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21MATME41

Fourth Semester B.E. Degree Examination, Dec.2023/Jan.2024
Complex Ananlysis, Probability and Linear Programming

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Use of statistics tables are allowed.

Module-1

1 a. With usual notations, derive Cauchy-Riemann equation in the Cartesian form. **(06 Marks)**

b. Construct an analytic function whose real part is $e^{-x}\{(x^2-y^2)\cos y + 2xy\sin y\}$ **(07 Marks)**

c. Find the analytic function f(z) given that $u - v = (x-y)(x^2+4xy+y^2)$. **(07 Marks)**

OR

2 a. If f(z) is analytic, show that $\left[\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}\right]|f(z)|^2 = 4|f'(z)|^2$. **(06 Marks)**

b. If $\phi+i\psi$ represents the complex potential of an electrostatic field where $\phi = x^2 - y^2 + \frac{x}{x^2+y^2}$, find ϕ and also the complex potential as a function of z. **(07 Marks)**

c. Determine the analytic function f(z) whose imaginary part is $\left(r-\frac{k^2}{r}\right)\sin\theta$. **(07 Marks)**

Module-2

3 a. Discuss the transformation $w = z^2$. **(06 Marks)**

b. Evaluate $\int_0^{2+i} (\bar{z})^2\, dz$ along,

(i) The line x = 2y

(ii) The real axis upto 2 and then vertically to 2 + i. **(07 Marks)**

c. State and prove Cauchy's Integral formula. **(07 Marks)**

OR

4 a. Find the bilinear transformation which maps z = ∞, i, 0 into w = −1, −i, 1 **(06 Marks)**

b. Verify Cauchy's theorem by integrating e^{iz} along the boundary of the triangle with the vertices at the points (1 + i), (−1 + i) and (−1, −i). **(07 Marks)**

c. Evaluate $\oint_C \frac{\sin\pi z^2 + \cos\pi z^2}{(z-1)^2(z-2)}\, dz$, where 'C' is the circle with $|z| = 3$. **(07 Marks)**

Module-3

5 a. A random variable X has the following probability function,

x	0	1	2	3	4	5	6	7
P(x)	0	K	2K	2K	3K	K^2	$2K^2$	$7K^2+K$

Find the value of K and also find

(i) $P(1 \le x \le 5)$

(ii) $P(x > 5)$

(iii) $P(x \le 4)$ **(06 Marks)**

b. Find the mean and standard deviation of Bionomial Distribution. **(07 Marks)**

c. 2% of the fuses manufactured by a firm are found to be defective. Find the probability that a box containing 200 fuses contains

(i) No defective fuses.

(ii) 3 or more defective fuses. **(07 Marks)**

OR

6 a. The probability density function of a continuous random variable x is given by $P(x) = y_0 e^{-|x|}$, $-\infty < x < \infty$ find y_0. Also find mean, variance and S.D. **(06 Marks)**

b. In a certain city the duration of a shower is exponentially distributed with mean 5 minutes. What is the probability that a shower will last for,

(i) 10 minutes or more.

(ii) Less than 10 mins.

(iii) Between 10 and 12 minutes. **(07 Marks)**

c. In a normal distribution 31% of the items are under 45 and 8% of the items are over 64. Find the mean and S.D. of the distribution. Given A(0.5) = 0.19, A(1.4) = 0.42. **(07 Marks)**

Module-4

7 a. Using Simplex method, solve the LPP

Maximize : $z = 2x + 3y + z$

Subject to $x + 3y + 2z \le 11$

$x + 2y + 5z \le 19$

$3x + y + 4z \le 25$

$x, y, z \ge 0$ **(10 Marks)**

b. Solve the following LPP using Big-M method :

Maximize : $z = -2x_1 - x_2$

Subject to $3x_1 + x_2 = 3$,

$4x_1 + 3x_2 \ge 6$,

$x_1 + 2x_2 \le 4$

$x_1, x_2 \ge 0$ **(10 Marks)**

OR

8 a. Using Simplex method, to minimize $P = x - 3y + 2z$,

Subject to the constraints $3x - y + 2z \le 7$,

$-2x + 4y \le 12$,

$-4x + 3y + 8z \le 10$,

$x, y, z \ge 0$ **(10 Marks)**

b. Solve the following LPP using two phase method,

Maximize $z = 3x_1 - x_2$

Subject to $2x_1 + x_2 \geq 2$,

$x_1 + 3x_2 \leq 2$,

$x_2 \leq 4$ and

$x_1, x_2 \geq 0$

(10 Marks)

