Pabna University of Science and Technology

Department of Physics

B.Sc. (Honours) 2nd Year 1st Semester Examination 2020

Course Title: Heat and thermodynamics

Course Code: PHY 2101

Time: 3:00 Hours | Full Marks: 70

N.B.: (i) Answer any **Five** questions out of **Eight.**
(ii) Figures in the right margin indicates full marks.

1.	(a)	Write down the fundamental assumptions of kinetic theory of gages.	4
	(b)	Show that, $P = \frac{1}{3}\rho c^2$, where the symbols have their usual meanings.	7
	(c)	Write a short note on intermolecular forces.	3
2.	(a)	What are the corrections involved in the kinetic theory of gases that lead to the equation of state for a real gas?	3
	(b)	Argon with density 100 kg/m^3 under a pressure of 10 MPa is in pressure vessel. Considering argon under each pressure to be a Van der Waals gas, find its temperature. [$a = 0.136\ Nm^4/mole^2,\ b = 3.201 \times 10^{-5}\ m^3/mole$].	3
	(c)	How can the critical points P_c, V_c, *and* P_c are fixed by the Van der Waals constants a and b?	4
	(d)	Using transport phenomenon of gases, obtain an expression for thermal conductivity of it.	4
3.	(a)	Define thermodynamic system.	3
	(b)	State the zeroth law of thermodynamics.	3
	(c)	Write the comparison between heat and work.	3
	(d)	State and prove the first law of thermodynamics.	5
4.	(a)	What is adiabatic process? Derive the equation of work done during an adiabatic process.	6
	(b)	Define reversible and irreversible process. Write the conditions of reversibility for any heat engine.	6
	(c)	What is thermodynamic equilibrium?	2
5.	(a)	State the Kelvin-Planck as well as Clausius version of the second law of thermodynamics.	3
	(b)	Show that the Kelvin-Planck and Clausius statements of second law of thermodynamics are equivalent.	7
	(c)	What is refrigerator? Write the working mechanism of a refrigerator.	4
6.	(a)	State and prove Carnot's theorem.	5
	(b)	Define entropy. Illustrate the Carnot's cycle in entropy-temperature (ST) diagram.	4
	(c)	Calculate the entropy of one mole of an ideal gas.	5
7.	(a)	Define C_p and C_v and find their relation.	6
	(b)	What do you mean by equilibrium state? Deduce the relation $PV^\gamma = constant$.	6
	(c)	What is internal energy?	2
8.	(a)	What is phase transition?	2
	(b)	Deduce the Clausius- Clapeyron equation.	5
	(c)	Why the triple point temperature $T_{TP} = 273.16\ K$ is higher than the normal melting point temperature $T_{NMP} = 273.15\ K$?	4
	(d)	Define chemical potential. Show that chemical potential is the Gibbs function per particle.	3

Pabna University of Science and Technology

Department of Physics

B.Sc. (Honours) 2nd Year 1st Semester Examination 2020

Course Title: Bangladesh Studies

Course no: **PHY-2105**

Time: 3:00 Hours | Full Marks: 70

N.B.: (i) Answer any **Five** questions out of **Eight.**
(ii) Figures in the right margin indicate full marks.

1. What are the salient features of the Constitution of Bangladesh? Do critically analyse the major amendments of the constitution and their impacts on political development in the country. 7+7

2. Discuss major characteristics and functions of the three organs of government. Write an evaluation on the role of executive organ of the government during Covid-19 pandemic in Bangladesh. 7+7

3. Elucidate the key points of the historic 7th March speech. Expound the significance of the 7th March speech on Bengali nationalism and independency. 6+8

4. Explain the role of India and UN in our Liberation war, 1971. 14

5. What are the main traditional festivals of Bangladesh? Delineate the impact of Globalization and social media trends on our Bengali culture in present days. 6+8

6. What were the causes behind partition of Bengal in 1905? Elucidate the impacts of partition of Bengal in 1905. 14

7. What is Development? Explain the major determinants of economic development. Write a discussion paper on the present challenges and prospects of the economy of Bangladesh. 2+4+8

