

2021

Full Marks - 60

Time - 3 hours

The figures in the right-hand margin indicate marks

Answer *all* questions**Part-I**

1. Answer the following by fill in the blanks or one word answer : 1 × 8

- a) The period of sine function is ____.
- b) The product of an odd function and even function is ____.
- c) $\beta(9, 15) - \beta(15, 9)$ ____.
- d) For a stationary wave, the points where there is no displacement of particles are called ____.
- e) At ____ point a function is not analytic.
- f) $\operatorname{erf}(x) + \operatorname{erf}(-x) =$ ____.
- g) $\gamma(n + 1) =$ ____.
- h) Can a non-periodic function be expanded in Fourier series ?

Part-II

2. Answer any *eight* of the following : 1½ × 8

- a) Find the period of $\cos \frac{\pi x}{2L}$.
- b) Define even and odd function with examples.
- c) Define ordinary point.
- d) Find the value of Legendre Polynomial $P_n(x)$ at $x = 0$.
- e) Write Rodrigue's formula for Hermitie's polynomials. Find its value for $n = 0$.
- f) Find the singular point of Laguerre differential equation.
- g) Find the value of $r(\tau)$.
- h) Find the order and degree of the differential equation $\left(\frac{d^2y}{dx^2}\right) + 2\left(\frac{dy}{dx}\right)^2 + 5y = 0$
- i) What is the solution of the partial differential equation $\frac{\partial u}{\partial x} = 2\frac{\partial u}{\partial y}$, of $u(0, y) = e^{-2y}$.
- j) Show that β -function is symmetric.

Part-III

3. Answer any *eight* of the following : 2×8

- a) For a period function $f(x)$, write the expression for Fourier series and find the 1st co-efficient ' α_0 '.
- b) Find the singular point of the differential equation $x^2y'' + 2xy' + \lambda y = 0$.
- c) Find the Fourier series expansion of $f(x) = x$ in $(-\pi, \pi)$
- d) Prove that $p'_n(-x) = (-1)^{n+1} P'_n(x)$.
- e) Explain regular singular point for a differential equation $y'' + P(x)y' + Q(x)y = 0$
- f) Evaluate $\int_0^{\infty} x^3 e^{-x^2} dx$.
- g) Define error function. Write two characteristics.
- h) What are harmonics and overtones ?
- i) Find the value of $\gamma\left(\frac{3}{4}\right) \times \gamma\left(\frac{1}{4}\right)$.
- j) Prove that $\int_0^{\infty} \frac{x^8(1-x^6)}{(1+x)^{24}} dx = 0$.

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Part-IV

4. a) Find Fourier series for $f(x) = x \sin x$ in the interval $(-\pi, \pi)$ and show that 6

$$\frac{\pi}{4} = \frac{1}{2} + \frac{1}{1.3} - \frac{1}{3.5} + \frac{1}{5.7} - \dots$$

OR

- b) State and prove Parseval identity.
5. a) Find the series solution of Hermite's differential equation. 6

OR

- b) Derive Rodrigue's formula for Legendre polynomials.
6. a) Derive expression for Associated Legendre differential equation. 6

OR

- b) Define γ -function and β -function. Derive a relationship between them.
7. a) Write the Laplace's equation in spherical polar co-ordinates and find a solution for it by using method of separation of variables. 6

OR

- b) Write the expression for wave equation. Find the solution for it.

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Answer *all* questions

Part-I

1. Answer the following : 1 × 8
- a) First law of thermodynamics is a consequence of the conservation of ____.
 - b) How entropy changes with disorder ?
 - c) Give one example of each extensive and intensive thermodynamic variables.
 - d) ____ is Gibb's free energy per unit area.
 - e) Define Joule-Kelvin coefficient.
 - f) A wire is stretched adiabatically, the temperature of wire ____ after stretching.
 - g) The expression for rms speed of gas molecule is ____.
 - h) Write the unit of Van der Waal's constant.

[2]

Part-II

2. Answer any *eight* of the following : $1\frac{1}{2} \times 8$

- a) State second law of thermodynamics given by Clausius and Planck's.
- b) Why efficiency of a heat engine cannot be 100%.
- c) What is enthalpy of a thermodynamic system.
- d) Draw temperature versus surface tension graph for a liquid and explain it.
- e) Write first law of thermodynamics in adiabatic process.
- f) Define degrees of freedom.
- g) Write the expression for freepath in terms of pressure and temperature.
- h) Define critical temperature.
- i) What are the factors which affect diffusion.
- j) Write Clausius Clayperon's equation. Mention terms used.