Module-5

9 a. Find optimal solution of the given balanced transportation problem using Vogel's method,

	A	B	C	
F_1	10	9	8	8
F_2	10	7	10	7
F_3	11	9	7	9
F_4	12	14	10	4
	10	10	8	

(10 Marks)

b. A company has three cement factories located in cities 1, 2, 3 which supply cement to four projects located in towns 1, 2, 3, 4 each plant can supply 6, 1, 10 truckloads of cement daily and daily cement requirements of the projects are respectively 7, 5, 3, 2 truckloads. The transport costs per truckload of cement (in hundreds of rupees) from each plant to each project site are as follows :

		Project sites			
		1	2	3	4
Factories	1	2	3	11	7
	2	1	0	6	1
	3	5	8	15	9

Determine the optimal distribution for the company so as to minimize the total transportation cost.

(10 Marks)

OR

10 a. Obtain an initial basic solution to the following transportation problem.

		To				
		A	B	C	D	Availability
From	I	11	13	17	14	250
	II	16	18	14	10	300
	III	21	24	13	10	400
	Requirements	200	225	275	250	

(10 Marks)

b. A company has four machines to do four jobs. Each job can be assigned to one and only machine. The cost of each job on each machine is given in the following table :

		Machines			
	M / J	M_1	M_2	M_3	M_4
Jobs	J_1	18	24	28	32
	J_2	8	13	17	19
	J_3	10	15	19	22

What are job assignments which will minimize the cost?

(10 Marks)

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21ME42

Fourth Semester B.E. Degree Examination, Dec.2023/Jan.2024
Machining Science & Jigs & Fixtures

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. List the operations carried out on drilling machine and explain any 2 operation with neat sketch. **(08 Marks)**

b. Explain the step by step procedure of taper turning operation carried out and lathe machine. **(06 Marks)**

c. Define machining process and explain the classification of material removal process. **(06 Marks)**

OR

2 a. Explain with neat sketch, the construction of horizontal milling machine (column × knee type). **(08 Marks)**

b. Explain the step by step procedure of machining a rectangular slot of 10 mm wide × 5 mm depth on a rectangular block using shaping machine. **(06 Marks)**

c. With neat sketch, explain the following operation :
   (i) Straddle milling
   (ii) Reaming
   (iii) Plain turning **(06 Marks)**

Module-2

3 a. Sketch and explain the tool geometry of a single point cutting tool and highlight the significance of different angles. **(08 Marks)**

b. Explain the various types of cutting fluids used in metal cutting and state the properties of cutting fluids. **(06 Marks)**

c. List out the differences between orthogonal and oblique cutting. **(06 Marks)**

OR

4 a. Briefly explain the different types of chips produced during metal cutting with neat sketches. **(08 Marks)**

b. Explain the steps involved in cutting force measurement with dynamometers for tuning operation. **(06 Marks)**

c. A Seamless tubing 35 mm outside diameter is turned orthogonally on a lathe. The following data is available. Rake angle = 35°, Cutting speed = 15 m/min, Feed = 0.10 mm/rev, Length of continuous chip in one revolution = 50.72 mm. Cutting force = 200 N, Feed force = 80 N. Calculate the co-efficient of friction, shear plane angle, velocity of chip along tool face and chip thickness. **(06 Marks)**

Module-3

5 a. What is machinability? List and explain the variables that affect the tool life. **(08 Marks)**

b. Explain with neat sketch, the principal of lapping. **(06 Marks)**

c. Explain with neat sketch, the principal of honing. **(06 Marks)**

OR

6 a. Explain with a neat sketch, the various forms of tool wear found in the cutting tools. **(08 Marks)**

b. Write a short notes on the following :
(i) Electroplating
(ii) Powder coating.
(iii) Liquid coating. **(12 Marks)**

Module-4

7 a. With neat labeled sketch, explain the working of Abrasive water jet machining along with its application. **(10 Marks)**

b. Explain the process parameters of USM and list the advantages, limitation of it. **(10 Marks)**

OR

8 a. With neat labeled sketch, explain the working principal of electrical discharge machining. List the various in EDM process and explain any one of them process parameters. **(10 Marks)**

b. Explain with neat sketch the working of ultrasonic assisted electric discharge machining along with its advantages. **(10 Marks)**

