

Production and Operations Management

New Syllabus

Course Title: Production and Operations Management

Course No.: MSC 502

Nature of the Course: Core

Duration of the Course: 100 lecture hours

Duration of the Class: 60 minutes

Full Marks: 100

Pass Marks: 40

Course Objectives

This course aims to enable the students to understand the important aspects of production mechanism of goods and services and develop the skill of applying operations research tools in production management systems.

Course Description

This course deals on production mechanism of goods and services and includes designing the products and choice of technology, facilities location and layout, production planning and control, inventory control, quality control, maintenance management, productivity management and the overview of new and automated technology to improve production competitiveness in manufacturing and service industries and also operations research tools like programming models, network models, decision making, queuing theory and simulation that are applied in production management system.

Course Contents

- Unit 1: Introduction** LH 10
Concept. Production function. Production vs Productivity. Production system. Evolution of production management. Strategic perspective of production management. Forecasting approach and model. Decision making under risk: Expected Monetary Value Criteria, Expected Opportunity Loss, Expected Value for Perfect Information, Marginal Analysis, Decision tree approach. Game Theory: Pure and mixed strategies, Two-person zero-sum games, Pure strategies (Minimax and Maximax Principles), Games with Saddle Point, Mixed Strategies: Games without Saddle point (Dominance rule).
- Unit 2: Designing Products, Process and Services** LH 5
New Products design. Product Development process. Manufacturing process technology. Design of service and service process.
- Unit 3: Facility Location and Layout Planning** LH 20
Capacity and location decision. Need for facility location planning. General procedure for facility location planning. Facility location models. Behavioural impact in facility location. Layout concept. Basic layouts: process layout, product layout, fixed position layout and combination layout, behavioural aspect in layout designing. Linear programming: Concept of linear programming. Structure and assumptions of a linear programming problem (LPP). General mathematical model of LPP. Guidelines on LP model formulation. Introduction to Simplex Method. Standard form of LPP Simplex algorithm: maximization and minimization. Types of LPP solutions. Multiple, unbounded, infeasible, and degeneracy. Introduction and formulation of duality. Standard results on duality. Advantages of duality. Interpretation of dual values from primal solution and primal values from Dual solution. Transportation problems: Concept of transportation problem The transportation problem. LP formulation of the transportation problem. Methods for finding initial solution. Test for optimality. Variation in transportation problem: unbalanced problem, degeneracy, alternative optimal solutions. Maximization and minimization of transportation problem.
Assignment problems: Concept of assignment problem. Mathematical statement of the problem.
Solution methods of assignment problem both maximization and minimization.
- Unit 4: Conversion Process** LH 5
Job Design and its physical and behavioral dimensions. Work measurement.
- Unit 5: Production Planning and Scheduling** LH 20
Capacity planning concept. Aggregate planning process. Master production schedule and behavioural considerations. Intermittent system and scheduling process. Scheduling and control process. Loading. Priority sequencing, Scheduling for job-shop, batch and mass production Network models: Introduction to networking. Basic differences between PERT and CPM. Steps of PERT and CPM techniques. PERT/CPM network components and precedence relationships, Probability in PERT analysis. Project time cost trade off. Shortest path. Maximum flow problems.

Unit 6: Inventory Control and Material Requirement Planning..... LH 10

Concept. Inventory system. Inventory control procedure. EOQ. Deterministic inventory model with and without shortages. ABC inventory planning system. Material requirement planning: concept and elements. Manufacturing resource planning and implementation. Purchasing. Materials handling. Simulation model: Meaning, definitions and characteristics of simulation. Types of simulation and their models. Objectives of simulation. Advantages and disadvantages of simulation.

Unit 7: Managing for Quality LH 10

Concept. Quality control. Techniques of quality control. Approaches to quality improvement. Quality circle. Zero-defect program, Traditional and statistical quality control. Acceptance sampling. Control charts for variables and attributes (X, R, P). ISO 9001:2000 Quality Management Systems, Producer's and consumer's risk, Operating Characteristic Curve.

Unit 8: Maintenance Management LH 10

Concept. Types of maintenance management. Choice of maintenance alternatives. Queuing theory: Meaning, definitions and objectives of queuing theory. Problems involving queuing theory. Queuing theory and its essential elements: arrival pattern, queuing discipline, customer behaviour, service mechanism, service discipline and pattern. Types of queuing system. Single channel system.

Unit 9: Productivity Management LH 5

Concept. Types and level of productivity. Factors affecting productivity. Productivity measurement and analysis. Introduction to productivity improvement techniques.

