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A CONSOLIDATED QUESTION PAPER-CUM-ANSWER BOOKLET



MAINS TEST SERIES-2021

(JUNE to DEC.-2021)

IAS/IFoS

MATHEMATICS

Under the guidance of K. Venkanna

PDE. NA & COMPUTER PROG. & MECHANICS AND FLUID DYNAMICS

TEST CODE: TEST-4: IAS(M)/(PAPER-II) 11-JULY-2021

Time: 3 Hours Maximum Marks: 250

INSTRUCTIONS

- This question paper-cum-answer booklet has <u>52</u> pages and has
 - $\underline{\textbf{33 PART/SUBPAR}} T \text{questions. Please ensure that the copy of the question} \\ \text{paper-cum-answer booklet you have received contains all the questions.}$
- 2. Write your Name, Roll Number, Name of the Test Centre and Medium in the appropriate space provided on the right side.
- 3. A consolidated Question Paper-cum-Answer Booklet, having space below each part/sub part of a question shall be provided to them for writing the answers. Candidates shall be required to attempt answer to the part/sub-part of a question strictly within the pre-defined space. Any attempt outside the pre-defined space shall not be evaluated."
- 4. Answer must be written in the medium specified in the admission Certificate issued to you, which must be stated clearly on the right side. No marks will be given for the answers written in a medium other than that specified in the Admission Certificate.
- Candidates should attempt Question Nos. 1 and 5, which are compulsory, and any THREE of the remaining questions selecting at least ONE question from each Section.
- The number of marks carried by each question is indicated at the end of the question. Assume suitable data if considered necessary and indicate the same clearly.
- 7. Symbols/notations carry their usual meanings, unless otherwise indicated.
- 8. All questions carry equal marks.
- All answers must be written in blue/black ink only. Sketch pen, pencil or ink of any other colour should not be used.
- All rough work should be done in the space provided and scored out finally.
- 11. The candidate should respect the instructions given by the invigilator.
- The question paper-cum-answer booklet must be returned in its entirety to the invigilator before leaving the examination hall. Do not remove any page from this booklet.

READ	INSTR	UCT	IONS	ON	THE
LEFT	SIDE	ΟF	THIS	P	AGE
CAREI	FULLY				

Name	
Roll No.	
Test Centre	

Medium

abide by them

Do not write your Roll Number or Name
anywhere else in this Question Paper
cum-Answer Booklet.

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Signature of the Candidate

I have verified the information filled by the candidate above

Signature of the invigilator

IMPORTANT NOTE:

Whenever a question is being attempted, all its parts/ sub-parts must be attempted contiguously. This means that before moving on to the next question to be attempted, candidates must finish attempting all parts/ sub-parts of the previous question attempted. This is to be strictly followed. Pages left blank in the answer-book are to be clearly struck out in ink. Any answers that follow pages left blank may not be given credit.

DO NOT WRITE ON THIS SPACE

INDEX TABLE

QUESTION	No.	PAGE NO.	MAX. MARKS	MARKS OBTAINED
1	(a)			
	(b)			
	(c)			
	(d)			
	(e)			
2	(a)			
	(b)			
	(c)			
	(d)			
3	(a)			
	(b)			
	(c)			
	(d)			
4	(a)			
	(b)			
	(c)			
	(d)			
5	(a)			
	(b)			
	(c)			
	(d)			
	(e)			
6	(a)			
	(b)			
	(c)			
	(d)			
7	(a)			
	(b)			
	(c)			
	(d)			
8	(a)			
	(b)			
	(c)			
	(d)			
			Total Marks	

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		3 01 32
		SECTION - A
1.	(a)	Find the partial differential equation of the family of planes, the sum of whose x,
		y, z intercepts is equal to unity. [10]



1.	(b)	Solve (D^3 –	$-4D^2 D' + 5DD'^2 -$	$-2D'^3$) z = $e^{y+2x} + (y+x)^{1/2}$.	[10]



1.	(c)	Find the positive root of $log_e x = cos x$ nearest to five places of decimal by N	ewton-
	` '	Raphson method.	[10]
		•	



1.	(d)	Use Hamilton's	equations	to	find	the	equation	of	motion	of	the	simple
		pendulum.										[10]