Module-5

9 a. With neat sketch, explain template jig and leaf jig. **(10 Marks)**

b. State the factors to be considered for the design of jigs and fixtures. **(05 Marks)**

c. List the difference between jigs and fixtures. **(05 Marks)**

OR

10 a. What is jig and fixture? List and explain the essential features of jigs and fixtures. **(10 Marks)**

b. List the different types of fixtures and with neat sketch explain any one type of fixture in detail. **(10 Marks)**

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21ME43

Fourth Semester B.E. Degree Examination, Dec.2023/Jan.2024
Fluid Mechanics

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Define the following terms :
(i) Absolute pressure
(ii) Gauge pressure
(iii) Differential manometers
(iv) Buoyancy
(v) Meta-centre. **(05 Marks)**

b. The left limb of a mercury U-tube manometer is open to atmosphere and the right limb is connected to a pipe carrying water under pressure. The centre of the pipe is at the level of the free surface of mercury. Find the difference in level of mercury limbs of U-tube, if the absolute pressure of water in the pipe is 14.5 m of water, atmospheric pressure is 760 mm of Hg. **(05 Marks)**

c. Derive an expression for the depth of centre of pressure from free surface of liquid of an inclined plane surface submerged in the liquid. **(10 Marks)**

OR

2 a. Define the equation of continuity. Derive the continuity equation for the three dimensional flow in Cartesian co-ordinates. **(10 Marks)**

b. If for a two-dimensional potential flow, the velocity potential is given by : $\phi = 4x(3y-4)$, determine the velocity at the point (2, 3). Determine also the value of stream function ψ at the point (2, 3). **(08 Marks)**

c. State Reynold's transport theorem. **(02 Marks)**

Module-2

3 a. Derive Euler's equation of motion along a stream line for an ideal fluid stating clearly the assumptions. Explain how this is integrated to get Bernoulli's equation along a stream line. **(10 Marks)**

b. A pipe 5 m long is inclined at an angle of 15° with the horizontal. The smaller section of the pipe which is at a lower level is of 80 mm diameter and the larger section of the pipe is of 240 mm diameter. Determine the difference of pressure between the two sections, if the pipe is uniformly tapering and the velocity of water at the smaller section is 1 m/s. **(06 Marks)**

c. A jet of water of diameter 100 mm strikes a curved plate at its centre with a velocity of 15 m/s. The curved plate is moving with a velocity of 7 m/s in the direction of the jet. The jet is deflected through an angle of 150°. Assuming the plate smooth find :
(i) Force exerted on the plate in the direction of the jet.
(ii) Power of the jet. **(04 Marks)**

OR

4 a. Define an orifice-meter. Prove that the discharge through an orifice-meter is given by the relation $Q = C_d \frac{a_0 a_1}{\sqrt{a_1^2 - a_0^2}} \times \sqrt{2gh}$. **(10 Marks)**

b. Water flows over a rectangular notch 1 m wide with a head of 15 cm and afterwards passes through a triangular (V notch) of 90° . Taking C_d for the rectangular and V-notch as 0.62 and 0.59 respectively. Find the head over the triangular notch. **(06 Marks)**

c. With a neat sketch, explain Rota meter. **(04 Marks)**

Module-3

5 a. Prove that the maximum velocity in a circular pipe for viscous flow is equal to two times the average velocity of the flow. Also derive Hagen Poiseuille's formula. **(10 Marks)**

b. Determine :

(i) The pressure gradient,

(ii) The shear stress at the two horizontal plates.

(iii) The discharge per metre width for Laminar flow of oil, with a maximum velocity of 2 m/s between two plates which are 150 mm apart. Given $\mu = 2.5$ N-S/m^2. **(06 Marks)**

c. The external and internal diameters of a collar bearing are 200 mm and 150 mm respectively. Between the collar surface and the bearing, an oil film of thickness 0.25 mm and of viscosity 0.09 N-S/m^2 is maintained. Find the torque and the power lost in overcoming the viscous resistance of the oil when the shaft is running at 250 rpm. **(04 Marks)**

