2517
9.30 AM.

09/1

2005

ELECTRICAL ENGINEERING

Paper 1

Time : 3 Hours] *[Maximum Marks : 300*

INSTRUCTIONS

Candidates should attempt ***all*** *the questions in Parts A, B & C. However, they have to choose only* ***three*** *questions in Part D. The number of marks carried by each question is indicated at the end of the question.*

Answers must be written in English.

This paper has four parts :

A	20 marks
B	100 marks
C	90 marks
D	90 marks

Marks allotted to each question are indicated in each part.

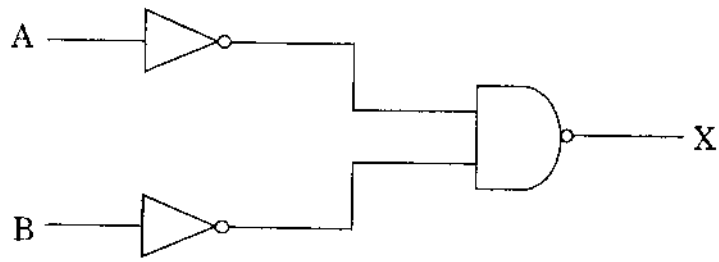
PART A

4×5

Each question carries 5 marks.

1. (a) When a DC current is passed through a iron-cored coil, the energy stored in the magnetic field is 1000 J, and the copper loss in the coil is 2000 W. Find the time-constant of the coil.

(b) For the circuit shown in figure, find the output X.



(c) What are the physical effects used in electrical measuring instruments ?

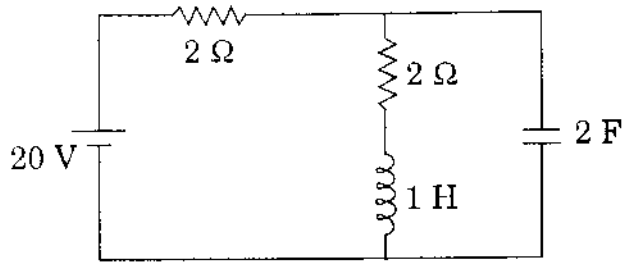
(d) Briefly explain the factors that influence the space-wave propagation.

PART B

10×10=100

Each question carries 10 marks.

1. Under steady state conditions, evaluate the total power dissipated, the energy stored in the inductor and the energy stored in the capacitor in the circuit shown in Figure.

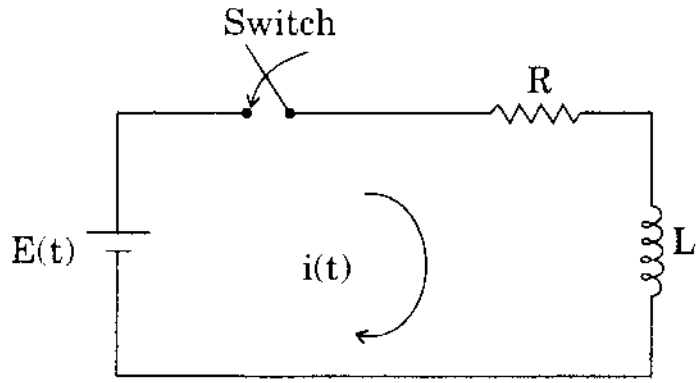


2. Find the eigen values of the following given matrix and obtain the eigen vector corresponding to the smallest eigen value.

