ELECTRICIAN'S LICENCE 'B' (Syllabus)

LICENCE 'B' - FACTORY WIRING

Candidates wishing to qualify for Licence B must first qualify in Licence A.

The Examination for Licence B - Factory Wiring - consists of the following:

(a) Written test in Electrical Theory - Paper I.
(b) Written test in Electrical Installation Technology - Paper II.

Candidates who obtain pass marks in Papers I and II will be required to submit testimonials on practical training in an approved institution or centre, or of experience in electrical installation at least equivalent to the level of the approved courses. The candidates will undergo an interview in which practical ability and training or experience will be assessed.

Electrical Theory

Paper 1 - Syllabus

1. Effects of Temperature on Resistance

    1. Variation of resistance with temperature in metals, alloys and non-metals.
    2. Define temperature coefficient.
    3. Calculate temperature rise from zero Deg. Celcius and at different temperatures.

2. Kirchoff's Laws

    1. Application of Kirchoff's laws to 2 loop and 3 loop circuits, Wheatstone bridge network, d.c. two-wire distributor cables and ring mains.

3. A.C. Parallel Circuits

    1. Use of circuits containing Resistance. Inductance and Capacitance.
    2. Calculate Power Factor, angle of phase difference and resonant frequency.
    3. Sketch circuit and phasor diagrams for their use in solution of problems.

4. Three-Phase Circuits

    1. Star and Delta connections. Relationship between line and phase voltages and currents in balanced systems.
    2. Power and apparent power in three-phase systems.
    3. Measurement of power and power factor with two-wattmeter method.
    4. Neutral current in three-phase four-wire system.
    5. Circuit and phasor diagrams and their use in solution of problems.

5. Power Factor and Power Factor Correction

1. Describe briefly the meaning of power factor.
2. Describe the causes and effect of low power factor.
3. Describe the benefits of power factor correction to consumers and authorities.
4. Describe the methods of power factor improvement e.g. capacitors, synchronous motors and phase advancers.
5. Compare and state the merits of individual and group improvement methods.
6. Power factor improvement calculations.
7. Calculate values of power, apparent power and power factor of parallel loads.
8. Phasor diagrams and their use in solution of problems.

6. Electricity Tariffs

1. Explain briefly electricity tariffs: e.g. running and fixed costs including industrial two part tariff.
2. Explain briefly consumer's load factor.
3. Calculate costs using industrial two-part tariff.

7. Transformers

1. Describe the operation and construction of double wound single-phase transformers.
2. Calculate no-load current.
3. Deduce and use the relationship $\frac{V_s}{V_p} = \frac{I_p}{I_s} = \frac{N_s}{N_p}$
4. Deduce and use the E.M.F. equation for a transformer $E = 4.44\ N.f.\emptyset_m$.
5. Describe primary and secondary leakage fluxes, and methods of reducing leakage flux.
6. Definitions of voltage regulation.
7. Describe transformer losses including open and short circuit tests.
8. Calculate full load efficiency, all-day efficiency and maximum efficiency.
9. Describe the operation and connections of three-phase double wound transformers, (star-star, delta-delta, star delta and delta-star) including calculations.
10. Describe the operation and precautions to be taken of an auto-transformer, including calculations.
11. Describe methods of cooling transformers.

8. D.C. Machines

1. Describe the principle of operation of a d.c. machine.
2. Sketch circuit diagrams for a:
   (i) Separately excited d.c. generator.
   (ii) Self-excited d.c. machine, shunt, series and compound excitation.
3. Describe armature reaction of a d.c. machine

4. Derive the equation for the e.m.f. generated by a d.c. generator.
5. Derive voltage and current equations for each connection i.e. for self-excited machine $V = E +/- I_a R_a$
6. Sketch V/I_L characteristics for d.c. generators.
7. Sketch T/I_a and N/T characteristics for d.c. motors.
8. Describe methods of varying the speed of d.c. motors above and below normal, including advantages and disadvantages.
9. Derive speed equation for a d.c. motor in the form

$$\frac{E_1}{E_2} = \frac{N_1}{N_2} = \frac{\emptyset_1}{\emptyset_2}$$

10. Derive power and torque equations.
11. Describe the various forms of losses occurring in d.c. machines.
12. Calculate losses and efficiencies in d.c. machines.