OR

6 a. Derive Darcy-Weisbach equation for loss of head due to friction in pipes. **(08 Marks)**

b. A horizontal pipe line 50 m long is connected to a reservoir at one end and discharges freely in to the atmosphere at the other end. For the first 25 m length from the reservoir the pipe has a diameter of 15 cm and it has a square entrance at the reservoir. The remaining 25 m length of pipe has a diameter of 30 cm. The junction of the two pipes is in the form of a sudden expansion. The 15 cm pipe has a gate valve (K = 0.2) in fully open condition. If the height of the water surface in the tank is 10 m above the center line of the pipe, estimate the discharge in the pipe by considering the Darcy-Weisbach friction factor f = 0.02 for both the pipes. (Include all minor losses in the calculations). **(08 Marks)**

c. Two tanks are connected with the help of two pipes in series. The lengths of the pipes are 1000 m and 800 m where as the diameters are 400 mm and 200 mm respectively. The co-efficient of friction for both the pipes is 0.008. The difference of water level in the two tanks is 15 m. Find the rate of flow of water through the pipes. Considering all losses. **(04 Marks)**

Module-4

7 a. Define the terms : (i) Lift (ii) Drag. **(04 Marks)**

b. Obtain an expression for the lift produced on a rotating cylinder placed in a uniform flow field such that the axis of the cylinder is perpendicular to the direction of flow. **(10 Marks)**

c. A Jet plane which weighs 19620 N has a wing area of 25 m^2. It is flying at a speed of 200 km/hour. When the engine develops 588.6 kW, 70% of this power is used to overcome the drag resistance of the wing. Calculate the co-efficient of lift and co-efficient of drag for the wing. Taken density of air as 1.25 kg/m^3. **(06 Marks)**

OR

8 a. Using Buckingham's π-theorem, show that the velocity through a circular orifice is given by $V = \sqrt{2gH}\phi\left[\frac{D}{H}, \frac{\mu}{\rho VH}\right]$, where H is the head causing flow, D is the diameter of the orifice, μ is co-efficient of viscosity, ρ is the mass density and g is the acceleration due to gravity. **(10 Marks)**

b. Explain the different types of similarities that must exist between a prototype and its model. **(06 Marks)**

c. Define the following non-dimensiional numbers :
   (i) Reynold's number
   (ii) Mach's number.
   What are their significances for fluid flow problems? **(04 Marks)**

Module-5

9 a. Obtain an expression for velocity of the sound wave in a compressible fluid in terms of change of pressure and change of density. **(10 Marks)**

b. A projectile travels in air of pressure 8.829 N/cm^2 at -10° C at a speed of 1200 km/hr. Find the mach number and mach angle. Take K = 1.4 and R = 287 J/kgK. **(05 Marks)**

c. Explain Normal and Oblique shocks. **(05 Marks)**

OR

10 a. Obtain an expression for stagnation pressure of a compressible fluid in terms of approaching mach number and pressure. **(10 Marks)**

b. Find the velocity of air flowing at the outlet of a nozzle, fitted to a large vessel which contains air at a pressure of 294.3 N/cm^2(abs.) and at a temperature of 30°C. The pressure at the outlet of the nozzle is 137.34 N/cm^2(abs.). Take K = 1.4 and R = 287 J/kgK. **(04 Marks)**

c. Define computational fluid dynamics. Mention the applications and limitations of CFD. **(06 Marks)**

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21ME44

Fourth Semester B.E. Degree Examination, Dec.2023/Jan.2024
Mechanics of Materials

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Define the following terms:
i) True stress
ii) Poisson's ratio
iii) Stiffness
iv) Volumetric strain. **(04 Marks)**

b. Derive the expression for the total elongation of a tapered circular bar cross-section of diameter 'd_1' and 'd_2' when subjected to an axial load 'P'. **(08 Marks)**

c. A steel bolt of 16mm diameter passes centrally through a copper tube of internal diameter 20mm and external diameter 30mm. The length of the whole assembly is 500mm. After tight fitting of the assembly, the nut is over tightened by quarter $\left(\frac{1}{4}\text{th}\right)$ of a turn. What are the stresses introduced in bolt and tube. If pitch of nut is 2mm. Take E_{steel} = 200GPa and E_{copper} = 120GPa. **(08 Marks)**

OR

2 a. State Hooke's law. Sketch the typical stress-strain curve for mild-steel specimen during tension test. Show the salient points on the graph and briefly explain them. **(10 Marks)**

b. Define Young's modulus and rigidity modulus. Derive relation between Young's modulus (E) and rigidity modulus (G). **(10 Marks)**