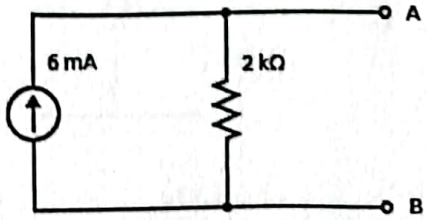
8. Write short notes on: 14
   (a) Budgeting Process in Bangladesh
   (b) Function of ECNEC

Pabna University of Science and Technology
Department of Physics
B.Sc. (Honours) 2nd Year 1st Semester Examination 2020
Course Title: Basic Electronics
Course no: **PHY 2103**

Time: 3:00 Hours | Full Marks: 70

N.B. : (i) Answer any Five questions out of Eight.
(ii) Figures in the right margin indicate full marks.

1. a) Explain the differences between electricity and electronics. 3
   b) Distinguish between voltage source and current source. 2
   c) What is constant current source? How can you convert a current source into voltage source? 1+4
   d) Convert the following current source into equivalent voltage source:



4

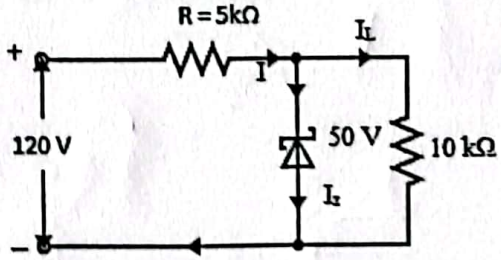
2. a) Explain different types of vacuum tubes. 5
   b) Describe the characteristics of a vacuum triode. 6
   c) What are vacuum tube constants? 3

3. a) What are the characteristics differences between conductor and semiconductor? 4
   b) Explain the different types of semiconductors. 6
   c) Describe the mechanism to convert an intrinsic semiconductor to an extrinsic semiconductor. 4

4. a) Explain the terms: i) Breakdown voltage, ii) Knee voltage and iii) PIV. 6
   b) What is pn junction? Discuss the behavior of a pn junction under forward and reverse biasing. 1+7

5. a) What do you mean by rectifier? 3
   b) Describe the working principle of a full wave rectifier. 5
   c) Explain tunnel diode and photodiode. 6

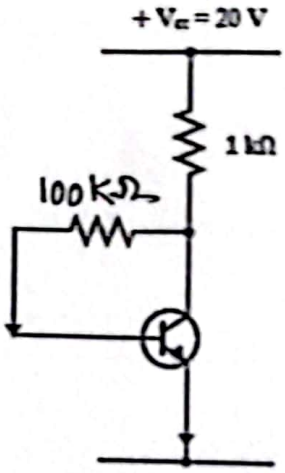
6. a) What is Zener diode? What is its equivalent circuit? 1+2
   b) Explain how Zener diode maintains constant voltage across the load. 5
   c) For the following circuit, find: i) the output voltage, ii) the voltage drop across series resistance and iii) the current through Zener diode.



6

7. a) Draw the block diagram of npn and pnp transistor and explain their working principle. 1+6
   b) Define operating point and d.c. load line. How will you draw d.c. load line on the output characteristics of transistor? 2+3
   c) In a transistor circuit, collector load is 4 kΩ whereas zero signal collector current is 1 mA.
      i) What is the operating point if $V_{cc} = 10$ V?
      ii) What will be the operating point if $R_c = 5$ kΩ? 2

8. a) What do you understand by transistor biasing? What is its need?
   b) Explain biasing with feedback resistor method for transistor biasing.
   c) A silicon transistor shown below is biased by feedback resistor method. Determine its operating point. Given $\beta = 100$.



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Pabna University of Science and Technology

Department of Physics

B.Sc. (Honours) 2nd Year 1st Semester Examination 2020

Course Title: Optics

Course no: **PHY 2102**

Time: 3:00 Hours | Full Marks: 70

N.B. : (i) Answer any **Five** questions out of **Eight**.
(ii) Figures in the right margin indicate full marks.