9. Three Phase Induction Motors

1. Describe essential features of construction of the following types of three-phase induction motors:
   (a) cage rotor type, (b) double cage rotor type and (c) wound rotor type.
2. Explain the production of a rotating magnetic field produced in a three-phase motor.
3. Define and calculate values of synchronous speed, rotor speed, slip, slip speed and rotor frequency.
4. Concept of rotor e.m.f., current and power factor.
5. Torque/slip and Torque/Speed characteristics.
6. Describe the various forms of losses occurring in a three-phase induction motor.
7. Calculate mechanical power, torque, losses and efficiency

10. Rectification

1. Describe with the aid of diagrams.
   (a) the action of metal and semiconductor diodes.
   (b) the use of semiconductors in charging circuits.
   (c) the action of thyristors. (Simple treatment as a controlled rectifier)
   (d) the rectification of single-phase and three-phase alternating currents: half-wave and full-wave circuits.
   (e) simple smoothing circuits.

ELECTRICIAN'S LICENCE 'B' (Syllabus)

Electrical Installation Technology

Paper II - Syllabus

1. Regulations

    1. Apply relevant I.E.E. Regulations

2. Electrical Safety

    1. Describe the precautions to be taken when working on or near "live" equipment.
    2. Describe the action to be taken in the event of accident to personnel.
    3. Describe reporting procedures.

3. Fire Safety

    1. Fire prevention:
        (a) conditions required for combustion.
        (b) methods of dealing with different types of fire.
    2. Types of fire extinguishers and their appropriate uses.
    3. Dangers from toxic fumes and smoke, and materials which produce them.

4. Wiring Systems

    1. Describe common wiring systems and their application to various types of installation:
    2. MIMS System.
    3. Trunking systems metallic and non-metallic.
    4. Busbar trunking systems: overhead and rising mains.
    5. Underfloor duct systems.

5. General Consideration For Special Installation

    1. State and describe special requirements for the following installations:
        (a) Flameproof installations.
        (b) Fire alarm systems.
        (c) Emergency lighting systems.
        (d) Installation or construction sites.
        (e) Lifts installation.
        (f) Electrode boilers installation.

6. Cable Installations

    1. Describe the construction and state the use of PVCSWAPVC and XLPE cables.
    2. Describe methods of cable laying, fixing and termination.

7. Consumer's Switchgear and Protection

1. State the types and applications of control gear including switch fuses, fuse switches, distribution boards, circuit breakers, busbar chambers and motor control boards.
2. Compare respective function of fuses and circuit breakers.
3. Describe methods of obtaining over-current protection and discrimination.
4. Describe and explain with the aid of diagrams, three-phase residual current devices.

8. Distribution

1. Describe the incoming supply system to the consumer's installation.
2. State the comparison between single-phase and three-phase supplies.
3. Describe the need for balancing single-phase loads on three-phase systems.
4. Describe provision for future extension.
5. State factors governing the choice of system.
6. Carry out simple calculations to determine the size of switchgear and sub main cables.
7. Draw single line diagrams of switchboards.

9. Measurement and Metering

1. Describe with the aid of diagrams the methods of measuring voltage, current and power supplied to single-phase and three-phase loads.
2. Describe with the aid of diagrams the methods of extending the range of instruments by shunts and multipliers,
3. Simple calculations on range extension of ammeters and voltmeters.
4. Draw and describe the use of current transformers and voltage transformers including selector switches.
5. Precautions to be taken.
6. Draw and describe the use of three-phase energy meters and maximum demand meters.
7. Describe methods of measuring temperature rise of machines and equipment.
8. Describe methods of measuring speed.

10. Installation of Machines

1. Describe with the aid of diagrams as appropriate:
   (a) The choice of an electric motor and motor enclosures.
   (b) The essential parts, circuit operation and applications of:
      - series, shunt and compound d.c. machines,
      - split-phase, capacitor start, capacitor start-run and Universal motors,
      - shaded-pole motors,
      - three-phase squirrel cage and wound induction motors.
   (c) The main function and location of control gear.
   (d) The application of protection devices: Bimetallic and oil dashpot overload relays, undervoltage protection and single-phasing protection.
   (e) The methods of starting and reversing these motors.

e.g. D.C. starters, Direct-on line, Star-Delta, Rotor resistance and Auto transformer starters.

(f) The advantages and disadvantages of each method of starting.

(g) Use of relays, contactors and timers in control circuits.

11. Maintenance

1. Describe maintenance requirements for switchgear, transformer and rotating machines.
2. Describe planned maintenance routines, the use of inspection list and manufacturers' recommendations.

12. Earthing

1. Describe methods of earthing.
2. Describe and explain earth loop impedance.
3. Determination of earth fault currents, earth leakage currents and prospective earth fault current.
4. Lightning protection: protection of buildings, bonding, earthing of protective systems and the need for periodic inspection and testing.

13. Testing and Inspection

1. Describe methods of visual inspection and electrical testing of installations.
2. State the diagnosis and rectification of common faults likely to be encountered in a.c. and d.c. motors, generators and starters.
3. State routine testing and reporting procedures.