Unit 10: Improving Productivity, Quality and Competitiveness LH 5

Overview of the Japanese management. Just in time. Participatory management. Total quality management. Production process change: resistance and remedy. KANBAN system. Kaizan System. Flexible manufacturing system dynamics. Cost Control.

Basic References

- Adams, Evarett E. Jr. and Ronald, J.E. (1992). **Production and Operations Management**. (5th Edition). New Delhi: Prentice Hall of India Ltd.
- Buffa, ES. and Sarin, R. (1994). **Modern Production Operations Management**. Singapore, New York: John Wiley and Sons.
- Hamdy, T. (1999). **Operations Research: An Introduction**. New Delhi: Macmillan, Prentice-Hall of India.
- Hiller, F.S. and Liberman, G.G. (2000). **Operations Research**. New Delhi: CBS, Publishers and Distributors.
- Richard, I.L., David, S.R., Joel, P.S. and Everette, S.G. Jr. (1992). **Quantitative Approaches to Management**. New York: McGraw Hill.

Supplementary Readings

- Chase, R.B. and Aquilano, N.J. (1977). **Production and Operations Management: A Lifecycle Approach. USA**: Irwin Homewood, Illinois, Richard D. Irwin.
- Dilworth, James B. (1992). **Operations Management**. Princeton NJ: McGraw Hill Inc.
- Manandhar, K.D., Singh, P, Shrestha, K.N. and Maharjan. A. (2057). **Production and Operations Management**. Kathmandu: Sukunda Prakashan.
- Muhlemann, A., Oakland, J. and Lockyer, K. (1998). **Production and Operations Management**. New Delhi: Macmillan India Ltd.
- Regmi, L.K., Joshi, P.R., Chaudhary, A.K. and Fago, G. (2009). **Production and Operations Management**. Kathmandu, Buddha Academic Enterprises.
- Schroeder, Roger G. (1998). **Operations Management**. New York: McGraw-Hill, Inc.
- Sharma, J.K. (1998). **Operations Research Theory and Applications**. New Delhi: Macmillan India.
- Shrestha, S. and Silwal D.P. (2063). **Production and Operations Management**. Kathmandu: Taleju Prakashan.
- Sthapit, A.B., Yadav, R., Tamang, G., Dhital, S. and Adhikary, P (2007). **Production and Operations Management**. Kathmandu: Asmita Publishing House.

New Model Question

Attempt any EIGHT questions.

[8 × 10 = 80]

Question number 11 is compulsory.

[1 × 20 = 20]

- Describe the production function in a manufacturing system. Discuss the strategic perspective of production management.
- What are the process technologies? Explain various process technologies with suitable examples.
- What is the importance of plant location decisions? Describe the techniques used in location decision.
- Discuss the master production schedule (MPS). Explain the behavioral considerations of MPS in production planning.
- What is Total Quality Management (TQM)? Describe the various approaches of quality improvement.
- What are various types of productivity and the level of productivity? Discuss how Japanese management techniques can be effective in productivity improvement.
- Draw a network diagram and identify the critical path for the following information.

Activities	A	B	C	D	E	F	G	H	I
Predecessor	-	-	-	A	B	C	D, E	B	E, H
Expected time (days)	3	5	4	2	3	9	8	7	9

Ans: Critical path is C - F

- Suppose Nepal Distillery has a product that has a constant annual demand rate of 3600 cases. A case of the product costs Rs. 100. If ordering cost is Rs.32 and the inventory holding cost is 25% of the product cost. Find the EOQ and the cycle time in days.
 - The checking-out desk of a central library receives request for assistance at a mean rate of 10 requests per hour. Assuming that the checking-out desk has a mean service rate of 12 requests per hour.
- Ans: (a) 96 units and 10 days (b) 0.67 and 0.08
- Find out the optimum transportation solution that minimizes the total transportation cost from the following data:

Origin	Destinations			Supply
	D1	D2	D3	
O1	13	15	16	17
O2	7	11	2	12
O3	19	20	9	16
Demand	14	8	23	45

Ans: Initial transportation cost = Rs. 430; Total min T.C. = Rs. 430

- A newspaper boy has the following probabilities of selling a newspaper.

No. of copies sold	10	11	12	13	14
Probability	0.10	0.15	0.20	0.25	0.30

Cost of the copy is Rs. 30 and sales price is Rs. 50. He cannot return the unsold copies. Use expected opportunity loss criterion (EOL) to find the number of copies, the boy should order.