1.	a)	What are the methods for the determination of velocity of light?	3
	b)	State and explain Huygen's principle.	6
	c)	What is wavefront? Discuss the formation of wavefronts.	5
2.	a)	What are coherent sources? Why coherent sources are needed to get interference fringes?	2+2
	b)	Mention the conditions for interference.	3
	c)	Explain the phenomenon of thin film interference by transmitted light.	7
3.	a)	What are Newton's rings? Why Newton's rings are circular?	2+2
	b)	How do you determine the wavelength of light in Newton's ring method?	4
	c)	Derive the expression for the radius of the n^{th} bright and dark rings in the formation of Newton's rings by reflected light.	6
4.	a)	What do you mean by diffraction of light? Write down the conditions for diffraction of light.	1+3
	b)	Distinguish between different types of diffraction of light.	4
	c)	Discuss the Fraunhofer diffraction of monochromatic light from a single slit.	6
5.	a)	What is double refraction?	2
	b)	What is resolving power? Derive an expression for the resolving power of a plane diffraction grating.	8
	c)	Two spectral lines at $\lambda = 6200$ Å have a separation of 0.652 Å. Find the minimum number of lines a diffraction grating must have to just resolve this doublet in the second order spectrum.	4
6.	a)	What do you mean by polarization of light? Name some crystals which produce polarization.	2+2
	b)	Explain ordinary and extra-ordinary rays.	3
	c)	Explain how Nicol prism can be used as a polarizer or as an analyzer?	7
7.	a)	Write down the abbreviation of LASER.	1
	b)	Write down the basic features of LASER.	3
	c)	Mention some practical applications of LASER.	3
	d)	Describe the construction and working principle of Ruby LASER.	7
8.	a)	Distinguish between photography and holography.	3
	b)	How can a hologram be produced and reproduced?	3
	c)	Describe the theory of holography.	6
	d)	Mention two applications of holography.	2

Pabna University of Science and Technology

Department of Physics

B.Sc. (Honours) 2nd Year 1st Semester Examination 2020

Course Title: Mathematical Methods in Physics-II

Course no: **PHY-2104**

Time: 3:00 Hours | Full Marks: 70

N.B.: (i) Answer any **Five** questions out of **Eight**.
(ii) Figures in the right margin indicate full marks.

1. (a) Define odd and even functions with example. 3
   (b) What is Fourier series? Show that an even function can have no sine term in its Fourier series. 1+5
   (c) Find the Fourier series of $f(x) = \begin{cases} -Cosx; & -\pi \leq x \leq 0 \\ Cosx; & 0 \leq x \leq \pi \end{cases}$. 5

2. (a) State and prove Walli's formula. 4
   (b) A particle is attached toward a fixed point **O** with a force inversely proportional to its instantaneous distance from **O**. Applying the knowledge of gamma function, show that if the particle is released from rest the time for it to reach **O** is given by $T = a\sqrt{\frac{\pi m}{2k}}$. 4
   (c) Prove the following identities: 6
   i) $\Gamma\left(-\frac{1}{2}\right) = -2\sqrt{\pi}$, ii) $\int_0^{\pi/2}\sqrt{Cot\theta}\,d\theta = \frac{1}{2}\Gamma(1/4)\Gamma(3/4)$ and iii) $\int_0^{\pi/2} Sin^6 x dx = 5\pi/32$.

3. (a) Define Bessel's function, Laguerre polynomials and hypergeometric function. 3
   (b) Prove the following identities: 6
   i) $2F1(\alpha,\beta;\gamma;x)_{x=0} = 1$, ii) $\frac{d}{dx}[2F1(\alpha,\beta;\gamma;x)]_{x=0} = \frac{\alpha\beta}{\gamma}$ and
   iii) $xJ_n'(x) = nJ_n(x) - xJ_{n+1}(x)$.
   (c) State and prove Parseval's identity. 5

4. (a) Define Hermite polynomials and show that $H_n'(x) = 2nH_{n-1}(x)$. 4
   (b) Show that $H_{2n}(0) = \frac{(-1)^n(2n)!}{n!}$. 2
   (c) Define Dirac Delta function. Obtain Fourier Dirac Delta function. 5
   (d) Find the Laplace transform of $Sin^3 2t$. 3