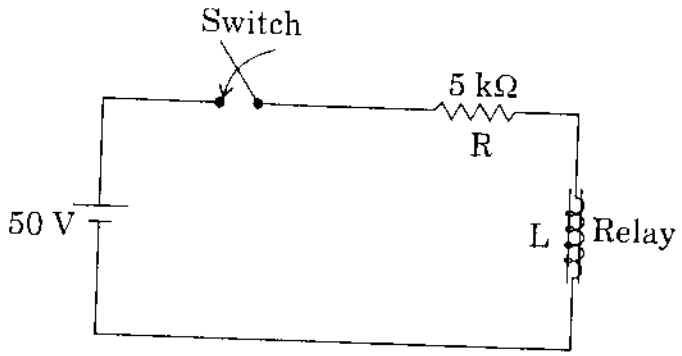
$$\begin{bmatrix} 3 & 0 & 0 \\ 5 & 4 & 0 \\ 3 & 6 & 1 \end{bmatrix}$$

3. Simplify the Boolean expression $Z = (X + Y) \cdot (X + \overline{Y}) \cdot (\overline{X} + Y)$ Realize this function using the minimum number of two input NAND gates.

4. (a) Consider the series R, L circuit with forcing function step voltage of E volts, as shown in figure. Assume that at t = 0, when the switch is closed, there is an initial current Io through the inductor due to previously applied forcing function. Using Laplace transform method, derive the expression for current i(t).



(b) In the circuit shown in figure, R = 5 kΩ, the relay is adjusted to operate with a current of 7 mA. The switch is closed at t = 0 with initial current i(0) = 0. It is found that the relay operate at t = 0·2 sec. Find the inductance L of the relay coil.



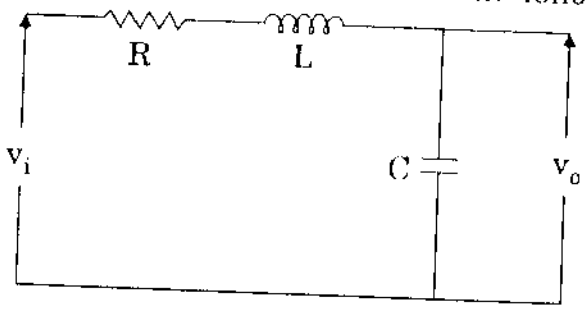
5. (a) Define and explain the following terms related to the transfer function of a system. (i) poles (ii) zeros (iii) characteristic equation.

(b) The transfer function of a system is given by

$$T(s) = \frac{10(s+6)}{s(s+2)(s^2+6s+25)}$$

Obtain its poles, zeros and sketch its pole-zero plot on s-plane.

6. Find out the transfer function for the following network.



7. An unbalanced, star connected load is fed from a symmetric three-phase system. The phase voltages across two of the arms of the load are $V_B = 295 \angle 97{\cdot}5°$, $V_R = 206 \angle -25°$. Calculate the voltage between the star point of the load and the supply neutral.

8. (a) With the help of circuit diagram, explain the direct-coupled two-stage amplifier using similar transistors. Obtain the expression for voltage gain.

(b) What are the advantages and disadvantages of such amplifiers ?

9. (a) Indicate the basic methods of amplifier coupling with the help of schematic diagrams.

(b) Under what conditions direct coupling of amplifiers is permissible.

(c) Give examples of some devices where direct coupling can be used.

10. (a) Briefly explain, with the help of circuit diagrams, the different types of D.C. generators based on their field excitation and winding connections.

(b) An 8-pole D.C. shunt generator with 778 wave-connected armature conductors and running at 600 rpm, supplies a load of 12·5 Ω resistance at terminal voltage of 250 V. The armature resistance is 0·24 Ω and the field resistance is 250 Ω. Find the armature current, the induced e.m.f. and the flux per pole.

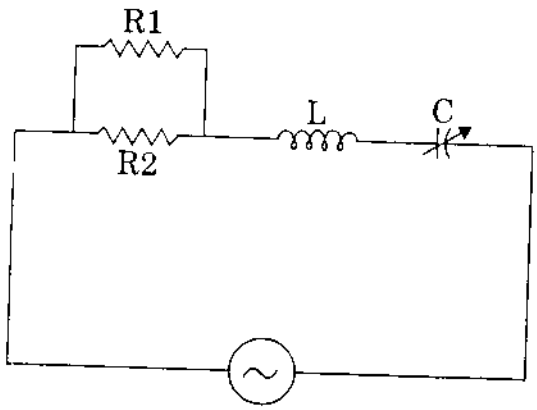
PART C

Each question carries 15 marks. 6×15=

1. (a) Explain briefly the phenomena of electrical resonance in AC circuits.

