C.S.E.-(Main)-1999

ELECTRICAL ENGINEERING

PAPER - I

Time Allowed: Three Hours **Maximum Marks: 300**

Candidates should attempt Question 1 and 5 which are compulsory, and any THREE of the remaining question selecting at least ONE question from each Section.

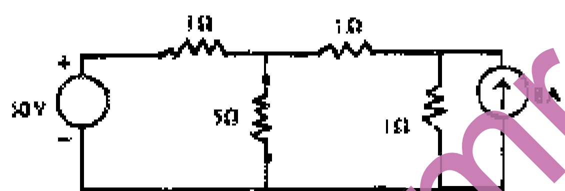
SECTION A

1. Answer any three of the following:

(a) Explain the concept of complex frequency. Discuss its usefulness in specifying network functions.

(20)

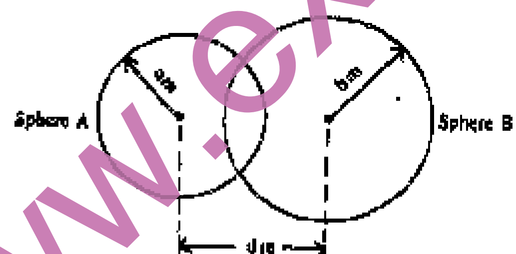
(b)



Determine the current in the 5 ohm resistor using Thevenin's theorem.

(20)

(c)



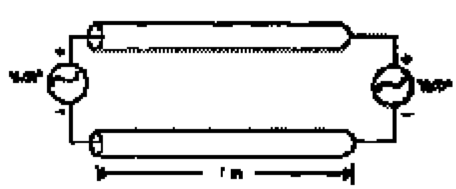
Determine the electric field in the overlap region cit two spheres A and B shown in the above figure. Sphere A carries a charge –ρ c/m^3 and the sphere B, a charge of –ρ c/m^3.

(20)

(d) Discuss the merits and demerits of using counters in digital measuring instruments.

(20)

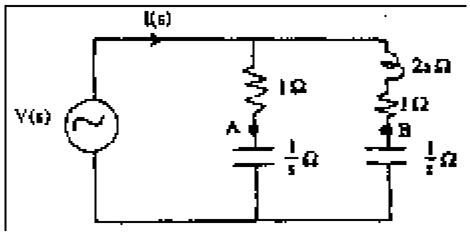
2. (a)



A loss-less transmission of length ℓ m and characteristic impedance Z_0 ohm is excited at both the ends as shown in the above figure. Determine the currents delivered by the two sources. Determine also the current at the mid-point of the line.

(20)

(b)



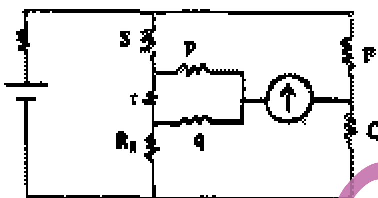
Determine

(i) $\frac{V(s)}{I(s)}$ and

(ii) $\frac{V_{AB}(s)}{V(s)}$ for the network shown in the above figure.

(10 + 10)

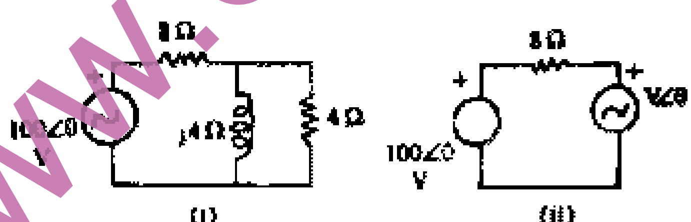
(c)



The bridge circuit, shown in the above figure, is balanced when S = 10 milli ohm, P = 1100 ohm, Q = 1000 ohm, q = 500 ohm and r = 0.1 ohm. Find the value of R_x.