5. (a) Define complex number. Perform the following operations both analytically and graphically: (i) (2+3i) + (4-5i) and (ii) (6-2i) - (2-5i). 7
   (b) What is harmonic function? Prove that the function u=$CosxCoshy$ is harmonic. 4
   (c) Show that $\frac{dz}{dz}$ does not exist anywhere. 3

6. (a) State and prove Rouche's theorem. 5
   (b) What is residue? How can you calculate it? 4
   (c) Find the residues of $f(z) = \frac{z^2+4}{z^3+2z^2+2z}$ at all its poles. 5

7. (a) Define tensor with its importance in physics. 3
   (b) Define: i) Covariant tensor, ii) Contravariant tensor, iii) Mixed tensor, iv) Summation convention, v) Dummy index, vi) Free index and vii) Symmetric tensor. 7
   (c) Show that (i) $\frac{\partial x^p}{\partial x^q} = \delta_q^p$ and (ii) $\frac{\partial x^p}{\partial \bar{x}^q}\cdot\frac{\partial \bar{x}^q}{\partial x^r} = \delta_r^p$. 4

8. (a) Define Kronecker delta and Christoffel's symbols. 4
   (b) A covariant tensor has components xy, 2y-z^2, xz in rectangular coordinates. Find the covariant components in spherical coordinates. 6
   (c) What is Quotient law. 2
   (d) What is rank of a tensor? 2

Pabna University of Science and Technology

Department of Physics

B.Sc. (Honours) 2nd year 1st Semester Examination-2019

Course Title: Bangladesh Studies

Course no: **PHY-2105**

Time: 3:00 Hours | Full Marks: 70

N.B.: (i) Answer any **FIVE** questions out of **EIGHT**.
(ii) Figures in the right margin indicate full marks.

1.	(a)	What do you know about Permanent Settlement?. Discuss the background of Permanent Settlement.	3+5
	(b)	Elucidate the merits and demerits of Permanent Settlement.	3+3
2.	(a)	Briefly describe the background and causes of Liberation War.	7
	(b)	Discuss the formation of Mujibnagar government.	7
3.		What are the salient features of the Constitution of Bangladesh? Identify the major contradictions among the fundamental principles of Bangladesh Constitution.	7+7
4.		"Historic 7th March speech was a turning speech in the history of Bangladesh's struggle for independence"-Explain.	14
5.		What are the main organs of government? Describe the major functions and the interrelationships among the three organs of the government.	14
6.		'Six-points were Bengalis' charter of freedom'. Do explain the statement with evaluating its impact on the struggle for autonomy and independence of Bengali nation.	14
7.		What are the basic economic problems of Bangladesh and recommend its solution.	14
8.		Write short notes on (a) Shamsuddin Iliyas Shah. (b) Judicial System of Bangladesh.	14

Pabna University of Science & Technology

Department of Physics

B.Sc. (Honours) 2nd Year 1st Semester Exam-2019

Course Title: Basic Electronics

Course Code: **PHY-2104/PHY-2103(Imp.)**

Time: 3:00 Hours | Full Marks: 70

N.B: (i) Answer any **Five** set of questions out of **Eight** set.
(ii) Figures in the right margin indicate full marks.