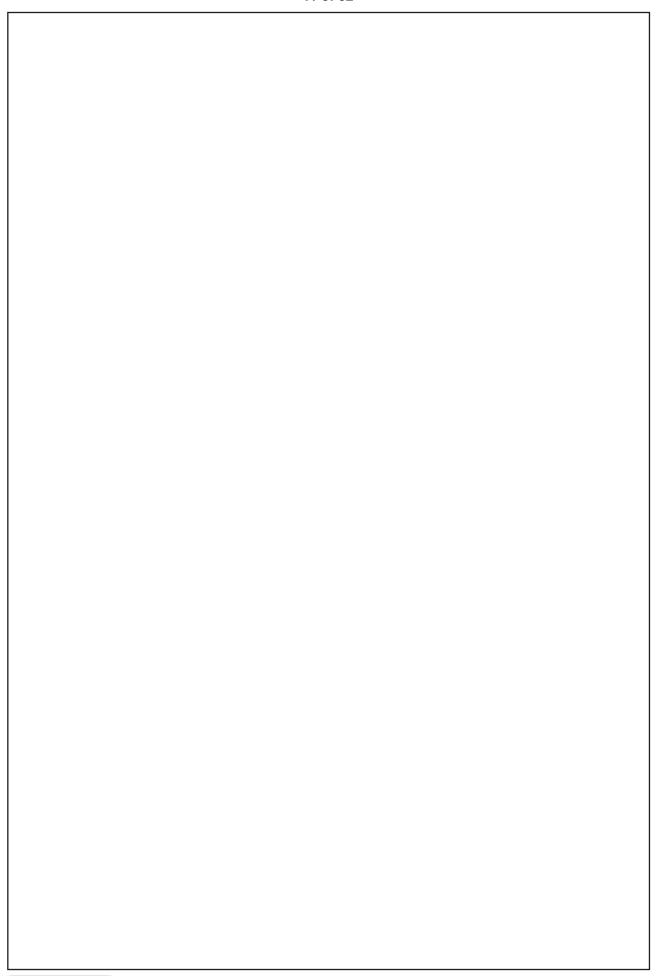


		3 01 02
1.	(e)	Find the stream lines and paths of the particles for the two dimensional velocity field:
		$u = \frac{x}{1+t}, v = y, w = 0.$ [10]
		1+t
1		



2.	(a)	(i)	Find the surface which is orthogonal to the one parameter system
	(α)	(1)	$z = cxy(x^2 + y^2)$ which passes through the hyperbola $x^2 - y^2 = a^2$, $z = 0$
		(ii)	Solve $(x^2 + y^2)(p^2 + q^2) = 1$ [18]
		(11)	

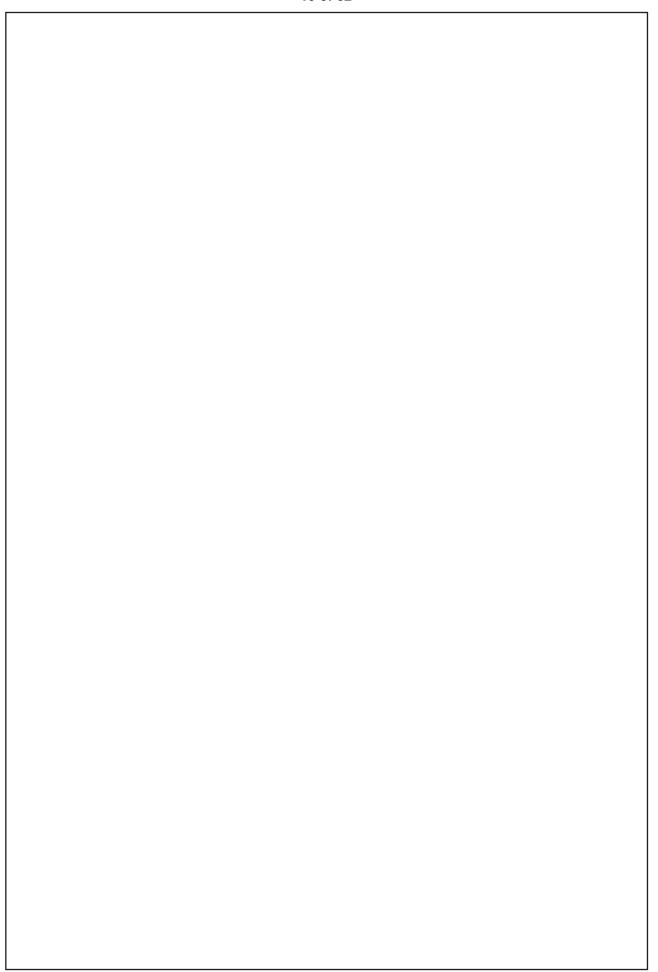






2. (b) Obtain the Simpson's rule for the integral $I = \int_a^b f(x) dx$ and show that this rule is exact for polynomials of degree $n \le 3$. In general show that the error of approximation for Simpson's rule is given by $R = -\frac{(b-a)^5}{2880} f^{iv}(\eta), \eta \in (0,2)$. Apply this rule to the integral $\int_0^1 \frac{dx}{1+x}$ and show that $|R| \le 0.008333$.







