

**SECTION - A**

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) A function  $f(x)$  is defined by  $f(x) = \begin{cases} x^2, & \text{when } x \leq 0 \\ x, & \text{when } 0 < x < 1. \\ \frac{1}{x}, & \text{when } x \geq 1 \end{cases}$ . Discuss the continuity and differentiability of the function at  $x = 0$  and  $x = 1$ , also represent  $f(x)$  graphically. (15)
- (b) If  $y = \ln(x + \sqrt{x^2 + a^2})$ , then prove that  $(x^2 + a^2)y_{n+2} + (2n+1)xy_{n+1} + n^2y_n = 0$ . (10)
- (c) Evaluate:  $\lim_{x \rightarrow 0} \left\{ \frac{1}{x} - \left( \frac{1}{x^2} \right) \ln(1+x) \right\}$ . (10)
2. (a) If  $u = \tan^{-1} \left( \frac{x+y}{\sqrt{x} + \sqrt{y}} \right)$ , then show that  $x \frac{\partial u}{\partial x} + y \frac{\partial u}{\partial y} = \frac{1}{4} \sin 2u$ . (15)
- (b) State Rolle's theorem. Verify Rolle's theorem for the function  $f(x) = e^x \sin x$  in the interval  $(0, \pi)$ . (10)
- (c) Expand  $\frac{1}{1-x}$  in power of  $x$  with Lagrange form of remainder after  $n$  terms and find the value of  $\theta$  in  $R_n$ . (10)
3. (a) Find the absolute maximum and minimum of the function  $f(x) = 1 + |9 - x^2|$  on the interval  $[-5, 1]$  and determine where absolute extremum values occur. (15)
- (b) Find the equation of the circle of curvature at the point  $(0, 1)$  of the curve  $y = x^3 + 2x^2 + x + 1$ . (10)
- (c) Find the area of the triangle formed by the axes and tangent to the curve  $x^{2/3} + y^{2/3} = a^{2/3}$ . (10)
4. (a) Find all the asymptotes of the curve  $x^3 - 2y^3 + xy(2x - y) + y(x - y) + 1 = 0$ . (13)
- (b) Find the angle between the tangent to the curve  $r^m = a^m(\cos n\theta + \sin n\theta)$  and the radius vector. (12)
- (c) Find the radius of curvature of the curve  $\sqrt{x} + \sqrt{y} = \sqrt{a}$  at the intersection point of the line  $y = x$  and the curve. (10)

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**SECTION-B**

There are **FOUR** questions in this section. Answer any **THREE**.

5. Perform the following integrals: **(11+12+12)**

(a)  $\int \frac{2 \sin x + 3 \cos x}{3 \sin x + 4 \cos x} dx.$

(b)  $\int \frac{x^2 + 1}{x^4 + 1} dx.$

(c)  $\int (x-2)\sqrt{\frac{x+1}{x-2}} dx.$

6. (a) Find a reduction formula for  $I_n = \int \sin^n x dx$  and hence obtain  $\int \sin^4 x dx.$  **(12)**

(b) Evaluate: **(11)**

$$\lim_{n \rightarrow \infty} \left[ \left(1 + \frac{1}{n^2}\right) \left(1 + \frac{4}{n^2}\right) \left(1 + \frac{9}{n^2}\right) \dots \dots \left(1 + \frac{n^2}{n^2}\right) \right]^{1/n}$$

(c) Evaluate:  $\int_0^\pi x \ln \sin x dx.$  **(12)**

7. (a) Prove that,  $\int_0^\infty \log\left(x + \frac{1}{x}\right) \frac{dx}{1+x^2} = \pi \log 2.$  **(11)**

(b) Prove that  $\Gamma\left(\frac{1}{2}\right) = \sqrt{\pi}.$  **(12)**

(c) Find the area included the curve  $y^2(2a-x) = x^3$  and its asymptote. **(12)**

