Code: AE55   **Subject: PRINCIPLES OF ELECTRICAL ENGINEERING**

AMIETE – ET (Current Scheme)

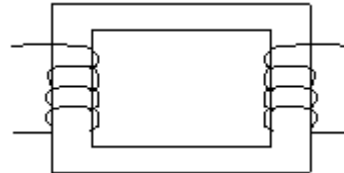**Time: 3 Hours**   **JUNE 2017**   **Max. Marks: 100**

PLEASE WRITE YOUR ROLL NO. AT THE SPACE PROVIDED ON EACH PAGE IMMEDIATELY AFTER RECEIVING THE QUESTION PAPER.

NOTE: There are 9 Questions in all.
- **Question 1 is compulsory and carries 20 marks. Answer to Q.1 must be written in the space provided for it in the answer book supplied and nowhere else.**
- **The answer sheet for the Q.1 will be collected by the invigilator after 45 minutes of the commencement of the examination.**
- **Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.**
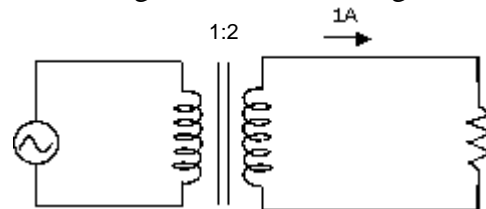- **Any required data not explicitly given, may be suitably assumed and stated.**

  Q.1   **Choose the correct or the best alternative in the following:**   **(2×10)**

    a. The single phase, 50Hz, iron core transformer in the circuit has both the vertical arms of cross sectional area 20cm^2 and both the horizontal arms of cross sectional area 10cm^2. If the two windings shown were wound instead on opposite horizontal arms, the mutual inductance will
      (A) Double
      (B) remain same
      (C) be halved
      (D) become one quarter

    b. A single-phase transformer has a turns ratio of 1:2, and is connected to a purely resistive load as shown in the figure. The magnetizing current drawn is 1A, and the secondary current is 1A. If core losses and leakage reactances are neglected, the primary current is
      (A) 1.41A
      (B) 2A
      (C) 2.24 A
      (D) 3 A

    c. A balanced three-phase voltage is applied to a star-connected induction motor, the phase to neutral voltage being V. The stator resistance, rotor resistance referred to the stator, stator leakage reactance, rotor leakage reactance referred to the stator, and the magnetizing reactance are denoted by r_s, r_r, x_s, x_r and X_m, respectively. The magnitude of the starting current of the motor is given by

    (A) $\dfrac{V}{\sqrt{(r_s + r_r)^2 + (x_s + x_r)^2}}$ **(B)** $\dfrac{V}{\sqrt{(r_s)^2 + (x_s + x_m)^2}}$

(C) $\dfrac{V}{\sqrt{\left(r_s + r_r\right)^2 + \left(x_m + x_r\right)^2}}$ **(D)** $\dfrac{V}{\sqrt{\left(r_s\right)^2 + \left(x_m + x_r\right)^2}}$

d. A 4-point starter is used to start and control the speed of a
   (A) DC shunt motor with armature resistance control
   (B) DC shunt motor with field weakening control
   (C) DC series motor
   (D) PMDC motor

e. Which of the following motors is non-self starling?
   (A) Squirrel cage induction motor
   (B) Wound rotor induction motor
   (C) Synchronous motor
   (D) DC series motor

f. A synchronous motor working on leading power factor and not driving any mechanical, is known as
   (A) Spinning motor   **(B)** Reluctance motor
   (C) Induction generator   **(D)** Synchronous condenser

g. The demagnetising force required to reduce to zero the remnant flux density in a magnetic body is called
   (A) Coercive force   **(B)** Mangento motive force
   (C) Electro motive force   **(D)** Electromagnetic force

h. The load factor, use factor and capacity factors of a power plant is related by
   (A) Load factor = use factor x capacity factor
   (B) Load factor x use factor = capacity factor
   (C) Load factor x capacity factor = use factor
   (D) None of these

i. The motor with the highest starting torque from the list is a
   (A) permanent split capacitor squirrel cage asynchronous motor
   (B) shaded pole motor
   (C) two-value capacitor squirrel cage asynchronous motor
   (D) split phase

j. The cost fuel transportation is minimum for
   (A) Hydro Electric power plant   **(B)** Nuclear power plant
   (C) Thermal power plant   **(D)** Steam power plant

Answer any FIVE Questions out of EIGHT Questions.
Each question carries 16 marks.

