0

* * *

TL\ AC (Train Lighting & Air Conditioning)

Chapter 01

Lesson No. 01 Foundation

Sub-lesson - 01 Various fields of electrical works.

1. General services-

a) **Out side maintenance (OSM)-** They look after operation andmaintenance of electrical installation at stations, service buildings, yards, quartes, pumping station, air conditioning, etc.

b) **Train lighting and air conditioning (coaching)-** They look after trainlighting and air conditioning of coaches.

2.Traction distribution (T.R. D.)-

a.Power supply installation.(PSI)
B.Over head equipments (OHE)
C.remote control equipments(RCE)

3. Traction rolling stock(TRS)-

Repairs and maintenance of electric locomotives.

4. Traction rolling operations(TRO)-

Movement of locomotives with running staff.

Lesson-2 Portable and hand tools.

Sub-lesson- 1 Name, size and uses of hand tools.

Sr No	Name of tool	size	Use
01	Plier, nose plier, side cutting, etc	15 cm 20 cm 25 cm	To hold or cut the wire, tighten nut bolts, etc.
02	Screw driver	10,15,20, 30,60 cm	To loosen or tightenthe screw.
03	Firmer chisel	15 cm, 2 to 5 cm wide	Carpentry work.
04	Cold chisel	--- do ---	To cut the iron/steel, to make holes, etc.
05	Hammer	250 gram to 7 kilogram	For black smith, etc to prepare a job.
06	Mallet	---do---	--- -- do-- ----
07	Files	Flat, round, half round, triangular, et C.	Fo filing the job.
08	Drill machine	Hand driven and electrically operated	To make holesin wooden or iron job.
09	Spanners	Flat, double end, adjustable, box type, wrenches	To open or tighten the nut bolts
10	Centre punch	-----	For marking on the job
11	Tennon saw	250, 400 mm	To cut the wooden job
12	Hack saw	Fixed, adjustable	To cut the iron job
13	Steel foot	15,30 cm	For measurements
14	Try square	150,300 mm	To shape the job with proper angle.
15	Electrician knife	---------	Splicing of insulation, etc.
16	Soldering iron	25,40,65,125 watts	For soldering purpose
17	Standard wire gauge	-----	To measure the size of wires, etc.
18	Micrometer	-----	To measure thickness, diameter, etc accurately
19	Vice	Pipe vice, bench vice	To hold the job tightly
20	Tachometer	------	To measure the speed of the machine

Chapter 02

Name, Locations and size of the Major TL/AC equipments.

Lesson -1 Train lighting Belts

Sub-lesson - 1 Type of Belts, Number and Life

Mainly the belts used in Railways are of two types. Flat belts and V belts.

1. **Flat belt:-** Flat belt is used for underframe mounted alternators. In thistype alignment of axle pulley and alternator pulley is disturbed at the curvatures \ due which belts are broken or slipped away from the pulleys.
   Size used - length- 4.11 m and width- 4 inches.

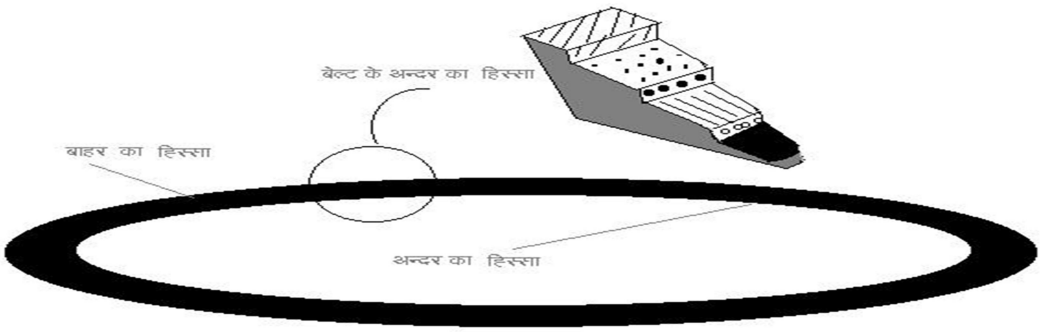
2. **V Belt -** V belts are used for Bogie Transom mounted brushlessalternators. Alignment of axle pulley and alternator pulley does not disturb at any time with yhis arrangement. Thus belt remains in position.

Belt size C122. In non AC coach 4 belts are required, and in AC coach 6+6 = 12 belts are required for each alternator.
Storage life of the belt is 2 years.

Sub-lesson - 2 Grading of V belts and its use.

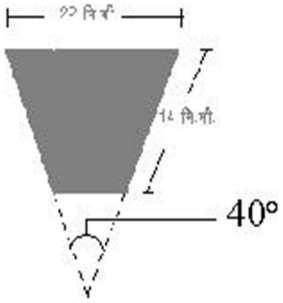
Belt having accurate specified length is given grade number 50. For more length than the specified grade number 51, 52 is given, where as for smaller length grade number as 49, 48 is given. There is a difference of 2.5 mm between two grades.

Figure-



Sub-lesson-3 **Belt, measurements and alignment.**

Alignment of alternator pulley and axle pulley should be accurate, however tolerance of 5 mm per metre is allowed.



Belt size-- C-122
Width (W)= 22 mm
Thickness(T)= 14 mmú
Belt gradeü- 50

Sub-lesson- 4 **Types of pulleys, power transmission.**

Two sizes of V belt pulleys are in use-

1. Axle pulley - 525 mm for non AC coach.
   - 572.6 mm for AC coach.
2. Alternator pulley - 175 mm for non AC coach.
   - 200 mm for AC coach.

Lesson - 2 Generating equipments.

Sub-lesson - 1 **Type, capacity, Ratings and working.**

In train lighting when train moves its axle rotates thus through axle pulley, alternator pulley and V belts mechanical power is transmitted to alternator. Brushless alternator converts mechanical energy in to electrical energy. Three phase AC supply is taken to rectifier regulating unit (RRU) where it is converted from AC to 110 Volts constant DC supply. This is used to charge the batteries and also fed to the coach lights and fans. Capacity of Alternator-

1. For MG/NG - 3 KW= 30 volts x 100 ampere = 3000 Wü
2. For non AC coach - 4.5KW= 120 voltsü x37.5 ampere=4500W
3. For AC 2 T coach - 18 KW= 135 voltsü x 133 ampere= 18000W
6. For AC 3 T coachü - 25 KW= 130 voltsx 193 ampere = 25000W

Power increases with current and voltage.

Working- when train is in motion alternator generates sufficient power/voltage to charge the battery feed lights, fans, etc. in the coach. Alternator generates 3 phase supply which is controlled and converted in to DC by RRU feed to load as per demand.

Sub-lesson - 2 Function of Rectifier Regulator unit.

Every alternator is provided with RRU and its functions are-

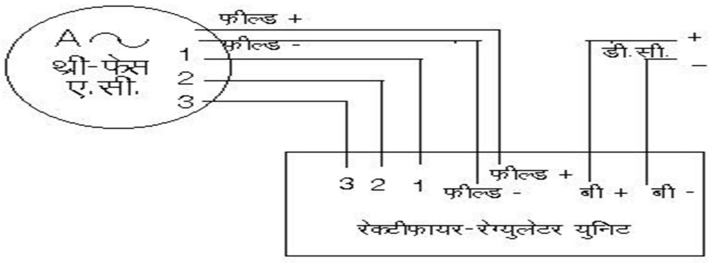
1. To convert AC current in to DC and feed to field winding to strengthen the magnetic fieldto get desired output voltage.
2. To convert 3 phase AC supply into DC to charge battery and to feed to the load.
3. To control the voltage according to setting.
4. To control the current according to setting.
5. To prevent reverse flow of current from battery to alternator.

Working principle of RRU- As per the speed of the train current of thefield coil varies. When speed of the train increases current of the field is controlled (reduced) and it do not alow the voltage to increase and vice versa. Thus the output voltage is kept constant at variable speeds.