8. (a) Find the larger area enclosed by the circle  $x^2 + y^2 = 64a^2$  and the parabola  $y^2 = 12 ax.$  **(17)**

(b) Find the volume and surface area of the solid generated by revolving the cardioid  $r = a(1 - \cos \theta)$  about its initial line. **(18)**



**SECTION – A**

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) What are Lissajous' figures? Electrons in an oscilloscope are deflected by two mutually perpendicular electric field in such a way that at any time 't' the displacement is given by  $x = A \cos \omega t$  and  $y = A \cos(\omega t + \phi)$ . Describe the path of the electrons and determine their equation when (i)  $\phi = 0^\circ$  (ii)  $\phi = 30^\circ$  and (iii)  $\phi = 90^\circ$ . (3+12+4  $\frac{1}{2}$ )
- (b) Two masses are joined together by an ideal spring horizontally and the system can oscillate. Derive an expression for reduced mass of the system. (10  $\frac{1}{2}$  + 2  $\frac{1}{2}$  + 2  $\frac{1}{2}$ )
- (i) Under what circumstance would the reduced mass of the system be equal to the mass of one of the bodies?
- (ii) What is the reduced mass if the bodies have equal mass?
2. (a) Discuss the theory of a forced oscillator in presence of damping. Write down its differential equation. Solve it for steady state. (6+4+15)
- (b) Show that the maximum velocity of a forced oscillator is (10)
- $$v_{\max} = \frac{F_0}{\sqrt{\left(\frac{K}{w'} - mw'\right)^2 + b^2}}$$
- where  $F \rightarrow$  magnitude of the driving force ( $F_{\text{ext}}$ ).
- $w' \rightarrow$  angular frequency of the driver
- $K \rightarrow$  Force constant
- $b \rightarrow$  damping constant
- Given  $F_{\text{ext}} = 4.0 \sin 30t$  in M.K.S unit.
- and the damping constant  $b = 20 \text{ Nsec cm}^{-1}$
- Calculate the  $v_{\max}$  at resonance.
3. (a) Define energy density and intensity of a plane progressive wave. Obtain expressions for both. (4+10)
- (b) What do you mean by phase velocity and group velocity of a train of waves and establish a relationship between the two. Show that in a non-dispersive medium they are same. (12)
- (c) The motion of ripples of shortwave length on water is controlled by surface tension. The phase velocity of such ripples is given by (9)

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**Contd... Q. No. 3(c)**

$$v_p = \left( \frac{2\pi S}{\rho\lambda} \right)^{1/2}$$
 where S is the surface tension and  $\rho$  the density of water.

Show that the group velocity is  $v_g = \frac{3v_p}{2}$ .

4. (a) Briefly describe the aberrations: (i) coma, (ii) astigmatism (iii) curvature and (iv) distortion. (10)
- (b) Mention the possible ways to minimize spherical aberrations. Show that the spherical aberration for a combination of two convergent lenses is minimum when the distance between the two lenses is equal to the difference of their focal lengths. (17)
- (c) Two coaxial convex lenses of focal lengths 20 cm and 5 cm are 10 cm apart. Calculate the power of such combination. (8)

**SECTION – B**

There are **FOUR** questions in this section. Answer any **THREE** questions.

5. (a) What do you mean by coherent sources? Mention two important conditions for interference of light? (10)
- (b) Using displacement method, how can you determine the wavelength of light with the help of Fresnel's biprism experiment? (15)
- (c) Two coherent sources of intensity  $10 \text{ w/m}^2$  and  $5 \text{ w/m}^2$  interfere to form fringes. Determine the ratio of maximum intensity to minimum intensity. (10)
6. (a) Mention three differences between interference and diffraction of light. Briefly discuss two classes of diffraction. (10)
- (b) State Malu's law. With the help of Brewster's law, show that  $i_p + r = \frac{\pi}{2}$ , where the symbols have their usual meanings. (15)
- (c) Unpolarized light is incident on a glass-plate, and the reflected light is found to be polarized. Calculate the angle of polarization for it. Also calculate the angle of refraction. The refractive index for the material of glass-plate is 1.55. (10)
7. (a) What are the assumptions of kinetic theory of gases? Briefly describe the volume correction and pressure correction in Van der Waal's equation for a real gas. (14)