2.	(c)	inside a field hollow cylinder of radius b. Show that the plane through their axes
		moves like a circular pendulum of length (b-a) $\left(1 + \frac{K^2}{a^2}\right)$ [15]

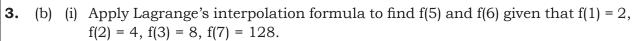


3.	(a)	Find the characteristics of the equation $xp + yq - pq = 0$ and then find the equation of the integral surface through the curve $z = x/2$, $y = 0$. [17]







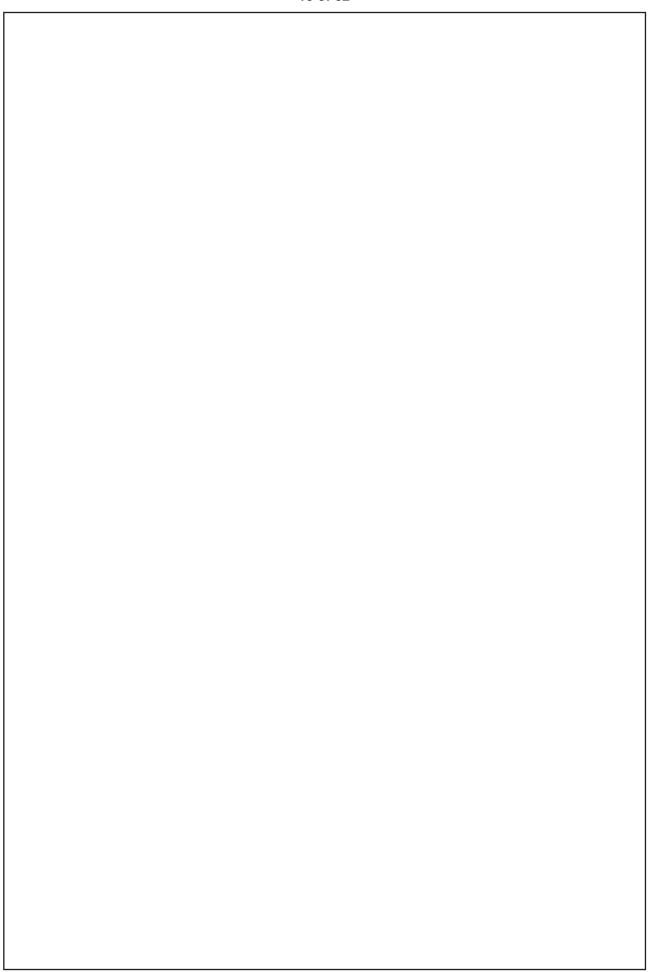


(ii) Using Newton's forward formula find the number of men getting wages between Rs. 10 and 15 from the following data :

Wages in Rs. :	0-10	10 - 20	20 - 30	30-40
Frequency:	9	30	35	42

[17]

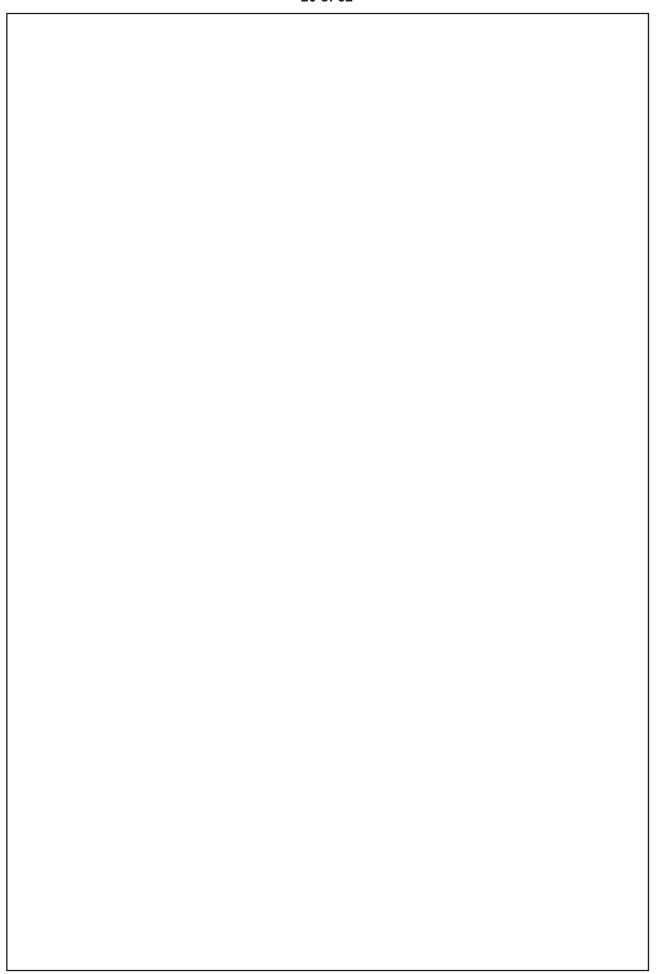






3.	(c)	If the velocity of an incompressible fluid at the point (x,y,z) is given by $\left(\frac{3xz}{r^5}, \frac{3yz}{r^5}, \frac{3z^2-r^2}{r^5}\right), r^2 = x^2 + y^2 + z^2,$	
		then prove that the liquid motion is possible and that the velocity potential is Further, determine the streamlines.	$\frac{z}{r^3}$. [16]

