

Engg. Services Exam, 2011

021501

D-RSR-L-RRB

**ELECTRICAL ENGINEERING**  
**Paper II**  
**(Conventional)**

Time Allowed : Three Hours

Maximum Marks : 200

**INSTRUCTIONS**

*Candidates should attempt FIVE questions in all.*

*Question No. 1 is compulsory. The remaining FOUR questions are to be attempted by selecting ONE question each from Sections A, B, C and D.*

*The number of marks carried by each question is indicated at the end of the question.*

*Answers must be written only in ENGLISH.*

*Assume suitable data, if necessary and indicate the same clearly.*

*Unless otherwise indicated, symbols and notations have their usual meanings.*

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1. A (a) The purpose of providing dummy coils in the armature of a DC machine is to
- (i) increase voltage induced
  - (ii) decrease the armature resistance
  - (iii) provide mechanical balance for the rotor
  - (iv) reduce the copper loss

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- (b) If an induction motor is operating at 60% of its synchronous speed, the maximum efficiency under ideal conditions (theoretically possible) is
- (i) 100%
  - (ii) 40%
  - (iii) 50%
  - (iv) 60%
- (c) Current chopping phenomenon is associated with
- (i) over current relays
  - (ii) synchronous generator
  - (iii) induction motor
  - (iv) power transformer
- (d) "Over reaching" and "Under reaching" are experienced in
- (i) frequency relays
  - (ii) over current relays
  - (iii) distance relays
  - (iv) under voltage relays
- (e) In a full wave rectifier circuit with centre-tap transformer, independently of the filter used, the peak inverse voltage across each diode is equal to
- (i)  $V_m$
  - (ii)  $2 V_m$
  - (iii)  $\frac{V_m}{2}$
  - (iv)  $\frac{V_m}{\sqrt{2}}$

where  $V_m$  is the maximum transformer voltage measured from the midpoint (centre-tap) to either end.

- (f) Among DTL, RTL, ECL and CMOS logic families, ECL has the propagation delay and power dissipation/gate respectively as
- (i) low, high
  - (ii) low, low
  - (iii) high, low
  - (iv) high, high
- (g) Which one of the following has the highest priority ?
- (i) RST 7.5
  - (ii) RST 5.5
  - (iii) TRAP
  - (iv) HOLD
- (h) In PAM, the carrier wave consists of a periodic train of rectangular pulses and the carrier frequency is equal to
- (i) the bandwidth of the modulating signal
  - (ii) the sampling rate of the modulating signal
  - (iii) atleast ten times greater than the bandwidth of the modulating signal
  - (iv) twice the bandwidth of the modulating signal
- (i) The main drawback of a phase control of 1-phase controlled rectifier circuit is
- (i) it requires more gate current
  - (ii) radio frequency interference
  - (iii) more power loss
  - (iv) efficiency is less

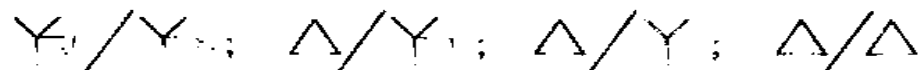
(j) The important features of rotor ON-OFF control are

- (i) fast response, smooth variations in speed
- (ii) better power factor at low speeds and wide range of speed control
- (iii) speed can be varied, suitable for group drives
- (iv) All of the above

2×10 =20

1. B (a) Why is armature control superior to field control scheme in the case of a DC shunt motor ?

(b) Draw the zero sequence network of the transformer connections shown below :



(c) Determine the diffusion capacitance due to holes in a Ge diode when the forward biased current is  $I = 26$  mA. Given that mean life time of holes,  $\tau = 20$   $\mu$  sec at  $T = 300^\circ$ K.

(d) With a block diagram, explain the basics of transmitter and receiver of PCM system.

(e) Show that a fully controlled 1-phase AC-DC bridge converter can operate in two quadrants.