1.	(a)	What is electricity? Distinguish electrical device and electronic device.	1+4
	(b)	Discuss constant voltage source and constant current source.	4
	(c)	What is ideal voltage source? How can you convert a voltage source into current source?	1+4
2.	(a)	What is semiconductor? Mention some of the properties of semiconductor.	1+3
	(b)	Define intrinsic and extrinsic semiconductor. Why do we need extrinsic semiconductor?	3+2
	(c)	What is a pn junction? Explain the formation of potential barrier in a pn junction.	1+4
3.	(a)	Derive expressions for rectification efficiency and ripple factor of a full wave rectifier.	6
	(b)	Explain the formation of n-type semiconductor material.	4
	(c)	Why does an LED emit light but a normal pn junction diode doesn't?	4
4.	(a)	Write short notes on: (i) Zener diode and (ii) LDR.	3+3
	(b)	Will a transistor result if two diodes are connected back to back?	3
	(c)	A half wave rectifier is used to supply 50V d.c to a resistive load of 800Ω. The diode has a resistance of 25Ω. Calculate a.c voltage required.	5
5.	(a)	Explain the mechanism of current flow in NPN transistor with neat diagram.	4
	(b)	Draw the CB, CE and CC configurations for NPN and PNP transistor.	6
	(c)	Why is collector region wider than emitter region in bipolar junction transistor?	4
6.	(a)	What do you mean by stability factor and thermal runaway?	2+2
	(b)	Describe the potential divider biasing method. How stabilization of operating point is achieved by this method.	6
	(c)	In a bipolar junction transistor, emitter current is 12 mA and the emitter current is 1.02 times the collector current. Find the base current.	4
7.	(a)	Define the different operating regions of transistor.	4
	(b)	What is faithful amplification? Explain the conditions to be fulfilled to achieve faithful amplification in a transistor amplifier.	1+4
	(c)	In a transistor circuit, if V_{CC}= 12V and R_C= 6 KΩ, zero signal base current	5

I_B= 20 μA and β= 50. Draw the dc load line and determine the Q point.

8. (a) Deduce the expression of emitter bias CE configuration for n-p-n transistor. 4

(b) Determine the dc bias voltage V_{CE} and the current I_c for the voltage divider CE configuration of Fig 8.1 4

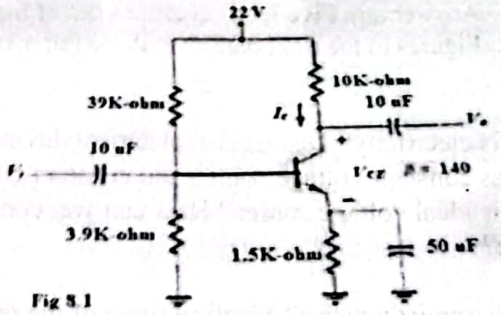

Fig 8.1

(c) How to use transistor as AND, OR and NOT logic gate? 6

Pabna University of Science & Technology

Department of Physics

B.Sc. (Honours) 2nd Year 1st Semester Examination 2019

Course Title: Heat and Thermodynamics

Course no: **PHY-2101**

Time: 3:00 Hours | Full Marks: 70

N.B.: (i) Answer any five questions out of eight.
(ii) Figures in the right margin indicate full marks.

1. a) What are the differences between real gas and ideal gas? 3
   b) Explain the zeroth law of thermodynamics. How the concept of temperature is obtained from the law? 4
   c) Show from the kinetic theory of gases that the mean kinetic energy of translation of one molecule of a perfect gas is $\frac{3}{2}kT$. 4
   d) Explain the principle of equipartition of energy. 3

2. a) What are the corrections in the kinetic theory of gases that led to the equation of state for a real gas? 3
   b) Define mean free path. Show that the mean free path is inversely proportional to the macroscopic collision cross section. 1+7
   c) The mean free path of the molecules of a gas is 2×10^{-5} cm, when there are 1.25×10^{19} molecules per cm^3. Compute the diameter of the molecules. 3

3. a) What are differences between reversible and irreversible process? 4
   b) Using the first law of thermodynamics show that $C_P - C_V = \left[P + \left(\frac{\partial U}{\partial V}\right)_T\right]\left(\frac{\partial V}{\partial T}\right)_P$. Use this result to show 4
      i) $C_P - C_V = R$, for an ideal gas. 2
      ii) $C_P - C_V \approx R\left(1 + \frac{2a}{RTV}\right)$, for Van der Waals gas. 4
      Note that $P + \left(\frac{\partial U}{\partial V}\right)_T = T\left(\frac{\partial P}{\partial T}\right)_V$.