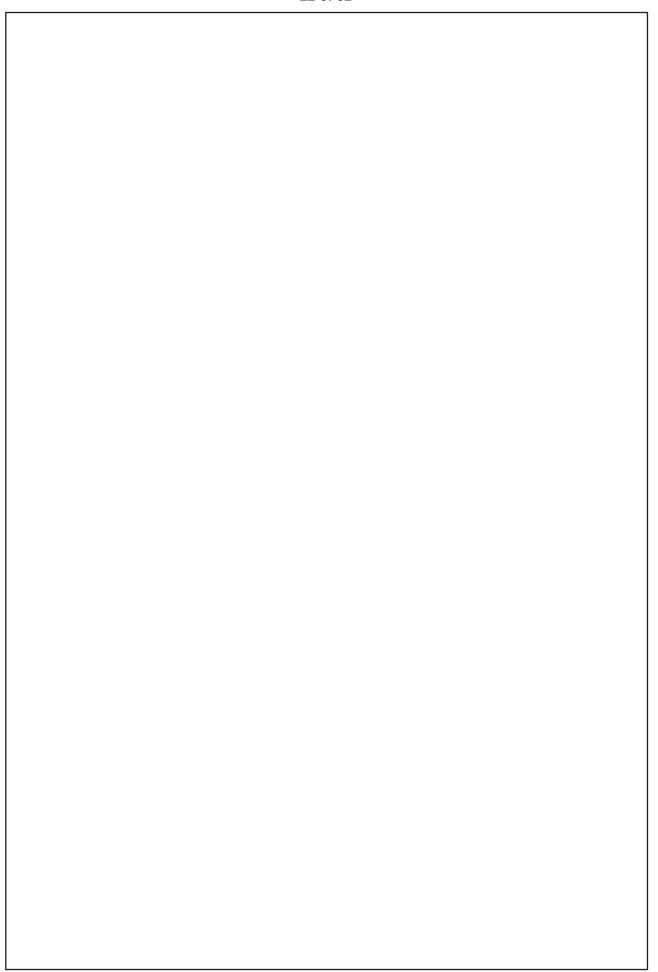






<u> </u>	(~)	The temperature of one and of a har EO are large with insulated aider in 1 and at
4.	(a)	The temperature at one end of a bar 50 cm long with insulated sides is kept at
		0°C and the other end is kept at 100°C until steady state condition prevails. The
		two ends are then suddenly insulated, so that the temperature gradient is zero
		at each end there after. Find the temperature distribution. [20]
		at each end there after. I find the temperature distribution.

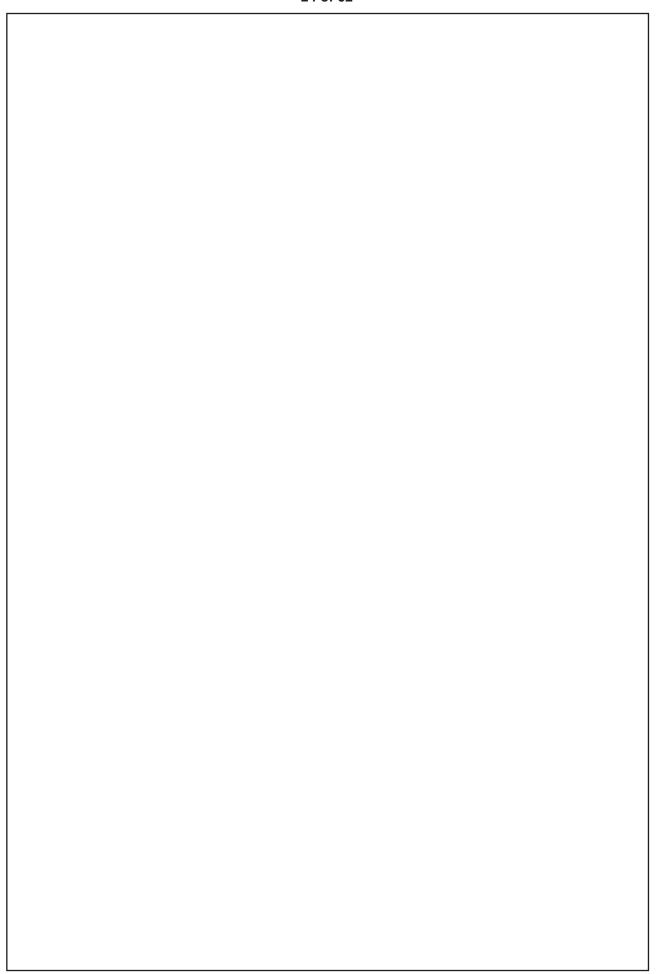






4.	(b)	Provide a computer algorithm to solve an ordinary differential equation $\frac{dy}{dx} = f(x, y)$ in the interval [a, b] for n number of discrete points, where the initial value is
		$y(a) = \alpha$, using Euler's method. [15]