Module-2

3 a. Derive the expressions for normal and tangential stress on a plane inclined at 'θ' to the plane of stress in x-direction in a general two dimensional stress system and show that sum of normal stress in any two mutually perpendicular directions is constant. **(12 Marks)**

b. The state of stress in a two dimensionally stressed body is shown in Fig.Q.3(b). Determine graphically (by drawing Mohr's circle), the principal stresses, principal planes, maximum shear stress and its planes. **(08 Marks)**

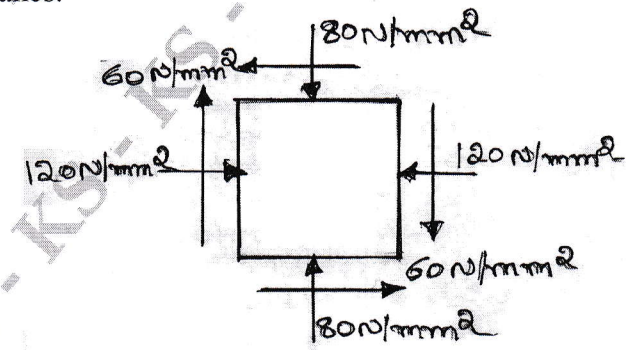

Fig.Q.3(b)

OR

4 The state of stress at a point in a strained material is shown in Fig.Q.4(a). Determine:
i) The direction of the principal planes.
ii) The magnitude of principal stresses.
iii) The magnitude of the maximum shear stress and its direction.
iv) Draw Mohr's circle and verify the results obtained analytically. **(20 Marks)**

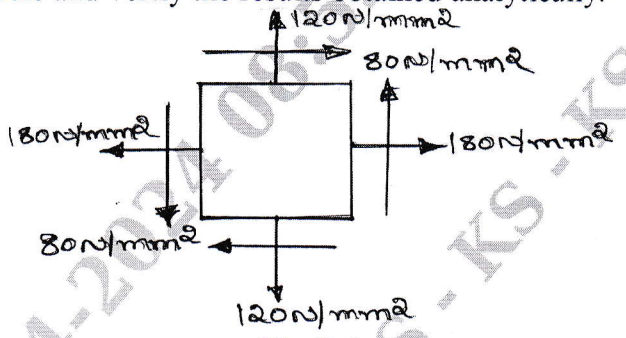

Fig.Q.4

Module-3

5 a. Define a beam. Explain with simple sketches, different types of beams. **(06 Marks)**

b. Draw the shear force and bending moment diagrams for the overhanging beam, carrying uniformly distributed load of 2kN/m over the entire length and a point load of 2kN as shown in Fig.Q.5(b). Locate the point of contra-flexure. **(14 Marks)**

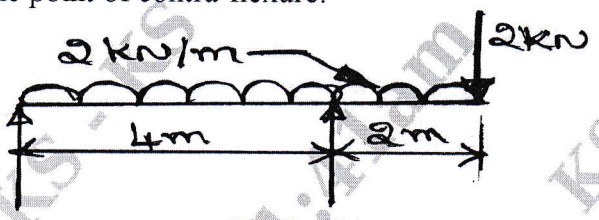

Fig.Q.5(b)

OR

6 Draw shear force and bending moment diagrams for the beam shown in Fig.Q.6. Locate the point of contraflexure. **(20 Marks)**

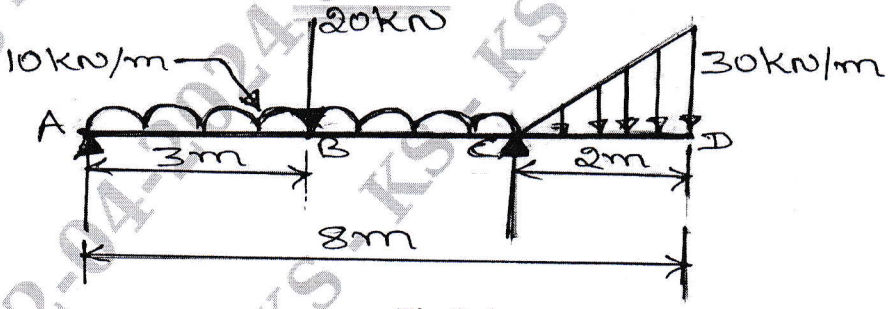

Fig.Q.6

Module-4

7 a. Prove the relation $\frac{M}{I} = \frac{\sigma}{Y} = \frac{E}{R}$ with usual notations. **(10 Marks)**

b. Prove that a hollow shaft is stronger and stiffer than the solid shaft of the same material, length and weight. **(10 Marks)**