4×5 =20

**SECTION A**

2. (a) Explain No voltage release (NVR) and Over load release (OLR) coils provided in a DC motor starter. 10
- (b) A 400 V shunt motor draws 30 A while supplying the rated load at a speed of 120 rad/s. The armature resistance is 1.0 ohm and the field winding resistance is 250 ohms. Determine the external resistance that must be inserted in series with the armature circuit so that armature current does not exceed 150% of its rated value when the motor is plugged. Find the braking torque at the instant of plugging. 10
- (c) A 6600 V/400 V/110 V Star/Star/Mesh connected three-phase transformer has a magnetizing current of 5.5 A and balanced three-phase loads of 1000 kVA at 0.8 lag on secondary and 200 kVA, 0.5 leading power factor load on the tertiary. Find the primary current and power factor. Neglect losses. 20
3. (a) How will the breakdown slip and breakdown torque be affected when the rotor resistance is increased? 10
- (b) A 4-pole, 50 Hz, 3-phase induction motor delivers a shaft torque of 110 N-m at full load and running at 950 rpm. Calculate (i) rotor copper loss (ii) power input to the rotor. The mechanical losses account for 100 W. 10

- (c) An industrial load of 4000 kW is supplied at 11 kV, the power factor being 0.8 lagging. A synchronous motor is required to meet an additional load of 1500 HP (1103.25 kW) and at the same time to raise the resultant power factor to 0.95 lagging. Determine the kVA capacity of the motor and the power factor at which it must operate. Take the efficiency of the motor as 80%. 20

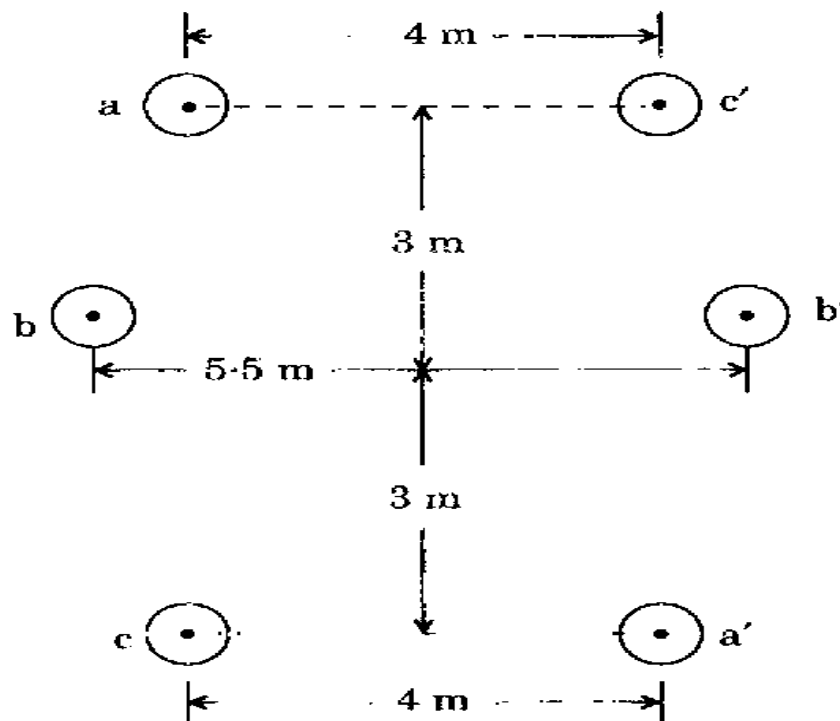
**SECTION B**

4. (a) Starting from fundamentals, derive the equations for sending end voltage and sending end current for a long transmission line. Use the distributed parameter form of representation of the long line. Obtain the A, B, C, D parameters of the line. 18
- (b) A synchronous generator is rated 20 MVA, 13.8 kV. It has  $X_1 = 0.25$  p.u.,  $X_2 = 0.35$  p.u. and  $X_0 = 0.10$  p.u. The neutral is solidly grounded. The machine is on no load and is operating at rated voltage when a D-L-G fault occurs at its terminals. Find the subtransient current in all the phases and the fault (all in amps) and the line-to-line voltages in all the phases (in kV). 20
- (c) Sketch typical swing curves for a synchronous machine (i) showing that the machine is stable after a disturbance (ii) showing that the machine is unstable after a disturbance. 2
5. (a) A ring feeder with five sections and fed at one point is to be protected using Directional over current (DOC) Relays and Over current (OC) Relays with suitable time grading. Explain the working of the scheme. Show the location of D.O.C's and O.C's and their time of operation. Assume a time grading of 5 ms between the relays. The fastest relay needs 5 ms for it to operate. 15