Ans: 12 copies

- Minimize the following problem using simplex method.

$$Z = 3X + 2Y$$

Subject to the constraints

$$2X + 4Y \geq 10$$

$$4X + 2Y \geq 10$$

$$Y \geq 4$$

$$X, Y \geq 0$$

[20]

Ans: Min $Z = \frac{19}{2}$, $X = \frac{1}{2}$, $Y = 4$

Production Management

1. INTRODUCTION**1. 2071 Q.No. 1**

Differentiate between 'production and productivity.' Discuss various internal and external environments affecting the production system. [10]

2. 2070 Q.No. 1

Describe the evolution of 'production and operation management.' Differentiate the features of 'products' and 'service'. [10]

3. 2069 (Old) Q. No. 1

What is production function? State the difference between production and productivity and describe internal environments that affect the production system. [10]

4. 2068 Q.No. 1

What are the factors affecting production system? Discuss various environments under which production and operations manager has to work. [10]

5. 2068 Old Q.No. 1

Differentiate between productivity and production. Discuss various environments under which production and operation manager has to work. [10]

6. 2067 Q.No. 1

What is production function? State the difference between production and productivity. Describe the environmental factors that affect production system. [10]

7. 2067 Q.No. 1 (Old)

What do you understand by productivity? Explain how productivity differs from production.

8. 2066 Q.No. 1

State and explain the external and internal environments that directly affect the production system of an organization. 10

9. 2065 Q.No. 1

Differentiate between production and productivity. Discuss the strategic perspective of operations management in an organization. [10]

10. 2064 Q.No. 1

Describe major differences and similarities between the manufacturing operations and service operations management. [10]

11. 2063 Q.No. 2

What is production function? Differentiate between production and productivity? [10]

12. 2062 Q.No. 1

What is a production function? State the difference between production and productivity. Describe the environment factors that affect a production system. [10]

13. 2061 Q.No. 2

Discuss various internal and external environment of production system. [10]

14. 2060 Q.No. 1

Discuss the strategic perspective of production and operation management. [10]

15. 2058 Q.No. 1

What are the factors affecting Production System? Discuss various environments under which production and operations manager has to work? [10]

2. DESIGNING PRODUCTS, PROCESS AND SERVICE**1. 2070 Old Q.No. 1**

What are the process technologies? Explain various characteristics of process technologies. [10]

2. 2069 Q. No. 1

Explain manufacturing process technology. Discuss how plant layout is affected by process technology. [10]

3. 2068 Q.No. 2

What is product life cycle? State its distinct phases with example. [10]

4. 2067 Q.No. 2

Describe the service design and service process technology. Describe various types of process layout. [10]

5. 2067 Q.No. 2(Old)

Describe service designs and service process technologies.

6. 2066 Q.No. 3

What are major process technologies adopted in the production system? Explain various characteristics of intermittent and continuous process technologies. 10

7. 2063 Q.No. 1

What are the process technologies? Explain the various characteristics of process technologies? [10]

8. 2061 Q.No. 1

What is product life cycle? State its distinct phases. [10]

9. 2059 Q.No. 1

Describe the service design and service process technology. Discuss the importance of location decision for a new product or service. [10]

3. FACILITY LOCATION AND LAYOUT PLANNING**1. 2071 Q.No. 2**

What is 'plant layout'? Explain various plant layout designs with suitable examples. [10]

2. 2070 Q.No. 2

What is the importance of plant location decision? Explain qualitative techniques of plant location decision. [10]

3. 2070 Q.No. 3

What is capacity planning? Discuss how it is related to the aggregate planning of any organization. [10]

4. 2070 Old Q.No. 2

Describe the relationship between capacity planning and location planning. Discuss various types of layout. [10]

5. 2069 (Old) Q. No. 2

Explain different types of layout with suitable examples. Describe how production processes affect the layout. [10]

6. 2068 Q.No. 3

Discuss how capacity planning is important in facility location decision. Explain the quantitative method of making location decision. [10]

7. 2068 Old Q.No. 2

What are general procedures for facility location decisions? Explain the quantitative method for making location decision. [10]

8. 2067 Q.No. 3(Old)

What are the general procedures for facility location planning? [10]

9. 2066 Q.No. 2

Describe the techniques and processes of making location decision for a dental clinic. [10]

10. 2065 Q.No. 2

Discuss how capacity planning is important in facility location decision. Explain the quantitative method of making location decision. [10]

11. 2064 Q.No. 2

For an Automobile Repair Shop (ARP) what factors are most important in determining the location? Explain the techniques applied for making location decision for ARP. [10]

12. 2064 Q.No. 3

Describe various types of layout. Explain the layout for a Nursing Home with example. [10]

13. 2063 Q.No. 3

What are the general procedures for facility location decision? [10]