(b) Explain the series resonance of R-L-C circuit and derive the expression for Q-factor.

(c) A circuit shown in figure having resistance of R1 = 6·25 Ω, R2 = 25 Ω, an inductance L = 0·5 H, and a variable capacitance C, is connected across a 110 V, 50 Hz supply. Calculate, the value of capacitance to give resonance and the Q-factor of the circuit.



2. (a) Draw the circuit diagram to measure power and power factor in 3-phase balanced AC system with star connected load using two-watt meters. Indicate clearly the current and pressure coils.

(b) Draw corresponding phasor diagrams. Deduce the expressions for total three-phase power and power factor of the load.

(c) The power input to a three-phase induction motor running at full load is measured by two wattmeters, which indicate W1 = 145 kW and W2 = 65 kW respectively. If 21 kW is the power loss in the induction motor, calculate the total input power to the induction motor, the power factor, and efficiency of the induction motor.

(a) Explain the following terms with reference to general electrical indicating instruments. (i) deflection torque (ii) Controlling torque (iii) Damping torque

(b) With the help of schematic diagram, explain the working principle of repulsion type, moving-iron instrument.

(c) Indicate sources of errors in such instruments.

4. (a) Give a brief comparison of FM and AM signals.

(b) In a amplitude modulation system, two signal frequencies of 300 Hz and 33 Hz modulate a carrier frequency of 533 kHz. Find the various frequency components of output signals.

5. (a) With the help of circuit diagram, explain the parallel operation of two single-phase transformers having equal voltage ratios. Make suitable assumptions and mention the assumptions made.

(b) Show the vector diagram and derive the expression for load sharing by the transformers.

(c) Two single-phase transformers A and B are connected in parallel. They have same kVA rating and per-unit impedances are,
$Z_A = 0{\cdot}005 + j\ 0{\cdot}05$ and $Z_B = 0{\cdot}004 + j\ 0{\cdot}04$.
If the transformer A is operating on full load at a power factor of 0·85 lagging, calculate the load and power factor of the transformer B.

6. (a) Obtain the expression for power developed by a salient pole synchronous motor.

(b) A three-phase 150 kW, 230 V, 50 Hz, 1000 rpm salient pole synchronous motor has Xd = 32 Ω per phase, Xq = 20 Ω per phase. Neglecting the losses, calculate the power developed by the motor if field excitation is so adjusted as to make the back-emf twice the applied voltage at $\alpha = 15°$.

PART D

Answer any ***three*** *of the following questions. Each question carrie* 3×
30 marks.

1. (a) Write the electro-magnetic Maxwell equations and briefly explai the equations.

(b) Describe the properties of plane waves.

(c) A microwave link on 10 GHz free space conditions has antenna gain 30 db and receiving antenna gain 40 db, separated by 60 km. Calculate the transmission path loss and received power for a transmitted power of 24 watt.

2. (a) Show the basic three types of circuit configurations for a PNP transistor.

(b) The reverse saturation current in PNP Germanium transistor type OC-71 is 8 μA. If the transistor common base current gain is 0·979, calculate the collector and emitter current for 40 μA base current. What is the collector current when base current is zero ?

3. (a) What are the advantages of parallel operation of generators ?

(b) With the help of circuit diagram, explain the procedure for parallel operation of two shunt generators.

(c) Two shunt generators A and B are operating in parallel to deliver a total load current of 250 A. The generator A is rated 500 V, 100 kW with 4% regulation and generator B is rated 500 V, 50 kW with 5% regulation. Assuming linear characteristics, determine the current delivered at each machine.

4. (a) With the help of a schematic diagram show the arrangement of three-phase transformers with (i) Delta-Delta connection, (ii) Delta-Wye connection.

(b) Discuss the advantages and disadvantages of the arrangements for power distribution applications.

