M.Sc. 4th Semester Examination, 2023
Department of Mathematics,
Mugberia Gangadhar Mahavidyalaya
(Functional Analysis)
Paper MTM – 401

FULL MARKS: 50 : : Time : 02 hours

(***Candidates are required to give their answers in their own words as far as practicable***)

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1. Answer any four questions **2×4=8**

(a) Give an example of incomplete Inner Product space. Justify. **2**

(b) Show that the complex plane ℂ is separable. **2**

(c) Is every Cauchy sequences in a metric space is convergent? Justify. **2**

(d) Let H be a Hilbert space and y be a fixed element of H. Define $f: H \to C$ by $f(x) = < x, y >$ for all $x \in H$. Find $\|f\|$. **2**

(e) Let X be a normed space and Y be a closed subset of X. If $x_n \xrightarrow{w} x$ in X, then show that $x_n + Y \xrightarrow{w} x + Y$ in X/Y. **2**

(f) Let S be a non-empty subset of an inner product space X. Show that $S^{\perp}$ is a closed linear subspace of X. **2**

2. Answer any four questions **4×4=16**

(a) If M be a nonempty subset of a metric space (X, d) and $\bar{M}$ its closure then prove that **4**

(i) $x \in \bar{M}$ if and only if there is a sequence (x_n) in M such that $x_n \longrightarrow x$.

(ii) M is closed if and only if the situation $x_n \in M, x_n \longrightarrow x$ implies that $x \in M$.

(b) Show that if a normed space X is finite dimensional, then every linear operator on X is bounded. **4**

(c) Is a closed and bounded subset of a metric space compact? Explain it with an example. **4**

(d) If M is a non-empty closed and convex subset of a Hilbert space H, then show that there exists an unique element in M of smallest norm. **4**

(e) Let $X = C^3$. For $x = (x(1), x(2), x(3)) \in X$, let $\|x\| = \Big[(|x(1)|^2 +$ **4**

$|x(2)|^2)^{\frac{3}{2}} + |x(3)|^3\Big]^{\frac{1}{3}}$. Show that $\|.\|$ is a norm on X.

(f) Let X and Y be inner product spaces. Then show that a linear map $F: X \to Y$ satisfies $\langle F(x), F(y)\rangle = \langle x, y\rangle$ for all $x, y \in X$ if and only if it satisfies $\|F(x)\| = \|x\|$ for all $x \in X$ where the norms on X and Y are induced by the respective inner products. **4**

3. Answer any two questions **8×2=16**

(a) (i) If $\{e_n : n \in \mathbb{N}\}$ is a orthonormal set in an Hilbert space H and (α_n) be any sequence of H, then prove that $\sum_{n=1}^{\infty} \alpha_n e_n$ converges if and only if $\sum_{n=1}^{\infty} |\alpha_n|^2$ converges. **5+3**

(ii) Is the space $C[a, b]$ an inner product space? Justify.

(b) If $T: H_1 \longrightarrow H_2$ be a bounded linear operator, here H_1 *and* H_2 are Hilbert spaces then show that **2×4**

i) $< T^*y, x > = < y, Tx > \ for\ all\ x \in H_1\ ,\ y \in H_2$

ii) $(T^*)^* = T$

iii) $\| TT^* \| = \| TT^* \| = \| T \|^2$

iv) $T^*T = 0 \Leftrightarrow T = 0$

(c) (i) Let X and Y be Banach spaces and $A \in BL(X,\ Y)$. Show that there is a constant $c > 0$ such that $\|Ax\| \geq c\|x\|$ for all $x \in X$ if and only if $Ker(A) = \{0\}$ and $Ran(A)$ is closed in X. **3+5**

(ii) Let X, Y be Banach spaces and Z be a normed space. Consider $G \in B(X,\ Z)$ and $H \in B(Y,\ Z)$. Suppose that for every $x \in X$, there is a unique $y \in Y$ such that $G(x) = H(y)$ and define $F(x) = y$. Show that $F \in B(X, Y)$.