14. 2062 Q.No. 2

Explain different types of layout with suitable examples. Describe how the types of production process affect the types of layout. [10]

15. 2061 Q.No. 3

Explain how behaviour aspects affect location decision with suitable examples. [10]

16. 2060 Q.No. 2

What are the different types of layout? Explain them with suitable examples. [10]

17. 2058 Q.No. 2

Describe the relationship between capacity planning and the location planning. Consider the financial institution in explaining the relationship. [10]

4. CONVERSION PROCESS**1. 2065 Q.No. 3**

Describe the manufacturing process technology (conversion process) and explain their major characteristics. [10]

2. 2064 Q.No. 4

Explain the differences between horizontal and vertical job expansions. Discuss how productivity can be improved by job expansion. [10]

3. 2062 Q.No. 3

What is work measurement? Describe one important technique of work measurement. [10]

4. 2060 Q.No. 4

*What is control chart? Explain the basic principles underlying it and discuss the role of control charts in manufacturing process. [10]

5. PRODUCTION PLANNING AND SCHEDULE**1. 2071 Q.No. 4**

What is aggregate planning? Describe the advantages and disadvantages of aggregate planning? [10]

2. 2070 Old Q.No. 6

Describe Master Production Scheduling. State and explain the aggregate planning strategies in a manufacturing organization.

3. 2069 Q. No. 4

Discuss aggregate planning and master production scheduling. [10]

4. 2069 (Old) Q. No. 3

What do you understand by aggregate planning process? Explain the advantages and disadvantages of aggregate planning strategies. [10]

5. 2068 Q.No. 4

What do you understand by production planning and control? Discuss its main elements and functions. [10]

6. 2068 Old Q.No. 3

What is an aggregate planning? Explain how a master production schedule is developed in an organization. [10]

7. 2067 Q.No. 4

What is an aggregate planning process? Explain how a Master Production Schedule (MPS) is developed in an organization. [10]

8. 2066 Q.No. 4

Explain the Gantt scheduling chart based in the production planning and scheduling. 10

9. 2064 Q.No. 6

Describe Master Production Scheduling. State and explain the aggregate planning strategies in a manufacturing organization. [10]

10. 2063 Q.No. 4

What are priority-sequencing rules? Why are they needed in scheduling process? [10]

11. 2062 Q.No. 3

What is work measurement? Describe one important technique of work measurement. [10]

12. 2061 Q.No. 4

What capacity planning? How is the capacity planning related to aggregate planning? [10]

13. 2060 Q.No. 3

Explain how does a Gantt chart for detailed scheduling differ from a Gantt loan chart. [10]

14. 2059 Q.No. 2

What is an aggregate planning process? Explain how a Master Production Schedule (MPS) is developed in an organization? [10]

15. 2058 Q.No. 3

What do you understand by aggregate planning process? Explain the advantage and disadvantage of aggregate planning process? [10]

6. MAINTENANCE MANAGEMENT**1. 2070 Q.No. 6**

What are the preventive and breakdown maintenance? Explain the choice of maintenance alternatives. [10]

2. 2070 Old Q.No. 4

What are different types of maintenance management? Explain the criteria of selecting the maintenance alternatives. [10]

3. 2069 Q. No. 5

Discuss the various alternates of maintenance management. [10]

4. 2069 (Old) Q. No. 5

What are various types of maintenance management systems? Describe single channel queuing system. [10]

5. 2068 Q.No. 5

What are different types of maintenance management? Explain the criteria of selecting the maintenance alternatives. [10]

6. 2068 Old Q.No. 5

What are different types of maintenance management? Explain the criteria of selecting maintenance alternatives. [10]

7. 2067 Q.No. 6(Old)

What are different types of maintenance management? Explain the criteria of selecting the maintenance alternatives.

8. 2066 Q.No. 5

State and explain the preventive and breakdown maintenance management. Discuss the advantages and limitations of both types. 10

9. 2065 Q.No. 4

Differentiate between the preventive and breakdown maintenance management. Discuss the seriousness and the considerations of each in the production management system. [10]

10. 2060 Q.No. 5

What is a breakdown maintenance system? Discuss the relationship of breakdown maintenance with preventive maintenance. [10]

11. 2059 Q.No. 5

Explain different types of maintenance management? Discuss the single channel waiting line system in queuing theory. [10]

7. PRODUCTIVITY MANAGEMENT**1. 2070 Q.No. 4**

What is productivity? Explain various types of productivity measurement and how it can be improved. [10]

2. 2067 Q.No. 6

What is productivity? Discuss the importance of productivity improvement techniques in an organization. [10]

