**Max. Marks: 80**                                                                                 **Time: 3 hrs.**

**N.B. :** 1. Q1 is compulsory
2. Attempt any three questions from Q2 to Q6.
3. Figures to the right indicate full marks.

Q1. (a) Evaluate the integral $\int\limits_C \dfrac{1}{\left(z^2+1\right)\left(z^2+4\right)}\ dz$, C: $|z-2i|=2$.                          [5]

(b) A r.v. X has the distribution                                                                          [5]

| X : | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| p(x): | k | 3k | 5k | 7k | 9k | 11k | 13k |

Find  i) k  ii) $P(3 < X \le 6)$

(c) Using Gram Schmidt method, find an orthogonal set of vectors                          [5]
corresponding to $(1,1,0,1)$, $(-1,0,1,0)$, $(0,0,1,-1)$.

(d) Find the equations of line of regression of y on x for the following data.                          [5]

| x | : | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|
| y | : | 11 | 14 | 14 | 15 | 12 | 17 | 16 |

Q2. (a) Find the Extremal of $\int\limits_0^1 y\,y' + \left(y''\right)^2\ dx$,                          [6]

$y(0)=0,\ y'(0)=1,\ y(1)=2,\ y'(1)=4$

(b) Find the Laurent series expansion of $\dfrac{z+2}{z^2-1}$ convergent in the                          [6]

domain $|z|>1$.

(c) Reduce the quadratic form $x_1^2 + 2x_2^2 + 3x_3^2 + 2x_1x_2 - 2x_1x_3 + 2x_2x_3$                          [8]

to diagonal form by congruent transformation. Obtain the transformation

applied in the reduction and Find the rank, index and class value.

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Q3. (a) Find the Extremal of $\int_{x_1}^{x_2} \sqrt{1+\left(y'\right)^2} \; dx$ . [6]

(b) There the two brands of smartphone available in the market. A person [6] may buy a smartphone of brand X in 75% and that of Y is 25%. If 95% of brand X and 80% of brand Y perform according to the specification. If the smartphone bought by him is working according to the specification, then what is the probability that it is of brand Y?

(c) Find a singular value decomposition of the matrix $\begin{bmatrix} 1 & 1 \\ 1 & -1 \\ 1 & -1 \end{bmatrix}$. [8]

Q4. (a) Evaluate the integral $\int_C \dfrac{\cos^2 z}{z^5} \; dz, \;\; C:|z|=1,$ using Cauchy [6] integral formula.

(b) Find the usual inner product between the two vectors $(2,6,1,-3)$ [6] and $(3,2,1,0)$. Find the norm of each vectors and verify the Cauchy Schwarz inequality.

(c) The marks of 1000 students of an Engineering college are distributed [8] normally with mean $70$ and standard deviation $5$. Estimate the number of students whose marks will be i) between $60$ and $75$ ii) more than 75

Q5. (a) If C is the rectangle formed by the lines $x = \pm 2, \; y = \pm \dfrac{1}{2}$, then [6]

Evaluate the Integral $\int_C \dfrac{2z}{z^4-1} \; dz$

(b) Calculate the rank correlation coefficient for the following data. [6]

x : 10 12 18 16 15 40
y : 12 18 20 15 50 25

(c) Using Rayleigh-Ritz method, find an approximate solution for the [8]

Extremal of $\int_0^1 \left(y'\right)^2 - 4y^2 + 2x^2 y \; dx, \; y(0)=0, \; y(1)=0$

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**2**

Q6. (a) Random variables $X_1$ has mean 5 and variance 5, $X_2$ has [6]

mean -2 and variance 3, $X_1$ & $X_2$ are independent. Find

$E(2X_1 + 3X_2 - 5)$, $Var(X_1 + X_2)$, $Var(3X_1 - 2X_2 - 5)$.

(b) Let $W_1 = \{(x,y) \mid x,y \in \mathbb{R}, y = mx\}$ and $W_2 = \{(x,y) \mid x,y \in \mathbb{R}, xy \geq 0\}$. [6]

Show that $W_1$ is a subspace and $W_2$ is not a subspaces of $\mathbb{R}^2$

(c) Fit a second degree parabolic curve to the following data to predict the [8]

annual production where $year = 1974 + x$.

| x | : | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|
| Production in crores tons (y) | : | 2 | 4 | 6 | 4 | 3 | 7 |

Predict the production (in crores tons) in the year 1980 based on this fitting.

