U.G. 2nd Semester Examination - 2021

PHYSICS
[PROGRAMME]

Course Code : PHYG-CC-T-02(A-D)

Full Marks : 20   Time : 1 Hour

The figures in the right-hand margin indicate marks.

Candidates are required to give their answers in their own words as far as practicable.

Answer all the questions from selected Option.

OPTION-A

PHY-G-CC-T-02A

(Mathematical Physics-II)

GROUP-A

1. Answer any **five** questions: $1×5=5$

    a)   What is a periodic function?

    b)   What is the complex presentation of Fourier series?

    c)   What do you mean by even function?

    d)   State Parseval identity in connection with the Fourier series.

    e)   What is a regular singular point?

    f)   What do you mean by zeros of Bessel's function?

    g)   What is systematic error?

    h)   Write the wave equation in spherical coordinate.

GROUP-B

2. Answer any **one** question: $5×1=5$

    a)   Show the relation between the beta $\beta(m,n)$ and gamma function $\Gamma(n)$ is $\beta(m,n)=\dfrac{\Gamma(m)\Gamma(n)}{\Gamma(m+n)}$.

    Show that $\beta(m,n)=\beta(n,m)$. $2½+2½$

    b)   Find the Fourier series expansion of the periodic function $f(x) = x^2$ in the interval $-\pi \le x \le \pi$.

    Hence find the sum of the series $\sum_{1}^{\infty}\dfrac{1}{n^2}=\dfrac{\pi^2}{6}$.

    $4+1$

    c)   Write down the expression of Bessels differential equation. Hence write down the form of Bessel's function $J_n(x)$. Using the form of Bessel's function show that

    $x\dfrac{d}{dx}J_n(x)= nJ_n(x)-xJ_{n+1}(x)$. $1+1+3$

GROUP-C

3. Answer any **one** question: 10×1=10

a) What is separation of variable method? Find out the form of two-dimensional Laplace equation $\nabla^2 u = 0$ in plane polar (r, θ) coordinate and solve the resulting equation, subject to the boundary conditions:

$$u(r, 0) = 0, 0 \le r \le a$$
$$u(r, \pi) = 0, 0 \le r \le a$$
$$u(a, \theta) = c$$

2+2+6

b) Write the mathematical expression of Error function. Show that for error function erf(0)=0 and erf(1)=1. Expand the function $f(x) = x$ into Fourier series in the interval $0 < x < 2\pi$. What is Half range sine series? State the Dirichlet Theorem and Dirichlet conditions in connection with the Fourier series. 1+(1+1)+3+1+3

c) i) What is Frobenius method?

ii) $x\dfrac{d^2 y}{dx^2} + \dfrac{dy}{dx} + xy = 0$ – Check the singularity of this differential equation about x = 0. Solve the differential equation about x = 0 using series solution. 2+(2+6)
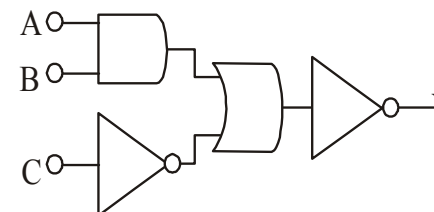
OPTION-B
PHY-G-CC-T-02B
(Digital Systems and Applications)

GROUP-A

1. Answer any **five** questions: 1×5=5

a) Draw the logic diagram of a Master-Slave J-K flip-flop.

b) Write down Boolean expression of output Y in terms of three input A,B,C for the following logic circuit:

c) Define 'SSI' and 'VLSI'.

d) Define 'ROM' and 'RAM'.

e) Draw simplified block diagram of 'CRO'.

f) Give example of 'Linear' and 'Digital' IC.

g) Draw the logic symbol and write down the truth table of NOR and NAND gate.

h) Convert decimal number 25.85 to a binary number.

GROUP-B

2. Answer any **one** question: 5×1=5

a) Define 'multiplexer' and 'demultiplexer'? Draw a logic block diagram of 4:1 multiplexer. Write down truth table of a 4:1 multiplexer. 2+2+1

b) Write down and prove De Morgan's two theorems. $2\frac{1}{2}+2\frac{1}{2}$

c) Draw block diagram of a 8085 microprocessor with proper labeling. Write down the function of ALU for this. 3+2

GROUP-C

3. Answer any **one** question: 10×1=10

a) i) Perform the binary addition 1111+101. Also show the corresponding decimal addition.

ii) Use 1's complement to perform binary subtraction 1101 – 1010.

iii) What is a flip-flop? Give logic symbol and truth table of a S-R flip-flop. Draw its logic circuit realization using NOR/ NAND gates. 2+2+(1+2+3)

b) i) What is the time base generator in a CRO?

ii) A sine wave is displayed on a CRO screen with the calibrated time base set at 0.1ms/ div. One cycle of displayed waveform spreads over 10 divisions along the horizontal axis. Find the frequency of the waveform.