(c) A three-phase transformer of 2 MVA, 33 kV / 6·6kV delta-star connected has primary resistance of 8 Ω per-phase and secondary [illegible] of 0·08 Ω per-phase. The percentage impedance is 8%.

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A	20 marks
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09/2

2005

ELECTRICAL ENGINEERING

Paper 2

Time : 3 Hours] *[Maximum Marks : 300*

INSTRUCTIONS

Candidates should attempt ***all*** *the questions in Parts A, B & C. However, they have to choose only* ***three*** *questions in Part D. The number of marks carried by each question is indicated at the end of the question.*

Answers must be written in English.

This paper has four parts :

A	20 marks
B	100 marks
C	90 marks
D	90 marks

Marks allotted to each question are indicated in each part.

PART A

4×5=20

Each question carries 5 marks.

1. (a) What are the typical values of ripple factor without a filter in a single-phase diode half-wave rectifier and full-wave rectifier.

(b) Sketch a general cross sectional layout of a pumped storage hydro-electro scheme. Under what conditions is it economical to use.

(c) A 220/66 kV substation has 3-phase fault level of 2500 MVA and single-line-to ground fault level of 3000 MVA at 220 kV side bus. Find the zero sequence driving point impedance at the bus, assuming resistance and line charging susceptances are neglected.

(d) A remote bus has a load of 400 kW with 0·8 power factor lagging. Find the kVAR compensation required to improve the load power factor to 0·9 lagging.

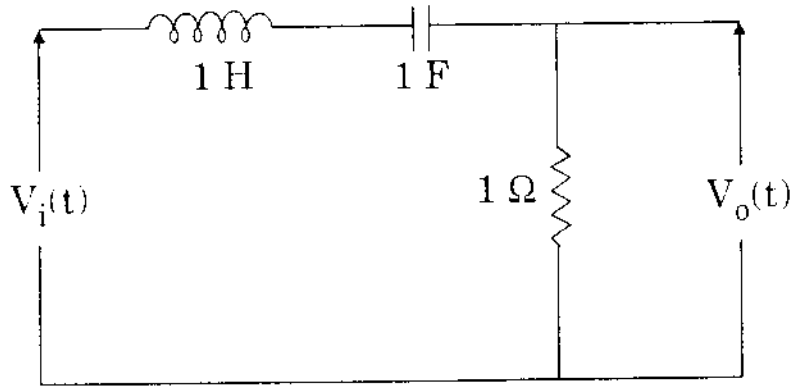
PART B

10×10=100

Each question carries 10 marks.

1. (a) Explain the terms transient response, steady state response, and steady state error of a control system.

   (b) Find the time response $V_0(t)$, for the circuit shown in figure below, for an step input $V_i(t)$ = 10 V.



2. Explain the basic working principle of a PUSH-PULL inverter.

3. Explain the basic working principle of a voltage regulator using OP-Amps.

4. (a) What is the surge-impedance loading of a transmission line.

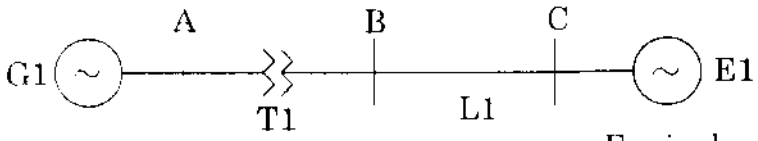
   (b) A 3-phase, 50 Hz 100 km long 220 kV line has inductive reactance 0·44 ohms per km per phase and shunt leakage susceptance 4·4 micro mhos per km per phase to neutral. Find the MW surge impedance loading (SIL) of the line :

5. (a) Make a comparative study based on techno-economic operation among the following types of power stations.
   (i) Hydro power station
   (ii) Coal based thermal power station
   (iii) Diesel based thermal power station
   (iv) Nuclear based power station

   (b) Indicate some places in Karnataka State, for each type of above power stations.

