I.E.S. (Conv.) - 1999

ELECTRICAL ENGINEERING

PAPER – I

Time Allowed: 3 Hours **Maximum Marks: 200**

Candidates should attempt SIX questions, selecting TWO question from Section - A, ONE from Section - B, ONE from Section - C and TWO from Section – D. Assume suitable data, if necessary and indicate the same clearly.

SECTION A

1. (a) In Fig. 1, the switch was in position 2 for a long time. It is switched to position 1 at t = 0. At t = 5 sec it is switched back to position 2 and left there. Obtain an expression for i(i), the capacitor current for t > 0.

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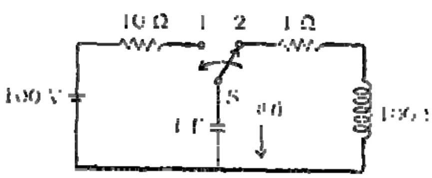

Fig 1

(b) A circuit is made up of a 10 Ω resistance, a 1 μF capacitance and a I h-inductance all connected in series A voltage of 100 V at varying frequencies is applied to the circuit. Find the frequency (or frequencies) at which the circuit would consume only 10% of the power it consumed at resonance.

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(c) A 2-poe network made up of passive linear resistors is fed at port 1 by an ideal voltage source of V volts.

It is loaded at port 2 by a resistance R:

(i) With V = 10 volts and R = 6Ω, currents at ports 1 and 2 were 1.44 A and 0.2A respectively.

(ii) With V = 15 V and R = 8 Ω, the current at port 2 was 0.25 A.

Determine the π-equivalent circuit of the 2-pod network.

12

2. (a) Derive expressions for the hybrid parameters in terms of the Transmission parameters. Hence interpret the relation AD — BC = 1 in terms of hybrid parameters.

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(b) Find the input resistance of the infinite ladder network of Fig.2.

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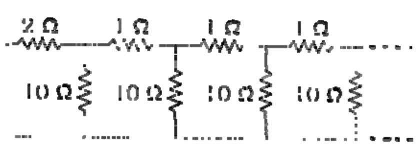

Fig. 2

(c) For the circuit of Fig. 3 choose a set of state variables and derive the voltage, current equations necessary for solving the circuit in terms of the chosen state variables.

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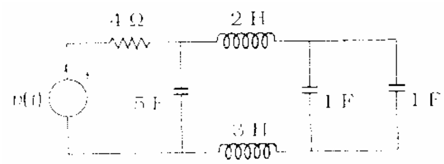

Fig. 3

(d) Given the impulse response of a system is e^{-t} obtain the system response for an input a sin cit using the convolution integral?

8

3. (a) The open loop gain G(s) H(s) of a feedback control system is

$$\frac{K(s+10)(s+40)}{S(s+1)(s+4)}$$

Work out and sketch the Nyquist plot for the system and comment on the stability of the closed loop system for—

(i) K = .01 (b) K = 100

12

(b) Fig. 4 is a block diagram of a linear feedback system. Obtain a signal flow graph for the system and hence calculate the overall gain C(s)/R(s) for the system.

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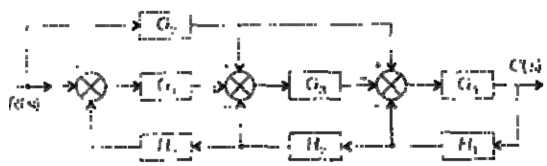

Fig. 4

(c) What is 'aliasing' in respect of obtaining z-transforms and their inversions? How are the effects of aliasing reduced in a digital system?

4

(b) Consider a zero-order hold circuit, with a sequence of discrete inputs sampled at an interval of T sec. In terms of the Laplace transform of this sequence, find the Laplace transform of the output of the hold circuit.

8

SECTION B

4. (a) Determine the force exerted per meter by a 2 mm dia conductor of infinite length on a similar parallel conductor 1 m away, when a potential of 1000 V is existing between them. Make suitable assumptions about other details you need, and state them.