(d) (i) Let M be a closed subspace of a Hilbert space H and $x \in H$. Then show that there exist unique $y \in M$ and $z \in M^{\perp}$ such that $x = y + z$. **3+5**

(ii) Show that a normed space $\boldsymbol{X}$ is a Banach space if and only if every absolutely summable series of elements of $\boldsymbol{X}$ is summable in $\boldsymbol{X}$.

[Internal Assesment-10 marks]

M.Sc. 4th Semester Examination, 2023
Department of Mathematics,
Mugberia Gangadhar Mahavidyalaya
(Fuzzy Mathematics with Applications and Soft Computing)
Paper MTM – 402

FULL MARKS: 50 : : Time : 02 hours

(***Candidates are required to give their answers in their own words as far as practicable***)

Unit I: **Fuzzy Mathematics with Applications**

1. Answer any two questions **2×2=4**

(a) Let $f(x) = x^2 - 1$. Find $f(\tilde{A})$, where $\tilde{A} = \{(-2, 0.41),$ $(-1,0.75),\ (0,1.0),\ (1,0.32),\ (2,0.96),\ (3,0.2)\}$. **2**

(b) Show that union of two convex fuzzy sets is not a convex fuzzy set in general. **2**

(c) Write a short note on α-cut for fuzzy set. **2**

(d) Illustrate the Bellman and Zadeh's principle of fuzzy optimality. **2**

2. Answer any two questions **4×2=8**

(a) If $\tilde{A}\tilde{Y} = \tilde{B}$be a fuzzy equation, find the solution $\tilde{Y}$ such that the membership of $\tilde{A}$ and $\tilde{B}$ are as follows: **4**

$$\mu_{\tilde{A}}(x) = \begin{cases} 0, & x \le 3 \ and \ x > 5 \\ x - 3, & 3 < x \le 4 \\ 5 - x, & 4 < x \le 5 \end{cases}$$

$$\mu_{\tilde{B}}(x) = \begin{cases} 0, & x \le 12 \ and \ x > 32 \\ (x - 12)/8, & 12 < x \le 20 \\ (32 - x)/12, & 20 < x \le 32. \end{cases}$$

(b) Let $\tilde{A} = (0, 3, 5)$ be a triangular fuzzy number. Show that $\tilde{A}^2$ is not a triangular fuzzy number in general. **4**

(c) Graphically explain how a triangular fuzzy number $\tilde{A} = (1, 5, 13)$ can be expressed in the form $\tilde{A} = \cup \{\alpha A_\alpha : 0 < \alpha \le 1\}$, where $\cup$ **4** denotes the standard fuzzy union, αA_α is a special fuzzy set define as $\mu_{\alpha A_\alpha}(x) = \alpha \wedge \chi_{A_\alpha}$(x) and χ is a characteristic function of a crisp set.

(d) Prove that the fuzzy sets satisfy the distributive laws under standard fuzzy union and intersection. **4**

3. Answer any one question **8×1=8**

(a) (i) What do you meant by symmetric and non-symmetric fuzzy LPP? **2+6**

(ii) Explain Werner's method to convert the fuzzy LPP to corresponding crisp LPP.

(b) (i) Define a fuzzy multi-objective linear programming problem in general form. **2+6**

(ii) Using Zimmermann's method convert the following fuzzy LPP to corresponding crisp LPP

$$\widetilde{Max} \quad Z = x_1 + 2x_2$$
$$s.t. \quad -x_1 + 5x_2 \lesssim 21$$
$$4x_1 + 3x_2 \lesssim 31$$
$$3x_1 + 2x_2 \lesssim 41$$
$$x_1, x_2 \geq 0$$

Given that the aspiration level z_0 and tolerance levels p_i as $z_0 = 21.5, p_0 = 5, p_1 = 3, p_2 = 4,$ and $p_3 = 7$.