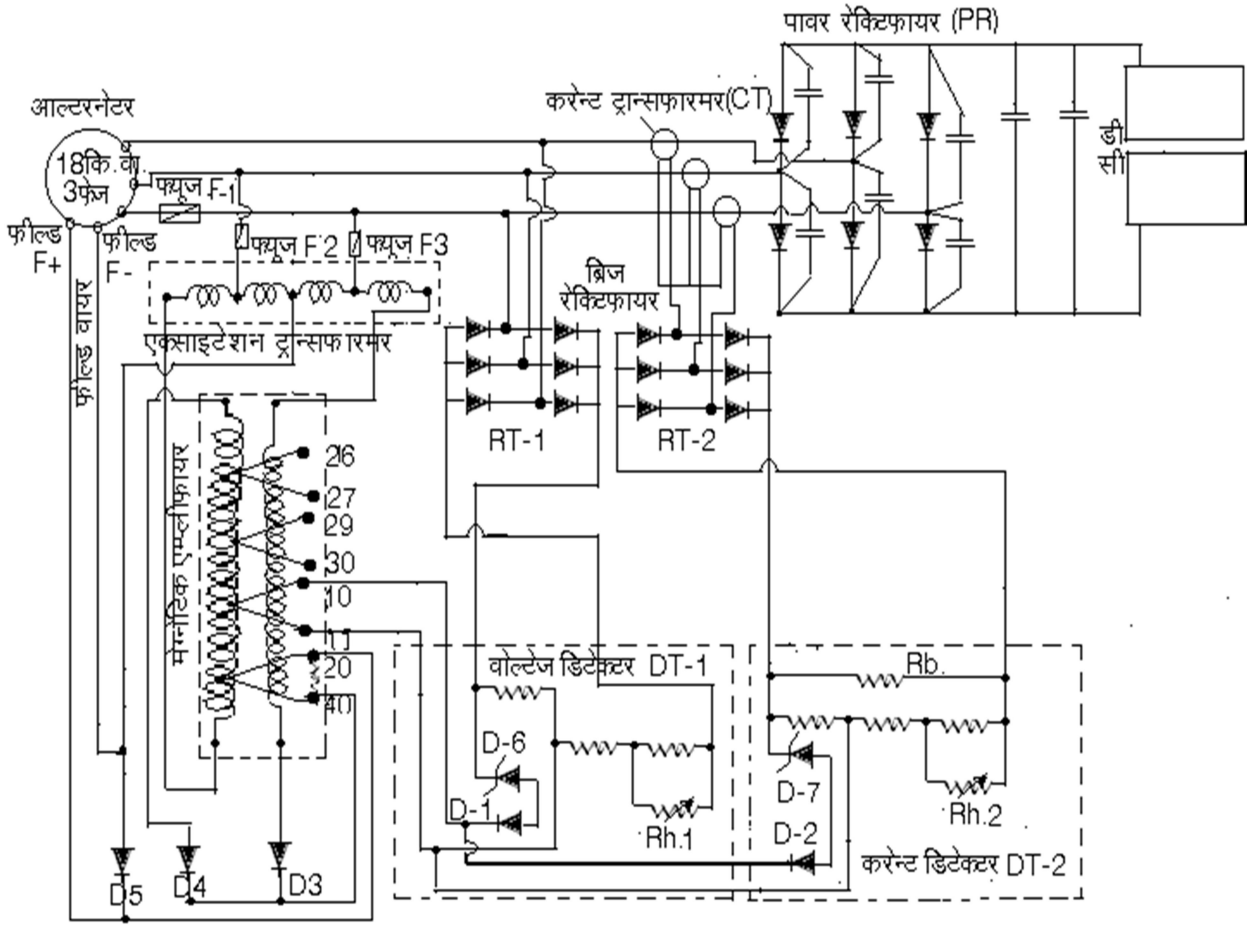
When the train is running rotor of the alternator rotates. Rotor has teeths and slots. When it rotates due to teeth and slots air gap between stator and rotor chages continuously due which the reluctance varies.

Due to rate of change of flux linkage EMF is induced in the main winding. This voltage is coverted into DC and applied to field winding through excitation transformer, magnetic amplifier, field diodes and field is strengthened. In turn the output AC voltage also increased up to the set limit. Then thrugh voltage detector magnetic amplifier gets control current. The impeadence of the MA increases and current is reduced which is in the series with the field coils thus output voltage reduces and vice versa. The process is continuous and contrls output votage to set standard.

Wiring diagram of rectifier regulating unit-



Circuit diagram of 18 KW brushless alternators RRU-



Description of various equipments used in 18 KW RRU-

Fuse F1- 120 amperes,Fuse F2 and F3 field fuse- 6 amperes,ü
Current transformers (CT-1,CT-2,CT-3),
Power rectifiers(PR) – 800 volts, 150 ampere,
Field diodesü (D-3, D-4) - 800 volts, 12 amperes,
Blocking diodes (D-1, D-2) - 1000 volts, 1 ampere,
Voltage detectorü (DT-1), Current detector (DT-2),
Rheostats (Rh-1, Rh-2) - 1 Kilo-ohms, 25 watts,
Capacitor (C-1) - 0.25 mfd,ü 600 volts, (C-2) -10 mfdü,250 volts,
Capacitor (C-3) -10 pieco-farad, 500 volts,
Bridge rectifier (RT1) for Voltage detector (DT-1),
Bridge rectifier (RT2) for Current detector (DT-2),
Surge protection diodeü (D-5) - 800 volts,12 amperes,
Zener diode for voltage detector (DT-1) - 100 volts, 10 watts,
Zener diode for current detectorü (DT-2) ü- 27 volts, 10 watts,
Burden resistance (Rb) - 220 ohms, 14 watts.

Lesson - 3 Battery

Sub-lesson - 1 Type of battery,working and capacity.

In self generation coach when train is at hault or running below cut in speed of alternator, battery supplies the electricity to lights, fans, etc. In all SG coaches Lead Acid cells are used.These are of two types-

1. Flooded type or normal Lead acid cell.
2. Valve regulated lead acid cell. (VRLA) or sealed maintenance free lead acid cell. (SMF)

Capacity- capacity of the cell is measured in ampere-hours.

SrNo	Type of coach	Type of battery	Capacity
01	24 volts DC	Lead acid single set 12 cell	320 AH
02	110 volts DC Non AC	i.Monoblock cell(18X6 voltü) ii.VRLA/SMF 54X2 voltü Alternatorü 4.5 KW	120 AH 120 AH
03	110 volt DC AC 2 T	Lead acid cell 56X2 volt Alternator- 18 KW	800 AH
04	AC2T/AC3T RMPU	VRLA 54 or 56 cell X 2 volt Alternator 25 KW	1100 AH

Sub-lesson- 2 Charging and discharging of Battery

When train speed is more than cut-in speed of alternator the supply to battery charging is from alternator through RRU. At the time of maintenance on pit line it is charged through external battery charger.

In AC coach 3 phase 415 volts AC battery charger of 200 ampere out put capacity is provide D. The battery charging and precooling is done through this charger.

Sub-lesson- 3 Electronic equipments.

In SG AC coach 200 ampere capacity battery charger is provided. Input of charger is 3 phase AC 415 volts through step down transformer and rectifier voltage is converted to output of 104-140 volts DC.

In Roof Mounted Package Unit 110 volt DC input supply received from alternator / Battery is converted in to 415 volts 3 phase AC by Invertor of 25 KVA capacity. In every RMPU coach two invertors for NPP side and PP side are provided.

Sub-lesson -4 Lights, Fans load calculation.

Presently in 110 Volt coach 40 Watt and 25 Watt lamps and 20 Watt FL tube are provided. Calculation of load is done as follows-

SrN	Item	watts	Total No	Total wattage	Load in amperes
01	Lights	40	16	640	640/110 =5.8 amps
02	Door, gallary	25	06	150	150/110 =1.36 amps
03	Lavatory	25	04	100	100/110 = 0.907 amps
04	Gallary	25	02	50	50/110 =0.45 amps
05	Fixed fans	38	18	684	684/110 = 6.22 amps
06	Reading lamps	15	02	30	30/110 =0.27 amps
				Total load	17.34 amps

Sub-lesson - 5 Protection of wiring, fuse, anti-theft measures.

In coach wiring Poly Vinyl Chloride (PVC) isulated wire are used.
Sizes of wires:-

For ligts and fans wiring - 4 mm^2

From junction box to cut-out -16 mm^2
In underframe - 35 mm^2

Battery to regulator - 50 mm^2

In under-frame wires are placed in the metal/steel conduits, however in the roof these are placed in the PVC conduits. Measures taken to prevent fire and short circuits:-

1. In the coach in place of open rewirable fuses High rupturing capacity fuses (HRC) are provided.

2. In place of rotary switches Miniature circuit breakers (MCB) are used.

3. Negative and positive wires are run separatetly in the roof and fuses are provided on both side for every appliance.

Measures Taken for prevention of theft-

1. Train lighting voltage is different than domestic voltage.
2. Special locking system is provided for light fittings.
3. Conduits are used for wiring.
4. Safety rod with double nuts is provided for battery box.
5. Tmbler switches are used without covers.

Lesson - 4 AC Equipments.

Sub-lesson - 1 AC Equipments and principle of refrigeration.