8. IMPROVING PRODUCTION COMPETITIVENESS**1. 2071 Q.No. 5**

What is just-in-time technique? Explain how JIT system helps in increasing competitiveness of the production system. [10]

2. 2071 Q.No. 6

What are the factors affecting productivity of an organization. Discuss how Kaizen system helps to improve the competitiveness. [10]

3. 2069 Q. No. 2

Compare and contrast production and productivity. Discuss how KAIZEN helps in improving productivity. [10]

4. 2066 Q.No. 6

Describe the Japanese Management System for improving the production competitiveness in a manufacturing system. 10

5. 2062 Q.No. 5

Define 'quality circle'. Discuss how the quality circle is used as a technique of quality improvement. [10]

6. 2059 Q.No. 6

Describe in brief what do you understand by 'Just-in-Time'. Discuss important 'Productivity improvement technique in an organization. [10]

7. 2058 Q.No. 5

Explain KANBAN system? Discuss the applicability of the system in Nepalese perspective [10]

9. MANAGING FOR QUALITY**THEORETICAL QUESTIONS****1. 2071 Q.No. 7**

What is 'quality circle'? Describe ISO 9000 standard and its implications in quality management. [10]

2. 2070 Q.No. 5

What is 'Zero Defect' programme? Discuss the techniques of statistics quality control (SQC).

3. 2070 Old Q.No. 3

What is operating characteristic curve? How does the OC-curve help in determining consumer's risk and producer's risk? [10]

4. 2069 Q. No. 6

Explain how acceptance sampling plan helps in controlling the quality of the product. [10]

5. 2069 (Old) Q. No. 4

What is control chart? Explain the basic principles underlying it and discuss the role of control charts in manufacturing process. [10]

6. 2068 Old Q.No. 4

What is operating characteristic curve? How does OC - curve help in determining consumer's risk and producer's risk? [10]

7. 2067 Q.No. 3

What is an operating characteristic curves? Discuss producer's risk and consumer's risk. [10]

8. 2067 Q.No. 5(Old)

Explain the central chart for variables in controlling the quality of the process.

9. 2065 Q.No. 5

What is the process control system as a tool of quality control? Discuss with reference to the statistical control chart for variable. [10]

10. 2064 Q.No. 5

What do you understand by the quality control of the product and the process? Explain the acceptance sampling method as a quality control tool. [10]

11. 2061 Q.No. 6

What do you mean by quality control? Discuss the factors affecting quality of goods and services. [10]

12. 2059 Q.No. 4

What is an operating characteristics curve? How does OC curve help determine consumer's risk and producer's risk? [10]

13. 2058 Q.No. 4

State and explain Acceptance sampling in quality control. [10]

NUMERICAL PROBLEMS**14. 2068 Q.No. 7**

Sample means and ranges for ten samples of size 5 each are given below. Draw control charts for mean and range and decide whether the process is under control or not. [10]

Sample number	1	2	3	4	5	6	7	8	9	10
Mean (\bar{X})	47	43	46	51	37	45	44	37	49	43
Range (R)	6	4	6	7	4	7	4	5	6	5

You may use the following constants:

For $n = 5$, $A_2 = 0.58$, $D_3 = 0$ and $D_4 = 2.115$. [10]

Ans: Control limit for mean chart: LCL = 41.07; CL = 44.20; UCL = 47.33; Control limit for Range chart: LCL = 0; CL = 5.4; UCL = 11.42

15. 2067 Q.No. 7

Assuming that the conversion factors for $n = 5$ are $A_2 = 0.58$, $D_3 = 0$ and $D_4 = 2.115$, calculate the central line and control limits for mean chart and range chart and range and also comment on the state of control of the process. [10]

Sample number	1	2	3	4	5	6	7	8	9	10
Mean \bar{X}	15	17	15	18	17	14	18	15	17	16
Range R	7	7	4	9	8	7	12	4	11	5

Ans: For \bar{X} -chart: UCL = 20.492; C.L. = 16.2; LCL = 11.908;
For R-chart: UCL = 15.651; CL = 7.4; LCL = 0

Operations Management**1. INVENTORY SYSTEM****THEORETICAL QUESTIONS****1. 2069 Q. No. 3**

What is ABC inventory system? Explain material requirement planning for inventory management. [10]

2. 2069 (Old) Q. No. 6a

Explain the benefit of ABC inventory system and describe the major costs involved in holding inventory. [5]

3. 2068 Q.No. 6

What is material requirement planning? Discuss the material handling methods with example. [10]

4. 2067 Q.No. 4(Old)

Explain inventory model with shortage and lead time. Discuss how would you obtain EOQ and re-order point in both cases. [10]