6. An overhead 3-phase line of 100 km, 132 kV has a total series impedance of 15 + j 60 ohms per phase and a total shunt admittance of j 0·0005 siemens per phase to neutral. The line is supplying a load of 40 MVA at 0·8 power factor lagging at 132 kV receiving end. With usual notations considering a nominal π circuit, find the A, B, C, D parameters of the line and sending end power.

7. A 250 MVA, 15 kV three-phase generator is connected to a large equivalent system through a 250 MVA, 15 kV/400 kV transformers, a 400 kV line as shown in the figure below.



Equivalent System

The data given is as follows :

G1 : Xd = 20% on its own base

T1 : X = 15% on its own base

L1 : X = 0·5 pu on 100 MVA base

E1 : Xd = 0·02 pu on 100 MVA base

Neglect the resistances and line charging. Find the three-phase fault MVA for a fault at bus C of the above system.

8. (a) Describe the main constructional features of string insulators and how the efficiency of insulator string can be improved.

(b) An insulator string for 66 kV line has 4 discs. The shunt capacitance between each joint and metal work is 10% of the capacitance of each disc. Find the string efficiency.

9. (a) Describe the role of protection in power systems.

(b) Explain the following terms with reference to protection of power systems :

(i) Pick-up, drop-out

(ii) Over-reach, under-reach

(iii) Sensitivity, selectivity

(c) Explain the effect of power swings in distance protection.

10. (a) Explain the working principle of a d.c. rectified welding unit.

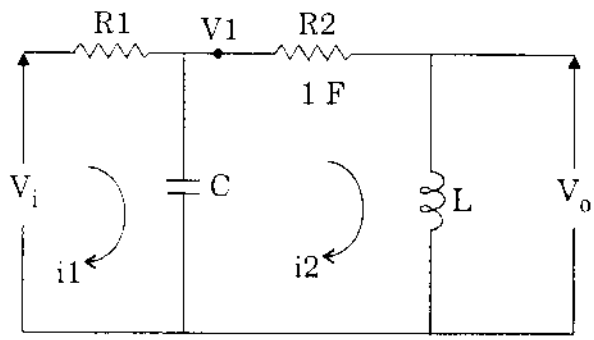
(b) What are the advantages and disadvantages of such unit ?

PART C

6×15=90

Each question carries 15 marks.

1. With usual notations, draw the signal flow graph for the given electrical network, using the branch currents as shown in figure below. Find the transfer function V_o / V_i of the network.



2. (a) Draw the circuit diagram and equivalent circuit of a single-phase full-wave rectifier using diodes.

   (b) Explain the working principle and derive the expression for average RMS values of voltages and currents.

   (c) A single-phase full-wave rectifier supplies power to a 1 kΩ load. The a.c. voltage to the diode is 300-0-300 V rms. If the diode resistance is 25 Ω and that of the transformer secondary is negligible, calculate the average value of load voltage.

3. (a) What is the main function of a filter in a rectifier ?

   (b) With the help of circuit diagram, explain the function of a L-C filter for a single-phase full-wave rectifier.

   (c) A single-phase full wave rectifier uses 300-0-300 V, 50 Hz transformer. For a load current of 60 mA, design an L-filter using 10 H coil and suitable capacitor to ensure a ripple factor of not more than 1%.

4. (a) What is the basic function of chopper ?

   (b) Explain the working principle of a d.c. chopper with a single load.

   (c) A d.c. chopper has ON time of 30 μs and OFF time of 10 μs. Calculate the chopper duty cycle, chopping frequency.

5. (a) Briefly describe the effect of varying excitation upon the armature current and the power factor of a synchronous motor, when input power to the motor is maintained constant.

(b) A 400 V 50 Hz three-phase 37300 W star connected synchronous motor has a full-load efficiency of 0·88 pu. The synchronous impedance of the motor is (0·2 + j 1·6) Ω per phase. If the excitation of the motor is adjusted to give leading power factor of 0·9, calculate for full-load, the induced emf and the total mechanical power developed.

