I.E.S. (Conv.) - 2000

ELECTRICAL ENGINEERING

PAPER – I

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

Candidates should attempt SIX questions, selecting TWO question from Part - A, ONE from Part - B, ONE from Part - C and TWO from Part - D.

SECTION A

1. (a) Write the Kerchief's voltage law equations for the network of Fig. 1. For v_1 (t) = $10_e^{-0.02t}$. u(t), find the expression for current i_2(t) and voltage v_2(t).

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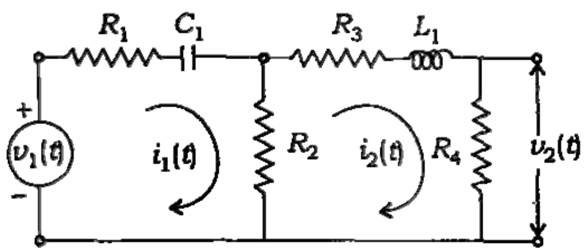
Given $R_1 = R_2 = R_3 = 1$ ohm, $C_1 = 1$ F,

$L_1 = 1$ H, $R_4 = 4$ ohms

Fig. 1



(b) The network shown in Fig. 2 has attained steady conditions with switch K open. At t = 0; the switch K is closed. Apply Norton's theorem or Thevenin's theorem to obtain expression for current i (t) through resistor R_4.

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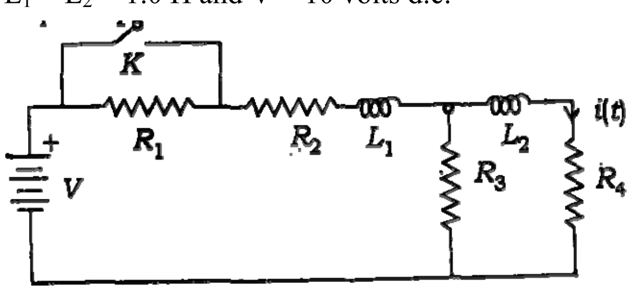
Given $R_1 = R_2 = R_3 = 1$ ohm,

$L_1 = L_2 = 1.0$ H and V = 10 volts d.c.

Fig. 2



(c) What do you understand by transient- and steady-state response? How can they be identified in a general solution?

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2. (a) Nodal determinates of a 3-node network with 3rd node as datum node is known to be with the following elements:

$$y_{11} = \frac{(s+3)}{2(s+1)}, y_{12} = \frac{-1}{(s+1)}, y_{22} = \frac{s^2+13s+8}{4s(s+1)}$$

Determine the network with its components. Also determine the expression for current I(s) in the resistor at 2nd node, if a 10 u (t) ampere generator is connected at node 1.

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(b) What do you understand by

(i) zeros of a function; (ii) zeros of transmission?

What information do poles and zeros provide in respect of a network to which they relate?

Draw poles and zeros for

$$V(s) = \frac{s^2 + 3s + 2}{s^2 + 7s + 12}$$

and evaluate v (t) either analytically or by making use of pole zero diagram.

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(c) (i) Derive from the first principle the Laplace transform of a unit step function. Hence or otherwise, determine the Laplace transform of unit ramp function and unit impulse function. 4

(ii) Discuss the advantages of Laplace transform method over the conventional classical methods of solving the linear differential equations with constant coefficients.

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3. (a) Write down the governing differential equations for the translational system shown in Fig. 3 and hence find the transfer function f_0/f_1

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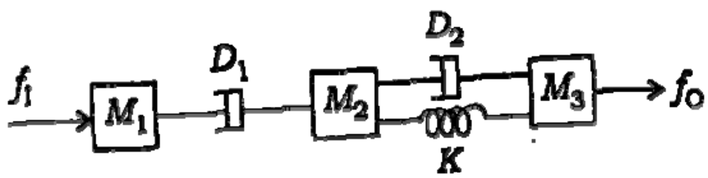

(b) What do you understand by the terms 'open - loop system', 'closed- loop system', 'manual control system and 'automatic control system'? Give one practical example of each type with proper diagram and explanation.

