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Enrolment No:



Semester

: II

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, June 2021

Programme Name: M.Tech. Automation & Robotics Engineering

: Optimization Techniques **Course Name** Time : 03 hrs Max. Marks: 100

Course Code : ECEG 7010

Nos. of page(s) : 03

Instructions: Attempt all questions. Scientific calculators are allowed for the examination.

SECTION A

(All the questions are compulsory: Each questions carries 5 marks)

	(All the questions are compulsory; Each questions carries 5 marks)	
S. No.		CO
Q1.	The optimal value of the objective function of the linear programming problem $\min_{\substack{x_1, x_2 \ge 0 \\ \text{A. } 20}} 3x_1 + 2x_2 \text{ subject to } 5x_1 + x_2 \ge 10, x_1 + x_2 \ge 6, x_1 + 4x_2 \ge 12 \text{ is}$ A. 20 B. 36 C. 13 D. 16	CO1
Q2.	The dual objective function of the linear programming problem $\min_{\substack{x_1,x_2\geq 0}} 3x_1 + 2x_2 \text{ subject to } 5x_1 + x_2 \geq 10, x_1 + x_2 \geq 6, x_1 + 4x_2 \geq 12 \text{ is}$ A. max $3v_1 + 2v_2$ B. max $10v_1 + 6v_2 + 12v_3$ C. min $10v_1 + 6v_2 + 12v_3$ D. max $5v_1 + 3v_2$	CO1
Q3.	The function $f(x_1, x_2, x_3) = \frac{1}{2}(x_1^2 + x_2^2 + x_3^2) - 2x_1 - 3x_2 - 4x_3 + 11$ has A. maximum value at (2,3,4) B. maximum value at (4,6,8) C. minimum value at (2,3,4) D. minimum value at (4,6,8)	CO3
Q4.	The following function $f(x_1, x_2) = x_1^2 - 2x_1x_2 + 2x_2^2 - 4x_1$ is convex A. for all $x_1, x_2 \in \mathbb{R}$ B. for $x_1, x_2 \notin \mathbb{R}$ C. for $x_1 \neq 0$ D. for $x_2 \neq 0$.	CO3
Q5.	For what values of b the matrix $\begin{bmatrix} 2 & -1 & b \\ -1 & 2 & -1 \\ b & -1 & 2 \end{bmatrix}$ is positive semidefinite? A. $b \le -1$ B. $b \ge 2$ C. $-1 \le b \le 2$ D. $b \in \mathbb{R}$	CO3
Q6.	The steepest descent direction to minimize the function $f(x_1, x_2, x_3) = 2x_1x_3^2 + x_1x_2x_3$ at the starting point $(1, -1, -1)$ is A. $\begin{pmatrix} -3\\1\\5 \end{pmatrix}$ B. $\begin{pmatrix} 3\\-1\\5 \end{pmatrix}$ C. $\begin{pmatrix} 3\\1\\-5 \end{pmatrix}$ D. $\begin{pmatrix} 3\\1\\5 \end{pmatrix}$	CO3

