477

Q. No. EEC - 01

ND/B.Tech./Even

Reg/2022-23

2022-23

ELECTRICAL TECHNOLOGY

EEC - 01

Full Marks : 60 Time : Three Hours

The figures in the margin indicate full marks.

Answer should be brief and to the point.

All parts of the question should be written in one place.

Answer any *six* questions.

1. (a) Give brief description about independent and dependent sources with example.

   (b) Determine the current through 5 Ω resistor in the circuit of Fig. 1 using Thevenin's Theorem.

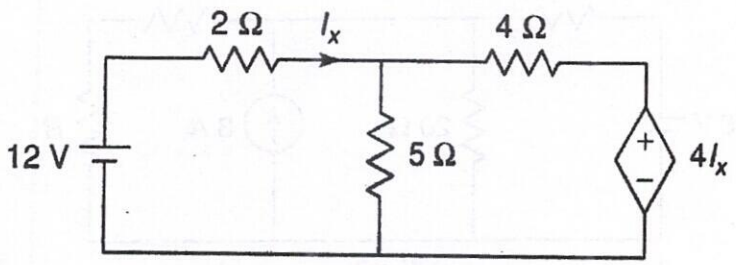

Fig.1

P.T.O.

(c) Determine the values of V_A and V_B in the circuit of Fig. 2.

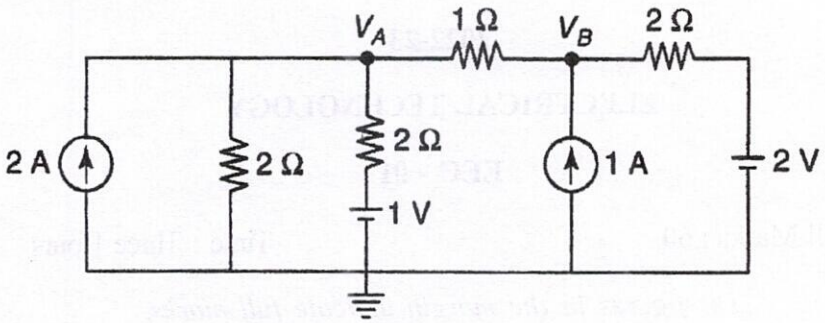

Fig.2

2+4+4 [CO1]

2. (a) State maximum power transfer theorem for AC circuits. Also derive the condition for maximum power transfer in the AC circuit.

(b) Determine the value of R for maximum power transfer in the network of Fig. 3.

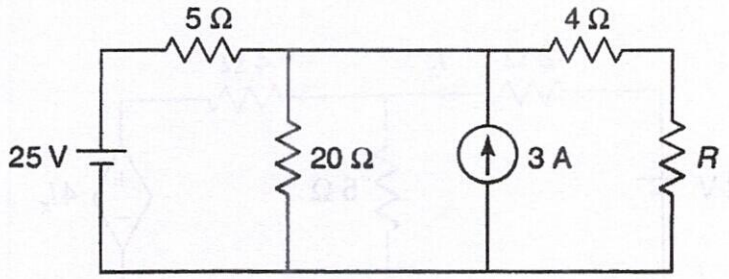

Fig.3.

5+5 [CO1]

3. (a) Enumerate the analogies between magnetic circuit and electric circuit.

(b) A magnetic circuit with a single air gap is shown in Fig. 4. The core dimensions are :

Cross-sectional area $A_c = 1.8\times10^{3}\ m^2$

Mean core length $l_c = 0.6\ m$

Gap length $g = 2.3\times10^{-3}\ m$

$N = 83$ turns

Assume that the core is of infinite permeability and neglect the fringing effects.

For a current of $i = 1.5$ A, calculate (i) the total flux ϕ, (ii) the flux linkages λ of the coil and (iii) the coil inductance L.

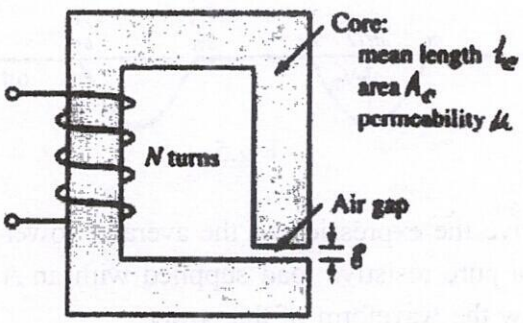

Fig. 4

(c) Two coils having 50 and 500 turns respectively are wound side by side on a closed iron circuit of cross-sectional area 50 cm^2 and mean length of 120 cm.

P.T.O.

Estimate the mutual inductance between the coils if the permeability of iron is 1000. Also, find the self-inductance of each coil. 3+4+3 [CO2, CO4]

4. (a) Derive the expression of voltage and current in a R-L series circuit with DC excitation in the transient condition. Also draw the voltage and current waveforms at the transient condition?

   (b) A resistance R and a $4\mu F$ capacitor are connected in series across a 200V DC supply. A lamp that glows at 120V is connected across a capacitor. Calculate the value of R to make the lamp glow 5 seconds after the switch has been closed. 5+5 [CO5]

5. (a) Derive the expression of the average value of the voltage waveform as shown in Fig. 5.

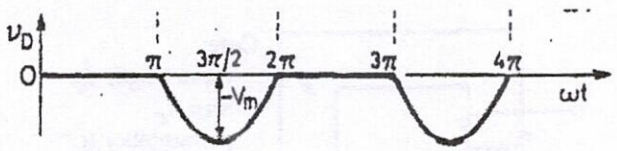

Fig.5

   (b) Derive the expression of the average power consumed by a pure resistive load supplied with an AC Voltage. Draw the waveform of the power.