OR

8 a. Derive the torsional equation for a circular shaft with usual notations. State the assumptions made. **(10 Marks)**

b. A hollow steel shaft transmits 392kW of power at 150rpm. The total angle of twist in a length of 3m of shaft is 2.5°. Find the inner and outer diameters of the shaft. If the permissible shear stress is 90MPa. Take G = 85GPa. **(10 Marks)**

Module-5

9 a. Differentiate between thin and thick cylinders. **(02 Marks)**

b. Derive an expression for circumferential and longitudinal stress for a thin cylinder subjected to an internal pressure 'P'. **(08 Marks)**

c. Derive the expression for radial and hoop stresses (Lame's equations) for a thick cylinder. **(10 Marks)**

OR

10 a. Derive an expression for Euler's buckling load in a column when both ends are fixed. **(10 Marks)**

b. Derive an expression for a critical load in a column subjected to compressive load, when both ends are hinged. **(10 Marks)**

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21BE45

Fourth Semester B.E. Degree Examination, Dec.2023/Jan.2024
Biology for Engineers

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Explain the structure and classification of carbohydrates, focusing on monosaccharide, disaccharides and polysaccharides. Discuss their biomedical importance of carbohydrates. **(10 Marks)**

b. Explain the construction, properties and importance of cellulose-based water filters. **(05 Marks)**

c. Discuss the properties, engineering applications and environmental impact of pHA and PLA as bioplastics. **(05 Marks)**

OR

2 a. Discuss the importance and potential applications of DNA and vaccines using rabies as an example. Explain how DNA vaccines work. **(10 Marks)**

b. Explain the properties, advantages and engineering applications of RNA vaccines, specifically for COVID-19. **(05 Marks)**

c. Discuss the benefits and uses of plant-based proteins as alternatives to animal-based proteins. **(05 Marks)**

Module-2

3 a. Compare and write architecture of the human brain as a CPU system with that based on their characteristics. **(10 Marks)**

b. What is EEG? Write the application of EEG. **(05 Marks)**

c. Eye act as camera. Explain with diagram. **(05 Marks)**

OR

4 a. Describe the architecture of the heart as a pump system. Discuss the function of each chamber. **(10 Marks)**

b. Discuss the reasons for blockages in blood vessels and their implications for cardiovascular health. **(05 Marks)**

c. Discuss the different shapes, materials, coating and expansion mechanisms used in stent design. **(05 Marks)**

Module-3

5 a. Explain the architecture of the lungs as a purification system. Discuss the different parts of the respiratory system and their role in filtering harmful substances and facilitating gas exchange. **(10 Marks)**

b. Discuss the principle and working of spirometry as a diagnostic test for evaluating lung function. Explain how spirometry results can be interpreted and used in the diagnosis of lung conditions. **(05 Marks)**

c. Explain the concept of abnormal lung physiology. Focusing on Chronic Abstractive Pulmonary Disease (COPD) as an example. **(05 Marks)**

OR

6 a. Describe the architecture of the kidney and its functional units. Known as nephrons. Discuss the role of each component of the nephron in the filtration, reabsorption and scoretion processes. **(10 Marks)**

b. Discuss the types of muscle and contract of muscle. **(05 Marks)**

c. Explore the bioengineering solutions being developed for osteoporosis. **(05 Marks)**

Module-4

7 a. Explain the working principle of ultrasonography and discuss its advantages and limitations in medical imaging. **(10 Marks)**

b. Discuss the history of technological echolocation. **(05 Marks)**

c. Explain components of bionic leaf. **(05 Marks)**

OR

8 a. Compare between Birds and Aircrafts with GPS technology for Navigation and discuss. **(10 Marks)**

b. Discuss the principle of super hydrophobic surfaces. **(05 Marks)**

c. Discuss the materials and examples of self cleaning surface. **(05 Marks)**

Module-5

9 a. Elucidate the difference between 3D printer and Bioprinter. **(10 Marks)**

b. Discuss technological importance of 3D printing of Human Ear. **(05 Marks)**

c. Discuss materials used in 3D printing of Bone. **(05 Marks)**

OR

10 a. Evaluate the importance of 3D printing in the food industry. **(10 Marks)**

b. Discuss the technological importance of self healing bio concrete. **(05 Marks)**

c. Evaluate the advantages of bioremediation and biomining. **(05 Marks)**

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