		_	_		SECT			_		
									rries 10 mark	s)
Q7.			show 1	that th	e follov	wing li	near progra	mming pro	blem has no	
	feasible solution. $\max z = -2x_1 + x_2 + 3x_3$									
		1 .					-			CO1
		subj	ect to	_	$-2x_2 +$	-				
	$3x_1 + 2x_2 + 4x_3 = 1$									
	$x_1, x_2, x_3 \ge 0.$									
Q8.	A transportation company ships truckloads of grain from three silos to four mills. The									
	supply (in truckloads), the demand (also in truckloads) and the unit transportation costs (in hundreds of rupees) per truckloads on the different routes are summarized below.									
		-								
									$x_{23} = 7, x_{24} = 1$	
									l distribution	
							shipping scl	nedule betw	een the silos	
	and mills, an	nd minimu	m trans	-		•				CO ₂
		ĺ		i .	lills	13.7				
	_	A .	<u>I</u>	II	III	IV	Supply			
		A	19	30	50	10	7			
	Silos _	В	70	30	40	60	9			
	_	C	40	8	70	20	18	_		
		Demands	5	8	7	14	<u> </u>			
Q9.	The head of	t the denar	tment o	tan l'	l' contor		ve inhe A l	2 (* 1) F	and tive cub	
Q).		_					-		and five sub-	
Q).	ordinates X	, Y, Z, W,	U. The	follov	ving tal	ble giv	es the numb	er of minu	tes each man	
Q).	ordinates X would take	, Y, Z, W, to perform	U. The each	follov job. H	ving tal	ble giv	es the numb	er of minu		
٧).	ordinates X	, Y, Z, W, to perform minimize t	U. The each	follov job. H time?	wing tal ow wo	ble givuld be	es the numb the jobs be	er of minu allocated,	tes each man	
V).	ordinates X would take ordinate, to	, Y, Z, W, to perform minimize t	U. The each the total	e follov job. H time? Y	wing talow wor	ble giv	es the numb the jobs be W	per of minu allocated, U	tes each man	CO2
Ψ,	ordinates X would take ordinate, to A	, Y, Z, W, to perform minimize t	U. The each the total	e follov job. H time? Y 75	wing tal	ble given ble	es the numb the jobs be W 125	per of minuallocated, U 75	tes each man	CO2
Υ).	ordinates X would take ordinate, to A B	, Y, Z, W, to perform minimize t X 85 90	U. The	e follov job. H time? Y 75	wing tallow word Z	ble given ble	es the numb the jobs be W 125 132	oer of minuallocated, U 75 78	tes each man	CO2
ψ).	ordinates X would take ordinate, to A B C	, Y, Z, W, to perform minimize t X 85 90 75	U. The	e followigob. Hotime? Y 75 78	Z 6: 6: 5:	ble givuld be 5 6 7	es the numb the jobs be W 125 132 114	er of minuallocated, U 75 78 69	tes each man	CO2
y /.	ordinates X would take ordinate, to A B C D	, Y, Z, W, to perform minimize t	U. The ach the total	e follov job. H time? Y 75 78 66	wing tal ow wor Z 6. 6. 6. 6. 6. 6. 6.	ble givuld be Z 5 6 7	w 125 132 114 120	oer of minuallocated, U 75 78 69 72	tes each man	CO2
	ordinates X would take ordinate, to A B C D E	, Y, Z, W, to perform minimize t X 85 90 75 80 76	U. The ach the total	e follow job. Ho time? Y 75 78 66 72 64	Z 6: 6: 5: 6: 5: 5: 5: 5:	ble givuld be 2 5 6 7 0 6	w 125 132 114 120 112	er of minuallocated, U 75 78 69 72 68	tes each man one per sub-	CO2
Q10.	ordinates X would take ordinate, to A B C D E A medical r	, Y, Z, W, to perform minimize t X 85 90 75 80 76 representati	U. The n each the total ve has	e following for time? Y 75 78 66 72 64 to visi	Z 6 6 6 5 5 5 1 5 1 1 1 1 1	ble givuld be 5 6 7 0 tations	w 125 132 114 120 112 A, B, C, D	over of minurallocated, U 75 78 69 72 68 and E, star	tes each man one per sub-	CO2
	ordinates X would take ordinate, to A B C D E A medical in The cost of	, Y, Z, W, to perform minimize t X 85 90 75 80 76 representating going one	U. The n each he total ve has station	e following for time? Y 75 78 66 72 64 to visito and	wing tallow work Z 6. 6. 5. t five so ther are	ble given ble given ble given ble given ble given ble given	w 125 132 114 120 112 A, B, C, D in the follow	oer of minuallocated, U 75 78 69 72 68 and E, starowing table.	tes each man one per sub-	CO2
	ordinates X would take ordinate, to A B C D E A medical in The cost of want to visit	, Y, Z, W, to perform minimize t X 85 90 75 80 76 representati going one t any station	U. The n each the total we has station on twice	e following for time? Y 75 78 66 72 64 to visite to another before	wing tallow work Z 6: 6: 5: t five so ther are ecomp	ble given ble gi	w 125 132 114 120 112 A, B, C, D in the followis tour of a	ber of minurallocated, U 75 78 69 72 68 and E, startwing table. Il stations a	tes each man one per sub- ting from A. He does not and wishes to	CO2
	ordinates X would take ordinate, to A B C D E A medical r The cost of want to visi return to the	, Y, Z, W, to perform minimize to X 85 90 75 80 76 representating one to any static e starting significant control of the starting signifi	ve has station.	e following for time? Y 75 78 66 72 64 to visite to another before Solve	wing tallow work Z 66 66 57 t five so ther are e compute trave	ble given ble given ble given ble given bleting bletin	w 125 132 114 120 112 A, B, C, D in the followis tour of a salesman p	ber of minurallocated, U 75 78 69 72 68 and E, startwing table. Il stations a	tes each man one per sub-	CO2
	ordinates X would take ordinate, to A B C D E A medical in The cost of want to visit	, Y, Z, W, to perform minimize to X 85 90 75 80 76 representating one to any static e starting significant control of the starting signifi	ve has station.	e following for time? Y 75 78 66 72 64 to visite to ance before Solve to train trains.	wing tallow work Z 6. 6. 5. t five so ther are ecompute travalurelling	ble given ble given ble given ble given bleting bletin	w 125 132 114 120 112 A, B, C, D in the followis tour of a salesman p	ber of minurallocated, U 75 78 69 72 68 and E, startwing table. Il stations a	tes each man one per sub- ting from A. He does not and wishes to	CO2
	ordinates X would take ordinate, to A B C D E A medical r The cost of want to visi return to the	, Y, Z, W, to perform minimize to X 85 90 75 80 76 representating one to any static e starting significant control of the starting signifi	ve has station.	e following for time? Y 75 78 66 72 64 to visite to ance before Solve to train trains.	wing tallow work Z 66 66 57 t five so ther are e compute trave	ble given ble given ble given ble given bleting bletin	w 125 132 114 120 112 A, B, C, D in the followis tour of a salesman p	ber of minurallocated, U 75 78 69 72 68 and E, startwing table. Il stations a	tes each man one per sub- ting from A. He does not and wishes to	CO2
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	ordinates X would take ordinate, to A B C D E A medical r The cost of want to visi return to the	, Y, Z, W, to perform minimize to X 85 90 75 80 76 representating one to any station e starting sould select select sould select se	ve has station on twice tation.	e following for time? Y 75 78 66 72 64 to visite to ance before Solve total tra	wing tal ow wor Z 6. 6. 5. 6. 5. t five so ther are ecomp the travaluelling Γο C	ble given ble given ble given bleting betting goost is	w 125 132 114 120 112 A, B, C, D in the followis tour of a salesman p	ber of minurallocated, U 75 78 69 72 68 and E, startwing table. Il stations a	tes each man one per sub- ting from A. He does not and wishes to	CO2
	ordinates X would take ordinate, to A B C D E A medical in The cost of want to visit return to the route he show	, Y, Z, W, to perform minimize to X 85 90 75 80 76 representating going one to any station estarting sould select select sould select selec	ve has station. so that t	e following for time? Y 75 78 66 72 64 to visite to another before solve to all transporters.	wing tal ow wor Z 63 66 66 57 t five s other are e comp the trav evelling Γο C 5	ble given letting lett	w 125 132 114 120 112 A, B, C, D in the follonis tour of a salesman p minimum. E 1	ber of minurallocated, U 75 78 69 72 68 and E, startwing table. Il stations a	tes each man one per sub- ting from A. He does not and wishes to	
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	ordinates X would take ordinate, to A B C D E A medical in The cost of want to visit return to the route he show	, Y, Z, W, to perform minimize to X 85 90 75 80 76 representating one to any static e starting sould select	ve has station twice station.	e following for time? Y 75 78 66 72 64 to visite to anote before Solve total transfer for the following for the followi	wing tal ow work Z 63 66 66 57 66 56 there are experience compute travelling Γο C 5 3	ble given letting be given letting by cost is be ble given letting by bl	w 125 132 114 120 112 A, B, C, D in the follonis tour of a salesman p minimum. E 1 2 7	ber of minurallocated, U 75 78 69 72 68 and E, startwing table. Il stations a	tes each man one per sub- ting from A. He does not and wishes to	
	ordinates X would take ordinate, to A B C D E A medical in The cost of want to visit return to the route he show	, Y, Z, W, to perform minimize to X 85 90 75 80 76 representating going one to any station estarting sould select select sould select	ve has station. so that t	e following for time? Y 75 78 66 72 64 to visite to another solve total tra	wing tal ow wor Z 6. 6. 6. 5. ct five so ther are ecomp the traval velling Γο C 5 3	ble given letting lett	w 125 132 114 120 112 A, B, C, D in the follohis tour of a salesman p minimum. E 1 2	ber of minurallocated, U 75 78 69 72 68 and E, startwing table. Il stations a	tes each man one per sub- ting from A. He does not and wishes to	