4. a) State and explain the first law of thermodynamics. 4
   b) Deduce the relation $TP^{(1-\gamma)/\gamma} =$ constant, where the symbols have their usual meaning. 5
   c) Ten grams of oxygen are heated at constant atmospheric pressure from 27.0 to 127 °C. How much heat is transferred to the oxygen? What friction of the heat is used to raise the internal energy of the oxygen? 3
   d) An ideal gas is originally confined to a volume V_1 in an insulated container of volume $V_1 + V_2$. The remainder of the container is evacuated. The partition is then removed and the gas expands to fill the entire container. If the initial temperature of the gas was T, what is the final temperature? Justify your answer. 2

5. a) Show that the efficiency of the Carnot engine depends only upon the temperature of the source and the sink. 6
   b) A Carnot refrigerator extracts 35.0 kJ as heat during each cycle, operating with a coefficient of performance of 4.60. What are (i) the energy per cycle transferred as heat to the room and (ii) the work done per cycle? 5
   c) Write the working mechanism of a refrigerator. 3

6. a) State and explain the Clausius theorem for a general reversible cyclic transformation. 5
   b) What do you mean by thermodynamic temperature scale? 3
   c) Show that, the thermodynamic and the ideal gas scales of temperature are identical. 4
   d) Consider a steam engine that operates between a maximum steam temperature of 500°C and an ambient temperature of 20°C. Find the efficiency of it. 2

7. a) What are the thermodynamic potential functions? 4
   b) State and explain the third law of thermodunamics. 4
   c) Deduce the four thermodynamic relations of Maxwell. 6

8. a) Explain Joule-Thomson effect. Show that this effect is isenthalpic. 3+3
   b) Show that the thermodynamic equation for Joule-Thomson coefficient is 5

$$\mu_{JK} = \frac{1}{C_P}\left[T\left(\frac{\partial V}{\partial T}\right)_P - V\right]$$

   c) Write a short note on Gibb's phase rule. 3

Pabna University of Science and Technology

Department of Physics

B.Sc. (Honours) 2nd Year 1st Semester Examination 2019

Course Title: Optics

Course no: **PHY-2102**

Time: 3:00 Hours | Full Marks: 70

N.B. :(i) Answer any **Five** questions out of **Eight.**
(ii) Figures in the right margin indicate full marks.

1. a) Explain the phenomenon of (i) reflection and (ii) refraction of light on the basis of wave theory. 5
   b) State and explain Fermat's principle. 4
   c) Deduce the law of reflection using Fermat's principle. 5

2. a) Explain coherence. 2
   b) Using Young's double slit experiment; obtain expression for the position of the bright fringes observed on the screen. Hence also find the expression of the fringe width. 5+2
   c) In Young's double slit experiment; the separation of the slit is 2mm and the fringe spacing is 0.3mm at a distance of 1m from the slits. Estimate the wavelength of the light. 3
   d) Can a person observe interference fringe from two headlights of a vehicle? Justify your answer. 2

3. a) Derive Stoke's relations for optical reversibility and hence explain the meaning of the minus sign in the second relation. 2+2
   b) Obtain expressions for maxima and minima due to multiple reflections from a plane parallel film. 4
   c) Newton's rings are observed in reflected light having wavelength of 5.9×10^{-5}cm. diameter of the 10^{th} dark ring is 0.50cm. Estimate the radius of the curvature of the lens and the thickness of the air film. 4

4. a) What do you mean by diffraction of light? Write down the conditions for diffraction of light. 1+3
   b) Distinguish between different types of diffraction of light. 4
   c) Discuss the Fraunhofer diffraction of monochromatic light from a single slit. 6

5. a) Explain the terms plane of polarization and plane of vibration. 3
   b) Discuss the production of circularly and elliptically polarized light. How they can be detected? 4+2
   c) State and explain Brewster's law of polarization. 5

6. a) Define polarization of light. Explain the phenomenon of double refraction. 1+3
   b) Describe the construction of a Nicol prism and show how it can be used as a polarizer or as an analyzer? 10

7. a) What is the abbreviation stands for LASER? Mention some real applications of LASER. 1+2
   b) Explain spontaneous emissions and stimulated emissions. 4
   c) Describe construction and working principle of Ruby LASER. 7

8. a) What is holography? How the hologram is produced? 2+3
   b) Describe the theory of holography. 5
   c) Classify hologram. Mention some applications of holography. 2+2

Pabna University of Science and Technology

Department of Physics

B.Sc. (Honours) 2nd Year 1st Semester Examination 2019

Course Title: Mathematical Methods in Physics-II

Course no: **PHY-2103**

Time: 3:00 Hours | **Full Marks: 70**

N.B. : (i) Answer any **Five** questions out of **Eight.**
(ii) Figures in the right margin indicate full marks.