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**Contd... Q. No. 7**

- (b) Define mean free path of a molecule of a gas. Prove that mean free path is equal to  $\frac{1}{\pi n d^2}$ , where the symbols have their usual meanings. Show that mean free path is inversely proportional to pressure. (12)
- (c) Estimate the size of a helium atom, assuming its mean free path at NTP to be  $28.5 \times 10^{-6}$  cm. Given that the density of helium at NTP is 0.178 g/litre and the mass of the helium atom is  $6 \times 10^{-24}$  g. (9)
8. (a) What do you understand by entropy? State 2<sup>nd</sup> law of thermodynamics in terms of entropy and deduce the efficiency of a Carnot cycle using the T-S diagram. (8)
- (b) Calculate the change of entropy for a gas when it is heated (15)
- (i) at constant temperature
- (ii) in general manner
- (c) 1 kg mass of water at 100°C is mixed with an equal mass of water at 0°C. Common temperature being 50°C, what is the change in entropy? Consider the entropy of water to be zero when it is in the liquid phase at 0°C and atmospheric pressure. (12)
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**SECTION – A**

There are **FOUR** questions in this section. Answer any **THREE** questions including Question No. 1 as compulsory.

1. (a) Explain with reference to the context **any two** of the following: (15)
- (i) "...But, poor devil, poor devil, he's best gone out of a life where he rides his rocking-horse to find a winner".
- (ii) ...I had done it solely to avoid looking a fool.
- (iii) ...I see once again great danger to your life if you go from home'.
- (b) Answer any **one** of the following: (15)
- (i) 'Golding's use of symbolism is very vivid and pragmatic'. Discuss in the light of the story "Fire on the Mountain".
- (ii) Draw a character portrayal of the con-artist in "An Astrologer's Day".
- (c) Answer any **three** of the following: (15)
- (i) What does the story "Shooting an Elephant" tell us about?
- (ii) Why did Guru Nayak come to the astrologer?
- (iii) What didactic lesson do you get from the story 'The Rocking-Horse Winner'?
- (iv) Identify the positive and negative sides of the characters Ralph and Jack?
- (v) Why do the young Europeans think that an elephant worth more than a Dravidian coolie?
2. (a) Recast and correct any **ten** of the following sentences: (15)
- (i) Adib was angry with the poor results.
- (ii) We heard a sound somewheres in the distant woods.
- (iii) Tanim only ate salad and a roll for lunch.
- (vi) They were suppose to help each other.
- (v) Every day when the boss arrived, Mr. Ratan would be at his desk.
- (vi) The fisherman put the boat up under the dock.
- (vii) It was her who first saw the intruder.
- (viii) On her table were her books, papers, and the old diary.
- (ix) Abraham Lincoln was one of the great men in the history of the world.
- (x) The trainers are sick of Hasan's failures.
- (xi) The committee are empowered to make a recommendation.
- (xii) The secretary gave a fulsome account of the minutes.
- (b) Give the meanings of and make sentences with any ten of the following words: (15)
- Strain, affluent, tumble, bump, beneficiary, coerce, condone, concurrence, deride, dilate, prolific, sultry.

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3. Amplify any one of the following: (30)
- (a) If you get none to start a journey,  
Dare to step alone.
- (b) Row, row, row your boat  
Gently down the stream,  
Merrily, merrily, merrily  
Life is but a dream.

