

Duration: 3 hours

Marks: 80

N.B. (1) Question No. 1 is **COMPULSORY**.

(2) Answer **ANY THREE** questions from Q.2 to Q.6.

(3) Use of Statistical Tables permitted.

(4) Figures to right indicate full marks.

- Que. 1 a. Show that the following quadratic form  $6x^2 + 3y^2 + 3z^2 - 4xy - 2yz + 4zx$  is **5**  
positive definite
- b. Find the extremal of  $\int_{x_1}^{x_2} \sqrt{1 + \left(\frac{dy}{dx}\right)^2} dx$  **5**
- c. Find a unit vector orthogonal to the vectors (1,1,1) and (0,1,1). **5**
- d. Evaluate  $\int_0^{1+i} \bar{z} dz$  along the real axis from  $z = 0$  to  $z = 1$  **5**  
then vertically to  $1 + i$ .
- Que. 2 a. Find the extremal of  $\int_0^{\frac{\pi}{2}} (y'^2 - y^2 + 2xy) dy$  with  $y(0) = 0$  **6**  
 $y\left(\frac{\pi}{2}\right) = 0$ .
- b. In a normal distribution 30% of the items are below 35 and 10% of the items are **6**  
above 60. Find the mean and standard deviation.
- c. The lines of regression are  $20x - 9y - 107 = 0$  and  $15x = 8y + 130$ ,  $V(x) = 16$  Find the **8**  
means,  $r$ , and  $V(y)$ .
- Que. 3 a. In sampling a large number of parts manufactured by a machine the mean number **6**  
of defectives in a sample of 20 is 2. Out of 1000 such a sample how many would  
you expect to contain i) 3 defectives ii) less than 3 defectives.
- b. Find the line of regression of Y on X for the following data **6**
- |   |    |    |    |    |    |    |    |
|---|----|----|----|----|----|----|----|
| X | 5  | 6  | 7  | 8  | 9  | 10 | 11 |
| Y | 11 | 14 | 14 | 15 | 12 | 17 | 16 |
- c. Show that  $V = \{(x, 0) / x \text{ is real}\}$  with the operations of addition and scalar **8**  
multiplication defined as  $(x_1, 0) + (x_2, 0) = (x_1 + x_2, 0)$  and  $k(x, 0) = (kx, 0)$  is a vector  
space.

- Que. 4 a. Reduce the following quadratic form  $3x^2 + 5y^2 + 3z^2 - 2xy - 2yz + 2zx$  to canonical form also find rank signature and index. **6**
- b. Verify Cauchy-Schwartz inequality for  $U = (2, 4, -3, 5)$  and  $V = (3, 2, 3, -1)$ . **6**
- c. Find all possible expansions of  $f(z) = \frac{7z-2}{z(z-2)(z+1)}$  about  $z = -1$ . **8**

- Que. 5 a. If the probability mass function of a random variable is  $f(x) = kx(1-x)$ ,  $0 \leq x \leq 1$ . find its mean and variance. **6**
- b. Find the orthonormal basis by Gram-Schmidt process to  $(-1, 1, 0)$ ,  $(0, 1, 1)$ ,  $(1, 0, 1)$ . **6**
- c. Fit a second-degree parabolic curve to the following data **8**

X	1	2	3	4	5	6	7	8	9
Y	2	6	7	8	10	11	11	10	9

- Que. 6 a. Show that  $\{(a, 0, 0) \mid a \text{ is real}\}$  is subspace of  $\mathbb{R}^3$ . **6**
- b. Evaluate  $\oint_C \frac{(z-3)}{z^2 + 2z + 5} dz$  where C is the circle (a)  $|z|=1$  **6**  
 (b)  $|z+1-i|=2$  (c)  $|z+1+i|=2$
- c. Use Rayleigh-Ritz Method to find the extremal of  $\int_0^1 (xy + \frac{1}{2}y'^2) dx$  given  $y(0)=1$  &  $y(1)=0$ . **8**

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(3 Hours)

Total Marks: 80

**N.B: (1) Question No. 1 is compulsory.****(2) Attempt any three from the remaining questions.****(3) Figures to the right indicate full marks.****(4) Each question is of 20 Marks.****Q1. Answer ANY FOUR.**