12

(b) Derive Laplaces equation pertaining to electrostatic potential distribution in a charge free space. Show how this is useful in computing the potential distribution in a two-digressional electrostatic problem using a digital computer

12

(c) The electron gun of a TV display tube emits electrons almost at zero velocity. These are accelerated through an electric held of 1000 V/cm over a distance of 5 cm. Then the pass through a vertical deflecting coil producing a flux density of 0.01 Wb/m^2 over a distance of 1 cm. If the screen is at a distance of 10 cm from the centre of the deflecting system calculate the deflection produced (charge per unit mass for electrons is 1.759×10^{11} C/kg).

12

5. (a) (i) Using Maxwell's equations, derive equations to demonstrate the propagation of uniform plane waves in a perfect dielectric medium.

(ii) The magnetic field intensity H of a plane wave in free space is 0.20 A/m and is in the '1-direction. If the wave is propagating in the Z-direction with a frequency of 3 GHz, find the wavelength, amplitude and direction of the E-vector, $\mu_0 = 4\mu \times 10^{-7}$ H/m and $\varepsilon_0 = 8.85 \times 10^{-12}$ F/m.

12 + 12

(b) Discuss the wave propagation in

(i) a lossy dielectric;

(ii) a conductor.

Derive relevant equations.

12

SECTION C

6. (a) (i) Discuss the wave nature of any matter in motion as postulated by de brogile.

(ii) Calculate the wavelength λ of an electron with kinetic energy of 300 eV.

Mass of an electron = 9.108×10^{-31} kg

Charge = 1.602×10^{-19} C

Planck's constant

h = 6.626×10^{-34} J-s.

4 + 8

(b) (i) What are the different ways in which liquids may be electrically polarized?

(ii) What is ferro-electric behaviour in crystals? What causes this?

6 + 6

(c) Explain any three of the following:

Diamagnetism; paramagnetism; ferromagnetism; antiferromagnetism; ferrimagnetism

12

7. (a) Explain the existance of the various electron energy hands in solids based on these hands distinguish between insulators, conductors and semi-conductors.

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(b) Giving relevant defining equations, explain the phenomenon of drift and diffusion associated with carrier movement in semiconductors.

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(c) Consider an abrupt p-n junction with donor density to atoms/cm and acceptor density $N_A = 0.5 \times 10^{16}$ atoms/cm^3. Sketch the charge distribution about the junction and estimate the junction width when—

(i) no external voltage is applied. (assume the junction barrier voltage to be 0.7V)

(ii) with an external voltage of -10 V applied.

Assume uniform charge distribution on both sides of the junction in the space charge region. Assume an ε_r of 10 for the material and $\varepsilon_0 = 8.85 \times 10^{-12}$ F/m.

14

SECTION D

8. (a) What do you understand by the dimension of a quantity? Obtain the dimensions of resistance R, inductance L and capacitance C in terms of mass length time and current. Hence, check dimensionally if the equation $R^2C = L$ is balanced. If not, indicate the missing dimension.

10

(b) A strain measuring Wheatstone Bridge used two identical and identically strained gauges in its opposite arms, Prove that the bridge will have maximum sensitivity for strain when the resistances in the other two arms are equal and equal to the unstrained resistance of the gauges.

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(c) Many voltage measuring system like potentiometers. A/D or D/A converters etc. require some standard reference voltages. Describe any two of such reference voltages and give an idea as to their accuracy:

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9. (a) (i) What are the advantages of integrating type A/D converters over the non-integrating type? What integrating interval would you recommend for a world class A/D converter to eliminate the power frequency related (50 Hz and 60 Hz, both) ripples from affecting the measurement?

(ii) Describe any good integrating A/D converter with a circuit diagram and explain its operation

6 + 6

(b) Distinguish between active and passive electrical transducers and give some examples of each. Show how operational amplifiers could be used to interface a weak voltage signal output from an active transducer to a measuring system requiring comparatively larger voltage and power.