Part-III

3. Answer any *eight* of the following : 2×8
- State Zeroth law of thermodynamics. Define temperature from it.
 - Distinguish between first order and second order phase transition.
 - A Carnot's heat engine absorbed 800 cal of heat from a source at 400K and rejects a part of it to the sink at 300K. Calculate heat rejected to the sink.
 - What is magnetic work ? Write it's expression.
 - Write the difference between ideal gas and real gas.
 - Find the temperature at which rms velocity of a gas is half of it's value at 0°C , when the pressure remain constant.
 - Find Joule-Thomson coefficient for a perfect gas.
 - Define Brawnian motion. Write some characteristic features of Brownian motion.
 - Write the expression for specific heat of monoatomic gas and hence find the value of γ .
 - Write down the limitations of first law of thermodynamics.

[4]

Part-IV

4. a) State and explain first law of thermodynamics.
Prove $C_p - C_v = R$ using first law. 6

OR

- b) Deduce expression for thermodynamic scale of temperature.

5. a) Derive Ehrenfest equation. 6

OR

- b) Derive Maxwell's thermodynamic relation.

6. a) Derive expression for Maxwell-Boltzmann law of distribution of velocities in an ideal gas. 6

OR

- b) What do you mean by transport phenomenon?
Derive expression for thermal conductivity of a gas.

7. a) Discuss Andrew's experiment on CO_2 gas. 6

OR

- b) Derive Van der Waal's equation of state for real gas.

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Answer *all* questions

Part-I

1. Fill in the blanks :

1 × 8

- a) The conductor ___ band is absent.
- b) The band gap for Ge is ___ eV.
- c) For a transistor $\gamma = 1 + \underline{\hspace{1cm}}$
- d) In a transistor the emitter junction is ___ biased.
- e) In Class-B amplifier the collector current flows for ___ cycle of input signal.
- f) Power amplifiers ___ the power level of the signal.
- g) For an ideal OP-AMP output impedance is ___.
- h) Voltage follower is also known as ___ gain buffer.

[Turn Over

Part-II

2. Answer any *eight* of the following : $1\frac{1}{2} \times 8$
- a) Draw forward bias circuit of a p-n junction diode.
 - b) Define ripple factor. What is its value for a half wave rectifier.
 - c) Draw the circuit diagram for forward biased LED.
 - d) Write three uses of solar cells.
 - e) Write down the most commonly used methods for transistor biasing.
 - f) Determine the value base current in a common based transistor if ammeter current is 4 mA and collector current is 1mA.
 - g) Define closed loop voltage gain.
 - h) Write down the condition for an ideal operational amplifier.
 - i) Define band width of RC-coupled amplifier. Write its expression.
 - j) Distinguish between Class-A, Class-B and Class-C amplifier.

[3]

Part-III

3. Answer any *eight* of the following : 2×8
- a) Define valence band and conduction band.
 - b) Write down the demerits of a center tap full wave rectifier.
 - c) Describe the construction of a photo diode.
 - d) Find the value of α and γ if $\beta = 29$.
 - e) Discuss different type of feedback circuit.
 - f) Write down the primary requirements of an oscillator.
 - g) Determine the maximum operating frequency for an OP-AMP having slew rate 0.1 V/pcs , pick output voltage is 10V .
 - h) Write four properties of OP-AMP.
 - i) Discuss the effect of negative feedback on the stability of gain.
 - j) Draw frequency response curve for the coupled amplifier.

Part-IV

4. a) Derive expression for drift velocity. Establish a relation between conductivity and mobility. 6

OR

[4]

- b) What is a zener diode ? Describe its construction and explain its function as a voltage regulation.
5. a) Describe the construction, working and characteristics of a PNP transistor in CE configuration with neat circuit diagram. 6

OR

- b) What are hybrid parameters ? Draw h-parameter equivalent circuit and find the expression for current gain voltage gain and power gain in CE mode.
6. a) Describe the construction, working and frequency response of a RC coupled amplifier with neat diagram. 6

OR

- b) Describe construction and working of a Hartley oscillator. Find the expression for frequency.
7. a) Define OP-AMP. Draw block diagram. Describe IC-741 OPAMP and mention its characteristics. 6

OR

- b) Design and describe OP-AMP as adder and subtractor.