   (c) What is admittance triangle? Draw the admittance triangle for a simple R-C parallel circuit. 4+4+2 [CO3]

6. (a) Derive the expression of resonance frequency of a circuit consisting of an iron cored choke coil (R & L in series) connected in parallel with R-C series combination.

(b) A constant voltage source of frequency 1 MHz is applied to a lossy inductor (R & L in series) in series with a capacitor. The current drawn is maximum when $C = 400$ pF. In another condition, while current is reduced to 0.707 of the above value, then the value of $C = 450$ pF. Find resistance, inductance, quality factor of the coil. 5+5 [CO3]

7. (a) Explain the working principle of a single phase transformer.

(b) An ideal transformer has 150 turns in primary and 750 turns in secondary. The primary is connected to a 240 V, 50 Hz source. The secondary supplies a load of 4 A at a lagging power factor of 0.8. Determine

(i) The turn-ratio.

(ii) The current in the primary.

(iii) The power supplied to the load.

(iv) The Maximum flux in the core.

(c) State and prove the condition for a transformer to be operated at maximum efficiency. 3+4+3 [CO4]

8. (a) What are the advantages of three phase system over single phase system?

(b) A balanced star connected source having phase voltage of 230 V is connected to a delta connected balanced load of $10+5j\ \Omega$ per phase. Calculate the load side line voltage, phase voltage, line current and phase current.

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(c) Prove that for a star connected balanced inductive load,

$$\phi = \tan^{-1}\sqrt{3}\frac{W_2 - W_1}{W_2 + W_1}$$

where the symbols are mentioned as per standard.

2+4+4 [CO3]

Course Outcomes (CO) :

CO1 : To learn the fundamentals of Electric Circuits and Network theorems.

CO2 : To develop an idea on Magnetic circuits, Electromagnetism.

CO3 : To learn about single phase and polyphase AC circuits.

CO4 : Introduction to single phase transformer.

CO5 : Analysis of transient phenomena in electrical circuits with DC excitation.

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POWER SYSTEMS - I

EEC - 401

Full Marks : 60 Time : Three Hours

The figures in the margin indicate full marks.

Answer any *four* questions from Part-I
and *two* questions from Part-II.

Assume any data if necessary, with proper justification.

Part - I

1. (a) What are the different standardized voltages used in electrical supply systems in India?

   (b) A direct current two-wire distributor, 550m long, is fed at both ends, 'A' and 'B' at 250V. It has two concentrated loads of 50A each at 200m and 300m from the feeding point 'A'. In addition, it has distributed lighting load of 1A/m for a distance of 100m from the end 'B'. The go-and-return resistance of the distributor is 10^{-4} Ω/m. Calculate (i) the point of minimum potential in the system, (ii) the consumer voltage at the point of minimum potential, and (iii) the current fed from the two ends.

   3+7 [CO1, CO2]

2. (a) State and prove Kelvin's law concerning feeders.

P.T.O.

(b) The daily load cycle of a 3φ, 132kV, 50Hz, 15km long line is as follows : 15MW at 0.85 power factor for 9 hours, 10MW at 0.8 power factor for 7 hours, and 8.0MW at 0.9 power factor for 8 hours. The cost of the line, including erection, is ₹ (6a + 10) per metre, where 'a' is the cross-sectional area of each conductor in cm^2. The rate of interest and depreciation is 8.5% of the capital cost. The cost of energy is ₹ 5.0 per kWh. The line is in use for the whole of the year. The resistance per km of each conductor is $0.175/a\,\Omega$. Determine the most economical cross-sectional area of the conductor. 4+6 [CO1, CO2]

3. (a) Show that the internal inductance of an overhead transmission line conductor is independent of conductor geometry.

(b) Three conductors A, B and C of a 3φ, 110kV, 50Hz overhead transmission are horizontally spaced as AB=BC=3.0m and AC=6.0m. Each conductor has a diameter of 3.0cm. Determine the inductance of each conductor when the line is (i) not transposed and (ii) transposed at regular intervals. 5+5 [CO1, CO2]

4. (a) What are the generalized constants of overhead transmission lines? How are their values determined?

(b) A 3φ, 50Hz, 150km overhead transmission line delivers 30MVA at 0.85 power factor to a balanced load at 132kV. The line conductors are spaced equilaterally 3.0m apart. The conductor resistance is $0.10\,\Omega$/km, and its effective diameter is 2.0cm. Calculate (i) the sending end

voltage, current, and power factor, (ii) voltage regulation, and (iii) the efficiency of the line. Neglect leakage conductance and use the nominal 'T' method.

(2+2)+6 [CO2, CO3]

5. (a) How is the Sag Template used to correctly allocate the position and height of supports on the profile?

   (b) An overhead line is supported by two towers of 50m and 60m, and the horizontal distance between the towers is 300m. The conductor diameter is 3.0cm, weighing 2.0kg/m in length. Calculate the sag at the lower support if the wind pressure is 40kg/m^2 of the projected area and 12.0mm radial ice coating over the conductor's surface. The maximum tensile strength of the conductor material is 3000kg/cm^2. Take the safety factor as 3.0 and the weight of ice as 910kg/m^3. 3+7 [CO2, CO3]

6. (a) What are the detrimental effects of interference of power transmission lines with the communication lines?

   (b) State the methods that may be used to reduce the interference.

