(3 Hours) [Total Marks: 80]

N.B.: 1) Question No. **1** is **Compulsory**.

2) Answer **any THREE** questions from Q.2 to Q.6.

3) Figures to the right indicate full marks.

Q.1 (a) Verify Cauchy Schwarz inequality for the vectors u=(2,1,1,-1) and (5)
v= (1,-2,1,1). Find the angle between vectors u and v.

(b) Find p , q and variance of X, if the mean of the following distribution is 16 and (5)

X	8	12	16	20	24
P(X)	1/8	p	q	1/4	1/12

(c) Evaluate $\int_c \frac{1}{z} dz$ where c is unit circle $|z| = 1$. (5)

(d) Find the extremal of $\int_0^{3\pi/2}(y^2 - y'^2)dx$ where y(0)=0 ; y(3π/2)=1. (5)

Q.2 (a) Evaluate $\int_c \frac{z+3}{(z-i)(z-4)}dz$, where c is the circle $|z-1|=2$. (6)

(b) Fit the second degree polynomial for following data (6)

X	1	2	3	4	5	6	7
Y	-5	-2	5	16	31	50	73

(c) Transform the basis {(1,1,1) ; (-1,1,0);(1,2,1)} into orthogonal basis using (8)
Gram-Schmidt process.

Q.3 (a) Check whether the following sets are subspace of R³ (6)
  (i) W=(a ,0,0)/ a belongs to R }
  (ii) W={(x ,y, z)/ x²+y²+z²≤1}

(b) Calculate the rank correlation coefficient 'R' for the following data (6)

x	0	2	8	6	5	20
y	2	8	10	5	40	15

(c) Obtain all possible Laurent's series expansion of $f(z) = \frac{1}{z^2+3z+2}$ about $z = 0$. (8)

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Q.4 (a) If X and Y are independent random variable with $E(X) = 6$ and (6)
$E(Y) = -6$, $V(X) = 4$, $V(Y) = 9$ then find
i) $E(2X + 3Y - 2)$
ii) $V(3X + 2Y + 2)$

(b) (6)
Evaluate $\int_0^{1+i} (x - y + ix^2) \, dz$ along the line from $z = 0$ to $z = 1 + i$.

(c) Find rank, index, signature and nature of the Quadratic form by reducing it into (8)
Canonical form by congruent transformation $x^2 + 3y^2 + 3z^2 - 2yz$.

Q.5 (a) Three factories A, B, C produce 30%, 50% and 20% of the total production of (6)
an item. Out of their production 80%, 50% and 10% are defective respectively.
An item is chosen at random and found to be defective. Find the probability
that it was produced by the factory A.

(b) A continuous random variable has pdf $f(x) = k(x - x^2), 0 \le x \le 1$. (6)
Determine k, mean, and variance of the distribution.

(c) Using Rayliegh-Ritz method solve boundary value problem (8)

$\int_0^1 (2x^2 y - 4y^2 + y'^2) dx$, y(0)=0 , y(1)=0.

Q.6 (a) (6)

x	65	66	67	67	68	69	70	72
y	67	68	65	68	72	72	69	71

Calculate the Karl Pearson's coefficient of correlation.

(b) Find the extremals of $\int_a^b (16y^2 - y''^2 + x^2) dx$. (6)

(c) Given: $6y = 5x + 90$, $15x = 8y + 130$ are regression lines and $\sigma_x^2 = 16$ (8)
then find (i) mean of X and Y (ii) correlation coefficient (r) $(iii)\sigma_y^2$.

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(Time: 3 Hours)   (Total Marks: 80)

N.B.:- **(1) Question No.1 is compulsory.**
(2) Attempt any three questions out of remaining five questions.
(3) Figures to the right indicate full marks.

Q 1.   Answer the following questions.   20
   a)   Explain connection and phasor diagram of Dd0 & Yy0?.
   b)   Illustrate the application of single-phase induction motor.
   c)   Compare auto transformer and two winding transformers. State application of auto transformer
   d)   Describe the need of parallel operation of transformer and explain condition for parallel operation.