4. Write a précis of the following passage: (30)

Men are not made in the same mould, like a lot of bricks. It would have ill-suited the wants of the world if it had been so. Consequently, even in the same country, men differ in disposition, and inclination and manners, and opinion, more probably than they do in face or form. And between the people of different countries the contrast is even more striking. We have then, also, different sentiments, different sympathies, different hopes, different ways altogether. It will always be so. So long as there are different minds, there will be different views on all matters that admit of opinion. So long as there are different degrees of latitude and longitude, as well as differing circumstances there will be different interests, different attachments and different habits. It behoves us, therefore, to cultivate a generous spirit of forbearance towards those, of whatever race, who may think differently and act differently, from ourselves. Even though we may be convinced that they are wrong, if we know them to be sincere, we should still bear with them and give them credit for their sincerity.

This is the virtue of toleration or bearing with others when we may differ from them or, may not like their ways. Toleration should be shown in all differences of opinion or even the highest matters of life and death; and here it is of more value than anywhere else. When we cannot agree with one about a point of science, or philosophy, or faith, we can at least agree to differ from him, and there is an end. We must always remember that we are all likely to make mistakes and possess weaknesses, and that we ourselves need the same forbearance and sympathy. We are, besides, all of the same human brotherhood, and should, "like brothers, agree".

### SECTION-B

There are **FOUR** questions in this section. Answer any **THREE** questions including Question No. 5 as compulsory.

5. Read the following passage carefully and answer the questions that follow: (45)
- Every new year, new decade, and new century brings a host of threats and unfolds a myriad of opportunities for many organizations and individuals. Year 2019 will definitely bring both threats and opportunities. Who can avail the opportunities and effectively face the threats? Only those who are capable of identifying the trends and will do homework before entering into the new year should be able to make good use of opportunities and to get around the possible threats.

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### Contd... Q. No. 5

Some managers or entrepreneurs, being proactive in orientation, may be able to convert threats into opportunities for themselves or for their organizations. Of course, history is replete with situations when managers could not even make use of the opportunities. However, leaving aside these two extreme groups, professional managers are expected to make use of the opportunities and to get around the threats. We have already stepped into the 'Information Age'. Explosion of information technology has pervaded our home and office. Individuals and organizations are now busy in structuring their operation in this new era of information technology. Now that everyone has an easy access to information, it has become an important input in the decision making process. The competitive edge of an organization will depend on how well it has an access to information. No matter whether you are free riding on information or you are making planned investment, you have to use information to survive and to grow in the market. Thus, we are heading towards knowledge – based society.

#### Questions:

- (i) In which context is the passage written?
  - (ii) What type of managers may be able to convert threats into opportunities, and how?
  - (iii) Does the author express optimism about the new year?
  - (iv) How does the author claim that we are heading towards knowledge – based society?
  - (v) What do we need to meet the challenges of the emerging world? order?
  - (vi) Give the meanings of the following words as used in the passage: Unfold, myriad, proactive, orientation, replete.
6. (a) As the Chief Engineer of a firm you have recently bought some products for your organization. But after delivery the products are found to be defective. Now write a letter of complaint for the replacement of those products. (10)
- (b) Write phonetic transcriptions of the following words: (Any five). (10)  
English, judge, angel, donate, paper, basic.
- (c) Explain the process of Communication with a diagram. (10)
7. (a) How many parts are there in a report? Describe in brief the components of 'Back Matter' of a report. (10)
- (b) Write a short essay on any ONE of the following topics: (10)
- (i) Environmental Disaster
  - (ii) Controlling Temper: A shower on Fire
  - (iii) Our Culture Our Pride