10

(c) With a block diagram, explain a typical data logging system.

10

10. (a) What is a Wien Bridge? What are its uses?

Show how a variable frequency oscillator can be built using an operational amplifier with a Wien Bridge. Derive an expression for the frequency of oscillation of the circuit.

10

(b) Explain the following and bring out their relative merits

12

(i) EM (ii) PCM (iii) Delta modulation

(c) Discuss briefly the different methods of measuring the following

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(i) Liquid flow

(ii) Temperature of the order of 1000 K.

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ELECTRICAL ENGINEERING

PAPER - II

Time Allowed: 3 Hours **Maximum Marks: 200**

Candidates should attempt FIVE questions in all, choosing at least ONE from each section.

SECTION A

1. (a) With necessary circuit diagrams explain the open-circuit test and short – circuit test conducted on single. Phase transformer. Justify that the copper loss in the open-circuit test condition and the iron loss in the short – circuit test condition are normally neglected

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(b) A 500 kVA single phase transformer with 0.012 p.u. resistance and 0.06 p.u. reactance, is connected in parallel with a 250 kVA single phase transformer with 0.014 p.u. resistance and 0.045 p.u. reactance to share a load of 600 kVA at 0.8 power factor logging. Find the 2VA and power factor shared by each transformer.

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(c) A 220 V d.c. shunt motor takes 20A at rated voltage and runs at 1000 rpm. Its field circuit resistance is 100 Ω and armature circuit resistance is 0.1Ω. Compute the value of additional resistance required in the armature circuit to reduce the speed to 800 rpm when

(i) the load torque is proportional to speed

(ii) the load torque varies as the square of the speed.

16

2. (a) What are the conditions to he satisfied for a d.c. shunt generator to built up? Explain the process of building up of emf in a d.c. shunt generator.

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(b) A 10 kVA, 440 V, 50 Hz. three phase alternator has the following OCC:-

Field current (amp.)	**Terminal voltage (Volts)**
1.0	100
3.0	300
5.0	440
8.0	550
11.0	600
15.0	635

With full load zero power factor load applied, an excitation of 14 A produced a terminal voltage of 500 V On short circuit, 4 A excitation was required to circulate the full load current. Using MME method, determine the full load percentage regulation for 0.6 p.f. lagging and 0.6 p.f. leading.

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(b) Explain how to determine the direct and quadrature axis reactances of a salient pole synchronous machine.

10

3. (a) Describe with the help of an appropriate diagram the Star-Delta method of starting a three-phase induction motor.

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(b) A 400 V 6 pole, 50Hz, three phase star connected induction motor running at rated voltage lakes 7.5 A with a power input of 700W. With the rotor blocked and 150 V applied to the stator the input current is 35 A and the power input is 5000W. The rotor and the stator copper losses are equal under the blocked rotor condition. The standstill leakage reactance of the stator and rotor as seen from the stator are estimated to be in the ratio of 1:0.5. Obtain the equivalent circuit of the induction motor. Calculate the net mechanical power output, torque, input power and the efficiently at a slip of 4%.

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(c) Explain the operation of single phase capacitor start motor.

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SECTION B

4. (a) Develop the long line exact equations in hyperbolic terms for the sending end voltage and current.

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(b) For the power system with the following line data compute the bus admittance matrix with four digit accuracy:-

Bus Code	Line	impedance	HLCA	Off nominal trans. ratio
1-2	005	+ j 0.12	j 0.025	-
2-3	0.0	+ j 0.40		1.05
3-4	0075	+ j 025	j 0.002	-
1-3	0.045	± j 045	0.015	-
1-4	0.015	+ j 005	-	-

15

(c) Develop necessary equations and describe the load flow solution using Gauss Seidel method.

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5. (a) In the power system shown in Fig. I the values marked are the per unit reactances taking 20 MVA and 11 kV as base values in the generator circuit. Both the transformers are rated for 11/110 kV.