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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)** | Illustrate OC and SC test of a single phase transformer. | **05** |
| **b)** | Compare autotransformer and two winding transformer. | **05** |
| **c)** | Describe connection and phasor diagram of Yd11 transformer. | **05** |
| **d)** | State applications of single phase induction motor. | **05** |
| **e)** | Draw and describe torque-slip characteristic of three-phase induction motor. | **05** |

**Q 2. Answer the following.**

**a)** Draw the circle diagram for 3.73 kW,200 V,50 Hz,3-phase, 4 pole star connected induction motor **10**
from given data
No load test:       200 V, 5 A, 350 W
Blocked rotor test:  100 V,26 A,1700 W
Rotor cu loss at standstill is half of total cu loss. From circle diagram at full load find line current,
power factor, slip, efficiency, maximum torque & maximum output.

**b)** Explain construction, working, characteristics, and application of shaded pole induction motor. **10**

**Q 3. Answer the following.**

**a)** Explain saving of copper in auto transformer with application. **10**
**b)** Explain Scott connection with neat diagram. **10**

**Q 4. Answer the following.**

**a)** Why starter is required in 3-phase induction motor? Explain star delta starter with neat diagram. **10**
**b)** A 220 V, 4 pole, 50 Hz, split phase induction motor has the following test results. **10**

| **Blocked Rotor Test:** | 120 V | 9.6 A | 460 W |
|---|---|---|---|
| **No load test:** | 220 V | 4.6 A | 125 W |

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

**Q 5. Answer the following.**

**a)** Describe power stages of 3-phase induction motor with necessary expressions. **10**
**b)** Explain in detail double field revolving theory of single phase induction motor. **10**

**Q 6 Answer the following.**

**a)** Enlist the different speed control methods of three phase induction motor and describe in detail **10**
Pole Changing Method.
**b)** Describe switching intransient phenomenon in three phase transformer. **10**

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3hrs                                    Total Marks: 80

**N.B: 1. Question no. 1 is compulsory.**
   **2. Attempt any three questions out of remaining five questions**
   **3. Assume suitable data wherever applicable**

Q1. Attempt any 4                                                                [20]

   A. Why and which code is used for labeling the cells of K-Map
   B. Realize 1-bit comparator using logic gates
   C. Compare PAL and PLA
   D. Convert $(352.7)_{10}$ into binary, octal and hexadecimal.
   E. What is race around condition in JK flipflop and how to overcome it.

Q2. A. Prove that NAND and NOR are universal gates                                [10]
Q2. B. Perform the following operation using 2's complement
   i) $(35)_{10} - (45)_{10}$              ii) $(45)_{10} - (35)_{10}$           [10]

Q3. A. Implement the 3 bit binary to gray code converter                         [10]
Q3. B. Using Boolean Algebra prove the following                                 [10]
   i) $AB + BC + \bar{A}C = AB + \bar{A}C$
   ii)$[(C+ \bar{C}D) (C+\bar{C}\bar{D})] )[(AB+\bar{A}B) (\bar{A}B +AB)]=C$

Q4. A. Design a asynchronous decade counter.                                     [10]
Q4. B. Convert the following                                                      [10]
   i) SR flipflop to T flipflop
   ii) T flipflop to D flipflop

Q5. A  Explain the 3 bit R-2R D/A converter                                       [10]
Q5. B. Explain the classification of memory.                                     [10]

Q6. Write in brief any two                                                       [20]
   a. Compare the TTL and CMOS logic families
   b. Full adder using PLA
   c. Implement 16:1 MUX using 4:1 MUX

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**Duration: 3hrs**        **[Max Marks: 80]**

Note: 1) Question No. 1 is compulsory
       2) Attempt any three questions out of remaining five
       3) All Questions carry equal marks
       4) Assume suitable data if required and state it clearly