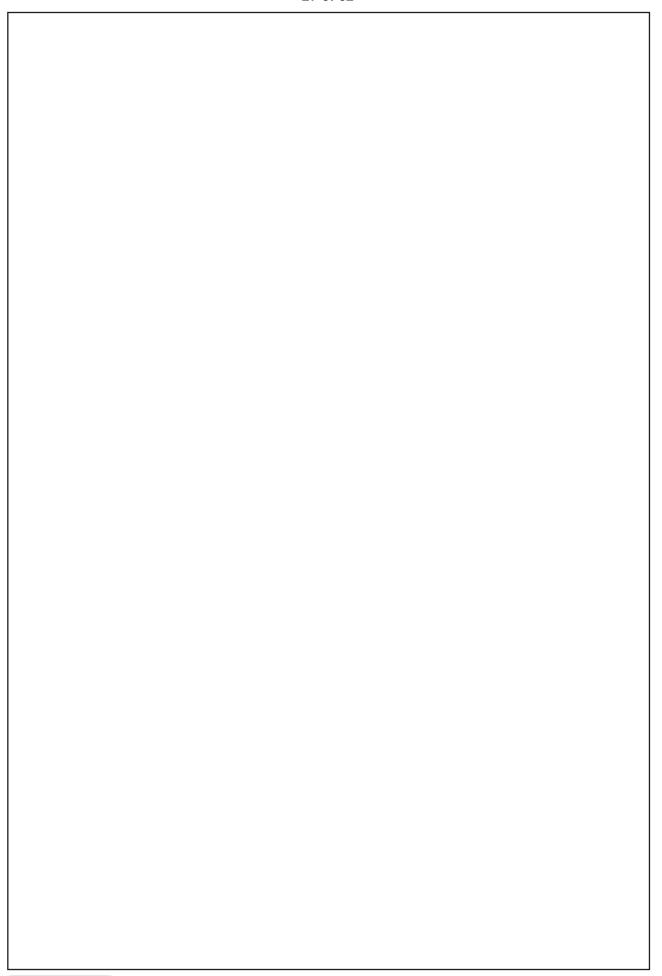


4.	(c)	If the fluid fills the region of space on the positive side of x-axis, is a rigid boundary,
••	(C)	
		and if there be a source + m at the point (0, a), and an equal sink at (0, b), and if the prossure on the possible of the boundary be the same as the prossure
		if the pressure on the negative side of the boundary be the same as the pressure
		of the fluid at infinity, show that the resultant pressure on the boundary is $\pi \rho m^2$
		$(a - b)^2$ /ab $(a + b)$, where ρ is the density of the fluid. [15]
1		



	SECTION - B	
5. (a)	Find a complete integral of $p^2 + q^2 - 2px - 2qy + 2xy = 0$	[10]







5.	(b)	Solve $r + s - 6t = y \cos x$.	[10]



5. (c) A rocket is launched from the ground. Its acceleration is registered during the first 80 seconds and is given in the table below. Using Simpson's $\frac{1}{3}$ rd rule, find the velocity of the rocket at t = 80 seconds.

t(sec):			l						
$f(cm/sec^2)$:	30	31.63	33.34	35.47	37.75	40.33	43.25	46.69	50.67

[10]



					_
5.	(d)	(i)	Simplify the expression	A = XY + XZ +	XYZ(XY+Z)

(ii) Simplify the Boolean expression $Y = \overline{A \cdot B} + \overline{\overline{A} + B}$

Prepare truth table to show that the simplified expression is correct. [10]



	31 of 52				
5.	(e)	Prove that the moment of inertia of a triangular lamina ABC about any axis through A in its plane is			
		$\frac{M}{6}\Big(\beta^2+\beta\gamma+\gamma^2\Big)$			
		where M is the mass of the lamina and β , γ are respectively the length of perpendiculars from B and C on the axis. [10]			



6.	(a)	Form a partial differential equation by eliminating the arbitrary function ϕ from
		$\phi(x + y + z, x^2 + y^2 - z^2) = 0$. What is the order of this partial differential equation?
		[08]

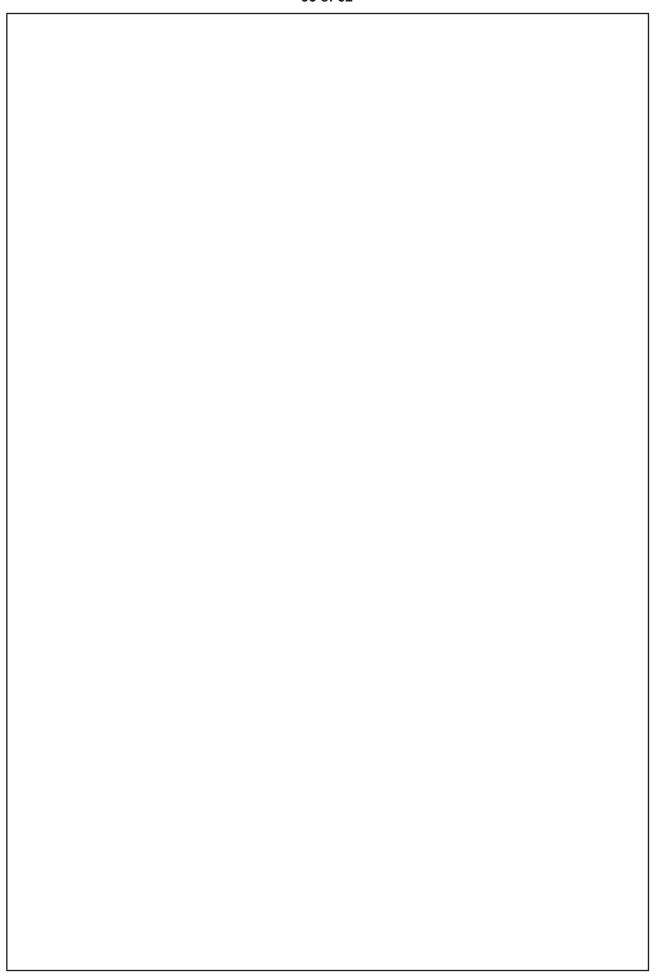


6.	(b)	Solve $(x^2 - yz)p + (y^2 - zx)q = z^2 - xy$.	[09]