Q11.	Solve the following linear problem by dynamic programming technique.			
	$\max_{x_1, x_2 \ge 0} 8x_1 + 7x_2$			
	subject to $2x_1 + x_2 \le 8$			
	$5x_1 + 2x_2 \le 15$			
	OR	CO4		
	Solve the following non-linear problem by dynamic programming technique.			
	$\max_{x_1, x_2, x_3 \ge 0} x_1^2 x_2 x_3$			
	subject to $x_1 + 2x_2 + x_3 = 15$			
	$x_1, x_2, x_3 \ge 0.$			
	SECTION C			
	Q12a. and Q12b. both have internal choices; Each question carries 10 marks			
Q12.	a. Compute Karush-Kuhn-Tucker (KKT) optimality conditions for the following			
	convex programming problem.			
	$\min_{x_1, x_2 \ge 0} -4x_1 + x_1^2 - 2x_1x_2 + 2x_2^2$			
	subject to $2x_1 + x_2 \le 6$			
	$x_1 - 4x_2 \le 0.$			
	OR			
	Using Lagrange multiplier method solve the following constrained optimization problem.			
	$\min_{x_1, x_2 \ge 0} x_1^2 - x_1 x_2 + x_2^2$			
	b. Use Fibonacci search method to minimize the function $f(x) = -\frac{1}{(x-1)^2} \left(\ln x - \frac{1}{(x-1)^2} \right)$			
	$2\frac{x-1}{x+1}$) in the range [1.5,4.5]. Reduce the size of the interval minimum $\frac{1}{5}$ of the original.			
	OR			
	Apply Steepest descent method to minimize the function $f(x_1, x_2) = 4x_1^2$			
	$4x_1x_2 + 2x_2^2$ with initial point $x_0 = (2,3)$. Perform iterations until $ \nabla f < {1 \choose 1}$.			