Refrigeration- It is the process in which the heat from any place,substance, air is extracted and the temperature of that place, substance, air, etc is brought down. For this the vapour compression system is used.

Principle-

1. Heat always flows from higher temperature to lower temperature.

2. Temperature of the gas is decreased with decrease in pressure and it increases with increase in pressure.

For any substance amount of heat required to change its state from liquid to gas or liquid to solid and vice-versa at constant temperature. This is called latent heat.

Sub-lesson - 2 AC coach, refrigeration cycle.

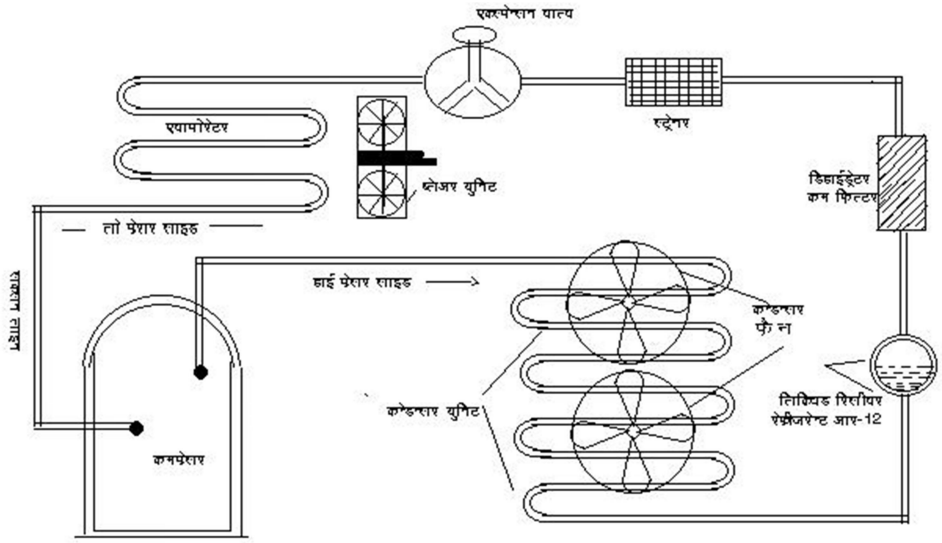
1. Capilary is used with sealed compressors.
2. Thermostatic expansion valve is used with open type compressor.

Main parts of conventional type AC coach.

1. Open type compressor.
2. condessor unit.
3. Liquid receiver.
4. Dehydrator cum filter.
5. Strainer.
6. Expanssion valve.
7. evaporator.

All parts connected with copper tube to form refrigeration cicuit.
F12 or F22 refrigerant gas is used in these coaches.

Conventional AC coach refrigeration cycle diagram-



Sub-lesson - 3 **<u>Description of refrigeration cycle.</u>**

1. Compressor sucks the refrigerant gas from evaporator through suction line. This low temperature low pressure vapour is compressed and thus high pressure gas is discharged towards condenser through discharge line. As the pressure of the gas is increased its temperature also increases.

2. The high pressure high temperature gas is cooled down in condenser and it changes its state from gaseous to liquid.The latent heat is extracted and rejected in atmosphere. From condenser liquid refrigerant is passed to liquid receiver.

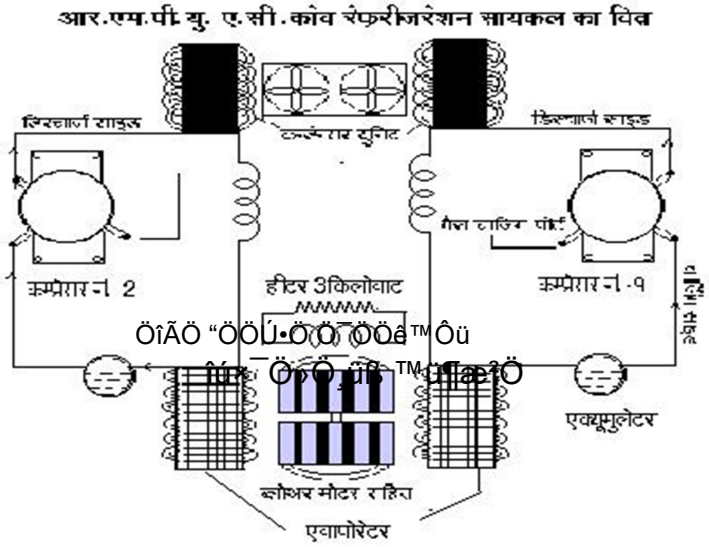
3. From liquid receiver it passes through dehydrator cum filter where moisture content if any is removed and it is filtered.

4. when refrigerant liquid is passed through strainer imurities are cleared and pure high pressure liquid refrigerant is passed through expansion valve.

5. Thermostatic expansion valve controls the flow of refrigerant to evaporator according to the load. When it passes through the pressure of refrigerant drops and its boiling point reaches. Thus while passing through eavaporator coil it absorbs heat from the surrounding air and the air is cooled. Liquid refrigerant absorbs latent heat and changes its state from liquid to gas while

leaving the evaporator. This cooled air (conditioned air) is passed to AC coach via ducts, and through suitable grills it is thrown in the compartments. Thus the cycle repeated and coach is cooled down.

Refrigeration cycle diagram of RMPU coach-



Description of one side (one plant) of the RMPU coach-

i) Compressor 3.5 ton - 2 Nos

ii) Condenssor motor 1.0 HP - 2 Nos
iii) Blower motor 1.5 HP - 1 No
iv) Heater 3 KW - 1 No
v) Refrigerant R22 - 2 x 2.8 Kg = 5.6 Kg
vi) Invertor 110 V DC to 415 V 3 phase AC, 25 KW - 1 No
vii) Alternator ü-25 KW - 2 for complete coach

Sub-lesson - 4 **<u>Pressure cut-out</u>**

Low pressure cut-out - This cutout is provided in the suction line. It is setto operate on 10 psi. Thus when suction pressure droped below 10 psi this cutout operates and breaks the supply of no volt coil of contactor of compressor and the compressor stops working. If the suction pressure is increased to 30 psi it switch on the compressor.

High pressure cut-out - If discharge pressure of the system is increasedbeyond desired pressure then this cutout disconnects the supply of compressor motor. If the pressure is reduced to normal its cutout is reset manually and then plant can work again.

Setting is done at 240 to 250 psi.

Oil pressure cut-out- It operates when the lubrication oil pressure of thesystem falls below the desired value. And disconnect the supply of the compressor. When desired pressure is reached it shoud be reset and then plant can work. The setting of this cut-out is 25 psi. All these cut-outs are provided for the safety of the plant.

Sub-lesson - 5 **Electric motors, Electronic material.**

In conventional AC coach following motors are used -

1. Compressor motor 110 volts DC,10/12.5 HP one each on both side.
2. Condensor motor 110 volts, 1 HP two each on both side.
3. Blower motor 110ü volts, 0.75 HPü/0.65 HP one each on both sides.
4. Heater 6 KW single unit one each on both sides.

In RMPU AC coach all motors are 3 phase-

1. Hermetically sealed compressor 2 x 3.5 ton on each side. 5250/5000 watts 3 phase 415 volts each.
2. Condensor fan motor 2 x 1 HP on each side.
3. Blower motor 1.5 HP, 3 phase, 415 volts.
4. Invertor/convertor 110 volts DC,415 volts, 3 phase AC, 25 KVA one on each side.

5. Heater2 x 3 kw on each side.

Unit of heat.

1. **BTU-** The amount of heat required to raise or lower the temperature of one pound of water by one degree fareinheit is called one british thermal unit (BTU).

2. **Kilo-calorie-** The amount of heat required to raise or lower thetemperature Of one kilogram of water by one degree centigrade is called one kilo-calorie.

3. **Ton of refrigeration-** Generally the capacity of refrigeration plant is expressed in ton of refrigeration. The amount of heat required to To convert one ton of ice (2000 lb) of 32^0F to te water of same temperature in 24 hours is known as one ton of refrigeration. The amount of heat required per pound is 144 BTU.

   Therefore for 2000 lb total heat required will be = 144x2000 BTU In 24 hours.

   Per hour heat required will be = $\frac{144x2000}{24}$
   = 12000 BTU/Hr.
   Hence 12000 BTU/Hr = 1 Ton of refrigeration.

Note - Heat load of one person in AC coach is taken as 400 BTU/Hr.

Sub-lesson - 6 **Window AC, split AC, Central AC**

In all above appliances mechanical vapour compression system is Used.