Q1    Attempt any **FOUR**                  [20]
     a. Give comparison between power MOSFET and IGBT      5
     b. Explain "Sin PWM" control of inverters.      5
     c. Explain SOA of MOSFET with appropriate diagrams      5
     d. What is significance of free-wheeling diode, explain with one example and
        waveforms.      5
     e. What is a bootstrap driver circuit? Why it is needed?      5

Q2.a) Explain with circuit diagram and waveform,3-phase bridge inverter for 180 degree
      conduction mode.        [10]
   b) Explain the Dynamic characteristics of SCR with appropriate waveforms.     [10]

Q3. a) What is commutation technique? Why it is needed? Differentiate between voltage and
      current commutation with example.        [10]
   b) Explain 3-phase full converter with circuit diagram and draw following waveforms for
      firing angle α=30°: 1. Supply voltage    2. Firing pulses    3. Load voltage. And 4.
      Load current        [10]

Q4. a) Draw single phase fully controlled bridge converter with R-L load. Explain its
      operation with appropriate waveforms.        [10]
   b) Explain with suitable diagram the different Gate –Triggering techniques for SCR
                       [10]

Q5.a) Draw and explain Boost regulator with waveforms and derive the relation for output
      voltage.        [10]
   b) In a Buck converter, the switch is operated at 25kHz.Given that, input voltage=14V
      and load resistance is 200Ω. If the output voltage required is Vo=6v voltage and peak to
      peak ripple current in inductor is limited to 0.8A , calculate (a) duty cycle; (b) value of
      Inductor

                                  [10]

Q6. Write short notes on (**any two**)                  [20]
         a) Single phase Dual- Converter
         b) Write short notes on Silicon Carbide (SiC) and GaN devices
         c) Performance parameters of Inverter
         d) Two-transistor's analogy of SCR

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**Time: 3 hour**                                                                                    **Max. Marks: 80**

**Note   :**
- **Question No.1 is compulsory.**
- Solve **ANY THREE** questions from the **remaining** questions.
- Figure to the right indicates full marks.

**Marks**

**Q. 1**      Solve **ANY FOUR** questions from following. (Each question carries 5 marks)

| | | |
|---|---|---|
| a) | Draw the schematic of general configuration of electrical subsystem of an Electric Vehicle (EV) and a Hybrid Electric Vehicle (HEV) | 5 |
| b) | What is the need and importance of electric vehicle? | 5 |
| c) | Describe the concept of "Hybridness" and classify the HEV based on hybridness. | 5 |
| d) | Draw and explain the ideal traction energy source (power plant) characteristic used in EV/HEVs | 5 |
| e) | The use of battery & ultra-capacitor as well fuel-cell & flywheel to form a hybrid energy source for EV application.. | 5 |

**Q. 2** a) Draw any one standard driving cycle and relate its application for EV performance analysis.                                                                                  **6**

b) Illustrate the fuel efficiency of ICE based conventional vehicles and Electric Vehicle with the help of neat diagrams and compare their overall performance.                                                                          **6**

c) Explain the two quadrant operation of chopper dc motor drive with suitable waveforms for electric vehicle.                                                          **8**

**Q3** a) Draw and explain the ideal traction energy source (power plant) characteristic and various energy source characteristics used in EV/HEVs.                                                                                           **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.                                                                                          **6**

c) What are the different battery charging modalities adopted for EV? Explain each one in brief and also elaborate on standards adopted for the same worldwide.                                                     **8**

| | | | |
|---|---|---|---|
| Q4 | a) | Enlist the different architectures of hybrid electric drive train and explain the series hybrid electric drive train. | **10** |
| | b) | Describe in detail all modes of operation for series-parallel hybrid vehicle. | **10** |
| Q5 | a) | Draw and explain the typical CAN system of a hybrid electric vehicle. | **10** |
| | b) | Enlist the different architectures of hybrid electric drive train and explain the series hybrid electric drive train. | **10** |
| Q6 | a) | Classify and describe in brief about the basic principle of optimization-based energy management system used in EV/HEVs. Elaborate on any one of the optimization-based energy management system | **10** |
| | b) | Illustrate with the help of diagrams, various components which contribute to the total tractive effort (FTE) needed in EV. Describe each in brief and also derive the expression for FTE by means of electric vehicle performance modeling. | **10** |

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