(20)

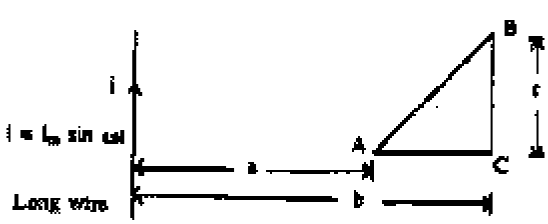
3. (a)



Determine V ∠θ so that the circuits (i) and (ii) shown in the above figure are equivalent.

(20)

(b)



Determine the emf induced in the triangular loop ABC due to the flux set up by a sinusoidal current $I_m \sin \omega t$ flowing in an infinitely long wire shown in the above figure.

(20)

(c) Two conductors have a potential coefficient matrix $\begin{bmatrix} 2 & 1 \\ 1 & 2 \end{bmatrix}$ Each conductor is given a charge 1 C. One of the conductors is then momentarily grounded. Thereafter it is connected to the other conductor. Determine the final potential of the composite conductor.

(20)

4. (a) (i) Why does an induction type energy meter creep? How is the creep prevented?

(10)

(ii) The calibration constant of a 3-phase energy meter is 0.14 revolutions of disc per kwh. It is used with a potential transformer of ratio 11 KV/110 V and a current transformer of ratio 500 A/5A. The test results are:

Line voltage = 100

Line current = 5.25 A,

Power Factor = 0.9 lagging,

Time to complete 30 revolutions of discs =0 sec.

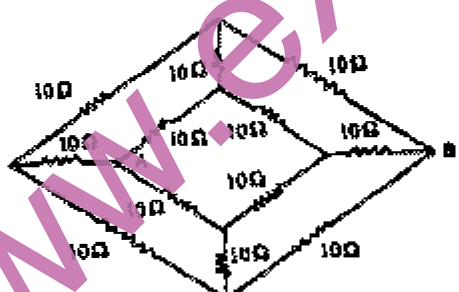
Determine the percentage error in the meter in terms of the actual energy consumed.

(10)

(b) The output of a LVDT transducer is 0.5 V at a frequency of $\frac{50}{2\pi} 10^3$ rad./sec. Determine the output if the frequency deviates by 10%. The time constants of primary and secondary circuits are 5 ms and 2 ms respectively.

(20)

(c)



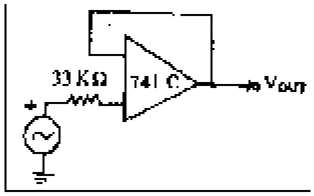
Determine the resistance across the terminals A and B of the network shown in the above figure.

(20)

SECTION B

5. Answer any three of the following:

(a)



The above figure shows the circuit of a voltage follower. Calculate its closed loop voltage gain, input impedance and output impedance. Determine also the output offset voltage. The parameters of 741 C are:

Open loop gain $A_{OL} = 10^5$,

$r_{in} = 2M\Omega$, $r_{out} = 75\Omega$, $V_{in}(off)$ 2mV,

I_{in} (bias) = 80 nA and $I_{in}(off)$ = 20 nA.

(20)

(b) (i) Simplify the Boolean function

$$Z = \left(\overline{A+\overline{B}}\right).B.\left(A+\overline{C}\right)$$

and realise it using NAND gates.

(10)

(ii) What is a race condition ? How is it prevented?

(10)

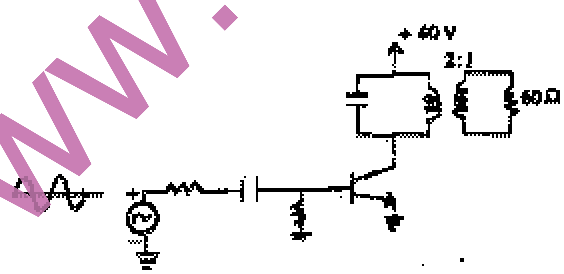
(c) A 400 V, 3-phase, star connected synchronous motor has x_d = 8 ohm and x_q = 6 Ω. It is running on infinite bus. If its field current is reduced to zero, determine the maximum load that the synchronous motor can carry. Determine also the corresponding armature current.