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(c) Define stability. Discuss any two methods for finding the stability of a linear system. What are the advantages of Routh's criteria of finding stability of a system over other methods?

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SECTION B

4. (a) State Gauss's law and develop its mathematical form. Give two examples of its applications.

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(b) For $\overline{F} = xy^2\overline{a}_x + yz^2\overline{a}_y + 2xz\overline{a}$, calculate the line integral $\int_C \overline{F}.\overline{dl}$ where C is the straight line between points (0, 0, 0) and (1, 2, 3).

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(c) The permittivity of the dielectric material between the plates of a parallel plate capacitor varies uniformly from ε_1 at one plate to ε_2 at other plate. Show that the capacitance is given by

$$C = \frac{A}{d}\frac{\varepsilon_2 - \varepsilon_1}{\log_e(\varepsilon_2 / \varepsilon_1)}$$

where A and d are the area of each plate and separation between the plates respectively.

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5. (a) Obtain by means of Laplace's equation, the potential distribution between two coaxial conducting cylinders of radii a and c with dielectric of constant ε_1 filling the region between a and b and a second dielectric of constant ε_2 filling the region between b and c. Given: $c > b > a$.

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(b) From Maxwell's curl equations derive the wave equation in E for a plane wave travelling in the positive Y-direction in an isotropic homogeneous lossless medium. The electric field is in Z-direction.

Assuming harmonic variation, state a solution of this equation and prove that it is a solution.

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(c) Define in relation to travelling waves, the following:

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(i) Reflection coefficient (ii) Transmission coefficient (iii) Standing-wave ratio

SECTION C

6. (a) (i) What is meant by relaxation time, collision time and mean free path as applied to conduction phenomenon?

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(ii) A conduction wire has a resistively of 1.54×10^{-8} ohm-m at room temperature. There are 5.8×10^{28} conduction electrons per m^3. Calculate the mobility and relaxation time of electrons.

6

(b) (i) List some of the ferroelectric materials and indicate their properties.

6

(ii) Explain the phenomenon of spontaneous polarization in ferroelectric materials.

6

(c) What are the properties of good insulating materials for use in electric devices? Give the classification of solid insulating materials.

12

7. (a) Explain the terms - Diagmagnetism, Paramagnetim, Ferromagnetism, Ant ferromagnetism and Ferrimagnetism with reference to magnetic dipoles of the atoms. Discuss the origin of such dipoles.

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(b) Discuss the property of Ferromagnetic materials which make them suitable for data storage in computers.

12

(c) Briefly explain the following theories of breakdown of liquid dielectrics

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(i) Colloidal theory (ii) Bubble theory (iii) Electronic theory

SECTION D

8. (a) (i) What is the difference between fundamental and derived units?

6

(ii) Give the salient features of primary and secondary standards.

6

(b) Two sets of large number of 10 kΩ and 15 kΩ resistors are used to make a large number of 6 kΩ and 25 kΩ resistors choosing one from each group. If the uncertainties of the two sets of resistors (10 kΩ and 15 kΩ) are 5% and 10% respectively, find the uncertainties of the combined resistor-sets (6 kΩ and 25 kΩ).

8

(c) Explain the construction and working principle of an electrodynamometer type wattmeter. How is this wattmeter compensated for power measurement at low power factors?

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9. (a) Compare an analogue type EVM with a DVM. Show that differential amplifier type EVM has the indicator current proportional to the unknown voltage V_x.

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(b) A Schering bridge is used for measuring the power loss in dielectrics. The specimens are in the form of discs 0.3 cm thick having dielectric constant of 2.3. The area of each electrode is 314 cm^2 and the loss angle is known to be 90 for a frequency of 50 Hz. the fixed resistor of the network has a value of 1000 Ω and the fixed capacitance is 50 pE Determine the values of the variable resistor and capacitance required.

Derive the equations for balance and draw the phasor diagram under balance conditions.