   (c) A 3φ load of 20MW is supplied at a voltage of 132kV, 0.9 power factor at 50Hz, at a distance of 150km. The line conductors are spaced equilaterally 3.0m apart. The effective diameter of the conductors is 1.6cm. The height of the lowest conductor is 15m from the ground. A telephone line runs on the same supporting towers, and the distances between the telephone line and the power line conductors are shown in fig. 6(c). Find the magnitude

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of the electromagnetically induced e.m.f. induced in the telephone line. 2+3+5 [CO2, CO3]

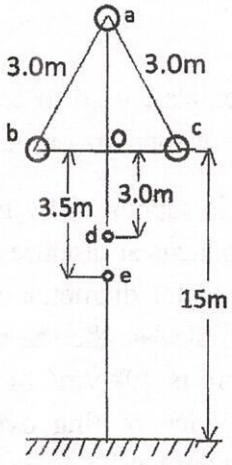

Fig.6(c)

Part - II

7. (a) Each of the three insulators forming a string has self capacitance of C Farad. The shunt capacitance between each link pin to earth and link pin to line are 25% and 10% of each unit's self-capacitance C, respectively. Calculate the string efficiency of the arrangement. Perform necessary calculations to design a Guard Ring so that string efficiency becomes 100%.

   (b) Discuss the various losses occur in Insulated Cables.

   (c) Explain the term visual critical voltage in the context of Corona in overhead conductors.

5+3+2 [CO4, CO5, CO6]

8. (a) Differentiate between intersheath grading and capacitance grading of insulated cables.

   (b) A 3φ, 220kV, 50Hz transmission line consists of 1.2cm radius conductors spaced 2.0m at the corners of an equilateral triangle. Find out the corona loss per km of the line. The condition of the wire is smoothly weathered and the weather is fair with temperature of 20°C and barometric pressure of 72.2cm of Mercury.

   (c) Justify the reason for unequal voltage distribution in line insulators of HV/EHV AC transmission line. What will happen if the supply is DC?

   2+5+(2+1) [CO4, CO5, CO6]

9. (a) Describe the steps to calculate power factor and dielectric loss of insulated cables having capacitance C and insulation resistance R.

   (b) State the reasons of lower critical disruptive voltage in stranded conductors compared to that of smooth conductors.

   (c) The capacitances of a 3-core belted type cable are measured as detailed below :

      (i) between three cores bunched together and sheath is 8.0μF and

      (ii) between a conductor and the other two connected to the sheath together is 6.0μF.

   Find out the capacitance per phase. Also, investigate the

difference in the value of charging current taken by eight kilometers of this cable when connected to a 3φ, 50Hz, 6600V supply and 11000V respectively.

3+2+(3+2) [CO5, CO6]

Course Outcomes :

- CO1 : Find out economical voltage, minimum consumer voltage for different kinds of loads for transmission of electrical energy, and suggest remedies to improve the voltage if needed.
- CO2 : Evaluate different parameters associated with electrical design and mechanical design of transmission lines, including the presence of neighbouring communication lines.
- CO3 : Analyze the performance of short, medium, and long-distance transmission lines.
- CO4 : Apply the knowledge to find out different important parameters of insulators and know different methods to improve the performance parameters of the insulators.
- CO5 : Select the appropriate type of power cables for different applications and determine operating voltage, charging current, charging kVAR, insulation resistance, and dielectric power loss of power cables.
- CO6 : Mitigate different adverse situations that may arise due to corona.

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ELECTRICAL MACHINES - I

EEC - 402

Full Marks : 60 Time : Three Hours

The figures in the margin indicate full marks.

Answer any *five* questions.

1. (a) Draw and explain the load characteristics of shunt, series and compound generator on a single graph paper and explain why their shapes are different from each other ?

   (b) The wave connected armature of 2 poles, 200 Volt generator has 40 conductor and run at 300 R.P.M. Calculate the useful flux per pole. If the no. of turn of each field coil is 1200, what is the average value of induced e.m.f. in each coil on breaking the field if the flux dies aways completely in 0.15 second.

   6+6 [CO1, CO3 & CO4]

2. (a) Explain in detail that the flux per pole of a DC machine decrease with increase of load. What is the name of the phenomenon and how do you understand physically that the above phenomenon is occurred in DC generator and DC motor?

   (b) A 110 kW belt-driven shunt generator running at 400 r.p.m. on 220 V bus bars. When the belt breaks, it takes

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11 kW and at that condition find the speed if the resistance of armature and field are 0.025 ohms and 55 ohms, respectively. Brush contact drop is 1 V.

(4+1+2)+5 [CO1, CO3 & CO4]

3. (a) Explain how does the DC motor adjust its input automatically to match the load on the shaft ? Also derive the torque equation of a DC machine.

   (b) Which one is preferable to start a DC motor starter or rheostat ? Explain.

   (c) Why a series motor should not be fitted to a load through belt-pulley mechanism ?

   A 500 Volt DC shunt motor takes 5 Amp at no-load. Its armature resistance is 0.5 Ω and shunt field resistance is 250 Ω. Determine the kW output and efficiency when the motor takes 50 Amp on full load. Also find the percentage change in speed from no-load to full load.

   (2+2)+2+(2+4) [CO1, CO3, CO4 & CO6]

4. (a) How the main flux of a transformer remains constant from no-load to full load — Explain.

   (b) Draw and explain in detail the equivalent circuit of single-phase transformer.

   (c) A 100 kVA, 2400/240 V, 50 Hz, 1-phase transformer has no-load current of 0.64A and a core loss of 700 W, when its high voltage side is energized at rated voltage and frequency. Calculate the two components of no-load current. If this transformer supplies a load

current of 40 amp at 0.8 lagging power factor at its low voltage side, determine the primary current and its power factor. Ignore leakage impedance drop. 3+4+5 [CO3]

5. (a) Validate the statements through suitable derivations. At what power factor will the regulation be (i) maximum and (ii) zero ? Does the maximum efficiency of the transformer also depend on the power factor ? Justify.