1. **Window AC**- In this system compressor, condenser, evaporator,capillary,et C. is accommodated in a compact space as a one unit. These are very compact and easy to install. These are installed in a window of suitable size and thus called window AC. These are readily available from 4.5 ton to 2 tons. Generally for airconditioning of small rooms.

2. **Split AC-** In this type compressor and condenser unit is kept out side ofthe room at desired place. Only evaporator unit is installed inside the room. Due this the maintenance can be done easily from outside. The noise level is also vely less.
3. **Central AC -** This system is used for the air conditioning of the bigbuildings, halls,etc. Separate room is required to install this system. All the refrigeration equipments are installed in this room and cold air (conditioned air) is taken

different parts of building through duct line and it is distributed through grills and diffusers. In chilled water system first water is chilled instead of air and it is taken to various parts of the building. The air is blown on the coils of chilled water and air gets cooled.

Sub-lesson - 7 **Water cooler**

In water coolers sealed compressors are used. Condenser, evaporator, capillary is installed in one frame. The storage water tank is surrounded by the evaporator coils. Thus refrigerant takes heat from this water for vaporization resulting in to cooling of the water in the tank. Thermostat is provided for automatic operation of the unit. The temperature is set at 15 degree centigrade. Hence when this desired temperature is reached supply of water cooler is cut-off by the thermostat and the temperature is maintained.

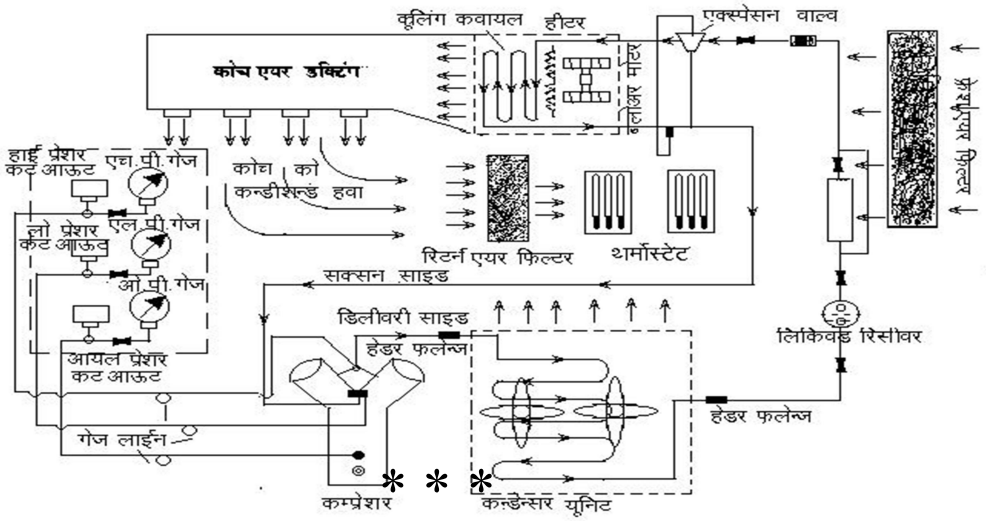
Sub-lesson - 8 **AC Roof Mounted Package Unit**

Equipments - In RMPU of AC coach there are two of alternators of 25 kwcapacity. Valve regulated lead acid battery (VRLA) of 1100 Ampere-hour capacity is used. It is also called sealed maintenance free battery.

Precooling unit/battery charger capacity is 200 amperes :-

Input	- 415 volts 3 phase AC
output	- 110 / 140 volts DC
Invertor-	
capacity	- 25 KVA X 2
Input	- 110 volts DC
Output	- 415 volts 3 phase AC
Heater	- 3 kw two nos on each side.
Sealed Compressorü	- 5250 watts each 2 nos on both sides
Condensor motorü	- 1 HP 2 nos on both sides.ü
Blower motor	- 1.5 HP one on both side.ü
Thermostat-	
Setting in summer	- 22,24, and 26 degree centigrade. Setting
in winter	- 17,19 and 21 degree centigrade.
Refrigerant gas	- R22, 2.8 Kg per compressor.Total gas in a coach 2.8 X 4 = 11.2 Kg Approx.

Diagram of Air flow inside the AC coach-



Chapter :- 03

Train lighting AC equipments, Tolarence.

Lesson -1 Train lighting AC equipments, Tolarence.

Sub-lesson -1 Maintenance of coach, pulleys.

While fitting the axle pulley and alternator pulley the alignment should be proper so that the life of belt and pulleys is enhanced.

1. The distance between axle centre, pulley centre and wheel hub is fixed as follows-

IRS ICF BEML	Axle centre to pulley centre = 514 mm. From side of the pulley to wheel hub = 129 mm.

2. Both parts of the axle pulley should be matched properly. Marking should be done so that it is not mismatched.

3. Proper size of nut bolts should be used.
   The gap between two parts of the pulley should be 4.5 to 1.5 mm.

4. White paint mark should be provided on both side of the pulley after tighting it properly.

5. Pulley should be tightened at 30 Kg-metre torque.

Sub-lesson - 2 Problems in V belts and its solution.

1. Uneven tession in belts - During replacement of V belts it should be ensured that all belts are of same company and same grade. If the same grade belts are not available one grade difference is allowed.
   Belt tension should be adjusted with the help of tension rod.
2. New and old belts should not be mixed.

3. There can be a overload due to twisting of belt, or misalignment, or any manufacturing defect. If belt is twisted then it should be put right immediately. Ensure that there is no manufacturing defects.
4. Tighting of pulley and defects- The reasons are-
   a. Nut bolts are not matching.
   b. Procedure of fitting is wrong.
   c. Alignment is not proper.
   d. Wrong storage procedure.

   Avoid all the problems mentioned above.

Sub-lesson - 3 Belt cutting, belt tensioning.

For flat belts-

1. Always cut with the help of cutting machine. Ensure that both ends are cut squarely and 90 degree angle.
2. Fastners should be fixed at 25 mm from the edges.

Belt tension- for flat belts-

1. Belt tension of all the belts should be same.

2. After the belts are tightened alternator angle should be 40 to 45 degree.

Belt tension for 75 mm belts should be 75 kg and for 100 mm belts it should be 130 kg.

Lesson - 2 Generating equipments.

Sub-lesson-1 Alternator and regulator

Brushless alternator output is three phase AC which is feed to the RRU where it is converted from AC to DC (rectified) and regulated. Out put of RRU is used for battery charging, lights, fans, etc.
Alternator out put setting is as below-

1. Charging voltage per cell should should not be more than 2.3 volts.
2. For flooded type lead acid 54 cell regulator voltage setting should be 124.2 volts.
3. For 56 cells it should be 128.8 volts maximum.
4. For VRLA 56 cells - M/E.126 0.5 volts,ü S/F125 ü 0.5 volts.
5. For VRLA 54 cells - P. 123 0.5 volts, M/E.122 0.5 volts.

S/F.120 0.5 volts.

This is as per SMI - RDSO/PE/TL/VRLA.0024-2003 (Rev.0)

Sub-lesson - 2 Maintenance, Rectification of defects.

1. Check the tightness of axle pulley by striking hammer. Check the availability of checknut, bolts, split pin, etc. If defective replace /repair the same.
2. If belts are loose retighten it and if it is broken/cut replace.

Maintenance of Alternator

1. Clean the surface by compressed air.
2. Check suspension pin, bush, nut bolts, safety chain, etc.
3. Check connections of output terminals. If it is loose or broken attend and put right reconnect.
4. Check the flexible pipe fitting.
5. Fix the terminal box cover properly. If it is missing provide new to avoid dust, dirt diposition on the terminals.
6. Check for overheating, loose connection, etc. and if found so.

Common defects-

1. No generation or low generation.
2. No voltage control.

3. Current limit is less.

Sub-lesson - 3 **Reasons for no generation**

a. Loss of residual magnetism. Field is flashed with DC supply.
b. Field coils are open circuited or burnt. Check with multimeter and attend.
c. Short circuit, open circuit, or earth fault in main winding. Check with multimeter and attend.
d. Check belt tension. Tighten if required.