(20)

(d) A d.c. shunt motor draws an armature current of 50 A from 250 V mains. It is required to increase its speed by 40% by weakening of the field flux. If the torque at the increased speed is also increased by 40%, find the per cent change in the field flux. The armature resistance is 0.2 ohm.

(20)

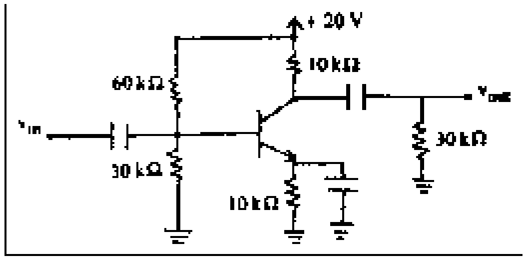
6. (a)



For the class C tuned amplifier shown in the above figure, calculate the maximum load power and the transistor power rating if $V_{CE(sat)}$ = 0.75 V.

(20)

(b)



The transistor shown in the above figure has following h parameters:

$h_{ie} = 1000\ \Omega$, $h_{fe} = 50$, $h_{re} = 3 \times 10^{-4}$ and $h_{oe} = 5 \times 10^{-5}$

Find the voltage gain aid ac. input impedance of the amplifier. Neglect capacitor impedances.

(20)

(c) Describe any two types of A to D converters. Discuss their merits and demerits.

(20)

7. (a) A 500 KVA, 11 K 3-phase, star connected alternator has the following data:

Friction and windage loss = 1500 W

Open circuit core loss = 2500 W

Effective armature resistance per phase 4 ohm

Field copper loss = 1000 W

Find

(i) alternator efficiency at half-full load and 0.8 power factor lagging

(ii) maximum efficiency of the alternator.

(10 + 10)

(b) Describe, giving reasons, the choice of materials for the following applications:

(i) Magnetic tapes

(ii) Recording heads

(iii) Super conductors

(iv) Insulation for 11 KV cable

(5 + 5 + 5 + 5)

(c) Three 600 KVA, 33000/11000 V, 50Hz, 3-phase, Delta/Star transformers are connected in parallel. These transformers give the following test results when operated at the rated full load current with their low voltage windings short-circuited:

Transformer A–300 V, 3000 W

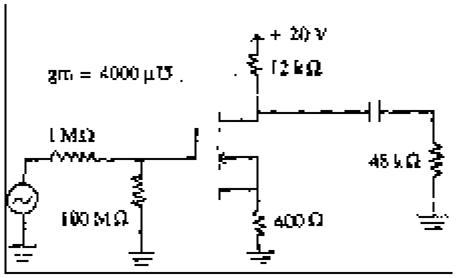
Transformer B–400V, 3500 W

Transformer C–450 V, 4000 W

Determine the maximum load at unity power factor which can be supplied by the parallel combination without overloading any of them.

(20)

8. (a)

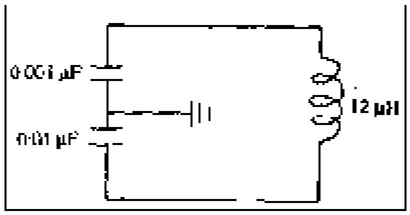


Describe the constructional features of E-MOSFET.

Calculate the voltage gain from gate to drain of the circuit shown in the above figure.

(10 + 10)

(b)



Explain the operation of colpitts oscillator. A colpitts oscillator has a tank circuit as shown in the above figure. Calculate its frequency of oscillation. What should be the minimum gain of the amplifier for the oscillations to start ?

(20)

(c) (i) Show that the use of a synchronous condenser improves the efficiency and regulation of a system.

(10)

(ii) A consumer has a total load of 2000 KW at a p.f. of 0.8 lagging. If it is required to improve the power factor to 0.95 lagging, determine the KVA rating of the synchronous condenser required for the purpose.