   (b) Consider a 4 kVA, 200/400 V, 50 Hz single phase transformer supplying full load current at 0.8 lagging power factor. The OC/SC test results are as follows :

OC Test (lv)	200 V	70 W	0.8 A
SC Test (hv)	20 V	60 W	10 A

   Calculate efficiency, secondary voltage and current into primary at the above load. Calculate the load at unity power factor corresponding to maximum efficiency.

   5+7 [CO5 & CO6]

6. (a) Explain with necessary diagram how two three phase transformers can be used to convert a three-phase supply to two phase supply. If the load is balanced on one side, show that it will be balanced on the other side.

   (b) Two electric furnaces are supplied with single phase current at 80 Volt from a three phase, 11000 Volt system by means of two single phase Scott-connected transformers, with similar secondary windings. When the load on the main transformer is 800 kW and, on the teaser, transformer is 500 kW, determine the current in

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the three phase lines (i) at unity power factor, (ii) at 0.5 power factor lagging. Draw the phasor diagrams.

(3+3)+6 [CO5]

7. (a) Derive and explain the percentage of overloading for each transformer in V-V connection. Also mention the important precaution of V-V system.

   (b) Developed winding diagram for a wave wound, six-pole DC armature having 16 slots with 2 coil-sides per slot where each coil has single turn.

   (c) Explain how a three-phase transformer Yd_{11} of group no 4 can be successively operated in parallel with another transformer Dy_1 of group no 3. 5+4+3 [CO2 & CO5]

CO1 : Able to understand the fundamental principles and classification of electromagnetic machines.

CO2 : Ability to design an armature winding.

CO3 : Able to learn about the constructional details and principle of operation of DC machines.

CO4 : Acquire knowledge about the working of DC machines as generators and motors.

CO5 : Acquire knowledge about the constructional details, principle of operation of transformers.

CO6 : Acquire knowledge about testing and applications of DC machines & transformers.

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DIGITAL ELECTRONICS

EEC - 403

Full Marks : 60 Time : Three Hours

The figures in the margin indicate full marks.

Answer any *five* questions from Part - A and any *five* questions from Part - B.

Part - A

1. What do you mean by the basic and universal logic-gates? Using two types of universal gates construct AND, OR, XOR an XNOR logic circuits. 6 [CO1, CO2, CO3]

2. Using the electrical power source from a standard household power supply, design the electrical circuit to generate digital data to feed the selector pins of a CD4067BE MUX/ DEMUX IC for activating the IC to switch its 7^{th} I/O channel. 6 [CO1, CO2, CO3, CO4]

3. Using five 4:1 MUX/DEMUX ICs construct a 16:1 MUX/ DEMUX circuit and explain the operation showing the truth table. 6 [CO3, CO4]

P.T.O.

4. Why encoder and decoder ICs are used in digital electronics? Using a truth table, explain the priority encoding operation. 6 [CO3, CO4]

5. Draw and explain the schematic diagram of a parallel to serial and serial to parallel data conversion system for transferring the parallel digital data wirelessly. 6 [CO5]

6. With proper circuit diagrams explain, the operation of a resistor divider DAC Circuit. 6 [CO5]

7. Write the short notes on the following (any *two*) :

   (a) Electrode witching with MUX

   (b) Graphical User Interface (GUI)

   (c) Analog to Digital to data conversion

   6 [CO3, CO4, CO5]

Part - B

1. A circuit that detects a sequence of three or more consecutive 1's in a string of bits coming through the input (which is a serial bit stream) needs to be designed. Construct the State Transition Diagram and hence design a Maely/Moore State Machine using J-K flip-flops. 6 [CO1, CO3, CO4]

2. Analyze the state transition table (Table B1) given below and construct reduced state transition diagram (includes minimum no of states). Now, realize a sequential circuit with the help of D flip-flops. 6 [CO1, CO3, CO4]

Table-B1

Present State	Next State		Output	
	x = 0	x = 1	x = 0	x = 1
a	f	b	0	0
b	d	c	0	0
c	f	e	0	0
d	g	a	1	0
e	d	c	0	0
f	f	b	1	1
g	g	h	0	1
h	g	a	1	0

3. Design and realize a BCD counter using T flip-flops.
6 [CO1, CO3, CO4, CO6]

4. A BCD-to-seven-segment decoder is a combinational circuit that converts a decimal digit in BCD to an appropriate code for the selection of segments in an indicator used to display the decimal digit in a familiar form. The seven outputs of the decoder (a, b, c, d, e, f, g) select the corresponding segments in the display, as shown in figure (Fig. B1) below. The numeric display chosen to represent the decimal digit is shown in the figure. Using truth tables and Karnaugh maps design the BCD-to-seven-segment decoder circuit to display only the prime numbers using a minimum number of gates.
6 [CO1, CO3, CO4, CO6]

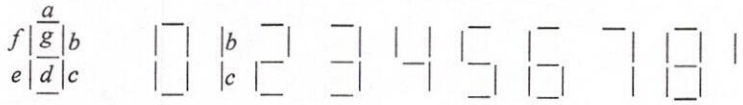

Figure B1

P.T.O.

5. Design a combinational circuit that converts a 4-bit Gray code to a 4 bit binary number and implement the circuit with exclusive-OR gates. 6 [CO1, CO2, CO3, CO4, CO6]

6. Design a four bit adder circuit with look carry ahead logic. 6 [CO1, CO3, CO4]

7. Explain the circuit of the Universal Shift Register with supporting functional table. 6 [CO1, CO3, CO4]

Course Outcomes :

CO1 : Acquire an idea about digital electronics and its applications.