2019

Full Marks - 60

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Answer *all* questions

1. a) The diagonals of a parallelogram are given by the vectors $\vec{A} = (3\hat{i} + \hat{j} + 2\hat{k})$ and $\vec{B} = (\hat{i} + 3\hat{j} + 4\hat{k})$. Find the area of the parallelogram. 6
- b) Distinguish between an inertial and non-inertial frame of reference. 3
- c) Explain conservation of linear momentum with an example. 3

OR

- d) Solve the differential equation

$$\frac{dy}{dx} = \frac{y}{x} + x \sin \frac{y}{x} \quad 4$$

[2]

- e) If $\phi = 3x^2y - y^3z^2$. Find grad ϕ at $(1, -2, -1)$ 4
- f) State and prove principle of conservation of energy for Oscillation of a simple pendulum. 4
2. a) State and explain Conservation of angular momentum with a suitable example. 5
- b) State Newtons law of Gravitation. What is the value, unit and dimensional formula for gravitational constant. 5
- c) What is G.P.S. Give one of its uses. 2

OR

- d) Explain motion of a body in a central force field. 5
- e) State Kepler's Laws of planetary motion. 5
- f) What is a Geo-stationary sattellite. Give one of its uses. 2

[3]

3. a) What is S.H.M. ? Find expressions for velocity and acceleration of a particle executing S.H.M. 4
- b) What is damped Oscillation. How it can be sustained ? 4
- c) Show that velocity of an Oscillating body is maximum at its mean position. 4

OR

- d) Establish the differential equation for a body executing S.H.M. 5
- e) Find expressions for K.E, and P.E of body executing S.H.M. 5
- f) Show that the total energy of a body executing S.H.M. is independent of the displacement. 2
4. Find relation between the elastic constants Y , k , η and σ . What is the limiting values of σ . 10 + 2

OR

[4]

Find an expression for torsion of twisting cylinder.
What is the expression for time period of a
torsional pendulum. 10 + 2

5. State postulates of Speical Theory of Relativity. By
considering Lorentz transformation equations find
the velocity addition formula. 4 + 8

OR

Write notes on the following ;

- i) Length contraction 6
ii) Time dilation. 6

L-252-600

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III-UG-REEH(SEC)-I (NC)

2021

Full Marks - 80

Time - 3 hours

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Answer *all* questions

Part-I

1. Answer the following by fill in the blanks or one word answer : 1 × 12
- a) ___ is used for making solar cells.
 - b) A device in which electricity is produced by the process of controlled nuclear fission is called ___.
 - c) ___ is the heat energy from the hot rocks which are present inside the earth.
 - d) Biogas is a better fuel than animal dung cake because ___.
 - e) Wind energy is ___ types of energy.
 - f) Wind energy utilizes ___.
 - g) What is main source for generation of wind.
 - h) Fossil fuels are rich in carbon and ___.
 - i) Burning of fossils fuel is leading environment towards ___.

[2]

- j) The part of the hydel power plant which takes water from valve house to turbine is ____.
- k) The main constituent of biogas is ____.
- j) Photo voltaic energy is the conversion of sunlight into ____.

Part-II

2. Answer any *eight* of the following within two to three sentences each :

2 × 8

- a) Define renewable energy.
- b) What is nuclear energy.
- c) Write four advantages of wind energy.
- d) Name any three forms of energy which could be harnessed from the sea.
- e) What is the source of heat contained in geothermal energy.
- f) Define solar pond.
- g) What is solar cell ? Name two materials mostly used for making solar cells.
- h) Define tidal energy.
- i) Why charcoal is better than wood as fuel ?
- j) Define geothermal energy.

Part-III

3. Answer any *eight* of the following within 75 words each : 3 × 8

- a) Enlist the disadvantages of geothermal energy.
- b) Mention the ways to reduce energy consumption.
- c) How geothermal energy is used to generate electricity.
- d) Write the advantages of small hydro-power plant.
- e) How is the increase in demand of energy affecting our environment adversely ?
- f) What are the disadvantages of thermal power plant ?
- g) Justify the statement hydro power is a renewable source of energy.
- h) How is charcoal obtained from wood ?
- i) Name the main constituent of a biogas and its approximate percentage content in it.
- j) What is the main basic cause for winds to blow ?

Part-IV

4. a) Define a resource. Differentiate between renewable and non-renewable resources. 7

OR

b) Write short notes on the following :

i) Wind energy

ii) Tidal energy.

5. a) What is solar energy ? Describe how does the solar panel system work ? 7

OR

b) Define photovoltaic. Mention the needs and characteristics of photovoltaic system.

6. a) Define wind energy. Explain the principles of wind power generation. Add a note on the advantages and disadvantages of wind energy. 7

OR

b) Write short notes on the following :

i) Wind turbines

ii) Components of wind energy system.

7. a) Define hydropower. Discuss how does hydropower works. 7

OR

b) Define geothermal energy. How does geothermal heat get from the interior of the earth to the surface. Add a note on the advantages and disadvantages of geothermal energy.