Q.2   a. A ferromagnetic core is shown in Figure 1. Three sides of the core are of uniform width, while the fourth side is somewhat thinner. The depth of the core

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(into the page) is 10 cm. and the other dimensions are shown in the figure. There is a 200 turn coil wrapped around the left side of the core. Assuming relative permeability μ_r of 2500, how much flux will be produced by a 1A input current? **(8)**
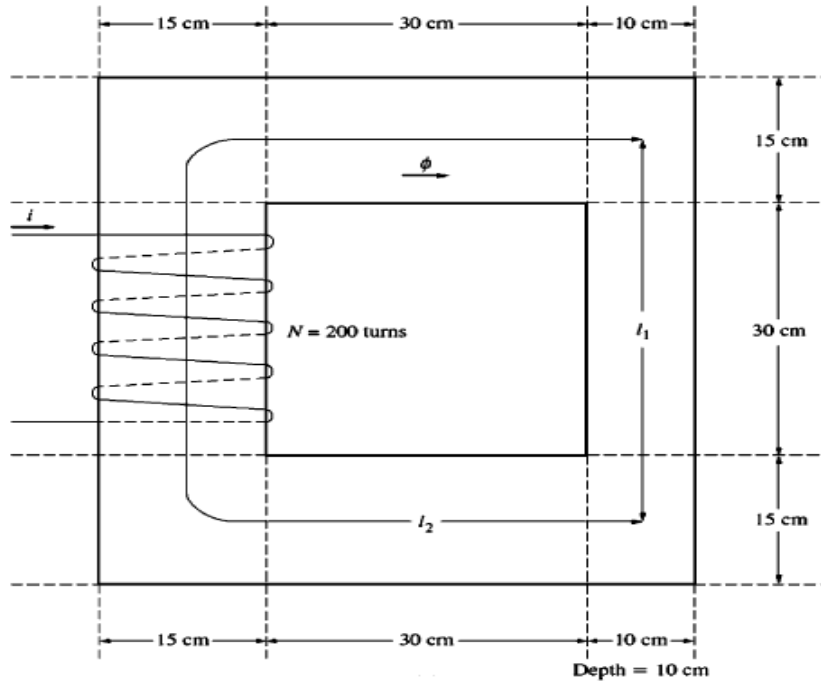

Figure 1

b. The following data were obtained on a 20kVA, 50HZ, 2000/200V distribution transformer:
Draw the approximate equivalent circuit of the transformer referred to the HV and LV sides respectively. **(8)**

	Voltage (V)	Current (A)	Power (W)
OC test with HV open -circuited	200	4	120
SC test with LV Short -circuited	60	10	300

Q.3 a. Define the term voltage regulation of transformer. Derive expression for voltage regulation of transformer with phasor diagram. **(8)**

b. A dc shunt generator driven by a belt from an engine run at 750 rpm while feeding 100kw of electric power into 230V mains. When the belt breaks it continues to run as a motor drawing 9Nkw from the mains. At what speed it would run? **(8)**

Q.4 a. What is the requirement of starter in a DC machine? Explain the function of a three point starter with suitable diagram. **(8)**

b. Write short notes on the following **(8)**

(i) Hysteresis and Eddy current loss
(ii) Self and mutual inductance

Q.5 a. A three-phase, 1200 HP, 2300 V, 60 Hz, synchronous machine has $R_s = 0.2\,\Omega$ and $X_s = 5.6\,\Omega$. When operated with the mechanical load disconnected with rated voltage and frequency, the field current is adjusted until line current has a minimum value. At this point, $I_a = 22.1\,\text{A}$, the measured input power is $P_T = 17.5\,\text{kW}$, and the measured field circuit values are $V_f = 276\,\text{V}$ and $I_f = 53.2\,\text{A}$. (*A*) Determine the rotational losses (core losses plus friction and windage) for this machine. (*B*) If the field current, frequency, and impressed terminal voltage are unchanged, but a mechanical load requiring 600 HP is attached, predict the power factor, line current, and efficiency. **(8)**

b. Derive expression for induced EMF equation in synchronous machine. What is distribution winding? What is distribution factor and derive its expression? **(8)**

Q.6 a. A three-phase, 440 V, 1000 rpm slip ring induction motor is operating with 4 % slip. Stator current is 30 A. Determine the stator current if the speed of the motor is reduced to 500 rpm using stator voltage control method. **(8)**

b. Show that the maximum torque in a three phase induction motor occurs at a slip $s = \dfrac{X2}{R2}$ and further show that T_{max} is independent of s. **(8)**

Q.7 a. Explain the construction and working principle of hysteresis motor. **(8)**

b. Explain the double-revolving-field theory of single-phase induction motors. **(8)**

Q.8 a. A power plant of 210 MW installed capacity has the following particulars:
Capital cost = Rs. 18000/kW installed
Interest and depreciation = 12 %
Annual load factor = 60 %
Annual capacity factor = 54 %
Annual running charges = Rs. 200 X 10^6
Energy consumed by power plant auxiliaries = 6 %
Calculate (i) the cost of power generation per kWh and (ii) the reserve capacity. **(8)**

b. Answer the following: **(8)**
(i) What is difference between a feeder and a distributor?
(ii) What are the advantages of ring main distribution system?

Q.9 a. Draw single line diagram of a typical power system. Locate various sections of it and mention there on typical voltages of generation, transmission and distribution. **(8)**

b. Write short notes on the following: **(8)**
(i) Fuel Cell
(ii) HVDC Transmission