6.	(c)	Reduce $x^2 r + 2xy s + y^2 t = 0$ to canonical form and hence solve	[15]

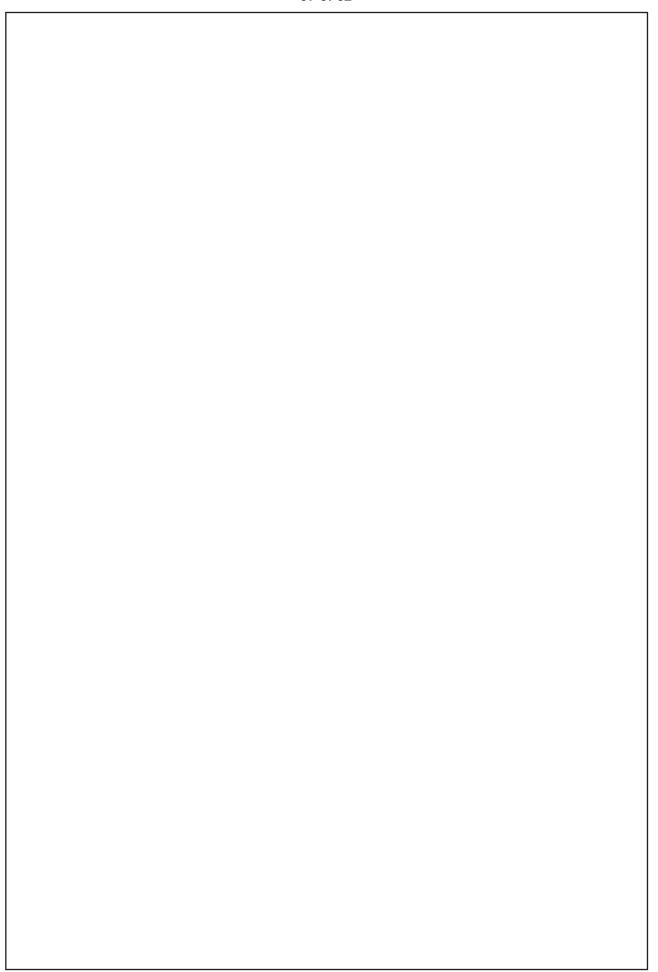






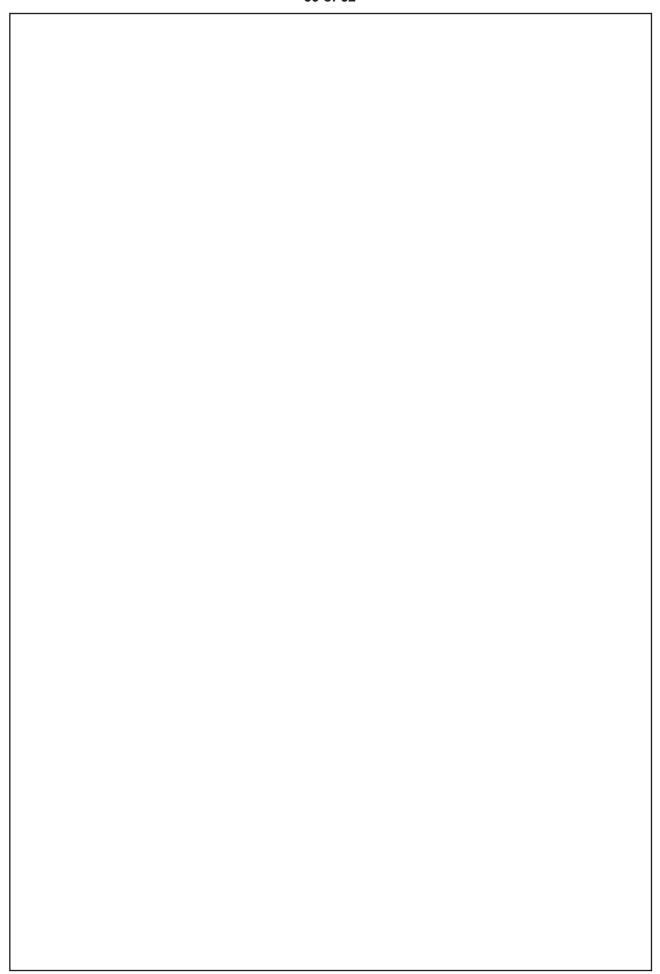
6.	(d)	A tightly stretched elastic string of length l , with fixed end points $x = 0$ and $x = l$ is
		initially in the position given by $y = y_0 \sin^3(\pi x/l)$, y_0 being constant. It is released
		from the position of rest. Find the displacement $y(x, t)$. [18]
1		