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(c) Describe in details the successive approximation method of analogue to digital conversion.

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10. (a) Explain the construction and principle of linear variable differential transformer used for measurement of displacement.

Why is the frequency of excitation of primary winding kept very high as compared to the frequency of the signal being detected?

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(b) Describe the construction and working of thermistors.

Draw their resistivity versus temperature characteristics to show that they have a very high value of sensitivity as compared with that of metals.

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(c) What are the different methods of data transmission? Explain with the help of a block diagram, a general telemetry system. What do you understand by TDM and FDM?

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ELECTRICAL ENGINEERING

PAPER - II

Candidates should attempt FIVE questions in all, including Question No. 1 which is compulsory. The remaining FOUR questions are to be attempted by selecting at least ONE question from each of the Sections A, B, C and D.

SECTION A

Question No. 1 is compulsory.

1. **A.** Tick out the connect answer

(a) As the line inductance increases the transmission capacity

(i) increases (ii) decreases (iii) remains the same

(b) As compared to the sending end voltage, the receiving end voltage of a short line under no load condition is

(i) higher (ii) lower (iii) remains the same

(c) An equipment has a per unit impedance of 0.9 P.U. to a base of 20 MVA, 33 KV. The P.U. impedance to the base of 50 MVA and 11 KV will be

(i) 4.7 (ii) 20.25 (iii) 0.9

(d) The symmetrical components are used in the fault analysis because

(i) the number of equations becomes smaller

(ii) the sequence of networks do not have mutual couplings

(iii) the results are required in terms of symmetrical components

(e) In a load flow study a P-V bus is treated as a P-Q bus when

(i) voltage limit is violated

(ii) active power limit is violated

(iii) phase angle is high

(iv) reactive power limit is violated

(f) The use of high speed circuit breakers

(i) improves transient stability

(ii) decreases transient stability

(iii) has no effect on system stability

(g) The constant H of a turbo generator of 200 MVA is 6.0. Its value corresponding to 300 MVA base will be

(i) 9.0 (ii) 4.0 (iii) 6.0 (iv) 13.5

(h) If the inductance and capacitance of a system are 1.0 H and 0.01 μF respectively and the instantaneous value of current intemipted is 10 amps, the voltage across the circuit breaker contacts will be

(i) 50KV (ii) 100KV (iii) 57KV (iv) 60KV

(i) A voltmeter gives 120 oscillations per minute when connected to the rotor of an induction motor. The stator frequency is 50 Hz. The slip of the motor is

(i) 2% (ii) 4% (iii) 5% (iv) 2.5%

(j) A 100/10 V, 50 VA double winding transformer is converted to 100/110 V autor transformer. The rating of the auto transformer is

(i) 550 VA (ii) 500 VA (iii) 11OVA (iv) 100 VA

$10 \times 2 = 20$

B. Explain the following with proper reasoning:

(a) Why the secondary of a current transformer is never kept open circuited?

(b) Why a 'Mho relay' is normally used for the protection of a long distance transmission line?

(c) Why the maximum number of instructions possible in an 8 bit Microprocessor is 256?

(d) Why a d.c. series motor is used for fraction drive?

(e) Why a decaying d.c. offset current wave appears when an a.c. circuit breaker is suddenly switched on to an inductive circuit at the instant when voltage wave is passing through zero?

$5 \times 4 = 20$

2. (a) Two d.c. generators having rectilinear external characteristics operate in parallel. One machine has the terminal voltage of 270 V on no load and 220 V at the load current of 30 A. The other has a voltage of 280 V at no load and 220 V at the load current of 30 A. Calculate the output current and the bus voltage of each machine when

(i) the total load current is 50 A

(ii) the load resistance of 10 ohms 16

(b) A 5 KVA, 220/110 V single phase transformer has the maximum efficiency of 96.97% at power factor logging. Its core loss is 50 W and full load regulation at 0.8 p.f. lag is 5%. Find the efficiency and regulation at 3/4 th full load, 0.9 p.f. lagging. At what p.f. at full load the regulation will be

(i) maximum (ii) minimum, and (iii) zero?