Defects in rectifier regulating unit-

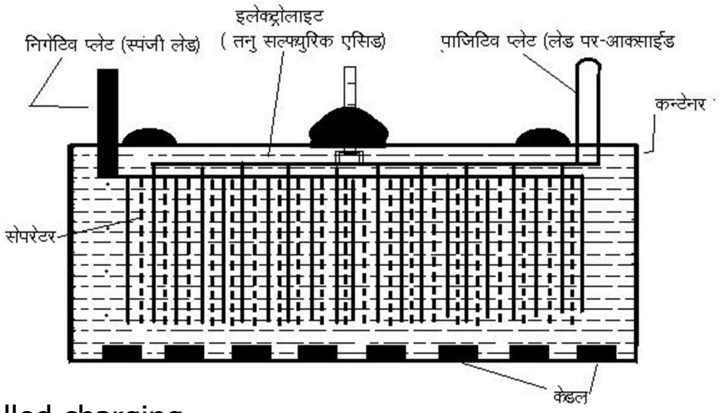
1. F -1 and / or F -2 field fuse blown.
2. Free wheeling diode is short.
3. Open circuit in field rectifier.
4. Main fuse blown.
5. Main power diode defective.
6. Voltage detector (DT) is defective.
7. Current detector is defective.
8. Defects in magnetic amplifier or field transformer.
9. Any other misclleneous fault.

Lesson - 3 Battery

Sub-lesson -1 Charging, discharging, and its types.

Charging- When battery is connected to DC supply (Battery charger) it draws the current due to which chemical action takes place and the electrical energy is stored in the battery in the form of chemical energy.

Construction of lead acid cell



This process is called charging.
Chemical action-

$$Pb + 2H_2SO_4 + PbO_2$$
_ ve plate electrolyte + ve plate

Discharging- When train is at hault or running at less than cut in speedof alternator battery supplies current to the lights, fans, etc. changing chemical energy in to electrical energy. The energy stored in battery gets reduced. This process is called discharging. Chemical action-

PbSO4
_ ve plate + 2 H2O + PbSO4
water + ve plate

Types of charging-

a. Normal charging.
b. Boost charging.
c. Trickle charging.
d. Float charging.
e. Initial charging.

1. **Normal charging-** In this method charging is done by current at therate of 10% of AH capacity of the cell for 10 hours.

Example-

For 120 AH cell charging current =120x10/100 = 12 amp. i.e cell is charged at 12 ampere rate for 10 hours. 0r for the 110 volts battery charging voltage of 120- 125 volts is applied.

2. **Boost charging-** In this method charging is done by current at the rateof double the nomal charging current i.e. 20% of AH capacity of the cell for 5 hours.

Example-

For 120 AH cell charging current =120x20/100 = 24 amp. i.e cell is charged at 24 ampere rate for 5 hours.

It should be ensured that temperature of cell does not go beyond 45 C - 49C.

3. **Trickle charging-** If charged cell is kept idle for more than 15 days itshould be charged at the rate of one third of the nomal charging current. This is called trickle charging.

4. **Float charging-** in this method the charged cell is kept connected with the same charging voltage source. Thus the cell is always fully charged. Generally the cell is charged by constant voltage method.

5. **Initial charging-** For initial charging very low current is applied.

Charging current for 120 AH cell =120/80 =1.5 ampere for 80 hours.

Sub-lesson- 2 **<u>Precautions while working on battery.</u>**

1. Do not allow any flame near battery.
2. Battery room should be airy, and well ventilated.
3. Do not spill electrolyte any where.
4. Prevent battery from damages.
5. Use safety goggle, hand gloves,etc while working.

Probable defects in battery-

1. Container broken - Wrong packing.

2. Internal short circuit - over heating, overcharging, sedimentation.
3. Sulphation - keeping battery in discharged condition for longer duration.
4. Reverse polarity - over discharge, reverse charge.
5. Buckling - wrong storage,abnormal temperature rise.
6. De-coloration - Distilled water is not topped up.

Colour of positive plate after charging is brown, and negative plate is slaty.

Important points in cell maintenance-

1. Keep the cell dry, clean and in airy room away from sunlight.
2. Top up the cell time to time to maintain proper electrolyte level.
3. Charge the battery immediately when it is discharged.
4. Apply petroleum jelly to the terminals of the cell to prevent corrosion.
5. charging voltage per cell should not be more than 2.3 volts per cell. For VRLA cells it should be 2.25 volts per cell.
6. During charging temperature should not go beyond 45C.

Sub-lesson -3 <u>Procedure of preparing electrolyte</u>.

1. Use sulphuric acid of 1840 spg.
2. Fill the jar with the distilled water first and then slowly add suphuric acid with continuous stirring.
3. Electrolite should be prepared in glass or plastic tank/container. Ratio of acid and distilled water shall be 1:4 and spg 1190-1200. Allow to cool the electrolyte.

<u>Filling of electrolyte in the cell-</u>

1. first clean the cell.
2. open the vent plug and fill the electrolyte in the with the help of funnel. Check the float level.
3. replace the vent plug and check level after 10-15 hours. If the the level is not proper top up the cell with electrolyte.

Sub-lesson - 4 <u>Distilled water plant.</u>

1. De-mineralising water plant.
2. Solar distilled water plant.

Lesson - 4 Circuits and devices.

Sub-lesson -1 Lights, fans, and safety items maintenance.

1. Clean bulb globe, tube light covers and replace if broken.
2. Replace /repair defective berth lights.
3. Attend side lamp, tail lamp, etc of SLR.
4. Clean the tube light fittings.
5. Check all fans smooth working. Check fuses, mcb, switches, regulator, etc.
6. Check fans blades,
7. Check carbon brush, spring, etc.
8. If fan is noisy check bearings, blade, jaali and repair it.
9. Check the movement of the moving fan.
10. Check all lights for proper working.
11. If bulbs are fused, replace.
12. Check the switches and put right.
13. Check the cut-out fuses.
14. Check the lamp holder.
15. Check wiring circuits.

Sub-lesson - 2 Protection of circuit from fire.

1. Fuses are provided for protection of lights and fans circuits-
   a. Use 16 amperes HRC fuse for L_1,L_2 and fan circuit in junction box.
   b. Main negative fuse of 35 amperes HRC or 20 SWG.
   c. Branch fuses of 35 SWG shall be used.
   d. For sockets use 16 amperes HRC or 22 SWG fuse.

2. Now a days MCB is used in place of rotary switches which provides protection against overloads and short circuits.

3. PVC conduit is used for coach wiring and positive and negative wires on saperate sides.

Lesson- 5 AC equipments.

Sub-lesson -1 Schedule maintenance.

a. Daily.
b. Weekly.
c. Monthly.

Sub-lesson -2 AC coach schedule maintenance.

1. Trip schedule.
2. Monthly schedule.
3. Quarterly schedule.
4. Annual schedule.

Sub-lesson-3 Trouble shooting of AC equipments.

Reasons for high discharge pressure-

I. Condensor fan not working.
II. Condensor dirty or jamm.
III. Compressor valve is partially opened.
IV. More gas charged.
V. Presence of air in the system.
VI. Atmospheric temperature is more.

Reasons for low discharge

a. Less gas charged.
b. Compressor cylinder not loading.
c. Speed of compressor motor is low.
d. Compressor valve reeds faulty.
e. Suction pressure is low.

Reasons for low suction pressure-

a. Less gas in the system.
b. Expanssion valva setting is not proper.
c. System chocked.
d. Air filter is dirty.
e. Evaporator chocked or dirty.

f. Blower not working or speed is low.
g. Compressor cylinder not unloading.

Compressor sweating-

1. Expanssion valve setting is not proper.
2. Thermal bulb of expansion valve is dislocated from suction line.
3. Blower not working or speed is low.
4. Air filter is chocked up.
5. Suction pressure is low. Liquid is coming to compressure.
6. ore lub oil is circulated.

Cooling is more-

I. Thermostat is defective.
II. Thermostat is bye-passed.
III. Compressor motor contact is welded.

Sub-lesson - 4 **Reasons for low cooling in the coach.**

a. Thermostat defective.
b. less gas in the system.
c. System is chocked.
d. Air filter is dirty.
e. Blower motor not working, or low speed.
f. Condensor fan not working or condenser is dirty.
g. Atmospheric temperature is high.
h. Compressor cylinders not loading.
i. Copressor otor speed is low or reeds are leaking.

* * *

Chapter 04

TL/AC equipments.

Lesson -1 Testing, erection, and commissioning.

Sub-lesson -1 Testing of alternator.

a. No load test.
b. Load test.
c. Temperature rise test.
d. Insulation resistance test.

No load test- For 25 and 18 KW alternator base load is taken as 10ampere battery or resistance. This test is carried out running alternator from 400 to 2500 rpm spee D. At various speeds the variation in the voltage shall not be more than 5%. Setting is done by potentiometer. Alternator should generate cut in voltage at 400 rpm.

18 or 25 KW - 400 to 2500 RPM, base load 10 ampere.
4.5 KW - 357 to 2500 RPM, base load 10 ampere.

At 357 RPM 110 volts shall be generated and variation should not be more than 5%.