[Internal Assesment-05 marks]

Unit II: **Soft Computing**

1. Answer any two questions **2×2=4**

(a) What are the disadvantages of binary coded Genetic Algorithm? **2**

(b) Find the weights and threshold values of an ANN that should classify the following input/ output pairs **2**

x_1	x_2	$x_1 \wedge x_2$
0	0	0
0	1	0
1	0	0
1	1	1

(c) Find the max-min composition of the following fuzzy relations **2**

$$\tilde{R}_1: \begin{array}{c} \\ x_1 \\ x_2 \\ x_3 \end{array} \begin{array}{c} \begin{array}{cc} y_1 & y_2 \end{array} \\ \begin{bmatrix} 0.3 & 0.2 \\ 0.1 & 0.7 \\ 1 & 0 \end{bmatrix} \end{array} \text{ and } \tilde{R}_2: \begin{array}{c} \\ y_1 \\ y_1 \end{array} \begin{array}{c} \begin{array}{cccc} z_1 & z_2 & z_3 & z_4 \end{array} \\ \begin{bmatrix} 0 & 1 & 0.8 & 0.6 \\ 0.5 & 0 & 0.2 & 0.5 \end{bmatrix} \end{array}$$

(d) How fuzzy logic differs from usual logic? **2**

2. Answer any two questions **4×2=8**

(a) Explain different learning process of ANN. **4**

(b) Realise a Hebb net for the logical AND function with bipolar inputs and targets. **4**

(c) What do you mean by Fuzzy Inference System? Describe Mamdani's fuzzy inference method in short. **4**

(d) Let $X = \{1, 2, 3, 4\}$ and $Y = \{a, b, c\}$ be two universes of discourses. Also, let $\tilde{A} = \{(1, 0.2), (2,0.5), (3,0.7), (4,1.0)\}$, $\tilde{B}$={(1,0.3),(2,0.4),(3,0.8),(4,0.7)} and $\tilde{C} = \{(a, 0.1), (b, 0.6), (c, 0.9)\}$. Determine the fuzzy relation of the following fuzzy rule "IF x is $\tilde{A}$ AND x is $\tilde{B}$ THEN y is $\tilde{C}$ ". **4**

3. Answer any one question **8×1=8**

(a) Write the iterative computation to classify the following patterns by perceptron learning rule $\{[(1, 1, 1), 1], [(1, 1, -1), 1], [(1, -1, -1), -1], [(-1, 1, -1), -1]\ \}$. **8**

(b) (i) How constraint optimization problem is handled to solve it using Genetic Algorithm. **3+5**

(ii) Select the parent chromosomes for crossover using Roulette wheel selection procedure for the following information. Objective function: Max $f(x) = 50x - x^2, 1 \leq x \leq 30$, Current population: 01011, 10011, 01110, 01010, 01101 Random numbers: 0.41, 0.97, 0.12, 0.36, 0.64.

[Internal Assesment-05 marks]

M.Sc. 4th Semester Examination, 2023
Department of Mathematics,
Mugberia Gangadhar Mahavidyalaya
(Magneto Hydro-Dynamics and Stochastic Process and Regression)
Paper MTM – 403

FULL MARKS: 50 : : Time : 02 hours

(***Candidates are required to give their answers in their own words as far as practicable***)

Unit I: **Magneto Hydro-Dynamics**

1. Answer any two questions **2×2=4**

(a) Write a short note on 'Hall effect' for the mageto-hydrodynamics flow. **2**

(b) Write down the Maxwell's electromagnetic field equations of moving media. **2**

(c) Define the terms 'drift velocity' and 'magnetic diffusivity'. **2**

(d) Define Magnetic Mach number. **2**

2. Answer any two questions **4×2=8**

(a) Define the terms Alfven's velocity and Alfven's waves. Hence, derive the speed of propagation is $\sqrt{c^2 + V_A^2}$ for magneto hydrodynamic wave, where symbols have their usual meaning. **4**

(b) Starting from the induction equation $\frac{\delta B}{\delta t} = \nabla \times (v \times B)$ for an infinitely conducting fluid, show that the magnetic flux across any closed contour moving with the fluid remains constant. Interpret this result in terms of the motion of the lines of force. **4**