Calculate the maximum and minimum regulation?

16

(c) What do you understand by the term vector group of a transformer? Show the terminal connections pf a 3-phase transformer having vector groups.

(i) DY11

(ii) Dd6, and the corresponding phasor diagrams

8

3. (a) Discuss about the 'open circuit' and 'short circuit characteristics of a synchronous generator. Draw the phasor diagram under short circuit condition. What do you understand by the term 'short circuit ratio"? Discuss how the short circuit ratio can be calculated from the two characteristic curves.

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(b) A 2000 KVA, 11 KM 3-phase star connected alternator has a resistance of 0.3 ohm and reactance of 5 ohms per phase. It delivers full load current at a p.f. of 0.8 lagging and normal rated voltage. Compute the terminal voltage for the same excitation and load current at a 0.8 p.f. leading.

10

(c) A 50 Hz, 3-phase induction motor designed for voltage V_1 is switched on to 40 Hz supply of voltage V_2. Find

(i) the ratio of starting torques, starting currents and maxi- mum torques when $V_2 = 1.5 V_1$.

(ii) the ratio of V_1 to V_2 to give equal values of starting torques both at 40 Hz and 50 Hz. Ignore stator impedance and neglect rotor resistance.

18

SECTION B

4. (a) Prove that for a line to ground fault, all three sequence networks must be connected in series to obtain the sequence currents.

6

(b) A 10 MVA 13.8 KV alternator has positive, negative and zero sequence reactance's of 30%, 40% and 5% respectively.

(i) what reactances must be put in the generator neutral so that the fault current for a line-to-wound fault of zero fault impedance will not exceed the rated line current?

(ii) what value of resistance in the neutral will serve the same purpose? Express both the resistance and reactance in P.U. and in ohms.

10

(c) Derive the equation

$Y_{Bus} = A^t yA$, where Y_{Bus} - Bus impedance matrix,

$Y \rightarrow$ Bus incidence matrix, $A^t \rightarrow$ Transpose of A.

$y \rightarrow$ primitive admittance matrix.

10

(d) Compute the bus admittance matrix, primitive admittance matrix, and bus-incidence matrix in a 3-bus power system.

Bus code	**Admittance**
1-Ground	y_1
2-Ground	y_2
3-Ground	y_3
1-2	Y_4
2-3	Y_5
3-1	Y_6

Y_4, Y_5 and Y_6 are mutually coupled with each other.

14

5. (a) Define the term "Plug Setting Multiplier" and "Time Multiplier Setting" as used in the context of an IDMTL relay.

How many plug selling and time multiplier setting are available with a standard IDMTL relay?

5

(b) A 20 MVA transformer which is used to operate at 30% overload feeds an 11 1KV bus bar through a CS. The transformer C.B. is equipped with a 1000/5 current transformer and the feeder G.B. with a 400/5 current transformer and both the current transformers feed IDMTL relays having the following characteristics,

Plug Setting Multiplier	2	3	5	10	15	20
Time (Sec.)	10	6	4.1	3	2.5	2.2

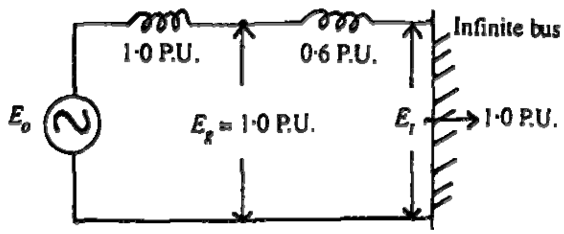
The relay on the feeder C.B. has 125% plug setting and a 0.3 time multiplier setting. If a fault current of 5000 amps flows from the transformer to the feeder, determine

(i) the operating time of feeder relay

(ii) suggest suitable plug setting and time multiplier selling of the transformer relay to ensure adequate discrimination of 0.5 sec. between the transformer relay and the feed relay.