Load test-For 18/ 25/ 22.75 KW alternator on half loa D.Full load of 25 KW is 193 amperes, i.e. half load is 97 ampere.97 amp battery load or resistance and speed from 400 to 2500 RPM. During testing at 100 rpm the variation should not be more than 4%. At 800 rpm full output shall begenerated. Setting is done at 1500 rpm and 97 amp load.

Testing is done on

19 amperes i.e. half load.

Testing speed 600 to 2500 rpm.

Variation not more than 5%.

Voltage setting is done at 19 amp and 1500

a) For VRLA cells - 122 volts (for 54 cells)

-126 volts (for 56 cells)

f) for ordinary cells -124 volts (for 54 cells) -
128 volts (for 56 cells)

Temperature rise test-

Testing speed- 2500 rpm.

Full load - 133 ampere 18 KW.

iv) 175 ampere 22.75 KW.
v) 193 ampere 25 KW.

Testing duration- 5 hrs	**Max.temperature**
Alternator terminals	100 C
Power diodes	100 C
Bearings	100 C
Stator and field winding	90 C

For 4.5 KW full load 37.5 amp. And speed 2500 rpm.

Duration -	5 hrs.
Alternator terminals	100 C
Power diodes	100 C
Bearings	35 C (above ambient)
Stator and field winding	90 C

Insulation resistance test-

Insulation resistance is measured with 500 volts megger-

	AC coach alternator - 18 /25 KW	Non AC -4.5 KW
1. Between stator and body	- 20 Mega ohm	- 01 Mega ohm
2. Between field wdg & earth	- 20 Mega ohm	- 01 Mega ohm
3. Between stator and field	- 20 Mega ohm	- 01 Mega ohm
4. Between RRU terminals (all shorted) and body	- 10 Mega ohm	- 01 Mega ohm

Sub-lesson - 2 **Safety devices testing.**

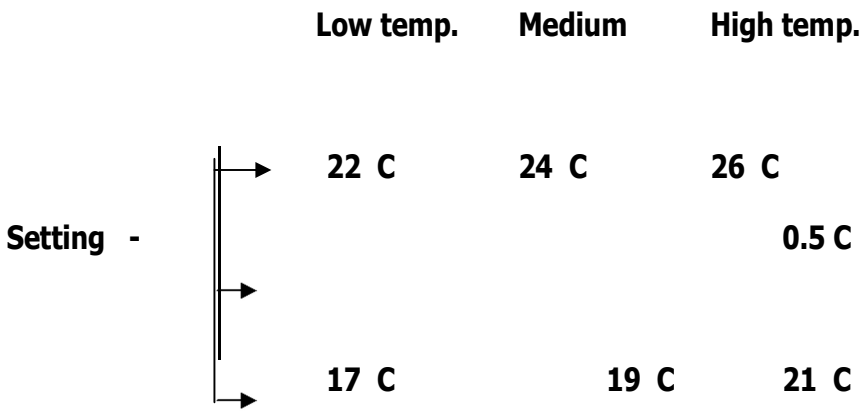
Low pressure cut-out-

Close te expansion valve and run the compressor.Check pressure in the LP gauge. At 10 psi plant should cut-off.Now open the expansion valve and check the LP gauge. When the pressure increase to 30 psi plant should cut-in.

High pressure cut-out-

Remove the condenser fuse and switch on theplant. Discharge pressure will go on increasing. When it reaches 240-250 psi the plant should trip. Variation should not be more than 5%.

Thermostat setting-



Check the return air temperature. Plant should cut-in cut-off at 0.5 C of thermostat setting.

Vane realay- Plant should not operate unless the blower is working anddelivering sufficient air. To monitor this vane relay is provided. It is the relay operating on air pressure.

When suction of blower is closed by some means, then vane relay position changes. It disconnects the further control circuit supply. Likewise all the safety devices i.e. hooter, overload relay, single phasing preventor should be tested.

Sub-lesson -3 **AC plant testing.**

Testing of AC plant is done as below-

General test.
Precooling test.
Pull down test.
Spare capacity test.

1. **General test-** Run the plant and ensure that-
   a. Discharge line is hot.
   b. Liquid line is warm.
   c. Suction line is cold.

2. **Precooling test -** Increase the temperature of the coach up to 45 Cwith the help of heater or higher capacity bulbs. Keep the fresh air filters closed during this test. Run the plant. Coach should be cooled in hour and plant should cut-off automatically.

3. **Pull down test-** Keep the fresh air filter open. Switch on all electricalload. Equivalent electrical load per passenger is taken as 120 watts. Load of person carrying out the test shall also be taken as 120 watts. Increasethe inside temperature of the coach up to 45 C.

   120 watts X 46 passengers = 5520 watts. Total load of aall passengers in AC2T coach. Switch on both the plants. Coach should be cooled within 2 hours and plant should cut-off.

4. **Spare capacity test-** The cut in time and cut off time of the plant isnoted. If in one hour cutt off time is 20 minutes and cut in time is 40 minutes then spare capacity is calculated as given below.

$$\text{Spare capacity} = \frac{\text{Total cut off time}}{\text{(Cut of time + cut in time)}} \times 100$$

If cut-of time in one hour is - 20 minutes

Cut-in time - 40 minutes.

Putting values-

Spare capacity = (20 / (20 +40)) x 100

= 2000 / 60 = 33.33 %

Thus more the spare capacity means cooling capacity of the plant is more.

Sub-lesson- 4 **Trouble shooting.**

No generation by alternator-

1. Loss of residual magnetism.
2. Field widing open circuit, short circuit, burnt.
3. Main winding open circuit, short circuit, burnt.
4. Defects in RRU like- main fuse or field fuse blown, voltage detector defective, current detector defective, free wheeling diode short, magnetic amplifier defective, excitation transformer defective, etc.

Low generation by alternator-

1. Loose V belts.
2. Voltage and current setting is not proper.

Over generation by alternator- Voltage detector of RRU defective.

Battery run down-

1. Alternator setting is not proper.
2. Reverse cell.
3. Cell short.
4. Defective cells.

Cell overheating-

a) Low electrolyte level in cells.
b) Alternator output voltage is high.
c) Cell short.

Frequent topping up required-

1. Cell ovr charge.
2. Alternator setting is not proper.

3. Charging voltage is more than 2.3 volts per cell.
4. Cell container is cracked and leaky.

Sub-lesson-5 Coach testing.

Proto test-

These are not carried out on all coaches. If 10 coaches are built in workshop it is carried out on only one coach.

Proto type tests are as follows-

1 Average illumination test.
2 Equal distribution of light.
3 Voltage drop test.
4 Joint heating test.
5 Insulation resistance test.
6 Water prof test.

Routine test-

These are carried out on all coaches-

1. Voltage drop test.
2. Joint heating test.
3. Insulation resistance test.
4. Alarm chain pulling system test.

AC coach testing program-

1. Refrigeration leak test.
2. Air flow test.
3. Commissioning test.
4. Super heat test.
5. Conditioning air leakage test.
6. Air delivery test.
7. Precooling test.
8. Pull down test.
9. Spare capacity test.
10. Safety device test i.e. LP,HP,OP testing.
11. Generation.

Sub-lesson- 6 **Coach builders.**

All tests shall be carried out in front of the customer engineer and certificate to be obtained likewise.

Sub-lesson-7 **Safety items.**

a) Alternator suspession pin. (link)
b) Axle pulley, pin.
c) Safety chain pins.
d) Battery box suspension system.
e) Circuit fuses and MCBs.
f) Fan guard. (Jaali)

* * *

Chapter 05

Lesson No. 1 Maintenance, code of practice, special maintenance Instruction

Sub-lesson -1 110 volts DC coach wiring.

Alternator 4.5 kw, Ampere Setting 37.5 A, Voltage setting 124 volts Monoblock battery (One monoblock cell 6 volts)18 Nos. -120 AH capacity VRLA 54 cells -120 AH

Light circuit - L1, L2, Fans - F, Socket - S

L1 (Emmergency Light) - when EFT connections are made to feed adjacent coach then L2 is kept off. Through L1 Night lamps, lavatory, corridor lights are swithed on.

Cable size-

i) 4 mm^2 7/0.85 = 10 Amps i.e. 7 strands of 0.85 mm. dia.

ii)16 mm^2 7/1.7 = 20 Amps i.e. 7 strands of 1.7 mm dia.

iii)35 mm^2 7/2.52 = 50 Amps i.e. 7 strands of 2.52 mm dia.

iv)50 mm^2 19/1.7 = Amps i.e. 19 strands of 1.7 mm dia.