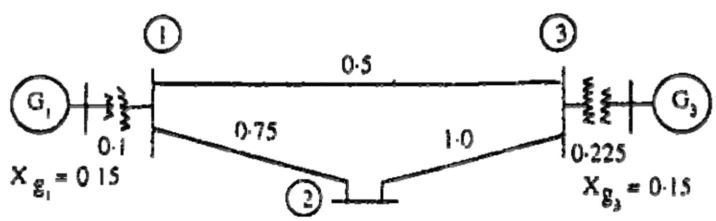

Fig. I

A three phase to ground fault with a fault impedance of j 0.038 p.u. occurs at bus 2. Determine the actual values of fault current at and the currents supplied by the generators

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(b) Consider the bower system shown in Fig. 2. The values marked are per unit reactances and per unit voltages.

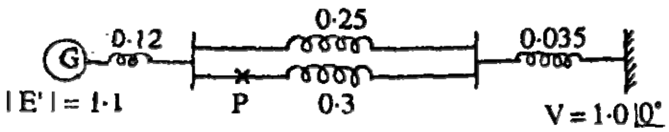

Fig.2

The generator was delivering 1.0 p.u. power before a three phase fault occurs at P. The fault was cleared by opening the circuit breakers and isolating the faulty line in 5 cycles. Generator has an inertia constant of 4.0 p.u. Using point by point method, with time interval of 0.05 sec. obtain the swing curve for a period of 0.2 sec. Assume f = 50 Hz.

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(c) Briefly discuss the advantages and the operational problems of HVDC transmission.

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SECTION C

6. (a) What are Astable, Monostable and Bistable multivibrators?

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(b) Describe the realization of transistor type monostable multivibrator.

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(c) For the monostable multivibrator calculate the output pulse width for the design values of R_C = 2 kΩ; R_B = 20 kΩ; C = 0.1 μF and V_{CC} = 12 V. Assume $V_{CE(sal)}$ = 0.2V; $V_{BE(sat)}$ = 0.8V and β = 50. Check up the saturation of the transistor so that the circuit acts as a monostable multivibrator.

16

7. (a) Explain with figure the working of a typical inductance type high frequency oscillator.

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(b) Discuss the limitations in realization of radio frequency signals using transistor circuits.

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(c) Explain how to realize radio frequency signals using crystal oscillator.

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(d) The parameters of a crystal oscillator equivalent circuit are L_s = 0.8 H; C_s = 0.08 pf: R_s = 5 kΩ and C = 1.0 pf. Determine the resonance frequencies f_s and f_p.

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8. (a) Explain the three different formats for the control field of SDLC message frame. How can multiple frames be transmitted without waiting for an acknowledgement from the receiver?

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(b) Write a program to add five 16 bit numbers stored in the memory with LSB first and MSB next and to store the 24 bit result in three consecutive memory locations.

14

(c) Write a program to generate sawtooth waveform using a DAC interface. Assume that a bipolar voltage in the range of -5V to +5V for a count of OO_H to FFH can be produced through DAC.

14

SECTION D

9. (a) What are the merits and demerits of amplitude modulation over frequency modulation?

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(b) Explain the square law modulation for the generation of AM signals.

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(c) Consider a carrier waveform 10 cos $w_c t$ and a modulating message signal 3 cos $w_m t$ with f_c = 100 kHz and f_m = kHz. Calculate the modulation index and the channel bandwidth for amplitude and frequency modulation. Assume the sensitivity of the frequency modulator to be 5 kHz per volt.

12

10. (a) What are the different methods of voltage control of single phase inverters? Explain them

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(b) A three phase inductive compensator (TCR) has an inductance of L Henry per phase and negligible resistance. P controlled by a pair of antiparallel SCRs in each phase. The triggering angle α is varied to get the required compensation. The supply voltage is V volts per phase. Derive the expressions for the ms voltage and corresponding rms current per phase of the the compensator.

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