(10)

ELECTRICAL ENGINEERING

PAPER - II

SECTION A

Question No. 1 is compulsory

1. Select any three of the following statements, read them carefully and identify correct and incorrect ones. Justify your answer using not more than 200 words in each case:

(20 x 3 = 60)

Case

(a) For a stable system, the gain margin and phase margin should be positive.

(b) Shaft encoders are extremely useful for the measurement of singular displacement.

(c) An SCR is derated when it handles pulsed anode current.

(d) An operation amplifier has features suitable for radio frequency timers.

2. (a) What is Bode-plot? Discuss how a Bode-plot can be drawn.

Derive the step response of a second order system expressed by:

$$a\frac{d_2\theta}{dt}+b\frac{d\theta}{dt}+c\theta = F(i).$$

(20)

(b) (i) Enumerate the salient features of phase-lead and phase lag networks.

(10)

(ii) Design an astable multivibrator with LM 555. Calculate also the duty cycle and frequency of oscillation.

(10)

(c) (i) The pole-zero configuration of a closed-loop control system is given by $(s_1, s_2) = -2 \pm j2$. Calculate the undamped resonance frequency and the damping ratio.

(10)

(ii) Explain Hurwitz stability criteria.

The characteristic equation of a system is represented by

$$4s^3 + 3s^2 + 2s + 3 = 0.$$

Verify the stability of the system through expansion by confined fraction.

(10)

3. (a) Fig. 3(a) shows a circuit employing class-C commutation. The circuit is initially relaxed. Sketch the waveform for V_{T1}, V_{T2}, i_c i_{T1}, v_c and i_{T2} for one cycle for explaining the commutation process of both the thyristors.

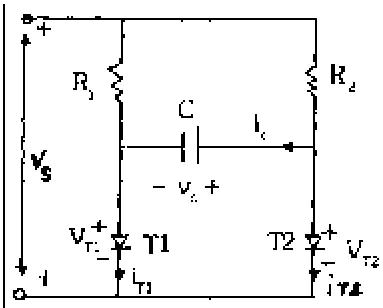


Fig. 3 (a)

(20)

(b) Describe the working of a 3-phase full converter when connected to a resistive load. The firing angle is approximately 70°.

Derive an expression for its average output voltage in terms of firing angle, input supply voltage.

(c) A fixed frequency chopper feeds a separately-excited dc motor supplied from 80 V dc source. The rated speed is 900 rpm and the rated armature current is 40 A. Armature circuit resistance is 0.25Ω. Find the duty cycle of the chopper at half the rated motor torque for a speed of 300 rpm ignoring the current pulsations.

(20)

4. (a) Enumerate states and state variable representation of a dynamic system.

Determine, by Routh array, whether a system represented by characteristic equation.

$$s^3 + 4s^2 + 8s + 11 = 0$$

is stable or not.

(20)

(b) Discuss the principle of working of a 3-phase bridge inverter with an appropriate circuit Draw phase and line voltage waveforms on the assumption that each thyristor conducts for 180° and the resistive load is star connected. Indicate the sequence of firing for thyristors as well.

(25)

(c) Explain the mechanism for the dissipation of stored energy in a SCR during its commutation process.

(15)

SECTION B

Question No. 5 is compulsory

5. Select any three of the following statements and justify the correctness or otherwise of them, restricting your answer to within 200 words for each:

(3 x 20 = 60)

(a) Restriking transients can be damped by connecting a resistance across the contracts of a circuit breaker.

(20)

(b) Gauss-Siedel method is preferred for load flow studies of large power system due to its quadratic convergence.

(20)

(c) An electrical machine has cylindrical stator and salient- pole rotor. Reluctance torque is produced when exciting winding is on the rotor.

(20)

(d) If the rotor of a 3-phase induction motor is assumed purely inductive, the electromagnetic torque would be optimum with load angle equal to 90°.