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### Contd... Q. No. 7

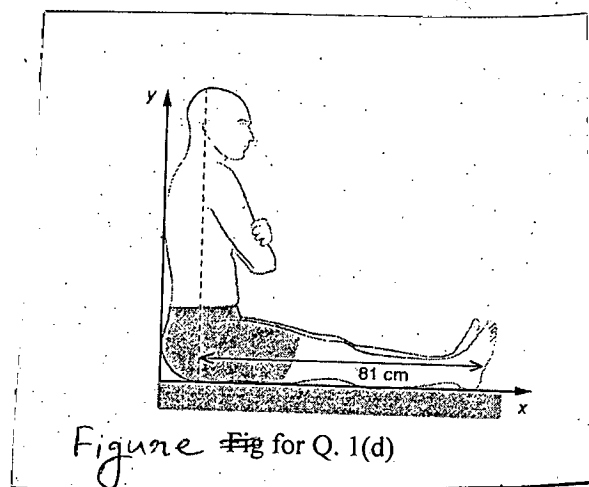
- (c) Write a dialogue between two parents about their concern over the behavioural change in young generation. (10)
8. (a) Transform the following sentences as directed (Any five). (10)
- (i) He cannot go unless I give consent. (make it Simple).
  - (ii) He worked to the best of his ability. (Complex).
  - (iii) Make haste or else you will be late. (Simple).
  - (iv) It was much regretted that he was absent. (Compound).
  - (v) A relation needs to be tended to like a plant. (Compound).
  - (vi) Be just and fear not. (Complex).
- (b) What are the salient features of a sales letter? (5)
- (c) Write short notes on any THREE of the following: (15)
- (i) The Diphthongs
  - (ii) Principles of writing business letter
  - (iii) Classifications of report
  - (iv) Qualities of a good paragraph.
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**SECTION – A**

There are **FOUR** questions in this section. Answer any **THREE**.

Symbols and abbreviations have their usual meaning.

1. (a) In an experiment to send at in Mars, an at stayed at International Space Station for almost a year. What are the possible biomechanical effects on the at due to this way? With the help of the Wolf's law discuss the phenomena. (7)
- (b) What is an antalgic gate? (6)
- (c) Human spinal column increases in size from top to bottom. Explain this phenomenon. (7)
- (d) Consider an adult with 70 kg mass and 1.70 m height, seated on the floor, with crossed arms and outstretched legs, as shown in the Figure 1 (d). It is not very easy to remain in this posture for a long time. The figure shows the lateral cut of human body, and the Table 1 (d) gives the x and y coordinates of the center of gravity (C.G.) of some segments, as well as the respective masses. The C.G. of head and neck-trunk-crossed arms is vertically aligned at a distance of 81 cm from the sole of the feet. Calculate the co-ordinates of the C.G. ( $x_{C.G.}$  and  $y_{C.G.}$ ) of this person's body. Do we feel comfortable in this position? Justify your answer with the help of C.G. position. (15)



**Table for Q 1(d):**

Parts of body	Coordinates of C.G.		Mass (kg)
	x(cm)	y (cm)	
Head	10.0	77.5	4.8
Neck-trunk-crossed arms	10.0	36.0	41.1
Thigh (both)	19.0	10.0	15.0
Leg (both)	60.0	10.0	6.7
Feet (both)	88.0	10.0	2.4

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2. (a) Assume, you are working with collagen, and it is known that it denatures during processing due to high voltage. Name a biomanufacturing technology you will use to process such protein. Briefly describe the working principle of that process. (10)
- (b) What are the standards followed by medical device manufactures. With example categorize the medical devices in Class I, II and III. (12)
- (c) With a schematic, describe different phases of the wound healing process. (13)
3. (a) Briefly describe the working principle of a glucose biosensor. (10)
- (b) Name four different types of thermal sensors. Compare these sensors in terms of sensitivity, accuracy, linearity and output type. (10)
- (c) Describe the difference between an electrode and a lead in ECG. How can three electrodes be used to generate the six standard limb leads? (15)
4. (a) With a schematic, describe the working principle of the most important component of an X-ray imaging system. (10)
- (b) Write short note on any two of the following: (4×2=8)
- (i) Gradient coil of MRI,
- (ii) SPECT,
- (iii) Smoothing filter.
- (c) What is the time required to receive an echo from the aorta, assuming that the transducer is abutted to the abdominal wall and the aorta is 6 cm deep? (8)
- (d) With schematic, describe how does the ultrasound interact with different body tissues. (9)