6. (a) With the help of sketch diagrams explain the following terms with reference to circuit breaker operations :

(i) Restriking voltage

(ii) Recovery voltage

(iii) Rate of rise of restriking voltage (RRRV)

(b) In a short circuit test on a 132 kV 3-phase system, the following observations were obtained on the circuit breaker.

Power factor of the fault = 0·35, Recovery voltage = 0·95 times of full line value. The breaking current is symmetrical. The restriking transient had a natural frequency of 16 kHz. Assuming that the fault is grounded, calculate the rate of rise of restriking voltage.

PART D

$3 \times 30 = 90$

*Answer any **three** of the following questions.*
Each question carries 30 marks.

1. (a) For a control system $G(s).H(s) = \frac{k}{s^2(s+2)(s+3)}$, find the value of k to limit steady state error to 12, when input to the system $r(t) = 1 + 10t + \frac{40}{2}t^2$.

   (b) A control system is described by the differential equation $\frac{d^2y(t)}{dt^2} + 7\frac{dy(t)}{dt} + 12y(t) = 12x(t)$ where y(t) is output and x(t) is input. Find the output response y(t) of the system for an unit step input.

2. (a) Explain the relation between torque and rotor power factor of an induction motor.

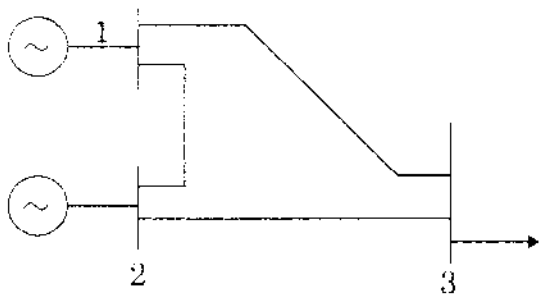
   (b) Explain the effect of change in supply voltage on starting torque of an induction motor.

   (c) A 150 kW, 3000 V, 50 Hz 6-pole star connected induction motor has a star connected slip-ring rotor with a stator/rotor transformation ration of 3·6. The rotor resistance is 0·1 Ω per phase and its leakage reactance is 3·6 mH per phase. The stator impedance may be neglected. Find the starting current and starting torque on rated voltage with short-circuited slip-rings.

3. (a) What is the purpose of a load flow study ?

   (b) Single line diagram of a sample power system with relevant data is given below. Form the Bus admittance matrix Y_{bus}.

(c) With node 1 as the slack bus, use an iterative method to obtain the load flow solution. Perform two iterations, find active power flow in line 2-3.



The line reactances in p.u. are : 1-2 0.02
1-3 0.05
2-3 0.04

Load at bus 3, P_L = 2·5 pu Q_L = 1·0 pu

Generation at bus 2, P_G = 1·2 Q_G : no limit

Initial voltages at all the buses (1·0 + j 0·0)

4. (a) With reference to a system consisting of a synchronous generator feeding to a large network through a large transmission line, define the terms, (i) steady state stability, (ii) steady state stability limit, (ii) transient stability.

(b) Explain briefly the equal area criteria to study the stability of such system mentioned in 4(a) above.

(c) Consider a simple power system where a double circuit transmission line connects a generator to a large network. The power corresponding to the limit of steady state stability for each circuit is 100 MW. Initially the system is transmitting 80 MW power (both circuits in service). One of the circuits is suddenly tripped leaving only one circuit in service. Assuming no change in the mechanical input of the generator, using equal area criteria, determine whether the generator is likely to remain in synchronism or not.

5. (a) What are the advantages and disadvantages of 25 kV, 50 Hz single phase AC supply system for electric traction.

(b) What are the speed/time curves with reference to train movements ? Explain a typical speed/time curve for an electric train.

(c) An electric train has an average speed of 42 kmph. on a level track between 1400 m apart. It is accelerated at 1·7 kmphps and braked at 3·3 kmphps. Draw the simplified speed-time curve for the run.

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