1. a) Define Gamma and Beta function. 2

b) Prove that 5

$$\int_0^{\frac{\pi}{2}} \sin^p x \cos^q x \, dx = \frac{\Gamma\left(\frac{p+1}{2}\right)\Gamma\left(\frac{q+1}{2}\right)}{2\Gamma\left(\frac{p+q+2}{2}\right)}.$$

c) Prove the following identities 3.5+3.5

i) $\Gamma\left(\frac{1}{2}\right) = \sqrt{\pi}$ and ii) $\int_0^{\infty} e^{-x^2} dx = \frac{\sqrt{\pi}}{2}$.

2. a) Define even function, odd function and periodic function. Give example each of them. 3

b) Write down the Legendre polynomial $P_n(x)$ and hence evaluate $P_3(x)$. 4

c) Establish the Rodrigues formula $P_n(x) = \frac{2^n}{n!}\frac{d^n}{dx^n}(x^2-1)^n$. 7

3. a) Define Laplace transform. Find the Laplace transform of $t\cos 3t$ 4

b) Solve the following differential equation using Laplace transform: 6

$$\frac{d^2y}{dx^2} + 9y = \cos 2t \, ; y(0) = 1, y\left(\frac{\pi}{2}\right) = -1.$$

c) Evaluate 4

$$\mathcal{L}^{-1}\left\{\frac{6s-4}{s^2-4s+20}\right\}.$$

4. a) Define analytic function. Find the values of a, b, c and d such that the function $f(z) = x^2 + axy + by^2 + i(cx^2 + dxy + y^2)$ is analytic. 5

b) Show that the function $u = e^{-x}(x\sin y - y\cos y)$ is harmonic. Find its harmonic conjugate v such that $u + iv$ is harmonic. 6

c) Prove that $\lim_{z\to 0}\frac{\bar{z}}{z}$ does not exist. 3

5. a) Define symmetric matrix. If P and Q are symmetric matrices then show that PQ is symmetric if and only if P and Q commute. 3

b) Decompose the matrix A into two parts. Where 6

$$A = \begin{bmatrix} 1 & 5 & 7 \\ 4 & 3 & 2 \\ 5 & 9 & 2 \end{bmatrix}.$$

c) Determine the eigen value and eigen vector of $\begin{bmatrix} 7 & 3 \\ 2 & 8 \end{bmatrix}$. 5

6 a) State and Prove Cauchy's theorem. 5

b) Use Cauchy's theorem to evaluate $\oint_c \frac{z+4}{z^2+2z+5} dz$, where $c|z+1| = 1$. 3

c) State Cauchy's integral formula. Evaluate $\oint_c \frac{e^{2z}}{(z+1)^5} dz$, where c is the circle $|z| = 4$. 6

7 a) A covariant tensor has the components $2x - z$, x^2y, yz in rectangular coordinates. Find its covariant components in spherical coordinates. 6

b) Define Kronecker Delta. Prove that Kronecker Delta is a mixed tensor of the second rank. 5

c) Prove $[pq, r] = g_{rs}\left\{{s \atop pq}\right\}$. 3

8 a) Find the covariant derivative of $A_k^j B_n^{lm}$ with respect to x^q. 4

b) Prove that $A_{p,qr} - A_{p,rq} = R_{pqr}^n A_n$, where A_p is an arbitrary covariant tensor of rank one. 6

c) Show that the inner product of two tensors A_r^{pq} and B_t^s is a tensor of rank three. 4