(c) Show that the tangential component of the magnetic field intensity is discontinuous across the surface. **4**

(d) Show that the charge decays very rapidly in an exponential manner at any point within a conducting fluid at rest. **4**

3. Answer any one question **8×1=8**

(a) (i) For a conducting fluid in a magnetic field, show that the magnetic body force per unit volume, i.e. $\mu(\nabla \times H) \times H$ is equivalent to a tension μH^2 per unit area along the lines of force, together with a hydrostatic pressure $\frac{1}{2}\mu H^2$, where symbols have their usual meaning. **5+3**

(ii) Define magnetic energy and further, find the rate of change of magnetic energy in magneto-hydrodynamic.

(b) (i) Define MHD Couette flow. **2+6**

(ii) Derive the velocity expression of MHD flow if it passes through two parallel plates.

[Internal Assesment-05 marks]

Unit II: **Stochastic Process and Regression**

1. Answer any two questions **2×2=4**

(a) Define multiple correlation coefficient, and indicate how it differs from simple correlation coefficients. **2**

(b) Define Markov Chain. What is the usefulness of Markov chain? **2**

(c) For a Markov chain with finite state space, the number of stationary distributions can be infinite. **2**

(d) Let $\{X_n : n \geq 0\}$ be a two state Markov chain with state space $S = \{0, 1\}$ and transition matrix $P = \begin{pmatrix} \frac{1}{2} & \frac{1}{2} \\ \frac{1}{3} & \frac{2}{3} \end{pmatrix}$. Assuming $X_0 = 0$, show that the expected return time to 0 is 2.5. **2**

2. Answer any two questions **4×2=8**

(a) State and prove Chapman Kolmogorov equation. **4**

(b) Starting from the probability-generating function of the birth and death process find the probability of ultimate extinction in the case of the linear growth process starting with i individuals at time 0. **4**

(c) Prove that $1 - r_{1.23}^2 = (1 - r_{12}^2)(1 - r_{13.2}^2)$. The symbols **4** have their usual meanings.

(d) Consider a Markov chain with transition probability matrix P is given by $\begin{pmatrix} \frac{1}{2} & \frac{1}{2} & 0 \\ 0 & \frac{1}{2} & \frac{1}{2} \\ \frac{1}{3} & \frac{1}{3} & \frac{1}{3} \end{pmatrix}$ for any two states i and j. Let $P_{ij}^{(n)}$ denote the n-step transition probability of going from i and j. Then prove that $P_{11}^{(n)} = \frac{2}{9}$. **4**

3. Answer any one question **8×1=8**

(a) Suppose $\left(x_{1\alpha}, x_{2\alpha}, \dots, x_{p\alpha}\right)$, $\alpha = 1, 2, \dots, n$, is a multivariate sample of size *n*. If X_1 is the value of x_1 obtained from the regression curve of x_1 on $x_2, x_3, \dots, x_p$, then show that **8**

$$Var(X_1) = Cov(x_1, X_1) \text{ and } Var(X_1) = \left(1 - \frac{|R|}{R_{11}}\right) s_1^2,$$

where the symbols have their usual meanings.

(b) Show that the generating function $P_n(s)$ for the branching process satisfies the following relations: **8**

(i) $P_n(s) = P_{n-1}(P(s))$

(ii) $P_n(s) = P(P_{n-1}(s))$, where $P_1(s) = P(s)$.

[Internal Assesment-05 marks]

M.Sc. 4th Semester Examination, 2023
Department of Mathematics,
Mugberia Gangadhar Mahavidyalaya
(Non-linear Optimization)
Paper MTM – 404B

FULL MARKS: 50 : : Time : 02 hours

(*Candidates are required to give their answers in their own words as far as practicable*)

1. Answer any four questions **2×4=8**

(a) What is Bi-matrix game? Give an example. **2**

(b) What is Non-vacuous matrix? Write it with an example. **2**

(c) Define Separating plane in NLPP. **2**

(d) What is degree of difficulty in connection with geometric programming. **2**

(e) Define Pareto optimal solution in a multi-objective non-linear programming problem. **2**

(f) State Karlin's constraint qualification. **2**

2. Answer any four questions **4×4=16**

(a) Define the following terms: **4**

(i) The (primal) quadratic minimization problem (QMP).

