Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech (NEW)/SEM-1/ES-101/2011-12

2011

BASIC ELECTRICAL & ELECTRONICS ENGINEERING – I

Time Allotted : 3 Hours *Full Marks* : 70

THIS QUESTION BOOKLET CONSISTS OF 2 PARTS — PART I & PART II.
TO ANSWER THE QUESTIONS USE SEPARATE ANSWER BOOKS FOR SEPARATE PARTS.
DO NOT ANSWER BOTH THE PARTS IN THE SAME ANSWER-BOOK.

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

PART – I

(Marks : 35)

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *five* of the following : $5 \times 1 = 5$

   i) The conductance G of a series R-L circuit having a resistance R and inductive reactance X_L is given by

   a) $G = \frac{1}{R}$ b) $G = \frac{R}{X_L}$

   c) $G = \frac{R}{R^2 + X_L^2}$ d) $G = \frac{R^2}{R^2 + X_L^2}$.

ii) Inductive reactance of a coil of inductance 0·2 H at 50 Hz is
   a) 62·8 Ω b) 628 Ω
   c) 0·2 Ω d) 20 Ω.

iii) For a coil with N-turns, the self inductance will be proportional to
   a) N b) $\frac{1}{N}$
   c) N^2 d) $\frac{1}{N^2}$.

iv) Area of hysteresis loop is a measure of
   a) retentivity
   b) coercivity
   c) saturated flux density
   d) energy loss.

v) The power factor of a purely inductive circuit is
   a) zero b) one
   c) infinity d) 0·5.

vi) The form factor of a current waveform is 1, its shape is
   a) sinusoidal b) triangular
   c) square d) sawtooth.

GROUP – B

(Short Answer Type Questions)

Answer any *two* of the following. 2 × 5 = 10

2. A network of resistances is formed as shown in Figure 1. Compute the resistance between the points A and B.

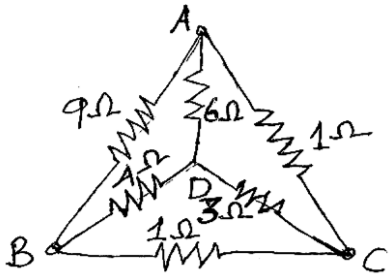


Figure 1

3. Derive a mathematical expression for r.m.s. value of a sinusoidal voltage $v = V_m \sin \omega t$.

4. Two coils have self inductances L_1 and L_2 and mutual inductance between them is M. Derive a mathematical expression for co-efficient of coupling k for these coils.

5. Determine the value of R in Figure 2 such that 4 Ω resistor consumes maximum power.

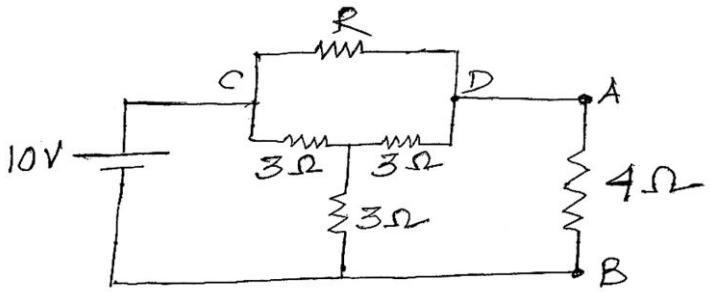


Figure 2

GROUP – C
(Long Answer Type Questions)

Answer any *two* of the following. 2 × 10 = 20

6. a) What is meant by the term "resonance" in a series R.L.C. circuit ? 3

   b) A 20 Ω resistor, a choke coil having some inductance and some resistance and a capacitor are connected in series across a 25 V variable frequency source. When frequency is 400 Hz, the current is maximum and its value is 0·5 A and the potential difference across the capacitor is 150 V. Calculate the resistance and the inductance of the choke coil and the capacitance of the capacitor. 7

7. a) A flux of 0·0006 Wb is required in the air-gap of an iron ring of cross-section 5·0 cm^2 and mean length 2·7 m with an air-gap of 4·5 mm. Determine the ampere turns required. Six H values and corresponding B values are noted from the magnetisation curve of iron and given below. 6

H (AT/m)	200	400	500	600	800	1000
B (Wb/m^2)	0·4	0·8	1·0	1·09	1·17	1·19

b) A circuit receives 50 A current at a power factor of 0·8 lag from a 250 V, 50 Hz, 1-ph A.C. supply. Calculate the capacitance of the capacitor which is required to be connected across the circuit to make the power factor unity. 4

8. a) State and explain Thevenins theorem. 3

b) Find the Thevenin equivalent of the circuit of Figure 3 as shown at terminal XY. 7

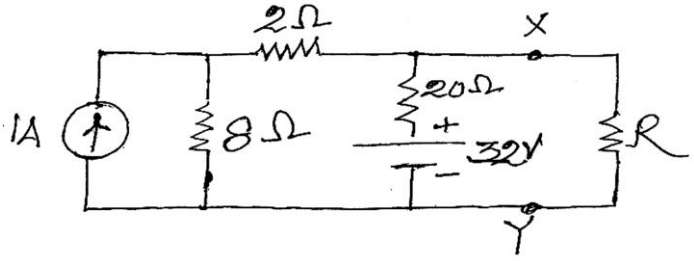


Figure 3

9. a) Derive a mathematical expression for the average real power delivered by a single phase *a.c.* source with an *e.m.f.* of $e = \sqrt{2}\, E_m \sin \omega t$ when the source current is $i = \sqrt{2}\ I_m \sin(\omega t - \theta)$. 6

b) Define power factor of an *a.c.* circuit. State the major disadvantages of poor power factor. 4

USE SEPARATE ANSWER-BOOK TO ANSWER PART-II QUESTIONS.