5. 2063 Q.No. 5

What is material requirement planning (MRP)? Discuss its merits and demerits. [10]

6. 2063 Q.No. 9 (b)

State and explain various inventory management systems in deterministic conditions. [10]

7. 2062 Q.No. 4

What do you understand by ABC classification in inventory management? Describe how ABC classification is applied in an organizations' inventory management system. [10]

8. 2061 Q.No. 5

Describe the ABC inventory planning system. What is the benefit of using inventory system? [10]

9. 2060 Q.No. 9(b)

What are the various types of inventory? State how would you obtain the optimum quantity level and reorder point in deterministic conditions. [10]

10. 2058 Q.No. 8 (b)

Describe the ABC inventory planning system. What is the benefit of using inventory system? [10]

NUMERICAL QUESTIONS**11. 2071 Q.No. 3**

What is ABC inventory system? A company uses annually 50,000 units of an item costing Rs.1.20. It operates 250 days in a year with no lead time. Each order costs Rs.45 and inventory carrying cost is 15% of the item cost. Find the optimum order quantity. [10]

Ans: 5,000 units

12. 2070 Q.No. 10b

Apply the EOQ model to the following quantity discount situation in which $D=500$ units per year, $CO=\$40$, the annual holding cost rate is 20%. What order quantity do you recommend?

Discount category	Order size	Discount (%)	Unit cost
1	0 to 99	0	\$10
2	100 or more	3	\$9.70

Ans: EOQ = 100 units and 143 units; TVC = \$5,282.84 and \$5,130.7; More than 100 units should be order since it has minimum total cost is \$5130.

13. 2069 Q. No. 7a

The demand of certain item per year is 100,000 units. The carrying cost per unit is Rs. 1.50 and ordering cost Rs. 100. Find the amount to be ordered at a time and also calculate reorder point. [5]

Ans: 3,652 units and 4,000 units (assuming L = 10 days)

14. 2069 (Old) Q. No. 6b

ABC Company requires 1000 units per month throughout the year at constant rate. If ordering cost are Rs. 250 per order, unit cost of the item is Rs. 25 and annual inventory cost are charged at 30%, determine the EOQ for the item. [5]

Ans: 894 units

15. 2068 Old Q.No. 6

Coca-cola Company has a soft drink product with constant annual demand rate of 3,000 cases. A case of soft drink costs the Co. Rs. 200. If ordering cost are Rs. 20 and inventory holding cost are charged at 25%; what is EOQ for this product? Also determine the cycle time (in days). [10]

Ans: 49 cases and 5 days (assuming 300 working days in a year)

16. 2065 Q.No. 6

Explain the ABC analysis as inventory management technique. An aircraft company uses rivets at an approximate rate of 2,500 kg per year. The rivets costs Rs. 30 per kg and the company personnel estimates that it costs Rs. 1.30 to place an order and the inventory carrying costs is 10% per year. How frequently should orders for rivets be placed and what quantities should be ordered? [10]

Ans: EOQ= 47 kg; Optimum number of order = 54 times; Time between order (cycle)= 6.67 days

17. 2064 Q.No. 9 b

Each year the 'Redstone Company' purchases 20,000 of an item that costs Rs. 16 per unit. The cost of placing an order is Rs. 12 and the cost to hold the item for one year is 24% of the unit cost. Determine the economic order quantity (EOQ) and the average inventory level, assuming that the minimum inventory level is zero. [10]

Ans: EOQ = 354 units and 177 units

18. 2062 Q.No. 6

A manufacturing organization experienced constant annual demand of 10,000 unit of an item which cost Rs. 40 per unit. If the order cost is Rs. 20 per order and the holding cost is 25% of the item costs determine the economic order quantity and the reorder level with no lead-time known. [10]

Ans: EOQ = 200 units, ROL = 40 L units

19. 2061 Q.No. 9 (b) (i)

A manufacturer has to supply his customer with 600 units of his product per year. Shortages are not allowed and the storage cost amounts to Rs. 0.6 per unit per year. The set up cost per run is Rs. 80. Find the optimum run size and the minimum average yearly cost. [5]

Ans: 400 units and Rs. 240

20. 2060 Q.No. 6

Nepal soft drink Co. has a soft drink product which has a constant annual demand rate of 3000 cases and cost Rs. 200/case. If ordering cost are Rs. 20 and inventory holding cost are charged at 25%, what is the EOQ for this product? Also determine the cycle time (in days). [10]

