Subject: Space Science
Paper: I (Mathematical Techniques & Quantum Mechanics)

Time: 3 Hrs.   Marks: 100

NOTE: *Attempt any FIVE questions by attempting atleast TWO questions from each Section. All questions carry equal marks.*

SECTION – I

Question No: 1

a) State and explain postulates of Quantum mechanics. [10]
b) Find the values of constant 'C' in Time dependent Schrödinger's equation. [10]

Question No: 2

a) Calculate the total energy of particle moving inside "one –dimensional" box. [10]
b) Explain de Broglie's Hypothesis with experimental proof. [10]

Question No: 3 [3+3+4+5+5]

Define the following terms

1-Operators in Quantum mechanics   2-commutation relation of two operators

3-Eigen operator & Eigen function.   4- Expectation value of physical observation

5-Hermition operator

Question No: 4

Define angular momentum and prove that "No two components of angular momentum commute" [20]

SECTION – II

Question No: 5 Discuss the spherical co-ordinate system and prove that co-ordinates of this system are orthogonal to each other. Also convert $\left(8,\frac{\pi}{4},\frac{\pi}{6}\right)$ into Cartesian co-ordinates. [20]

Question No: 6

a) Find the Fourier series of $f(x) = e^x$ on $(0,\pi)$. [10]
b) Using Laplace Transformation solve the IVB. $y'' + 4y' + 8y = \sin x$,
   $y(0) = 1, \ y'(0) = 0$. [10]

Question No: 7

a) Does the function $f(z) = e^{-z}$ satisfy CR-equations? [10]

b) Evaluate $\oint_c \frac{e^{3z}+3\cosh z}{\left(z-i\frac{\pi}{2}\right)^4} \, dz$, where c is any closed contour containing [10]

   the point $z = i\frac{\pi}{2}$.

Question No: 8

a) Find the eigenvalues and eigenfunctions of Strum-Liouville problem $y'' - 4\lambda y' + 4\lambda^2 y = 0$;
   having conditions $y'(1) = 0$ and $y(2) + 2y'(2) = 0$. [10]
b) Find the general solution near $x = 0$ of $y'' + y = 0$ by power series method. [10]

Question No: 9 Find the general solution by Frobenius method $2x^2 y'' + 7x(x + 1)y' - 3y = 0$
   near $x = 0$. [20]

NOTE: Attempt any FIVE questions in all by selecting atleast TWO questions from each Section. All questions carry equal marks.

SECTION-I

Q-1 (a) Write a note on global circulation system. (10)

(b) Write a brief note on upper level winds and vorticity. (10)

Q-2 (a) Write a note on precipitation processes and types. (10)

(b) List and explain the various forms of condensation. (10)

Q-3 (a) Explain the vertical structure of Atmosphere with respect to temperature and pressure. (10)

(b) What is the composition of the atmosphere near the Earth's Surface? (10)

Q-4 Define and derive the Poisson's Equation? (20)

Q-5 Write a detailed note on any two of the followings. (20)

(a) Air Mass, (b) Fronts, (c) Weather Forecasting, (d) Meteorological satellites and Interpretation of weather satellite imagery

SECTION-II

Q-6 Write a complete change in geologic history of earth. (20)

Q-7 Write a comprehensive note on any two of the following (20)

(a) Impacts of Climate change, (b) ENSO, (c) Climate Change in Geological history.

Q-8 (a) How climatology is different from Meteorology? (10)

(b) What are climate models? Also name any two climate models? (10)

Q-9 Define the following (20)

- Lithosphere
- Hydrosphere
- Cryosphere
- Biosphere

NOTE: Attempt any FIVE questions by selecting at least ONE question from each section.

SECTION – I

Q.1	State and explain Einstein Mass Energy Relation.	20
Q.2(a)	Discuss the emission of a photon from an excited Nucleus. Also prove that $hf = \Delta E (1 - \Delta E / 2M_0 c^2)$?	10
(b)	What is a light cone? Explain the concept of light cone by absolute past, absolute Future and absolute Remote regions via figures?	10
Q.3	State and explain Doppler Effect. Also discuss Longitudinal and Transverse Doppler Effect?	20

SECTION – II

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Q.4 (a)	By drawing necessary fig/diagrams Prove that Altitude of Pole (Polaris) = latitude of Observer.	10
(b)	State and explain horizontal system of co-ordinates by the help of diagrams?	10
Q.5 (a)	State and explain the Equation of time graphically. Also discuss where and why equation of time is zero.	10
(b)	What is the reason for Seasons. State and explain the Seasons on the Earth by the help of diagrams	10
Q.6 (a)	State and prove Kepler's FIRST law?	10
(b)	What is Escape velocity. Derive a relationship for the Escape velocity of a body from the Earth?	10

SECTION – III

Q.7	Write in details the characteristics, surface, atmosphere etc of Terrestrial planets?	20
Q.8 (a)	What are sun spots. Discuss the reason for the formation of Sun Spots and sun spots cycles?	10
(b)	What about the different phases of the Moon?	10
Q.9 (a)	Write a note on any TWO of the following	20

1. Earth Moon System
2. Solar eclipse
3. Big Bang Theory

NOTE: Attempt any FIVE questions selecting at least TWO questions from each section. All questions carry equal marks.