CO2 : To learn the fundamentals of different numbers systems and codes and code conversion techniques.

CO3 : To study about the Boolean algebra and basic logic gates along with their digital design procedure using elementary logic gates.

CO4 : To learn about the different sequential and combinational logic circuits and their use in digital electronics applications.

CO5 : Learn about the Analog to Digital Converter (ADC), Digital to Analog Converter (DAC), and data conversion and acquisition techniques.

CO6 : To study the different types of Codes (Gray code, Excess-3 code, BCD Code etc.) and Code converters.

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CONTROL SYSTEMS

EEC - 431

Full Marks : 60 Time : Three Hours

The figures in the margin indicate full marks.

Attempt any *ten* questions from Part-A
and any *five* questions from Part-B.

Part - A

Attempt any *ten* questions from Question No.1.

1. (a) What feedback is usually present in electronic oscillator circuit? 1 [CO1]

   (b) What is the advantage of State Variable model over the Transfer function model of a dynamic system? 1 [CO1, CO2]

   (c) What is the reason of nonlinearity in relay based temperature control? 1 [CO1]

   (d) What happens to the speed of the response if the closed loop pole pair move radially away from origin along a constant damping ratio line? 1 [CO4]

   (e) If a transportation delay is introduced to a first order

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open loop transfer function what changes would you expect in the closed loop step response? 1 [CO3]

(f) What is the velocity error constant for a unity negative feedback system with type 2, 2nd order forward path transfer function? 1 [CO3]

(g) If the proportional gain is increased for a unity feedback closed loop system what changes will be observed in different time domain specifications? 1 [CO3, CO4]

(h) Which frequency domain specification is related with the settling time for a closed loop step response? 1 [CO6]

(i) What is the frequency of oscillation when both the gain margin and phase margin are zero? 1 [CO5]

(j) Realize the circuit for Lead compensator using operational amplifier. 1 [CO7]

(k) How phase margin of the loop transfer function is related with closed loop performance of a negative feedback system? 1 [CO6]

(l) What is the justification of using logarithmic scale for frequency in Bode Magnitude plot? 1 [CO5]

Part - B

Attempt any *five* questions.

2. For the position control system shown in the Fig. 1(a), the closed loop step response is recorded in Fig. 1(b). What was the choice of gain of tachometer feedback made by the designer to ensure this response? 10 [CO3, CO4, CO6]

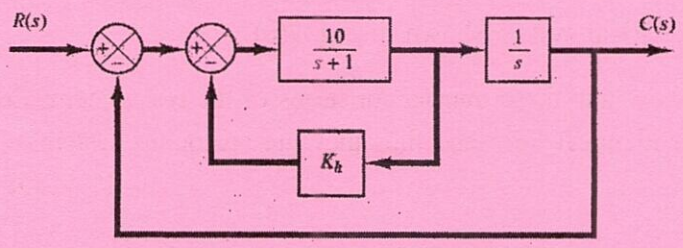

Fig. 1 (a)

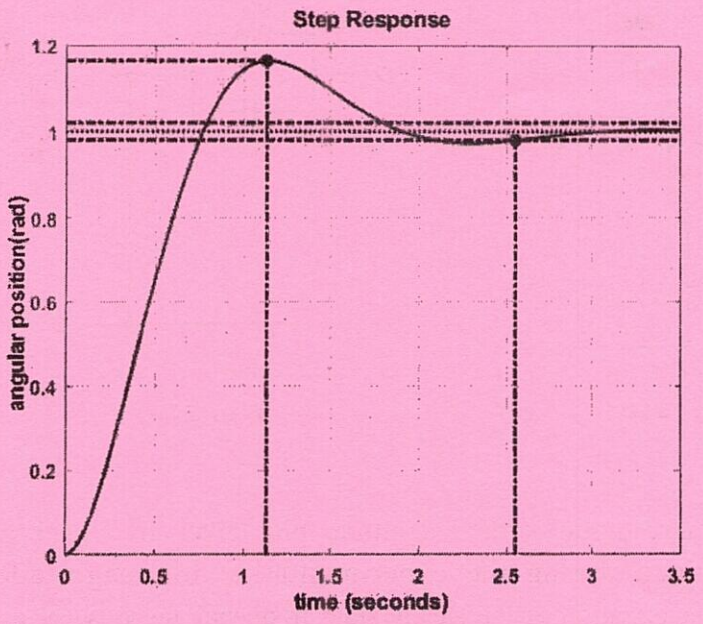

Fig. 1(b)

3. (a) Obtain the transfer function $X_o(s)/X_i(s)$ of the mechanical system shown in Fig. 2(a).

(b) Also obtain the transfer function $E_0(s)/E_i(s)$ of the electrical system shown in Fig. 2(b).

(c) Show that these transfer functions of the two systems are of identical form and thus they are analogous systems.

10 [CO2]

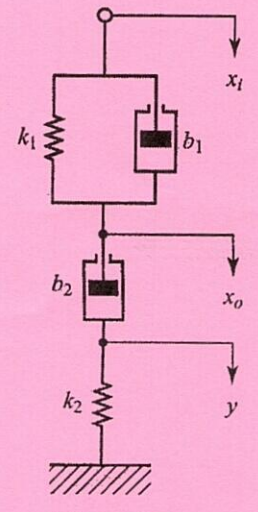

Fig. 2(a)

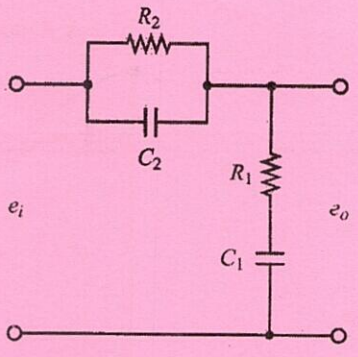

Fig. 2(b)

4. An asymptotic Bode magnitude plot given by Fig. 3 is obtained during the experimentation for magnitude characterization of the steady state frequency response of an unknown electronic system.