(b) (i) A surge of 100 kV is incident on a line having a surge impedance of 400 ohms. It meets a cable having a surge impedance of 40 ohms. Derive expression for the transmitted voltage and reflected voltage and compute their values. 7

(ii) Explain the practical importance of this situation. 3

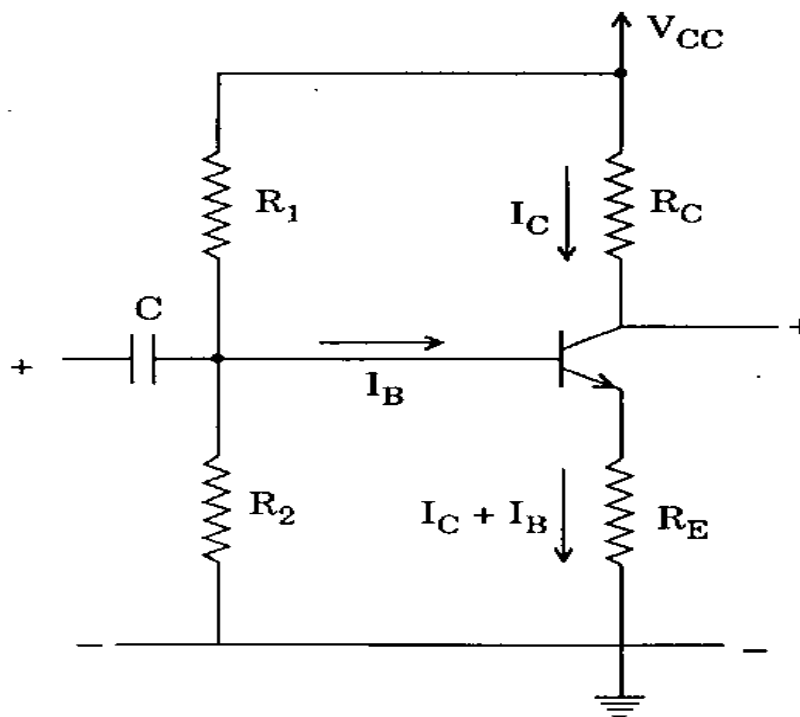
(c) A 3-phase double circuit line is arranged as shown below :



The conductors are transposed. The radius of each conductor is 0.75 cm. Phase sequence is ABC. Find the Inductance per phase per km. 15

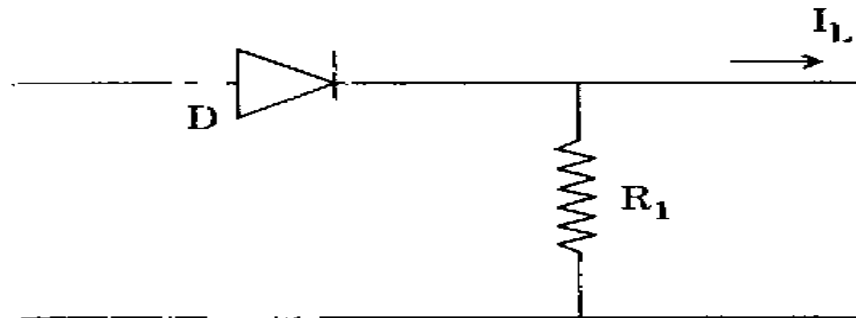
## SECTION C

6. (a) The circuit shown uses a silicon transistor with  $\beta = 50$ ,  $V_{BE} = 0.6 \text{ V}$ ,  $V_{CC} = 22.5 \text{ V}$  and  $R_C = 5.6 \text{ K}$ . Find the values of the resistors  $R_E$ ,  $R_1$  and  $R_2$  so that Q point is set at  $V_{CE} = 12 \text{ V}$  and  $I_C = 1.5 \text{ mA}$ . The stability factor,  $S$  must be  $\leq 3$ .