(20)

6. (a) Which type of distance relay is preferred for EHV transmission lines ? Discuss its principle of operation with its salient features.

(20)

(b) Develop necessary equations and explain the Newton-Raphson method in polar co-ordinates for solving the load flow problem when both load and voltage-controlled buses are present in the system.

(20)

(c) A 3-phase, 4-pole, 50 Hz, star-connected induction motor, during short circuit test, took 100 A and 30 kW. In case stator resistance is equal to equivalent standstill rotor resistance, calculate the starting torque.

(20)

7. (a) An overhead transmission line, with a surge impedance of 500 Ω, has a load comprising of a 10 kilo-ohm resistor is parallel with a 0.005 μF capacitor connected across the far end. A surge voltage of 10 kV magnitude and unit step travels along the line. Determine an expression for the time variation of the voltage across the load and calculate this voltage 5 μs after the arrival of the wave front of the surge.

State any assumptions made.

(20)

(b) A 3-phase generator, an open circuit, is excited to give a voltage of 2200 V between lines. The absolute values of fault currents for various types of faults are:

(i) 3-phase fault : 127.0 Amps

(ii) L–L fault : 129.5 Amps

(iii) L–G fault : 190.0 Amps

Find the positive, negative and zero-sequence reactances of the generator. Assume the resistance to be negligible.

(20)

(c) Explain how the power factor of a 3-phase induction motor is controlled by static capacitors. Show that for a constant capacitance, the degree of power factor correction is not the same at different loads.

(20)

8. (a) Describe the constructional features and working of a 2-phase, 4/6 pole hybrid stepping motor.

Discuss its torque-displacement characteristics also.

(20)

(b) A salient-pole synchronous motor; with $r_a = 0$, $X_d = 1.0$ pu and $X_q = 0.5$ pu, is operated on infinite bus-bar of 1.00 pu voltage. Show that for one per-unit synchronous power, the excitation voltage is given by $E_1 = \operatorname{cosec} \delta - \cos \delta$.

Also derive the condition for load angle when synchronous power is maximum.

(20)

(c) The generalized constants A and B of a transmission line are $0.96 \angle 1°$ and $100 \angle 80°$ respectively. If the line to line voltages at the sending and receiving ends are both 110 kV and phase angle between them is 30°, find the receiving end power factor and current. With the sending end voltage maintained at 110 kV, if the load is suddenly thrown off, find the corresponding receiving end voltage.

(20)

SECTION C

Question No. 9 is compulsory.

9. Select any three of the following statements and indicate with justification whether they are correct or incorrect. Your answer must not exceed 200 words for each statements.

(20 x 3 = 60)

(a) The characteristic of a twin–T network is similar to that of a notch filter in audio frequency range.

(b) The transposition of telephone lines is desirable.

(c) Magnetrons are capable of delivering low pulsed power output.

(d) Only one kind of dielectric substrate is used in microwave integrated circuits (MICs).

10. (a) Define spectral density and auto-correlation function for the measurement of noise.

Find out the spectral density and auto-correlation function of the output when white noise with spectral density η is applied to a low pass RC filter. Derive the expressions used.

(30)

(b) Discuss the microwave spectrum in satellite communication.

(c) Describe the technique of making stereophonic FM broadcast compatible with monophonic system.

(20)

11. (a) Discuss the realization techniques, with circuit diagrams, for inductor and capacitor in microwave communication.

(20)

(b) Derive the equivalent circuits and find out 'Q' factor of the inductor and capacitor. State any assumptions made.

(20)

(c) Enumerate the salient features of wave guides with diagrams based on band width and power handling capabilities.

(20)

12. (a) Describe the relative merits of single mode and multimode fibres used in communication system.

(20)

(b) Describe the schematic arrangement of pulse-code modulation by using optical fibre.

(20)

(c) Draw a schematic diagram and discuss how the thickness of foil can be measured by microwave sensors.

(20)