(ii) The quadratic dual (maximization) problem (QDP).

(b) Find the expected payoffs of two players **4**

Strategy	t_1	t_2
s_1	$(4, -4)$	$(-1, -1)$
s_2	$(0, 1)$	$(1, 0)$

(c) State and prove Motzkin's theorem of alternative. **4**

(d) State and prove the Wolfe's Duality theorem concerning on nonlinear programming problem. **4**

(e) Let θ be a numerical differentiable function on an open convex set $\Gamma \subset R^n$. θ be convex on Γ iff each $x^1, x^2 \in \Gamma$, $\theta(x^2) - \theta(x^1) \geq \nabla\theta(x^1)(x^2 - x^1)$. **4**

(f) Prove that all strategically equivalent bi-matrix games have the same Nash equilibria. **4**

3. Answer any two questions **8×2=16**

(a) Define multi-objective non-linear programming problem. Define the following in terms of multi- objective non-linear programming problem: **8**

(i) Complete optimal solution
(ii) Pareto optimal solution
(iii) Local Pareto optimal solution
(iv) Weak Pareto optimal solution

(b) State and prove Tucker's lemma of Non-linear Programming Problem. **8**

(c) Apply Beale's method for solving the QPP **8**

$$\text{Max } Z=4x_1+6x_2 -2x_1^2 -2x_1x_2 -2x_2^2$$
$$\text{subject to } \quad x_1 + 2x_2 \leq 2$$
$$\text{and } x_1 , x_2 \geq 0.$$

(d) How do you solve the following geometric programming problem? Find $X = \begin{Bmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{Bmatrix}$ that minimizes the objective function **8**

$f(x) = \sum_{j=1}^{n} U_j(x) = \sum_{j=1}^{N} (c_j \prod_{i=1}^{n} x_i^{a_{ij}})$,
$c_j > 0, x_i > 0, a_{ij}$ are real numbers, $\forall\, i, j$.

[Internal Assesment-10 marks]

M.Sc. 4th Semester Examination, 2023

Department of Mathematics,

Mugberia Gangadhar Mahavidyalaya

(Operational Research Modelling-II)

Paper MTM – 405B

FULL MARKS: 25 : : Time : 01 hour

(*Candidates are required to give their answers in their own words as far as practicable*)

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1. **Answer any two questions** **2×2=4**

(a) Find the failure rate of the equipment? Given that the reliability of the equipment per 100 hours operation has been estimated to be 0.98. **2**

(b) What is memory less channel? Discuss about measure of information. **2**

(c) Define entropy function and explain its importance. **2**

(d) Find the curve $x = x(t)$ which minimizes the function $J = \int_0^1 (\dot{x}^2 + 1)dt$, where $x\,(0) = 1$ and $x\,(1) = 2$. **2**

2. **Answer any two questions** **4×2=8**

(a) (i) In a system, there are n numbers of components connected in series with reliability $R_i(t) = p,\ i = 1, 2, \dots, n$. Find the reliability of the system. **2+2**

(ii) If $R(t) = e^{-\lambda t}$, then find the reliability of the system. What is mean time between failure?

(b) What is joint entropy? Prove that $H(X, Y) \leq H(X) + H(Y)$ with equality iff X and Y are independent. **4**

(c) An electronic device has a failure rate of 500 failures per 10^6 hours. One identical stand-by unit is added to increase the reliability of the basic device. The operating time is 1000 hours. The failure rate of the sensing and switching element is 0.97. What will be the system reliability if the sensing and switching element is 100% reliable? **4**

(d) Prove that the reliability function for random failure is an exponential distribution. How system reliability can be improved? **4**

3. Answer any one question **8×1=8**

(i) (i) Find the stationary path $x = x(t)$ for the functional $J = \int_0^1 \left[1 + \left(\frac{d^2x}{dt^2}\right)\right] dt$, where boundary conditions are $x(0) = 0, x(1) = \dot{x}(0) = \dot{x}(1) = 1$. **6+2**

(ii) What do you mean by "Mean time between failure" of an item.