Ans: EOQ = 49 cases and 6 days

21. 2059 Q.No. 3

What are the main objectives of holding inventory in an organization? What are the major costs involved in holding inventory? The ABC requires 100 units per months though out the year at constant rate. If ordering cost are Rs. 250 per order, unit cost of the item is Rs. 25 and annual inventory holding cost are charged at 30%, their determine the EOQ for the item. [10]

Ans: 1095.45 units

2. DECISION THEORY**M B S****THEORETICAL QUESTIONS****1. 2062 Q.No. 9 (a)**

What do you understand by 'decision making' under risk? Explain how decisions are made under risk situations? [10]

NUMERICAL QUESTIONS**2. 2071 Q.No. 9**

Management of XYZ company, is considering use of newly discovered chemical which, when added to detergents, will make the washing set, thus eliminating the necessity of adding softness. The management is considering at present time, hence alternatives S_1 , S_2 , S_3 select the optimal strategy using expected value criteria and expected loss method. [10]

Strategies	Pay off matrix state of nature		
	N_1	N_2	N_3
S_1 : New improved detergents	15	12	18
S_2 : Super soft	9	14	10
S_3 : Extra wash	13	4	26

If the probabilities are $N_1 = 0.35$; $N_2 = 0.45$ and $N_3 = 0.20$.

Ans: Minimum EOL = Rs. 2.1. The best alternative is S_1 : New improved detergents

3. 2070 Q.No. 8

The newspaper boy has problem of keeping the stock for tomorrow's demand. The newspaper has no value at the end of the day. Each paper is purchased for Rs. 7 and is sold at Rs. 10. Past record of newspaper demand is as follows:

No. of newspaper demanded	15	16	17	18	19	20	Total
No. of days	5	8	12	30	25	20	100

Obtain the optimal decision of the stock of newspaper the boy has to maintain to maximize the expected profit. Also compute expected value for perfect information. [10]

Ans: 18 copies, Rs. 4.96

4. 2070 Old Q.No. 9b

Daily demanded units	1000	1100	1200	1300	1400
Probabilities	0.05	0.15	0.35	0.30	0.15

If selling price per unit is Rs.40 and cost per unit is Rs.30 and salvage price per unit is Rs.8, what is

- optimum quantity that maximizes the profit
- maximum expected profit under condition of risk
- expected profit under condition of certainty?

[10]

Ans: (i) 1,200 (ii) Rs. 11,200 (iii) Rs. 850

5. 2069 Q. No. 8

A shop buys fruit cake from a baker for Rs. 8 each and sales for Rs. 12. All the cakes not sold on the same day goes back to the baker and the shop receives only 45% of the money what he paid for. Following data reveals sale history of the shop for past 120 days.

No. of cake sold	50	51	52	53	54	55
No. of days	10	20	30	35	15	10

Calculate the expected value of the perfect information and cost of uncertainty. [10]

Ans: Rs.4.612

6. 2069 (Old) Q. No. 9b

A newspaper vendor has the following probabilities of selling magazines.

No. of magazines demanded	1000	1100	1200	1300	1400
Probabilities	0.10	0.15	0.30	0.25	0.20

If the cost price of one magazine is Rs. 100 and selling price is Rs. 175. The unsold magazine can be sold later with a salvage value of Rs. 25. Use expected opportunity loss criterion (EOC) to find the number of copies of magazines the vendor has to order.

Ans: 1200 copies

7. 2068 Old Q.No. 9a

Find the expected profit and expected value for perfect information from the following: [10]
You are given

Selling price per unit	=	Rs. 400
Cost price per unit	=	Rs. 250
Salvage price per unit	=	Rs. 50

Units demanded	100	120	140	160	180
Probability	0.15	0.20	0.35	0.20	0.10

Ans: Rs. 17,500 and Rs. 3200

8. 2067 Q.No. 8a

The following is the pay off matrix i.e. conditional profit table: [5]

Strategies	States of nature			
	N ₁ (50)	N ₂ (55)	N ₃ (60)	N ₄ (65)
S ₁ (50)	3,500	3,500	3,500	3,500
S ₂ (55)	3,200	3,850	3,850	3,850
S ₃ (60)	2,900	3,550	4,200	4,200
S ₄ (65)	2,600	3,250	3,900	4,550

If the probabilities assigned are N₁ = 0.1, N₂ = 0.2, N₃ = 0.4, N₄ = 0.3. Find expected loss table and give decision based on minimizing expected loss method.

Ans: Min EOL = Rs. 225; Best strategy = S₃

9. 2067 Q.No. 9b (Old)

Find the optimum quantity by using opportunity loss method. What is the amount of expected opportunity loss?