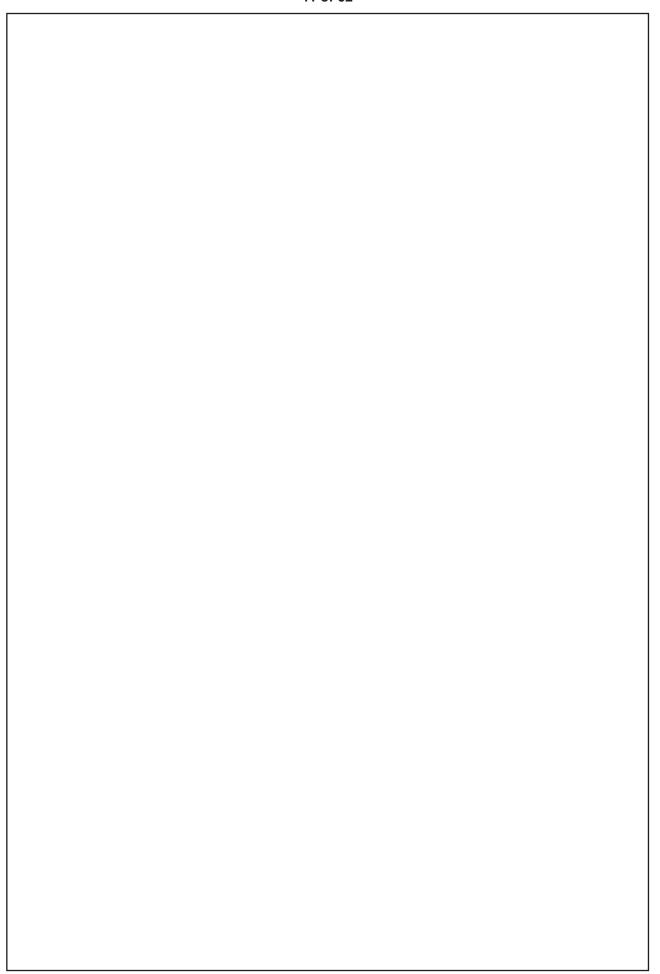
7.	(a)	Solve the following system of linear equations correct to two decimal places by Gauss seidel method $10x+2y+z=9\\2x+20y-2z=-44\\-2x+3y+10z=22$ [13]





7.	(b)	Using fourth order Runge-Kutta method find the solution of the initial value problem
		y' = 1/(x + y), y(0) = 1
		in the range $0.5 \le x \le 2.0$, by taking $h = 0.5$. [15]







7. (c) Simplify the boolean expression: $(a+b)\cdot(\overline{b}+c)+b\cdot(\overline{a}+\overline{c})$ by using the laws of boolean algebra. From its true write it in minterm normal form.	uth table

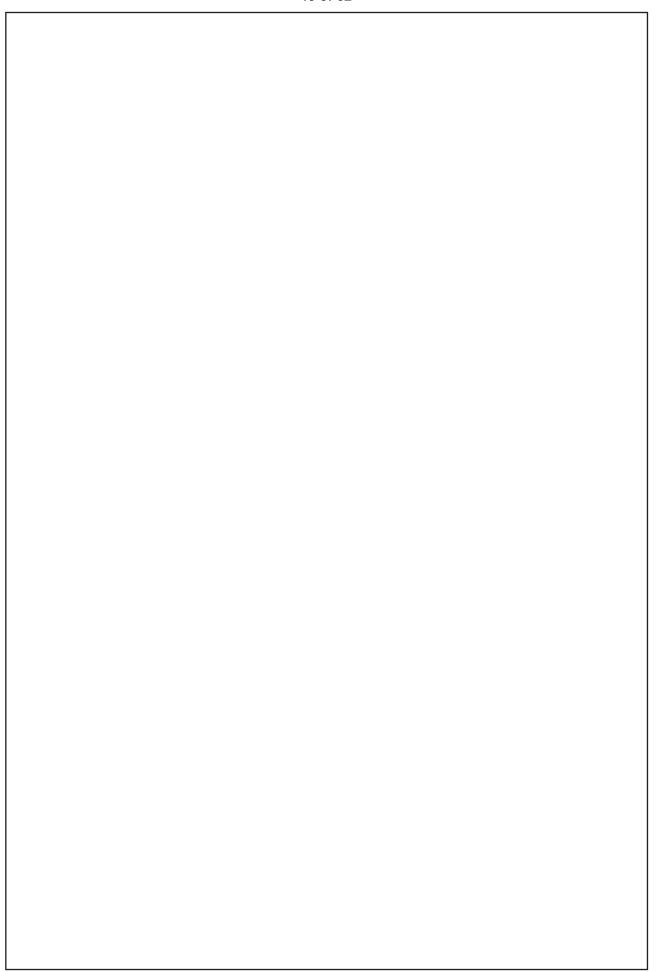


7.	(d)	(i) Convert 1011101.1011 to octal and then to hexadecimal.	
		(ii) Convert hexadecimal number 2647 to octal.	
		(iii) Convert hexadecimal number 4A.67 to binary.	[12]