(a) Estimate the transfer function of this system with justification.

(b) Analytically calculate the Phase Margin from the estimated transfer function at the highest frequency. 10 [CO5, CO6]

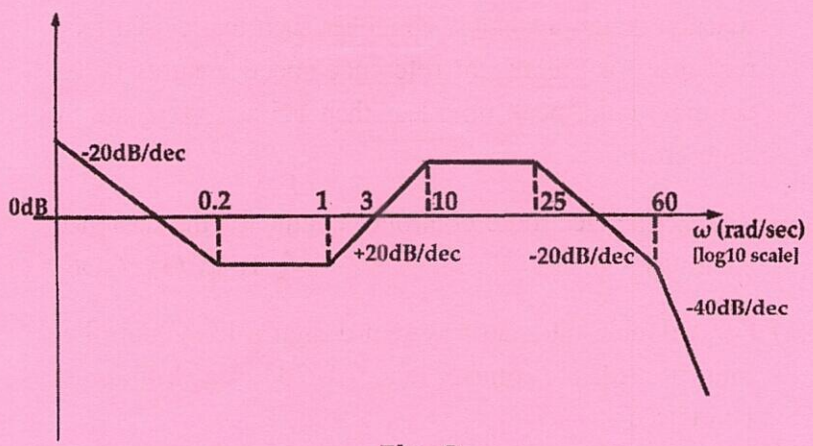

Fig. 3

5. A unity feedback closed loop system has forward path transfer function.

   Design a proportional controller following the method of frequency response approach such that the closed loop system ensures a phase margin of 50 degree.

   10 [CO5, CO6]

6. A passenger aircraft has elevator ( ) to angle of attack transfer ( ) function :

   (a) Design a suitable controller using the concept of root locus for the closed loop system with feedback such that the closed loop step response ensures a settling time (2% error band) of 0.2 sec and overshoot of 4.33%.

   (b) Realize the electronic controller circuit for the designed controller. 10 [CO4, CO6]

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7. (a) For a valve control system with forward path transfer function design a suitable controller such that closed loop response for a constant reference speed ensures 0.707 damping ratio, peak time less than 1.5 sec., zero steady state error.

   (b) Realize the electronic controller circuit for the designed controller. 10 [CO4, CO6]

8. (a) For a double integrator system design a lead controller that provides a phase lead of 70 at a frequency 10 rad/sec.

   (b) Realize the electronic controller circuit after your design. 10 [CO5, CO6, CO7]

Course Outcomes :

CO1 : To get the knowledge of basic objectives of control system design

CO2 : To derive input-output relationship of systems based on their mathematical modelling governed by basic laws of physics

CO3 : To justify stability of systems based on their transfer functions, time domain and frequency domain specifications

CO4 : To develop concepts on root pattern with variable gains and comment on the stability

CO5 : To determine the stability of closed-loop system based on open loop frequency response

CO6 : To be able to design controllers so as to meet design specifications both in time as well as frequency domain

CO7 : To be able to realize the controller both in software simulation through MATLAB coding as well as in

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ELECTRICAL MACHINES

EEC - 432

Full Marks : 60 Time : Three Hours

The figures in the margin indicate full marks.

Answer any *five* questions.

1. (a) Describe the working principle of a transformer.

   (b) Define efficiency of a transformer. State and prove the condition for maximum efficiency of a transformer.

   (c) The primary and secondary windings of a 500 kVA, 6000/400 V single-phase transformer have resistances of 0.4 Ω and 0.0015 Ω respectively. The iron loss is 3.2 kW. Calculate the efficiency at (i) full-load and (ii) half-load, assuming the power factor of the load to be 0.8. 3+(1+3)+5 [CO1, CO2 & CO4]

2. (a) Draw and explain the equivalent circuit of a single-phase transformer. How can the parameters of the equivalent circuit of a single-phase transformer be found from open-circuit and short-circuit tests?

   (b) Draw the phasor diagram of a transformer for lagging pf load.

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(c) A 100 kVA, 2200/220 V, 50 Hz single-phase transformer gave the following test results :

O.C. test (HV winding open) : 220V, 10 A, 440 W

S.C. test (LV winding short-circuited): 100 V, 20 A, 800 W

Find the parameters of the equivalent circuit as referred to LV side. 5+2+5 [CO1, CO2 & CO4]

3. (a) Classify DC machines based on the methods of excitation. Draw and explain the open-circuit and load characteristics of a DC shunt generator.

(b) Explain the methods of speed control of a DC shunt motor and show how the speed may be varied above and below the rated value.

(c) A 4-pole shunt generator with lap connected armature having field and armature resistances of 50Ω and 0.1Ω respectively supplies a 2400 W load at a terminal voltage of 100 V. Calculate the total armature current, the current per armature path and the generated emf.

4+4+4 [CO2, CO3 & CO5]

4. (a) What is the necessity of starter for starting of a DC motor?

(b) Derive the expressions for speed and torque of a DC motor. Explain the speed-current, torque-current, and speed-torque characteristics of DC shunt motor.