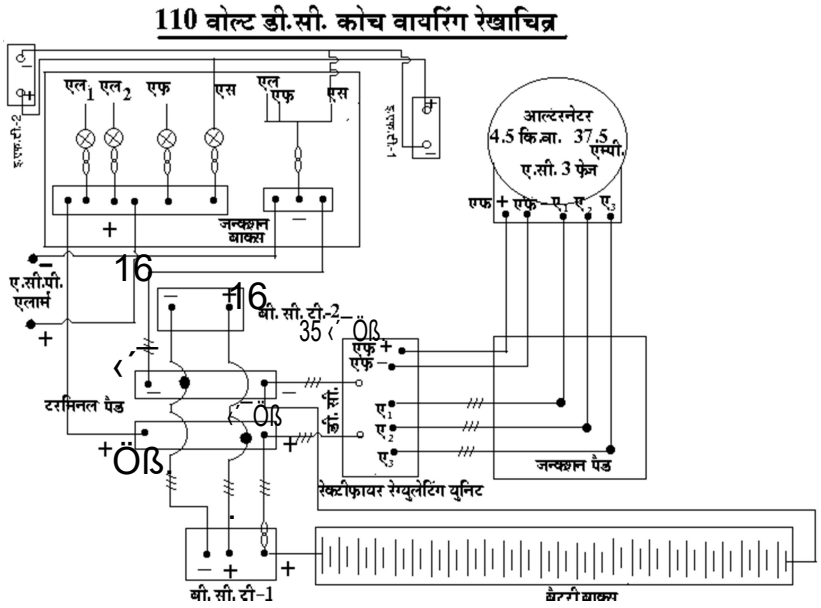
Symbol Size :-

4 × ´Ö.´Öß. 2

16 × ´Ö.´Öß 2

35 × ´Ö.´Öß.2

50 × ´Ö.´Öß 2.



लेड एसिड सेल मोनो ब्लाक 6 वोल्ट X 18 = 108 वोल्ट 120 एम्पीअर - आवर (AH.)

Color code-

3 phase AC - Gray

Fan+ - Red

Fan - - Black

Light + - Yellow

All other + - Red

All other - - Blue

Illumination level-

It is measured at From floor of the coach - 840 mm above.

From back of the seat - 500 mm horizontal.

First class compartment - 30 Lux (lumens per square metreü)

Second class compartment - 30 Lux

Parcel van - 40 Lux

Dining car - 30 Lux

Luggage compartment - 20 Lux

Coach with 20 w FL tube - 60 Lux

Corridor, toilet - 16 Lux

Lux - one lumen light faling on one square metre area is called one lux.

Voltage drop, tail voltage-

The voltage drop at the farthest point from the battery should not be more than 3 volts.

Example:If voltage at battery is 108 then 108-03 = 105 volts tail voltage.ü If voltage at battery is 106 then 106-03 = 103 voltsü

Fuse sizes table-

SrNo	Name of the circuit	Location	Size/capacity
01	Branch fuse	FDB	35Swg./ 6 Ampere
02	L1,L2,F & socket 1&2	Junction box	22Swg./16 Ampere
03	Main negative	Junction box	20Swg./35 Ampere
04	Battery fuse	Battery	20Swg./32 Ampere
05	Alternator/regulator	RRU	Main- 20Swg./32 Ampere Field- 35Swg./6 Ampere

Sub-lesson - 2 **Code of practice for prevention of Electrical fire.**

Causes of electrical fire- short circuit, loose connection, leakage,undersize cable, overload, oversize fuse, careless working, inferior quality of material, violation of rules.

Code of practice for prevention-

Air clearance- The clearance between current carrying cable terminals and coach body should be minimum10 mm, and between positive and negative terminals 4 mm. **(**Air gap between body and terminal)

Damage to insulation- cable insulation should not be spliced for testing purpose at any point other than terminals. PVC grommet or bushes shall be used between body as well as at crossings.

Insulation test shall be carried out by 500 volts megger and IR value should not be less than 2 mega-ohms.(minimum IR value in worst season not less than 1 mega-ohms)

Crimping- All terminals and joints should be crimped properly anddouble nut with spring washer should be used.

Re-wiring- Codal life of wiring is 12 years, hence re-wiring should be done after 12 years. IR value should be checked periodically. It should be replaced if found defective.
Coach wiring- PVC cables should be used in coach wiring. Steel conduit should be used in underframe and PVC conduit for roof wiring.

Insulation tape- Always use PVC adhesive tape for wire joints. Tape size 0.2,0.22,0.25 mm should be used.

Wooden cleats- wooden cleat or block should be seasoned and two coats of fire retardant paint (FRP) should be applied to it.

Guidelines for maintenance-

All loose wires should be tight properly. Switch on all lights and fans load and check all terminals for overheating. Check earth leakage. Check all fuses, they should be of proper size. Coach having positive leakage shal not be sent in service. Negative leakage coach should be attended after one trip any how.

After carrying out repairs in sick line the insulation resistance test should be done.

Sub-lesson- 3 Maintenance of lead acid cells

Maintenance of cells-

1. Trip maintenance
2. Fort-nightly maintenance
3. Quarterly maintenance(once in a three month)

1. **Trip maintenance-** On arrival of train all EFT connection should beremove D. Switch on all lights and fans and check the battery voltage. For 110 volts coach if voltage is less than 97 volts then battery is treated as discharge D. If specific gravity is less than 1180 mark the cell and put date. Floater shall be checked with hand, check electrolyte level and top up with distilled water if required. The work should be carried out after every trip.

2. **Fort nightly maintenance-** Clean sulphation, dust and dirt from thetop of the cell. Check voltage of every cell. If foud less than 1 volt compared to adjacent cell then the cell is condemned. Check spg and put on charging.

Spg correction at different temperatures-

Temp.	Specific gravity
10 °C	1210
15 °C	1210
30 °C	1200
40 °C	1190
50 °C	1180

1 °C ± 0.0007 ⎫ Refferance temperature 27 °C.

10 °C ± 0.007

Example-

17 °C	47° C
+ 1.200 S.P.G	+1.200
- .007	.014
1.193	1.214

At 27 °C temp Spg will be 1200

3. **Quarterly maintenance-** Equalising charge should be given to thebattery. Keep all the load off and charge the battery for 5 hours. After 2 hours note the voltage and SpG. Stop the charging when three to four consecutive readings are same. 15 minutes after charging if the voltage is less than 2.1 volts then this cell should be sent for repairs. Change the pilot cell numbers.

Sub-lesson- 4 **Do and Dont for V belts.**

Dos-

1. Belt grade should be same.(same length).
2. Belts should be stored in airy room and it should be dust free.
3. Belt tension should be proper. For 4.5 kw alternator 105 kg., for 12 kw 195 kg., and for 18/25 kw 330 kg (both side) $^{\pm}$ 5 kg difference is permissible.

4. Retighten the belts after one trip or 300 kms run.
5. Keep gap of 75 mm between supporting plate and fixing nut.
6. Alignment of axle pully and alternator pulley should be proper.
7. Replace defective pulley.
8. Difference in belt grades in special circumstances is permitted for not more than two grades.(48-52)

Donts-

1. Oil or greese should not stick up to belts.
2. Do not use different belt grades.
3. Do not mix old and new belts together.
4. Do not use different make belts together.
5. Do not keep belts loose.
6. Do not disturb tensioning device.
7. Do not use repaired pulley

Sub-lesson- 5 **Maintenance schedule of AC coach.**

a. Trip schedule
b. Monthly schedule
c. Quarterly schedule
d. Annual schedule.

Maintenance should be carried out as per instruction issued by RDSO.

Trip schedule- After every trip check and clean axle pulley, belts,alternator, condesor motor, compressor motor, blower motor, air filter, control panel, precoling unit, light, fans, etc.
Attend the defects mentioned in the log-book.

Monthly schedule- All items mentioned in trip schedule shall bechecked thoroughly. Replace defective parts.

Quarterly schedule- All defective machines should be replaced .Greesing of machines should be done. Replace compressor oil. Cary out IR test, air delivery test. Check anti vibration pads,painting,etc. POH of the coach is done after 4 lakh kms or 18 months whichever is earlier.

Sub-lesson-6 **Maintenance schedule of RMPU AC panel.**

Trip schedule-

1. Clean filter and panel with with compressed air.
2. Check safety devices. No safety device should be by-passe D.
3. Check indication lamps. Replace if defective.
4. Clean fresh air and return air filters.
5. Attend defects mentioned in log book.
6. Ensure proper working of the control panel.
7. Check operation of HP cut out.
8. Check LP_2, LP_1 cut outs.