### SECTION-B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) The hydrolysis of carbobenzozyglycyl-L-tryptophan catalyzed by pancreatic carboxypeptidase occurs according to the reaction: (20)
- $$\text{carbobenzozyglycyl-L-tryptophan} + \text{H}_2\text{O} \rightarrow \text{carbobenzoxyglycine} + \text{L-tryptophan}$$
- The following data on the rate of formation of L-tryptophan at 25°C and pH 7.5 was obtained in the absence of inhibitors, as well as in the presence of Inhibitor A:

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**Contd... Q. No. 5 (a)**

**Table for Q 5(a)**

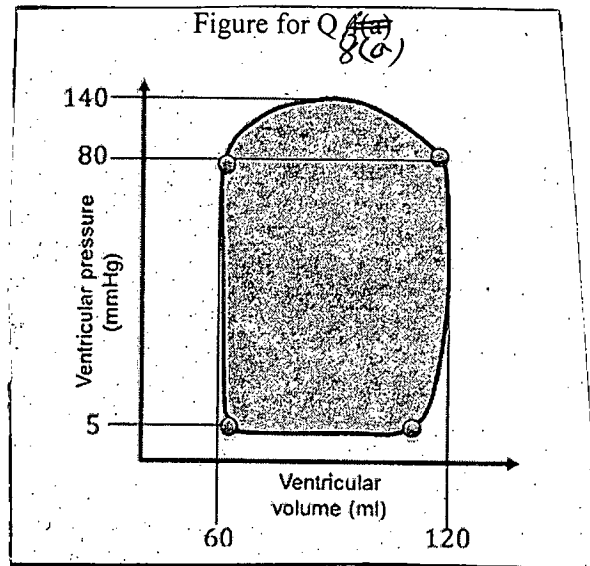
Substrate Concentration (mM)	No Inhibitor Rate (mM s <sup>-1</sup> )	Inhibitor A Rate (mM s <sup>-1</sup> )
2.5	0.024	0.010
5.0	0.036	0.025
10.0	0.053	0.039
15.0	0.060	0.055
20.0	0.064	0.058

Determine the  $V_{max}$  and  $K_m$  in the absence of inhibitors where  $V_{max}$  and  $K_m$  represent the maximum rate achieved by the system and the substrate concentration at which the reaction rate is half of  $V_{max}$ , respectively.

- (b) What are the functions of the major organelles of eukaryotic cells? (10)
- (c) What is dead space in lung physiology? Why is important? (5)
  
- 6. (a) Draw the shear stress vs shear rate diagram of different time independent fluids. (7)
- (b) With a suitable example, discuss neutral buoyancy in human body. (8)
- (c) Write down the advantages and disadvantages of metallic implants. (10)
- (d) In a digital dentistry lab, the dentist needs to work with powder-based material. Which type of 3D printing technology should be suggested to the dentist? Briefly, describe the working principle of that technology. (10)
  
- 7. (a) The plasma membrane separates the cell cytosol from the extracellular environment. However, molecules such as nutrients and waste products must be able to cross the barrier. Explain the transportation process of these molecules. (20)
- (b) A 140-lb 30-year old female patient is found to have high blood pressure at 175/105 mm Hg, and has a family history of kidney disease. Her doctor orders a creatinine clearance test as part of a comprehensive physical exam. The results show her plasma creatinine concentration is 0.01 mg/ml and in 1 hour she produces 60 ml of urine with a creatinine concentration of 1.25 mg/ml. Calculate the creatinine clearance for this person. (15)
  
- 8. (a) Pressure volume curve of the left ventricle during a cardiac cycle is shown below. Calculate the cardiac output and work done by the heart during the cardiac cycle. Calculate the power if heart rate is 70 beats/min. (20)

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**Contd... Q. No. 8 (a)**



(b) How is double-standard DNA copied to ensure that daughter cells each receive an exact version of the parent DNA? (10)

(c) The human vascular system is a complex ensemble of connected vessels. What are the factors that affect the blood flow rate through the vessel? (5)

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