PART – II

(Marks : 35)

GROUP – A
(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *five* of the following : $5 \times 1 = 5$

   i) Fermi level of an *n*-type semiconductor lies
      a) near the conduction band edge
      b) near the valence band edge
      c) at the middle of the band gap
      d) none of these.

   ii) For an *npn* transistor, I_{CBO} approximately doubles for temperature rise of every
      a) 5°C b) 7°C
      c) 10°C d) none of these.

   iii) If α of a BJT is 0·98, then the value of β is
      a) 0·99 b) 99
      c) 50 d) 49.

   iv) The power rating of a BJT is determined by which of the following ?
      a) Collector base junction area
      b) Base width
      c) Heat sink
      d) Emitter base junction area.

v) It is easy to break the covalent bond by thermal energy in case of

a) Carbon b) Germanium

c) Arsenic d) Silicon.

vi) The temperature coefficient of Zener breakdown voltage is

a) positive

b) negative

c) zero

d) either positive or negative.

GROUP – B

(Short Answer Type Questions)

Answer any *two* of the following. 2 × 5 = 10

2. What do you mean by an intrinsic semiconductor ? Will it behave as an insulator at any temperature ? Explain. 2 + 3

3. Explain the mechanism of Zener breakdown in *p-n* junction and write how it differs from avalanche breakdown. 3 + 2

4. What is meant by *d.c.* operating point or *Q* point in the context of transistor characteristics ? What is load line ? Why is transistor biasing necessary ? 2 + 1 + 2

5. Explain the principle of operation of a varactor diode. Mention one application. 4 + 1

GROUP – C

(Long Answer Type Questions)

Answer any *two* of the following. 2 × 10 = 20

6. Consider an intrinsic silicon bar of cross-section 5 cm^2 and length 0·5 cm at room temperature 300K. An average field of 20 V/cm is applied across the ends of the silicon bar.

   a) Calculate —

      i) electron and hole component of current density

      ii) total current in the bar

      iii) resistivity of the bar. 6

   b) If now donor impurity to the extent of 1 part in 10^8 atoms of Si is added, find the density of minority carriers and the resistivity. 4

      Given :

      Electron mobility = 1400 cm^2 /V - s

      Hole mobility = 450 cm^2/V - s

      Intrinsic carrier concentration of Si

      At room temperature (300K) = $1{\cdot}5 \times 10^{10}$ /cm^3

      No. of Si atoms/ m^3 = $4{\cdot}99 \times 10^{28}$.

7. a) Explain drift and diffusion of charge carrier in semi-conductors. Derive the expression for electric current due to drift and diffusion. 4 + 3

   b) With the help of energy-band diagram, differentiate among conductor, semi-conductor and insulator. 3

8. a) What is ripple factor ? Evaluate the ripple factor and efficiency of a full-wave bridge rectifier. 2 + 3

b) A silicon diode with internal resistance $R_F = 25\ \Omega$ is used for half-wave rectification. The input *a.c.* voltage is $V_i = 20 \sin \omega t$ and the load resistance is 500 Ω.

Find,

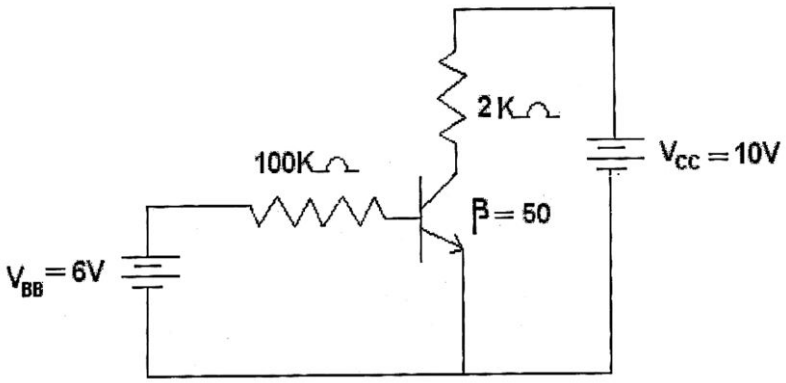
i) *d.c.* output voltage

ii) *a.c.* input power and

iii) efficiency of the rectifier. 2 + 2 + 1

9. a) Draw the circuit diagram for self-biased configuration considering an n-p-n transistor in CE configuration. Derive the expression for its stability factors. 3 + 2

b) Calculate V_{CE} and I_C in the circuit below. Assume $V_{BE} = 0{\cdot}7$ V. 4



c) What is the voltage gain of a transmitter circuit in CC configuration ? 1