(c) A 230V DC shunt motor is taking a current of 50 A. Resistance of shunt field is 46Ω and the resistance of

the armature is $0.02\,\Omega$. There is a resistance of $0.6\,\Omega$ in series with the armature and the speed is 800 rpm. What alteration must be made in the armature circuit to raise the speed to 850 rpm, if the torque remains the same? 2+(3+2)+5 [CO2, CO3 & CO5]

5. (a) Explain how rotating magnetic field is produced in a 3-phase induction motor. Why does an induction motor never run on synchronous speed?

   (b) A 440 V, 50 Hz, 6-pole, three-phase induction motor draws an input power of 76 kW from the mains. The rotor e.m.f. makes 120 complete cycles per minute. Its stator losses are 1 kW and rotor current per phase is 62 A. Calculate(i) rotor copper losses per phase; (ii) rotor resistance per phase and (iii) the developed torque. (4+2)+6 [CO2 & CO3]

6. (a) What is the effect of introducing resistance in the rotor circuit of an induction motor? In which type of motor is it possible? Deduce the condition of maximum torque at starting.

   (b) Draw and explain the torque-slip characteristics of a three-phase induction motor.

   (c) A 3-phase induction motor takes a starting current which is 5 times full-load current at normal voltage. Its full-load slip is 4%. What auto-transformer ratio would enable the motor to be started with not more than twice the full-load current drawn from the supply? What would be the starting torque under this condition?

(2+1+2)+3+4 [CO2, CO3 & CO5]

P.T.O.

7. (a) Distinguish the salient pole and non-salient pole type rotor of synchronous machines.

   (b) Explain the principle of operation of a synchronous motor. A synchronous motor is not a self-starting — give reason.

   (c) A 1200 KVA, 3300 V, 50 Hz, three-phase, star connected alternator has armature resistance of 0.25 ohms. A field current of 40 A produces a short circuit current of 200 A and open circuit emf of 1100 V. Calculate the voltage regulation on (i) full load 0.8 power factor lagging, and (ii) full load 0.8 power factor leading.

3+(2+2)+5 [CO2, CO3 & CO5]

Course Outcomes :

CO1 : Theory of electromechanical energy conversion, the concepts of voltage generation and fundamental torque equation.

CO2 : Basic understanding of the principles of operation and construction of direct and alternating current machines and transformers.

CO3: A study of theory and concept of Electric Machines (AC & DC).

CO4 : Deriving equivalent circuit of electrical machines.

CO5 : Studying the performance and characteristics of Electrical machines (AC & DC).

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ADVANCED POWER SYSTEMS

EEC - 601

Full Marks : 60 Time : Three Hours

The figures in the margin indicate full marks.

Instructions :

(i) All parts of any questions should be answered at one place

(ii) Materials to be supplied : NIL

(iii) Only neat & clean sketches will be eligible for marks.

Group - A

Answer *all* the questions.

1. (a) What are the factors responsible for study of High Voltage Engineering ?

(b) List the line materials are used in High voltage Substation.

(c) Write two major applications of High Voltage Engineering.

(d) Write the dielectric strength of Insulations in ascending order :

.....Insulation> .....Insulation> .....Insulation> .....Insulation 4 [CO1]

P.T.O.

2. (a) Derive the breakdown mechanism equations considering the Townsend's first and second ionization coefficients with a neat sketch for a flat and point configuration system of electrodes.

   (b) Describe Paschen's Law from the Gas breakdown functions as derived from Townsend breakdown mechanism. 8+4 [CO1 & CO2]

3. (a) Describe voltage Doubler circuit of 230V/100kV, 0.1A input transformer for building a 'Cockroft Walton circuit' of 1000 kV DC output with schematic diagram and explain the operation with each stage wave-shapes.

   (b) Explain the cascade connection of three transformers for 450 kV, 1.5A, AC high voltage generation with neat sketch. Indicate the voltage and currennt rating of each transformer. 6+6 [CO3 & CO4]

Or,

   (a) Describe one minute and Five minutes DryPower Frequency High voltage test of a Disc insulator rated 33kV with neat sketch.

   (b) Describe a modified impulse generator. It has eight stages with each condenser rated for 0.1 μF, 100kV. The load capacitor available is 500 pF. The charging resistance is available 10 k′Ω. Find out the series resistance and damping resistance for each stage needed to produce 1.2/50μS impulse wave and draw the circuit with the calculated and given parameters. 3+9

4. Write a short note on (any *three*) :
4×3 [CO2, CO3, CO4 & CO5]

(a) Vande Graff Generator

(b) Impulse test of a transformer

(c) Breakdown of Vacuum insulation

(d) Online monitoring of BDV of a transformer

(e) Characteristics of an Lighting Impulse voltage and Chopped Impulse Voltage.

Group - B

Answer *all* the questions.

5. (a) Prove that for salient pole synchronous machine, the reluctance power is $V^2/2 \sin 2\delta\left[1/X_q - 1/X_d\right]$

(b) A double circuit three phase feeder connects a single generator to a large network. The power corresponding to the limit of steady state stability for each circuit is 100 MW. The line is transmitting 80 MW, when one of the circuits is suddenly switched out. Determine with reference to appropriate diagram whether the generator is likely to remain in synchronism. 4+6 [CO1 & CO6]

6. (a) What is static load flow equation ?

(b) Why acceleration factor is necessary for load flow studies ?

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(c) Determine Y_{bus} for the following 4-bus systems. The line series impedances are as follows. Neglect the shunt capacitance of the line.

Line (Bus to Bus)	Impedances (P.U.)
1 - 2	0.25 + j 1.0
1 - 3	0.20 + j 0.8
1 - 4	0.30 + j 1.2
2 - 3	0.20 + j 0.8
3 - 4	0.15 + j 0.6

3+3+4 [CO1 & CO6]

Or,

The ABCD constants of a nominal Π network representing a three-phase transmission line are, $A = D = 0.97 < 0.6^0$, $B = 60 < 70^0$, $C = 0.001 < 91^0$. Find the steady state stability limit, if both the sending end and receiving end voltage are held at constant at 132 kV, (i) with the ABCD constants as given (ii) with the shunt admittance neglected.