iii) Write down name of different application of CRO and explain any two of them. 2+3+(1+4)

c) i) Draw the symbol and write down truth table of a ' Half-adder'. Hence write the Boolean expression for the 'sum' and 'carry'. Draw its circuit realization using logic gates.

ii) Define 'Register' in digital circuit. Name different types of register. Draw a 4-bit shift register logic circuit using flip-flops. (2+2+2)+(1+1+2)

OPTION-C
PHY-G-CC-T-02C
(Thermal Physics)
GROUP - A

1. Answer any **five** questions: $1\times5=5$

   a) What is meant by the mean free path of a molecule in a gas assembly?

   b) What do you mean by degrees of freedom of a dynamical system?

   c) Write down the conclusion of Andrews experiment on carbon dioxide.

   d) State first law of thermodynamics.

   e) What is enthalpy?

   f) Distinguish between extensive and intensive variables.

   g) Write down Clausius-Clapeyron equation.

   h) What do you mean by transport phenomena in ideal gases?

GROUP-B

2. Answer any **one** question: $5\times1=5$

   a) Write down Maxwell's law of distribution of molecular velocities and explain the symbols used. Hence derive the formula for RMS velocity of molecules.   2+3

   b) State and prove Carnot's theorem.   2+3

   c) A gas at 10 atm pressure and 1 litre volume expands adiabatically to 2 atm and 3.16 litre volume. Calculate the amount of work done by the gas in Joule. Assume $\gamma = 1.4$.   5

GROUP-C

3. Answer any **one** question: $10\times1=10$

   a) Distinguish between cooling produced by J-T process and adiabatic expansion. Derive an expression for J-T cooling. What is the temperature of inversion? Show how you can calculate it from van der Waal' critical constants.   2+3+2+3

   b) Explain clearly the meaning of Entropy. Show that the sum of entropies of all systems taking part in a reversible process remains constant and increases in all reversible processes. Calculate the increase in entropy when one gram of ice at $-10°C$ is converted into steam at $100°C$. Given specific heat of ice = 0.5, latent heat of ice=80 cal/g and latent heat of steam = 540 cal/g.   2+3+5

   c) Derive Maxwell's thermodynamic relations and hence prove the relation

   $$Cp - Cv = T\left(\frac{\delta p}{\delta T}\right)_v \left(\frac{\delta V}{\delta T}\right)_p$$

   Find the change in freezing point of water at $0°C$ for an increase in pressure by 1Atm. Given specific volume of ice at 0^0C equal to 1.091cc, latent heat of water at $0°C=76.9$cal/g.   4+2+4

OPTION-D
PHY-G-CC-T-02D
(Waves and Optics)
GROUP - A

1. Answer any **five** questions: $1 \times 5 = 5$

   a) Define 'bel' and 'phon'?

   b) The velocity of sound through a solid medium depends on which property of the medium? Write down the relation between them.

   c) The equation of a plane sound wave is

   $y = 6.0 \times 10^{-6} \cos(1900t + 5.72x)$.

   Determine the velocity of the sound wave.

   d) What are Lissajous figures?

   e) Give one example each of plucked, struck and bowed stringed musical instruments.

   f) If the wavelength range of visible light is 4000 Å - 8000Å in vacuum, calculate the frequency range of visible light.

   g) Why the center of Newton's Rings is dark?

   h) How a grating spectrum differs from a prism spectrum?

GROUP-B

2. Answer any **one** question : $5 \times 1 = 5$

   a) What is meant by natural and damped oscillation? – Explain graphically. Define Forced vibration and resonance.   3+2

   b) Determine the expression of velocity of longitudinal waves in a thin solid rod.   5

   c) What is Huygens' principle of wave propagation? Establish Snell's law of refraction using this principle.   2+3

GROUP-C

Answer any **one** question : $10 \times 1 = 10$

3. a) What is meant by standing wave.

   b) Obtain the equation of a standing wave.

   c) For a standing wave, where would the sound be louder – at node or anti-node? Why?

   d) Three strings A, B, C of the same length are stretched on a sonometer. Their relative masses per unit length are 2:8:18, and the tensions 12:12:27. Find the ratio of the frequencies of the notes emitted by them.   2+3+2+3

4. a) What is interference of light? State the conditions for sustained interference.

b) Deduce an expression for the intensity of light at a point due to the superposition of waves coming from two coherent light sources.

c) In Young's experiment for interference of light, the slits being 0.2 cm apart are illuminated by light of wavelength 5896Å. Calculate the fringe-width which is observed on a screen placed 1 cm away from the plane of the slits.

(2+2)+3+3

5. a) Write down the difference between Fresnel and Fraunhofer diffraction.

b) Explain how the wavelength of a monochromatic light can be determined by a plane transmission grating.

c) A grating produces the first order maxima at an angle 30° for a light of wavelength 6000Å. Find out how many lines per cm are there in the grating. 3+4+3

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