8.	(a) A	uniform straight rod of length $2a$ is freely movable about its centre and a particle of mass one-third that of the rod is attached by a light inextensible string of length a to one end of the rod ; show that one period of principal oscillation is $\left(\sqrt{5+1}\right)\pi\sqrt{\left(a/g\right)}$. [16]	





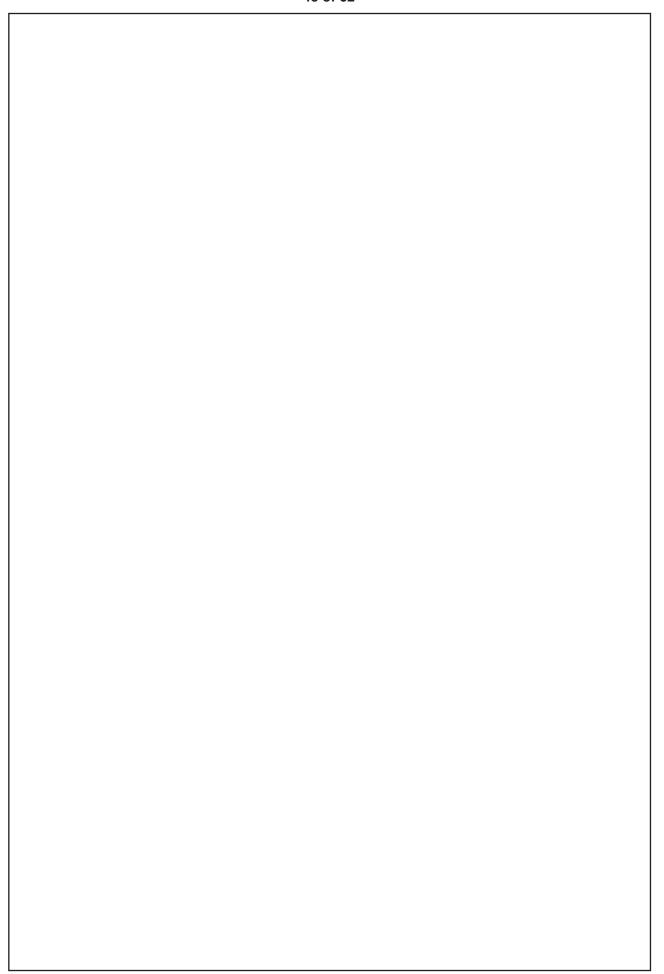


8.	(b)	An infinite row of equidistant rectilinear vortices is at a distance a apart. The
		velocities are of the same numerical strength K but they are alternately of opposite
		signs. Find the complex function that determines the velocity potential and the
		stream function. [17]



8.	(c)	Given the velocity potential $\phi = \frac{1}{2} \log \left[\frac{(x+a)^2 + y^2}{(x-a)^2 + y^2} \right]$ determine the streamlines. [17]

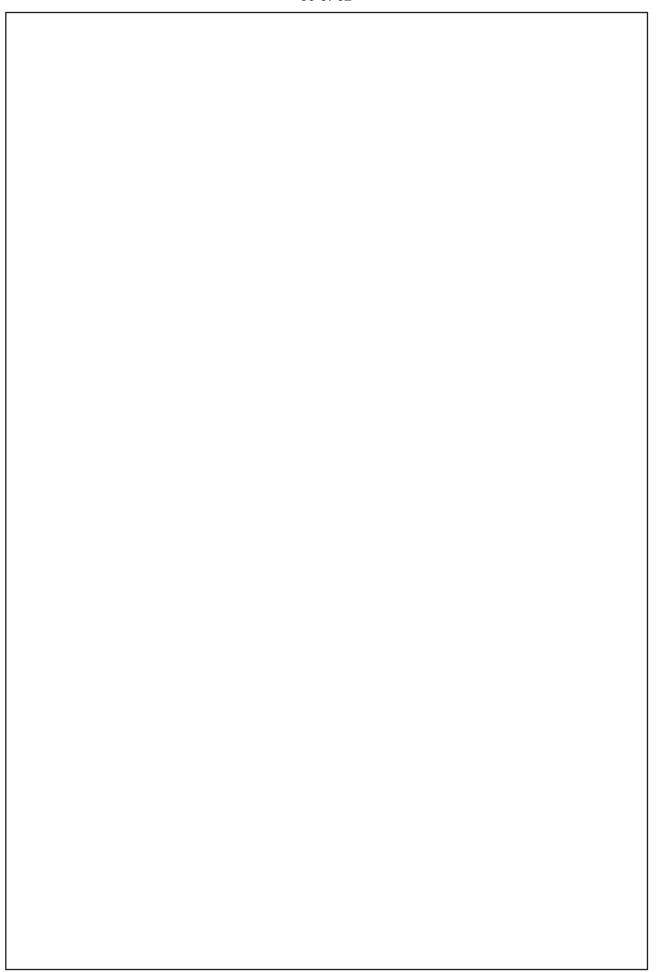






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