15

(c)



Find the steady-state stability limit of a system shown in the above figure, consisting of a generator of equivalent reactance 1.0 P.U. connected to an infinite bus through a series reactance of 0.6 PU. The terminal voltage of the generator (E_g) is held at 1.0 P.U. and the voltage of infinite bus (E_t) at 1.0 P.U.

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(d) An alternator with negligible damping is connected to an infinite bus. Write down its swing equation in usual form. How inertia constant H is defined here? Deduce the equal area criterion condition.

10

SECTION C

6. (a) What are the criterion of good "addressing mode"? Discuss with examples the different addressing modes used in an Intel 8085 microprocessor.

10

(b) Eight nos of 8 bit data are stored in consecutive memory locations, Develop programs in Assembly level language to determine

(i) the largest element in the block of data.

(ii) the smallest element (value $\geq$ 00H) in the same block of data

Give suitable comments.

10

(c) Sixteen nos of B bit data are stored in consecutive memory locations. Develop a program in Assembly language (without resorting to normal division routine) to determine the average value of the data. Make provision to store the quotient in two consecutive memory locations and the remainder in the next location. Give proper comments.

20

7. (a) What are the advantages of a "Switching Mode" d.c. voltage gulator over a "Linear Mode" one. Give the basic block diagrams of the two types and explain their operations. What is the purpose of energy storage elements in "Switching Mode' one?

10

(b) Explain the principle of operation of

(i) 'S-P type flip flop

(ii) D-type flip flop and

(iii) J-K type flip flop

Give their corresponding truth tables and their circuit diagrams.

10

(c) What should be the ideal characteristics of an operational amplifier? Name them. Distinguish between virtual ground and actual ground. Define the term "Common mode rejection ratio". How will you measure it?

10

(d) Give the circuit diagram of an "Unity gain amplifier" using operation amplifier. Discuss how with the help of unity gain amplifiers sample and hold circuit can be developed. Discuss with the help of a block diagram the function of a sample and hold amplifier used in the context of an A/D converter.

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8. (a) Draw the circuit diagram of an "UP-DOWN" ripple counter and explain its operation. How with the help of four J-K flip flops and associated circuitry a "decade counter" can be obtained. Discuss its operation.

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(b) Discuss where the sinusoidal oscillators are used? For phase shift oscillator why three sections of 'R-C' circuits are cascaded. Draw and explain a simple phase shift oscillator using three sections of R-C circuit and a transistor. Derive the formula for the frequency of oscillation. Make comments on the transistor current gain. Design the values of R-C to give oscillation of say nearly 1 kHz.

20

SECTION D

9. (a) What is an IGBT? Give the cross section and the equivalent circuit for IGBT. Make a comparative assessment between a BJI MOSFET and an IGBT.

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(b) Discuss with necessary circuit diagram and wave form the principle of operation of a single phase full bridge inverter. Obtain an expression of instantaneous load current for a R-L load. Name the different methods used for controlling the output voltage of inverters. Explain briefly the sinusoidal pulse width modulation technique.

20

(c) Enumerate the basic differences between a Triac and thyristor. Draw and explain V-I characteristic of a Triac. Draw and explain a full wave triac phase control circuit.

10

10. (a) What are the systems employed for generation of SSB ? Name them. How does balanced modulator suppress the carrier? Draw the circuit of a balanced modulator using PET and explain it Discuss the filter method of side band suppression with the help of a block diagram.

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(b) In a phase shift SSB system, the phase shift at the audio frequency of 500 Hz is only 880. To what extent will this frequency be present in the lower side band?

8

(c) In a broadcast super heterodyne receiver having no RF amplifier, the loaded Q of the antenna coupling circuit (at the input to a mixer) is 150. If the intermediate frequency is 455 kHz, calculate

(i) the image frequency and its rejection ratio at 1000 kHz. &

(ii) the image frequency and its rejection ratio at 20 MHz,

12