SECTION – I

Q.1. a) Explain potential barrier across the diode's PN junction? Also draw the I-V curves for Ge diode.
(10)

b) Differentiate between full wave and half wave rectification? Also draw bridge rectifier circuit?
(10)

Q.2. a) Explain power derating for Zener diode and draw a circuit for Zener diode regulator? (10)

b) How the minimum and maximum permissible load currents are determined in a loaded Zener regulator. (10)

Q.3. a) Write down the applications of an NPN transistor?   (10)

b) Given the information provided determine R_C, R_E and R_B (10)
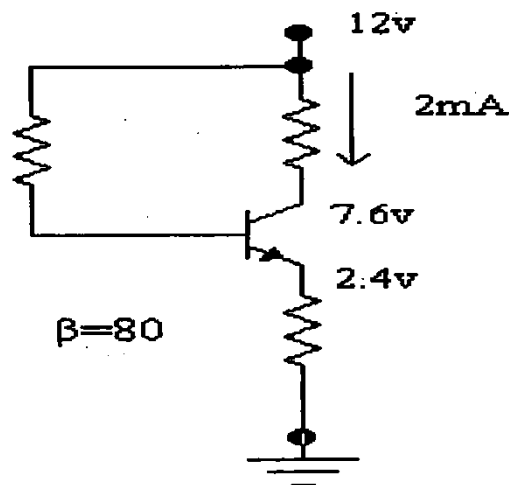
Q.4. a) What are the different biasing methods for a transistor? How more stability of Q point can be achieved in voltage divider bias configuration?   (10)

b) Given the information provided determine I_B, I_C, V_{CE}, V_C, V_E and V_B for the circuit.   (10)
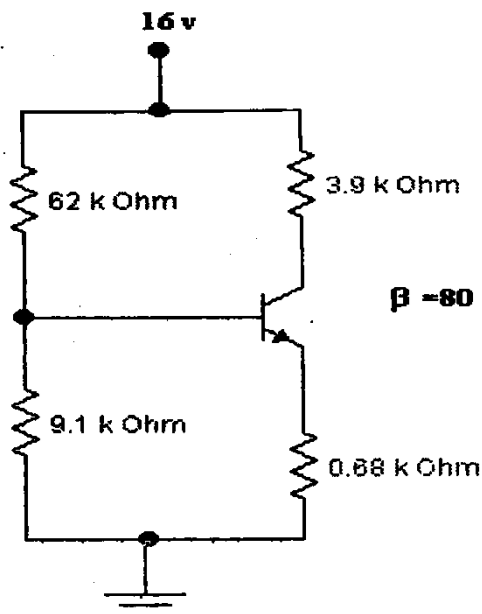
Q.5. a) Draw circuits for integrator and differentiator using operational amplifier? . (10)

b) Differentiate the function of clipper and clamper using circuit diagrams? (10)

SECTION – II

Q.6. a) How the decimal numbers are converted into floating point binary numbers? Explain by a typical example? (10)

b) Perform the conversion of following by typical examples (10)

    i)   Addition of BCD numbers

    ii)   Subtraction of signed numbers in 2's complement format

Q.7. a) Use the mapping method to minimize the following standard SOP expression (10)

$$\overline{A}\,B\,\overline{C}\,\overline{D} + A\,B\,\overline{C}\,\overline{D} + \overline{A}\,\overline{B}\,C\,\overline{D} + A\,B\,C\,D + A\,B\,C\,\overline{D} + A\,\overline{B}\,\overline{C}\,D + \overline{A}\,B\,\overline{C}\,D$$
$$+ A\,B\,\overline{C}\,D + \overline{A}\,B\,C\,D + ABCD$$

b) Construct a logical circuit having three inputs and one output. Draw truth table showing the output is high when the binary value of inputs is ≤ 3. The output is low otherwise. (10)

Q.8. a) Differentiate between half and full adder and design a logic circuit for full adder? (10)

b) What is difference between synchronous and asynchronous counter? Also design and construct 2-bit synchronous counter. (10)

Q.9. a) Explain serial-in and parallel-out shift registers? (10)

b) What is the basic principle of ring counter and Johnson counter? (10)

NOTE: Attempt any FIVE questions. All question carry equal marks.
Draw diagrams where necessary.

Q No.1 What are the major Atmospheric Interactions? Discuss in detail Selective Scattering and explain the blue-sky manifestation. **(4,10,6)**

Q No.2 What are the spectral signatures? Draw and discuss in detail the signature of Vegetation, describing dips in signature pattern in the context of atmospheric windows in different portions of spectrum **(3,14,3)**

Q No.3 What are different Resolutions in Remote Sensing? Describe the interdependency of Spatial and Spectral Resolutions on each other and the practical limitations in this regard **(8,8,4)**

Q No.4 What are True color composites (TCC) and False color composites (FCC)? Describe the use of FCC for the enhancement and variability for vegetation soil and Snow landcovers, elaborate using Landsat data **(5,15)**

Q No.5 How different sensors in Remote Sensing are categorized based on source of illumination? Discuss in detail the working of an Optical Mechanical Scanner **(6,14)**

Q No.6 Define geometric anomalies, and explain the process of rectification for the correction of geometric errors **(5,15)**

Q No.7 Define the process of classification and discuss in detail the process of ISODATA Classification **(4,16)**

Q No.8 What are two main types of Contrast Enhancements? Discuss in detail the process of Linear Contrast Enhancement using Percentage Linear contrast enhancements **(6,14)**

Q No.9 Write Note on any two of the following
1) Visual Interpretation Key
2) ASTER sensor
3) Cubical Color Model
(10,10)