20

- (b) An input of  $E = +50\text{ V}$  is applied to the clipping circuit. The output current from the circuit is to be  $I_L = 20\text{ mA}$  and the negative output voltage is not to exceed  $0.5\text{ V}$ .



Calculate the value of  $R_1$ . Specify the diode in terms of forward current, power dissipation and peak reverse voltage. Assume the reverse saturation current  $I_S$  is  $5\ \mu\text{A}$  and forward voltage of diode,  $V_F = 0.7\text{ V}$ .

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- (c) Construct a logic circuit to give an output  $X = (\overline{AB} + \overline{AC})(\overline{AD} + C)$  without any reduction in number of gates. Give the logic circuits in step by step.
7. (a) Explain Memory mapped I/O. 15  
 (b) Explain Interrupts and Serial I/O of 8085. 15  
 (c) List the machine cycles of 8085. 10

**SECTION D**

8. (a) With a neat circuit diagram and waveforms, explain how envelope detector detects AM signal. 16
- (b) A sinusoidal modulating wave of amplitude 5 V and frequency 1 kHz is applied to a frequency modulator. The frequency sensitivity of the modulator is 40 Hz/V. The carrier frequency is 100 kHz. Calculate
- (i) frequency deviation
  - (ii) modulation index
  - (iii) instantaneous frequency of the FM wave.
- Also write the expression of the FM waveform. 16
- (c) Consider an FDM system using AM-SSB modulation to transmit 24 independent voice inputs. Assume a bandwidth of 4 kHz for each voice input. Determine the transmission bandwidth. Compare the bandwidth with that of a standard 8-bit PCM with TDM. Assume bit duration is 0.647  $\mu$ s. 8

9. (a) In Fig. 9(a), the source voltage is 100 V and the load resistance is 10 ohm. The SCR can withstand a  $di/dt$  value of 50 V/ $\mu$ s. If the snubber discharge current must be limited to 2 A, find the value of the snubber resistor and capacitor. 8

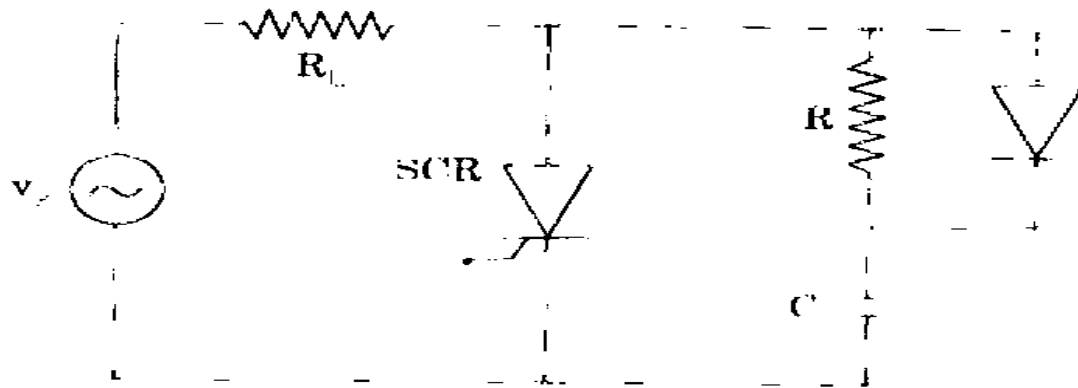


Fig. 9(a)

- (b) In a 1 phase AC-AC voltage controller feeding a (i) lighting load (ii) heating load, suggest a suitable control method. 12
- (c) In a phase controlled circuit using a 1 phase 230 V, 50 Hz supply, the triggering angle is adjusted to  $30^\circ$  in both half cycles of a resistive load. Calculate the r.m.s. value of the output voltage. 8
- (d) Explain the switching characteristics of Power MOSFET. 12