Course Outcomes :

CO1 : To understand basics of High Voltage Engineering & power system stability.

CO2 : To design the insulation system and load management module.

CO3 : To design the High Voltage test system and Laboratory.

CO4 : To learn about the testing of High Voltage power apparatus.

CO5 : To understand on line monitoring and conditioned monitoring.

CO6 : Given specification of stability analysis leads to modeling of power system equipment's like transmission line, generator and design system to obtain operating limits to satisfy the reliability criteria.

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MICROPROCESSOR AND MICROCONTROLLER

EEC - 602

Full Marks : 60 Time : Three Hours

The figures in the margin indicate full marks.

Answer *all* the questions.

1. Answer any *two* : 7½×2 [CO2]

   (a) Describe the architectural attributes of 8086 microprocessor with a suitable diagram. Also explain how 1MB memory can be addressed using 16-bit registers.

   (b) Provide an overview of the architecture of the 8051 microcontroller, along with a relevant diagram, and explain the mapping of internal registers.

   (c) Describe the different Modes of the Timer 0 for the 8051 microcontroller with suitable schematic diagram.

2. Answer any *two* : 7½×2 [CO1]

   (a) Draw a complete diagram illustrating all the external hardware connections, including Data and Address buses, Read and Write Control buses, Bus buffers, and chip Select signals, to explain a fully decoded addressing scheme for an 8085-based system with the following peripherals : one 8K RAM and one 8K EPROM. Ensure

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that the RESET location is mapped in EPROM and the stack pointer is mapped in RAM. Also, provide a list of available address locations.

(b) Write down the micro-operations along with machine cycles and timing diagram for the following 8085 based instructions : (i) STA 2045(H) (ii) JNZ 4000(H).

(c) Draw a complete diagram illustrating all the external hardware connections, including Data and Address buses, Read and Write Control buses, Bus buffers, and Chip Select signals, to provide I/O mapped I/O scheme for an 8085-based system with the following peripherals : one 8 bit input port consist of eight switches having port address 01(H) and one 8 bit output port consist of LEDs having port address FF(H).

3. Answer any *one* : 15×1 [CO4]

(a) Design an interfacing circuit between an 8-bit D/A converter and a microprocessor/microcontroller to generate a triangular waveform with an amplitude ranging from 0V to 4.0V and a frequency of 100Hz. Assume the clock frequency of the microprocessor/microcontroller is 2 MHz. Provide a schematic diagram of the interfacing circuit, clearly showing the connections between the D/A converter, microprocessor/microcontroller, and other necessary components. Label all the components used and explain the operation of the circuit in detail. Write the suitable assembly language program (with comment after every instruction) by assuming a delay subroutine of 1ms is available. Also mention the port address.

(b) Design an interfacing circuit between an 8255 and a microprocessor/microcontroller to read the status of 8 relays/switches (R0, R2,...R7) and update 8 LEDs (LED0, LED2, ...LED1) according to the following conditions of the input relays (switches).

(i) Turn 'ON' all LEDs if all the relays (R0, R2, ...R7) are 'OFF' (logic '0').

(ii) Turn off all the LEDs for any other states of the relays.

Provide a schematic diagram of the interfacing circuit, clearly showing the connections between the 8255, microprocessor/microcontroller, and other necessary components. Label all the components used and explain the operation of the circuit in detail. Write the suitable assembly language program (with comment after every instruction) with the suitable port and address of 8255 control register.

4. Answer any *two* : 7½×2 [CO3]

(a) Read the following program, and answer the questions :

```
2000    LXI     SP, 2100H
2003    LXI     B, 0000H
2006    PUSH    B
2007    POP     PSW
2008    LXI     H, 200BH
```

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```
200B    CALL    2064H
200E    OUT     01H
2010    HLT
2064    PUSH    H
2065    PUSH    B
2066    LXI     B, 80FFH
2069    DCX     B
206A    MOV     A, B
206B    ORA     C
206C    JNZ     2069
206F    POP     B
2070    RET
```

(i) What is the status of the flags and the contents of the accumulator after the execution of the POP instruction located at 2007(H) ?

(ii) Specify the stack locations and their contents after the execution of the CALL instruction (not the CALL subroutine).

(iii) What are contents of the stack pointer register and the program counter, after the execution of the CALL instruction ?

(iv) Specify the memory location where the program returns after the subroutine.

(v) What is the ultimate fate of this program ?

(b) Write a 5ms time delay subroutine using the register pair BC. Clear the Z flag without affecting any other flag registers and return to the main program. Also provide the instruction wise clock cycles for the time delay and calculate exact time of the delay subroutine. Assume clock frequency of 1 MHz.

(c) Write a program with a delay subroutine to count a number and display the same in output port with address 01(H). Assume clock frequency of 1 MHz. Explain how the same can be performed with a hardware Timer. Provide justifications for using software delay vs. hardware delay using timer.

Course Outcomes :

CO1 : Demonstrate programming proficiency using the various addressing modes and data transfer instructions of the target microprocessor microcontroller.

CO2 : Describe key H/W and S/W attributes of microprocessors/microcontrollers. Outline of the major architectural features of microprocessors.

CO3 : Identify — and exercise — opportunities for hardware and software trade-off.

CO4 : Design of interfacing circuits such as memory, keyboard, display, ADC, DAC, DMA etc. and programming in assembly language for typical microprocessor-based system.