Q.2 a)   Explain No load and blocked rotor test of 3 phase induction motor.   10

Q.2 b)   A 3-phase star connected 400V, 50 Hz, 4 pole induction motor has the following   10
          per phase parameters in ohm referred to stator. $R_1 = 0.6\Omega$, $X_1 = 1.1\Omega$, $R'_2 = 0.3\Omega$,
          $X'_2 = 0.5\Omega$, $Xm = 25\Omega$.The mechanical losses 1000W and stator core losses are
          500 W. The slip is 3%. Calculate 1) Stator current 2) Gross torque 3) Efficiency.

Q.3 a)   Describe harmonics and Suppression of harmonics in three phase transformers.   10

Q.3 b)   Write short note on Open delta Connection.   10

Q.4 a)   Explain capacitor start and run single phase induction motor.   10

Q.4 b)   Two single phase transformers share a load of 400 KVA at power factor 0.8   10
          lagging. Their equivalent impedance referred to secondary windings
          are$(1+j2.5)$ Ω, and $(1.5+j3)$ Ω respectively. Calculate the load shared by each
          transformer

Q.5 a)   Draw and explain Scott connection of transformer in detail.   10

Q.5 b)   Explain about copper saving in auto transformer.   10

Q.6 a)   Explain the different speed control methods of three phase induction motor in   10
          detail. Describe pole changing Method in detail.

Q.6 b)   Describe Sumpner's test on single phase transformers   10

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Time- 3 Hours

Total Marks: 80

Note:
1. Q. No. 1 is compulsory
2. Attempt any 3 from rest
3. Make suitable assumptions wherever required
4. Draw neat and clear diagrams
5. Write in legible handwriting
6. Figure to the right indicate full marks

Q.1 Answer any 4 questions 20

a. Convert the decimal number 2024 in to equivalent binary and octal number

b. Explain excess 3 codes and grey code with examples.

c. Explain 3 bits min and max terms with the help of data table.

d. Explain 3 bits digital register circuit in brief.

e. Explain the classification of logic family.

f. Explain random and sequential memory.

Q.2 a. Explain why NAND and NOR gates are called universal gates? 10

b. Explain in detail RCTL logic family with example with its advantages and

disadvantages 10

Q.3 a. Write short note on the specifications of digital IC. 10

b. Implement the logic given by the following SOP expression using NAND gate

$f(A,B,C,D)=\sum m(0, 1,2,5,7,9,10,11,13,15)$

10

Q.4 a. Design a logic circuit for two inputs half and full adder. 10

b. What is a multiplexer? Design a 16x1 multiplexer circuit using 4x1 multiplexers. 10

Q.5 a. Explain the working of any shift register with the help of suitable diagram. 10

b. Explain mode 10 counter with the help of suitable diagrams. 10

Q.6 Write short note on any two 20

a. R-2R Digital to analog converter

b. Successive approximation method of ADC

c. Memory Mapping and address decoding

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Time: 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

Q.1	Attempt any 4 questions	Marks
A	Define the concept of Vehicle to grid and Grid to vehicle in Electric vehicle technology.	5
B	What is hydridness? List the classification of HEV based on Hydridness.	5
C	Sketch the EV configuration and describe the various subsystem of the EV configuration.	5
D	List and classify the various types of DC and AC machine used in EV applications.	5
E	Discuss why Flywheel is called as Mechanical battery. Mention its advantages and disadvantages.	5

Q.2		Marks
A	Compare and Differentiate between the battery electric vehicle (BEV), Hybrid Electric Vehicle (HEV) and plug in hybrid Electric Vehicle (PHEV), with neat, labelled block diagrams.	10
B	Describe in detail all modes of operation for series-parallel hybrid vehicle.	10

Q.3		Marks
A	Explain the term rolling resistance and aerodynamic drag in vehicles and derive the expression for the total power required by the drive train.	10
B	Elaborate on the architecture of parallel hybrid electric drive train. List down the advantages, disadvantages and applications	10

Q.4		Marks
A	Elaborate on any one of the optimization-based energy management system of EV.	10
B	Explain the two-quadrant operation of chopper dc motor drive with suitable waveforms for electric vehicle.	10

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		Marks
Q.5		
A	Interpret on the concept of hybridization of Energy storages, with an example.	10
B	Draw and explain the typical CAN system of a hybrid electric vehicle.	10

		Marks
Q.6		
A	Classify the different EV battery charging methods. Explain in brief.	10
B	State and define the key battery parameters (i) Battery capacity (ii) C rate (iii) SoC (iv) DoD (v) Specific Energy (vi) Energy Density	10