(ii) (i) Describe the Bang Bang control and illustrate it with the help of an example. **6+2**

(ii) What is Pontryagin's Maximum Principle?

[Internal Assesment-05 marks]

M.Sc. 4th Semester Examination, 2023

Department of Mathematics,

Mugberia Gangadhar Mahavidyalaya

Paper MTM – 495 (Special Paper-OR: Lab. OR methods using MATLAB and LINGO)

FULL MARKS: 25 : : Time : 02 hours

Group-A (LINGO)

Answer any one question **1 x 6= 06**

1. Write a code in LINGO to solve the following QPP using Wolfe's modified simplex method.

$$\max z = 4x_1+6x_2-2x_1^2-2x_1x_2-2x_2^2$$

$$\text{subject to, } x_1+2x_2 \leq 2$$

$$x_1, x_2 \geq 0$$

2. Write a code in LINGO to solve the Nash equilibrium strategy and Nash equilibrium outcome of the following bi-matrix game.

$$\mathbf{A} = \begin{bmatrix} 1 & 0 \\ 2 & -1 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 3 & 2 \\ 0 & 1 \end{bmatrix}$$

3. Write a code in LINGO to solve the following problem of Inventory.

An engineering factory consumes 5000 units of a component per year. The ordering, receiving and handling cost are Rs.300 per order while trucking cost is Rs.1200 per order, internet cost Rs. 0.06per unit per year, Deterioration and obsolence cost Rs 0.004 per year and storage cost Rs. 1000 per year for 5000 units. Calculate the economic order quantity and minimum average cost.

4. Write a code in LINGO to solve the following Stochastic Programming Problem.

A manufacturing firm produces two machines parts using lathes, milling machines and grinding machines. The machining times available per week on different machines and the profit on machine part are given below. The machining times required on different machines for each part are not known precisely (as they vary from worker to worker) but are known to follow normal distribution with mean and standard deviations as indicated in the following table.

Type of Machine	Machining time required per unit(minutes)				Maximum time available per week (minutes)
	Part I		Part II		
	Mean	Standard deviation	Mean	Standard deviation	
Lathes	$\bar{a}_{11}=10$	$\sigma_{a11}=6$	$\bar{a}_{12}=4$	$\sigma_{a12}=4$	$b_1=2500$
Milling machines	$\bar{a}_{21}=4$	$\sigma_{a21}=6$	$\bar{a}_{22}=10$	$\sigma_{a22}=7$	$b_2=2000$
Grinding machine	$\bar{a}_{31}=1$	$\sigma_{a31}=2$	$\bar{a}_{32}=1.5$	$\sigma_{a31}=3$	$b_3=450$
Profit per unit(Rs)	$c_1=50$		$c_2=100$		

Determine the number of machine parts I and II to be manufactured per week to maximize the profit without exceeding the available machining times more than once in 100 weeks.

5. Write a code in LINGO to solve the following LPP using simplex method.

$$\max z = 2x_1+3x_2-x_3$$
$$\text{subject to, } 2x_1+5x_2-x_3 \le 5$$
$$x_1+x_2+2x_3 = 6$$
$$2x_1-x_2+3x_3 = 7$$
$$x_1,\ x_2 \ge 0$$

6. Write a code in LINGO to solve the following QPP using Wolfe's modified simplex method.

$$\max z=2x_1+3x_2-x_1^2$$
$$\text{subject to, } x_1+2x_2 \le 4$$
$$x_1,\ x_2 \ge 0$$

7. Write a code in LINGO to solve the following Geometric Programming Problem.

$$\min\ f(x)=5x_1x_2^{-1} + 2x_1^{-1}x_2+5x_1+x_2^{-1}$$

8. Write a code in LINGO to solve the following Queuing theorem problem.

A telephone exchange has two long distance operators. The telephone company finds that, during the peak load long distance all arrive in a Poisson fashion at an average rate of 15 per hour. The length of service on this call is approximately exponentially distributed with mean length 5 minutes.

