This question paper contains 8 printed pages]

HPAS (Main)—2011

ELECTRICAL ENGINEERING

Paper I

Time : 3 *Hours* *Maximum Marks* : 150

Note :— Attempt *Five* questions in all, taking at least *one* question from each part.

PART A

1. (*a*) For the circuit shown in Fig. 1, obtain current through (1 + *j*) Ohm impedance using Norton's Theorem. Also, verify your result using Nodal Analysis. 15

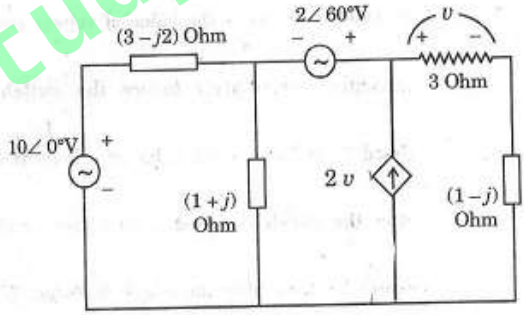

Fig. 1

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(b) Obtain all the Foster and Cauer realizations of the driving point impedance : 15

$$Z(s) = \frac{s(s^2 + 4)}{(s^2 + 1)(s^2 + 9)}.$$

2. (a) State and prove Tellegen's theorem. Also, verify Tellegen's theorem for the circuit in Fig. 1. 15

(b) The circuit of Fig. 2 has been in the condition shown for a long time. At $t = 0$, the switch is closed. (*i*) What is the value of voltage across capacitor immediately before the switch is closed ? (*ii*) What is the value of v immediately after the switch is closed ? Find the complete expression for v after the switch is closed. What is the time constant of transient term ? What

is the final steady state voltage across the capacitor ? 15

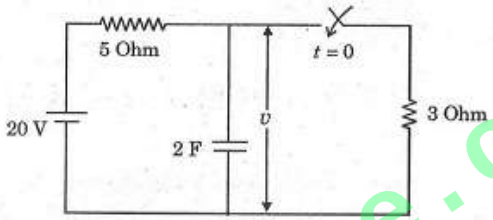

Fig. 2

PART B

3. (a) Derive the expression of capacitance of a parallel plate capacitor using Laplace's Equation. 15

(b) There exists a boundary between two magnetic materials at $y = 0$, having relative permeabilities $\mu_{r_1} = 4$ for region 1 where $y > 0$ and $\mu_{r_2} = 6$

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for region 2 where $y < 0$. There exists a surface current of density $\vec{K} = 60\,\hat{a}_x$ A/m at the boundary $y = 0$. For a field $\vec{B}_1 = 2\,\hat{a}_x - 3\hat{a}_y + \hat{a}_z$ mT in region 1, find the values of magnetic field intensities $\vec{H}_1$ and $\vec{H}_2$ in two regions. Also, obtain the magnetic flux density in region 2 ($\vec{B}_2$). 15

4. *(a)* Describe in detail, the construction, working and applications of CRO. 15

(b) Discuss how inductance and capacitance can be measured ? Explain in detail. 15

PART C

5. (a) Derive the Barkhausen Criterion. Discuss the working of Hartley's and Colpitt's Oscillators. 15

(b) What are the various properties of negative feedback ? Discuss in detail. What are the various topologies of feedback amplifiers ? Discuss their characteristics. 15

6. (a) What is a transistor ? Discuss its construction and operation. What are the various operating modes of BJT ? What are the various configurations of BJT ? Explain, their characteristics and applications. 15

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(b) What are multivibrators ? What are the various types of multivibrators ? Discuss the working and application of each. 15

PART D

7. (a) Discuss the classification of D.C. motor. Also, explain the characteristics of each type clearly, indicating their application area. 15

(b) What is a transformer ? What are the basic functions performed by a transformer ? Explain the characteristics of an ideal transformer. Draw the phasor diagram of a step-down real transformer connected to a capacitive load. 15

6. (a) A 4-pole, 3-phase, 440 V, 50 Hz induction motor has the following parameters for its circuit model (referred to the stator side on equivalent star basis).

$r_1 = 1.1\ \Omega$, $x_1 = 1.12\ \Omega$, $r'_2 = 0.4\ \Omega$, $x'_2 = 1.12\ \Omega$, $x_m = 32\ \Omega$.

Rotational losses are 750 W.

(i) For a speed of 1440 rpm, calculate the input current, power factor, net mechanical power, torque and efficiency.

(ii) Calculate the maximum torque and the slip at which it occurs. 15

(b) Compare the following :

(i) Generator and Motor;

(ii) Two winding Transformer and Auto Transformer;

(iii) Transformer and Induction Machine. 15