4.4 Energy Calculations

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Syllabus

UNIT – IV **11 Periods**

Measurements and Sensors: Introduction to measuring devices /sensors and transducers related to electrical signals - Elementary methods for the measurement of electrical quantities, impedance, power and energy in DC and AC systems and their practical application.

Electrical Wiring and Safety: Basic layout of distribution system - Types of Wiring System &Wiring Accessories –Electrical Safety - Necessity of earthing - Types of earthing.

Problem 1

A business uses two 3kW induction heaters for an average of 20 hours each per week, and six 150W lights for 30 hours each per week. If the cost of electricity is INR 14.25, determine the weekly cost of electricity to the business.

Problem 2

An energy audit is performed on a factory which operates at 0·8 p.f. lagging and has a monthly demand of 750 kVA. The monthly power rate is Rs. 8.50 per kVA. After the auditing process, it has been recommended to improve the power factor. To improve the power factor, 250 kVA capacitors are installed in which there is negligible power loss. The installed cost of equipment is Rs. 20,000 and fixed charges are estimated at 10% per year. Calculate the annual saving effected by the use of capacitors.

Real power demand = kVA × Cosϕ = 750 × 0.8

(kW) = 600

Reactive " " (kVAr) = kVA × Sinϕ = 750 × 0.6

↳ = 450 ✓

Net kVAr = 450 − 250 = 200 ✓

kVA = $\sqrt{600^2 + 200^2}$ = 632.45

Reduction = 750 − 632.45 = 117.5 kVA

Monthly saving = 117.5 × 8.5 = 998.75 INR

Year = 998 × 12 = 11,985

Fixed charges = 0.1 × 20,000 = 2000

Saving = 11,985 − 2000 = 9985 /-

Problem 3

- A homeowner consumes 700 kWh in January. Determine the electricity bill for the month using the following residential rate schedule:
    - Base monthly charge of 45.00 rupees
    - First 100 kWh per month at 2.50 rupees/kWh.
    - Next 200 kWh per month at 3.5 rupees/kWh.
    - Over 300 kWh per month at 5 rupees/kWh.
- Calculate the average cost per kWh if only 350 kWh are consumed in July when the family is on vacation most of the time.

Solution

Case (i)

- Base monthly charge =45 rupees
- First 100 kWh @ **2.50 rupees/kWh** = 250 rupees
- Next 200 kWh @ **3.5 rupees/kWh** =700 rupees
- Remaining 400 kWh @ **5 rupees/kWh=**2000 rupees
- Total charge = 45+250+700+2000= 2995 rupees

Case (ii)

- Base monthly charge =45 rupees
- First 100 kWh @ **2.50 rupees/kWh** = 250 rupees
- Next 200 kWh @ **3.5 rupees/kWh** =700 rupees
- Remaining 50 kWh @ **5 rupees/kWh=**250 rupees
- Total charge = 45+250+700+250= 1245 rupees

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UNIT – I **10 Periods**

Introduction and Basic Concepts: Concept of Potential difference, voltage, current - Fundamental linear passive and active elements to their functional current-voltage relation - Terminology and symbols in order to describe electric networks - Concept of work, power, energy and conversion of energy- Principle of batteries and application.

Principles of Electrostatics: Electrostatic field - electric field intensity - electric field strength - absolute permittivity - relative permittivity - capacitor composite – dielectric capacitors - capacitors in series & parallel - energy stored in capacitors - charging and discharging of capacitors.

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UNIT – II **14 Periods**

DC Circuit Analysis: Voltage source and current sources, ideal and practical, Kirchhoff's laws and applications to network solutions using mesh analysis, - Simplifications of networks using series- parallel, Star/Delta transformation, DC circuits-Current-voltage relations of electric network by mathematical equations to analyse the network (Superposition theorem, Thevenin's theorem, Maximum Power Transfer theorem), Transient analysis of R-L, R-C and R-L-C Circuits.

AC Steady-state Analysis: AC waveform definitions - Form factor - Peak factor - study of R-L - R-C -RLC series circuit - R-L-C parallel circuit - phasor representation in polar and rectangular form - concept of impedance - admittance - active - reactive - apparent and complex power - power factor, Resonance in R-L-C circuits - 3 phase balanced AC Circuits

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UNIT – III **10 Periods**

Principles of Electro Magnetics and Electro-mechanics: Electricity and Magnetism - magnetic field and faraday's law - self and mutual inductance - Ampere's law - Magnetic circuit - Magnetic material and B-H Curve – Single phase transformer - principle of operation - EMF equation - voltage ratio - current ratio – KVA rating - Electromechanical energy conversion – Elementary generator and motors.

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Summary

- Unit summary
- Problems
- Application oriented questions