(a) What is the probability that a subscriber will have to wait for this long distance call during the peak hours of the day?
(b) If the subscriber waits and are serviced in turn, what is the expected waiting time.

Group-B (MATLAB)

Answer any one **1X 9=09**

1. Write a code in MATLAB to solve the following problems of Inventory.

A constructer has to supply 10,000 bearing per day to an auto-mobile manufacturer. He find that when he start a production run, he can produce 25,000 bearing per day .The cost of holding a bearing in stock for one year is Rs 2 and set up cost for producing run is Rs 180. How frequently should the production ?

2. Write a code in MATLAB to solve the following Stochastic Programming Problem.

A manufacturing firm produces two machines parts using lathes, milling machines and grinding Write a program in MATLAB to solve machines. The machining times required on different machines for each part and the profit on machine part are given below. If the machining times available on different machines are probabilistic (normally distributed) with parameters as given in the following table , find the number of machine parts I and II to be manufactured per week to maximize the profit. The constraint have to be satisfied with a probability of at least 0.99.

Type of Machine	Machining time required per piece (minutes)		Maximum time available per week (minutes)	
	Part I	Part II	Mean	Standard deviation
Lathes	$a_{11}=10$	$a_{12}=5$	$b_1=2500$	$\sigma_{b1}=500$
Milling Machines	$a_{21}=4$	$a_{22}=10$	$b_2=2000$	$\sigma_{b2}=400$
Grinding Machines	$a_{31}=1$	$a_{32}=1.5$	$b_3=450$	$\sigma_{b3}=50$
Profit per unit(Rs)	$c_1=50$		$c_2=100$	

3. Write a code in MATLAB to solve the following problem of Inventory.

The demand for an item in a company is 18000 units per year. The company can produce the item at a rate of 3000 per month. The cost of one set-up is Rs. 500 and the holding cost of one unit per month is Rs. 0.15.The shortage cost of one unit is Rs. 20 per month. Determine the optimum manufacturing quantity. Also determine the manufacturing time and the time between setup.

4. Write a code in MATLAB to solve the following LPP using simplex method.

$$\max z = 3x_1+4x_2$$
$$\text{subject to, } x_1+x_2 \le 10$$
$$2x_1+3x_2 \le 18$$
$$x_1 \le 8$$
$$x_2 \le 6$$
$$x_1 ,\, x_2 \ge 0$$

5. Write a code in MATLAB to solve the following QPP using Wolfe's modified simplex method.

$$\max z=2x_1+x_2-x_1^2$$
$$\text{subject to, } 2x_1+3x_2 \le 6$$

$$2x_1+x_2 \leq 4$$
$$x_1, x_2 \geq 0$$

6 Write a code in MATLAB to solve the following Geometric Programming Problem.

$$\min f(x) = 5x_1x_2^{-1}x_3^{2}+x_1^{-2}x_2^{-1}+10x_2^{2}+2x_1^{-1}x_2x_3^{-2}$$

7. Write a code in MATLAB to find the Nash equilibrium strategy and Nash equilibrium outcome of the following bi-matrix game.

$$\mathbf{A} = \begin{bmatrix} 1 & 0 \\ 2 & -1 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 2 & 3 \\ 1 & 0 \end{bmatrix}$$

8. Write a code in MATLAB to solve the following Queuing theorem problem.

In a car wash service facility information gather indicates that cars arrive for service according to a Poisson distribution with mean 5 per hour. The time for washing and cleaning for each car varies but is found to follow an exponential distribution with mean 10 minutes per car. The facility cannot handle more than one car at a time and has a total of 5 parking spaces. If the parking spot is full, newly arriving cars balk to 6 services elsewhere.

(a) How many customers the manager of the facility is loosing due to the limited parking spaces?
(b) What is the expected waiting time until a car is washed?

Laboratory Note Book and Viva:	**05**
Field Tour with Report:	**05**