- a) List down the conditions to be fulfilled for successful parallel operation of transformers. **05**
- b) Explain torque speed characteristics of an induction motor. **05**
- c) Whether a single phase induction motor is self-starting, justify your answer. **05**
- d) With neat diagrams explain Dd6 and Dy1 connections. **05**
- e) Derive relation between starting torque and full load torque for three phase Induction motor. **05**

**Q 2**

- a) Two three phase transformers connected in parallel supply a load requiring an active power of 700 kW and lagging reactive power of 715 kVAR. Transformer 1 is rated at 400 KVA and has p.u. impedance of  $(0.03 + j0.08)$  while transformer 2 is rated at 600 KVA and has p.u. impedance of  $(0.02 + j0.07)$ . Determine active power shared by each transformer and operating power factor. **10**
- b) Write a short note on 'Saving of Copper in an Auto-transformer'. **10**

**Q 3**

- a) Explain various power stages in an induction motor with necessary expressions. **10**
- b) A 3 phase; 4 pole; 1440 rpm; 50 Hz induction motor has a star connected rotor with per phase rotor resistance and standstill reactance as  $0.2 \Omega$  and  $1 \Omega$  respectively. When the stator is energised with rated supply voltage at rated frequency the rotor induced e.m.f. between lines is 210V. Calculate, rotor current; power factor and torque at standstill and at full load. **10**

**Q 4**

- a) Write a short note on 'Open Delta' connection of three phase transformer. **10**
- c) An 8 pole 50 Hz, three phase induction motor runs at a speed of 720 rpm when delivering full load torque. Its rotor resistance and stand still reactance are  $0.1 \Omega$  and  $0.6 \Omega$  per phase respectively. An additional resistance of  $0.5 \Omega$  per phase is inserted in the rotor circuit to control the speed. Calculate the speed at which the motor will run now if full load torque remains same. **10**

**Q 5****15915**

- a) A 220 V, 4 pole, 50 Hz split phase induction motor has following test results: **10**

<b>Blocked rotor test:</b>	120 V	9.6 Amp.	460 Watts
<b>No load test:</b>	220 V	4.6 Amp.	125 Watts

The stator winding resistance is  $1.5 \Omega$  and during the blocked rotor test, the starting winding is open. Determine the equivalent circuit parameters. Also find core, friction and windage losses.

- b) Explain i) capacitor start & capacitor run and ii) shaded pole induction motor with neat diagrams. **10**

**Q 6 Write short note on ANY TWO of the following.**

- a) Deep bar and double cage induction motor. **10**  
 b) Oscillating neutral phenomenon in transformer. **10**  
 c) Scott connection. **10**

Duration: 3hrs

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- Note:** 1. Q. no. 1 is compulsory  
2. Solve any three questions from the rest  
3. Make suitable assumptions wherever applicable

**Q. no. 1. Answer any four****(20)**

- Draw the diagram of a three input AND gate and write the truth table and logic expression.
- Convert  $(247)_{10}$  in to octal and Hex equivalent.
- Explain what DCTL logic family is?
- Realize a half adder logic circuit using gates.
- What is a latch? Explain.

**Q. No. 2.**

- Perform the following subtraction using 2's complement method. **(10)**
  - $01000-01001$
  - $01100-00011$
- Write short note on characteristics of digital IC. **(10)**

**Q.No.3**

- Explain the TTL logic with the help of TTL NAND gate realization. **(10)**
- Minimize the four variable logic function using K map **(10)**  
 $f(A,B,C,D)=ABC\bar{D} + \bar{A}BCD + \bar{A}\bar{B}\bar{C} + \bar{A}\bar{B}\bar{D} + A\bar{C} + A\bar{B}C + \bar{B}$

**Q. No. 4.**

- Minimize the following logic function and realize using NAND and NOR gate **(10)**  
 $f(A,B,C)=\Sigma m(0,1,4,6,8)$
- Design a 6 bits binary to BCD converter using multiplexer. **(10)**

**Q. No. 5**

- Write short note on J-K master slave Flip flop. **(10)**
- Design a three bits asynchronous binary counter using flip flop. **(10)**

**Q. No. 6****(20)**Write short not on **any 2**

- A 3 bit R-2R D/A converter
- Dual slope A/D converter
- Classification of memory