Monthly schedule-

1. Run the plant for half an hour and check the current.
2. In heating position current should be 11 to 14 Amperes.
3. In cooling position current should 20 to 23 amperes.
4. Compressor motor current should be 7 to 10 amperes.
5. Condesor motor current should be 1.5 to 2.0 amperes.
6. Blower motor current should be 1.5 to 2.5 amperes.
7. To measure the currents clamp on meter/tong tester is used.

Quarterly schedule-

1. Put the water in the dip tray and check the drainage.
2. Check noise level of all the motors with shock pulse meter. Check the anti vibration mountings.
3. Charge the R-22 gas if required.
4. Check the locking arrangement of the control panel.
5. IR test of all the motors should be carried out by 1000 volts megger. Minimum IR value should be 2 mega-ohms.

Sub-lesson - 7 **Dehydration of refrigeration system.**

Due to presence of moisture in the system there is corrosion in the pipes/tubes. It affects the quality of lubricating oil.There is the possibility of choking of system due to formation of ice in the capillary/expansion valve.

Hence presence of moisture should not be allowed in systemfor which the vacuum is created to remove the moisture from the system. This process is called dehydration.

Create the vacuum of 29.6 inches of mercury with the help of 2 HP vacuum pump(735 mm of Hg). Charge the system with nitrogen gas up to 16 psi (1.2 kg/cm sqare). Again create the vacuum of 29.6 inches nd repeat the process twice and then charge the gas.

Gas charging- There should not be any impurity in the gas. Always keepthe cylinder in vertical position while charging the gas. Slightly warm the cylinder if required.

Sub-lesson - 8 **Lubrication of the compressor.**

Lubrication oil level in the crank case should be proper. Due to low lub-oil level compressor can fail/damage D. Oil recommended by the RDSO shall be used.

Quantity of oil-

1. 5 F-60	6 Litter	6 cylinder
2. 5 F-40	4 Litter	4 cyliner
3. 5 F-30	2.7 Litter	3 cylinder
4. 5 F-20	2.5 Litter	2 cylinder
5. SMC-4.65	10 Litter	4 cylinder
6. FK-4	4 Litter	4 cylinder

Oil level test- Compressor oil level can be checked from sight glass(Bull Eye) provided on the crank case.

1. ½ Bulls Eye level should be available when compressor is working.
2. 15 minutes after stopping the compressor 2/3 übulls eye level should be available.

Defects due to excess oil charging-

a. Suction pressure becomes low

b. Compressor makes abnormal noise.

c. Sweating on compressor.

Temperature-

Compressor crank case should be warm, temperature may be up to 105°C.

Sub-lesson- 9 Instructions for gas charging in RMPU.

1. Before charging the gas leak test shall be carried out. Conduct vacuum test twice.
2. Leak test should be done by charging nitrogen pressure 250 to 300 psi (17.5Kg./cm^2). Check the leakages.
3. Soap solution is used to detect leakage.
4. All leakages shall be attended if any.
5. Reapeat the process till all leakages are put right.
6. Create the vacuum of 29.6 inches of mercury with the help of vacuum pump.
7. Check the vacuum after 4 hours.

Gas charging-

a) Charge 2.8 kg R-22 gas in the system.
b) Check the leakage with the help of halogen leak detector.
c) Pinch the charging line.

Sub-lesson - 10 Instructions for prevention of failures of thermostat.

Common problems-

1) Mercury column breakage.
2) Breaking of glass.
3) Thermostat holder broken/defective.

Preventive measures-

a) Remove return air filter and check thermostat, if broken replace.
b) Clean thermostat bulb.
c) Check for mercury colum breakage, if breaked replace. Do not use it applying heat.
d) Frequent failures started after 4½ years the thermostat is provide. Replace it after 5 years.

Sub-lsson- 11 Precooling Voltage for SMF batteries.

200 ampere capacity precooling unit is provided for AC coach.

Input to unit is 415 volts 3 phase AC and output is DC 140 ± 8 volts. Setting for 54 cells will be 124 volts i.e. 2.3 volts per cell. For 56 cells 128 volts. In this unit there is a transformer to step down the voltage and rectifier to convert it from AC to DC.

Sub-lesson- 12 Out-put setting of alternator.

In non AC coach 120 AH and in RMPU AC coach 1100 AH capacity VRLA/ SMF batteries are used. Out-put setting of alternator-

For 54 cells 123 ± 0.5, 122±0.5 and120±0.5 volts for P./ME./SF respectively.

For 56 cells126±0.5 and 125±0.5 voltsü for ME./SF. Respectively.

Instructions for SMF battery charging and maintenance.

Dos-

Follow the instructions given in company manual.

i. Always keep the battery clean.

ii. Tight the terminal bolt connection with 11 N-metre torque. Trickle charge should be given to spare battery once in a six month.

iii. Use spring washer for the connections. Keep battery away from the heat, flame.

iv. After the battery is discharged charge it immediately. Check battery voltage every month.

Donts-

i. Charging voltage should not increase more than 2.3 volts per cell.

ii. Do not add water or acid to the cell.

iii. Do not disturb the safety valve.

iv. Do not boost charge for more than 12 hours. Do not try to open the battery.

v. Do not mix ordinary cells or cell of different companies with VRLA cells.

vi. Carry out the maintenance schedule of the cell timely.

* * *

Full forms-

1	CRB	- Chairman Railway Board.
2	CEE	- Chief Electrical Engineer.
3	CESE	- Chief Electrical Service Engineer.
4	HRC	- High Rupturing Capacity.
5	MCB	- Miniature circuit breaker.
6	ICF	- Integral coach factory.
7	RCF	- Rail coach factory.
8	SMF	- Sealed maintenance free.
9	VRLA	- Valve regulated lead acid.
10	PCD	- Pitch circle diameter.
11	FRP	- Fir retardant paint.
12	PVC	- Poly vinyle chloride.
13	H2SO4	- Sulphuric acid.
14	KOH	- Potasium Hydroxide.
15	RDSO	- Research, Design, and standards organisaton.
16	EFT	- Emmergency feeding terminal.
17	BCT	- Battery charging terminal.
18	RRU	- Rectifier cum regulating unit.
19	GM	- General Manager.
20	AGM	- Aditional General Manager.
21	DRM	- Divisional Railway Manager.
22	SMI	- Special maintenance instructions.
23	EIG	- Electrical inspector to Government.

16 points program for AC coaches :-

1. CESE expressed need for strengthening feed back/abnormal position information system between other railways so that necessary reports can be sent to headquarters for suitable action.

2. All A C coaches should be precooled before placing on the platform. This is the time when passngr needs quick and more comfort. Precooling leads shall be available in Underslung as well as RMPU coaches. In every SG coach one lead and in power car two leads moreover precooling points shall be available on the platforms.

3. From primary maintenance depot no coach is permitted with EFT connection or equipment in isolated condition.

4. All shortcomings in the coach shall be noted on arrival of the train and attended. Escorting staff should also note down the position of coach in register and log book at secondary depot with signature. The work carried out sould be entered in the log book.

5. From preimary depot both the alternators should be in working order. If the repairs/replacement of any alternator is not possible in secondary depot then it should be brought to the notice of higher officer and ensure the proper working of the healthy alternator.

6. From primary depot 6+6 V belts and from secondary depot 5+5 V belts shall be available for AC coach. V belts shall be retightened after 300 kms run to ensure its more life.

7. AC coach plant operation knowledge of AC mechanic and attendant should be tested. They should be given one week refresher training.

8. In primary depots Dyno Drive sytem should be available for alternator generation testing.

9. For replacement of unit, Unit Exchange Spare shall be available. Power should be given to every depot and depot incharge to maintain register with signature.

10. All depot should discuss the major failures and analyse it to find out cause so that its recuurence is prevented.

11. AC supply arrangement for precooling should be available as per the number of AC coaches increased.

12. Annual estimated consumption of material required for maintenance of AC coach shall be as per increased number of AC coaches.

13. Ensure proper cleating of field and phase wires of the alternators. It should be checked at primary depots.

14. Full load and no load voltage of every SMF battery should be recorded in abnormal condition in addition to monthly and quarterly.

15. Thermostat working shall be mentioned in the log book. If defective repair/replace it.

16. Ensure the proper working of WRA on arrival and before placing train on Platform.

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DISCLAIMER

Question Bank is prepared based on provisions in manuals/circulars issued by Railway Board time to time. There will be possibilities of amendments in the rules in future. Hence while going through the sample question bank please refer to latest circulars/amendments issued by Railway Board time to time for ensuring the correct answer. Any answer found incorrect may be brought to notice of SrDPO / DPO / APO for necessary corrections. This is for your reference only.

ELECTRICAL DEPARTMENT

Special thanks to Mumbai Division