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Time: 3 Hours

Max. Marks: 80

- Q1. Solve any 05 4 marks each**
- a Show the turn-on process of SCR using waveform and explain in short.
  - b What are the advantages of using PWM rectifier?
  - c How the silicon-carbide devices are different than normal silicone devices?
  - d Compare VSI and CSI
  - e Where the DC-DC converters are used.
  - f How Snubber circuit protects semiconductor switches
  - g How heat sink is selected?
- Q2. Solve any two out of three 10 marks each**
- A Why the gate driver circuit is required? Draw a Bootstrap and isolated gate driver (block diagram or circuit diagram)
  - B Explain working of buck-boost converter. Draw waveforms and derive equation to calculate output voltage
  - C Compare single phase half bridge inverter and full bridge inverter (any five points)
- Q3. Solve any Two out of Three 10 marks each**
- A Define different performance parameters of single-phase bridge inverter.
  - B Explain gate triggering techniques of SCR.
  - C Describe the working of three phase bridge Inverter for  $180^\circ$  conduction mode and draw the gating signals and phase voltages.
- Q4. Solve any Two out of Three 10 marks each**
- A Draw the circuit diagram for a Boost dc to dc converter. Explain the functioning and draw the following waveforms (i) Inductor voltage; (ii) Inductor current; (iii) Capacitor current; (iv) Capacitor voltage and (v) Switch current.
  - B Explain any two voltage commutation techniques for SCR.
  - C Explain different PWM techniques with appropriate waveforms.
- Q5. Solve any Two out of Three 10 marks each**
- A Draw waveforms and explain single phase controlled rectifier driving R-L load with and without freewheeling diode.
  - B Explain working of SCR and V-I characteristics of it.
  - C Explain different PWM techniques with appropriate waveforms.
- Q6. Solve any Two out of Three 10 marks each**
- A Compare power BJT, MOSFT and IGBT
  - B Explain working of SCR and V-I characteristics of it.
  - C Explain Turn-ON techniques of SCR.

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Time: 3 Hrs

Marks : 80

Note :

- **Question No.1 is compulsory.**
- Solve **ANY THREE** questions from the **remaining** five questions.
- Figure to the right indicates full marks.
- Assume suitable data wherever required, but justify the same.

		<b>Marks</b>
<b>Q. 1</b>	Attempt <b>any four</b> from the following. (Each 5 marks)	<b>20</b>
	a) Compare the characteristics and performance of different energy sources for EV application.	
	b) <i>What is the need and importance of electric vehicle?</i>	
	c) <i>Describe the concept of "Hybridness" and classify the HEV based on hybridness.</i>	
	d) State and explain the vehicle to grid and grid to vehicle operation in electric vehicle technology	
	e) Explain the performance parameter of the motors used in Electric vehicle	
<b>Q2</b>	a) Illustrate the historical background of EV / HEVs technology in brief. Also describe the current scenario of EV technology along with technology challenges associated it.	<b>(10)</b>
	b) Describe the power flow scenario in a Parallel Hybrid and Series-Parallel Hybrid electric drive-train topologies. Also explain different modes of operation for both types of HEV	<b>(10)</b>
<b>Q.3</b>	a) Draw and explain the ideal traction energy source (power plant) characteristic used in EV/HEVs.	<b>(6)</b>
	State and define the key battery parameters (i) Battery capacity (ii) C rate (iii) SoC (iv) DoD (v) Specific Energy (vi) Energy Density.	<b>(6)</b>
	b) What are the different battery charging modalities adopted for EV?	
	c) Explain each one in brief and also elaborate on standards adopted for the same worldwide.	<b>(8)</b>
<b>Q4.</b>	Enlist the different architectures of hybrid electric drive train and explain the series hybrid electric drive train.	<b>(10)</b>
	a) Describe in detail all modes of operation for series-parallel hybrid vehicle.	<b>(10)</b>
	b) Describe the design parameters of the ICE and motors in series hybrid drive.	<b>(10)</b>
<b>Q5.</b>	a) Compare and differentiate between the battery electric vehicle (BEV), hybrid electric vehicle (HEV), and plug in HEV (PHEV) technologies.	<b>(10)</b>
	b) Explain the two quadrant operation of chopper dc motor drive with suitable waveforms for electric vehicle.	<b>(10)</b>
<b>Q6.</b>	a) Explain fuel cell and flywheel as energy source element in electrical and hybrid electric vehicle.	<b>(10)</b>

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