Quantities bought:	50	55	60	65	70	75
Probability:	0.05	0.10	0.20	0.30	0.20	0.15
Cumulative probability	1.00	0.95	0.85	0.65	0.35	0.15

You are given

- (i) Selling price/ quantity = Rs. 50.
 (ii) Cost price/ quantity = Rs. 30.
 (iii) Salvage price/ quantity = Rs. 5.

Ans: Min. EOL = Rs. 118.75; Optimal stock = 65 units

10. 2066 Q.No. 7 a

A dairy farm wants to determine the quantity of butter it should produce to meet the demand. Past records have shown the following demand practice. The cost of butter is Rs. 40 per kg and is sold at Rs. 50/ kg. Determine the best alternative so as to maximize the profit. Also determine EVPI. [10]

Quantity required (kg)	15	20	25	30	35	40	50
No. of days demand occurred	6	14	20	80	40	30	10

Ans: Best alternative: 30 or 35 and EVPI = 101

11. 2065 Q.No. 8 a

A milkman buys milk at Rs. 20 per litre and sells at Rs. 25 per litre. Unsold milk has to be thrown away. The daily demand has the following probability distribution:

Demand (litres)	46	48	50	52	54	56	58	60	62	64
Probability	0.01	0.03	0.06	0.10	0.20	0.25	0.15	0.10	0.05	0.05

If each day's demand is independent of previous day's demand, how many litres should be ordered everyday so as to maximize the profit? [10]

Ans: 54 litres

12. 2063 Q.No. 9 (a)

A vendor buys magazine at the rate of Rs. 15 and sells them at the rate of Rs. 25. The unsold magazines can be sold at the rate of Rs. 5 per copy. The number of copies demanded and their corresponding probabilities are given below:

No. of copies demanded	Probabilities
400	0.08
410	0.16
420	0.25
430	0.27
440	0.13
450	0.11

Using EMV and EOL criteria, how many copies should the vendor buy in order to maximize the profit and minimize the loss? Also compute expected value for perfect information. [10]

Ans: (i) 430 copies both EMV and EOL criterion (ii) Rs. 116

13. 2061 Q.No. 9 (a)

The Captain Table is a mail-order distributor of Cobsters. The company buys these for Rs. 40 per kg and sells them for Rs. 75 per kg. The per week shipment distribution is as follows:

Shipment per week kg	Probability of occurrence
300	0.05
500	0.20
800	0.20
1200	0.40
1800	0.15
	1.00

The company has been approached by a consulting firm specialization in sales forecasting and offers a sales forecasting model, which will cost Rs. 9,000 a week. What advice will you give to the co. regarding the purchase and not purchasing the model? [10]

Ans: Rs. 35,875; Rs. 13,750

14. 2060 Q.No. 9 (a)

A retailer has to decide as to the optimum number of units to be stocked of a certain item under following conditions.

- a. cost price in season is Rs. 15. c. cost of holding the item beyond the season is Rs. 2.
b. bargain price after season is Rs. 9. d. selling price in season is Rs. 20.

Units Demanded	Probability
12	0.20
13	0.20
14	0.25
15	0.20
16	0.15

Determine the optimum stock and expected value for perfect information.

[10]

Ans: Rs. 7.1 and 13 units

15. 2059 Q.No. 9 (a)

A newspaper boy estimates the probability of the demand for a new magazine as follows:

Demand	1	2	3	4
Probability	0.40	0.30	0.20	0.10

A copy of the magazine sells for Rs. 5 that cost Rs. 4

- (a) Find the optimal number of the newspaper that would maximize the profit
(b) Find the expected profit with perfect information
(c) Find the expected value of perfect information.

[10]

Ans: (a) 1 unit (b) Rs. 2 (c) Rs. 1

16. 2058 Q.No. 9 (b)

Daily sales (units)	1000	1200	1400	1600	1800
Probability	0.05	0.15	0.35	0.30	0.15

If selling price per unit Rs. 40 and cost price per unit is Rs. 25 and salvage price is Rs. 5, what is (a) Optimum quantity (b) Maximum expected profit (c) Expected value for perfect information?

[10]

Ans: (a) 1400 units (b) Rs. 19250 (c) Rs. 2800

MBA**17. 2055 Q.No. 7**

- a. Yoghurt Hut Ltd. sells natural Yoghurt in a college community. Mrs. Yoghurt, the manager is filling out of the order for next week supply of Yoghurt. She is uncertain what sales will be. Mrs. Yoghurt has the table below as a historical representation of profits given certain sales and buying level combination.

Weekly sales	Actions		
	Buy 200	Buy 300	Buy 400
200	Rs. 50	Rs. 25	Rs. 0
300	50	75	50
400	50	75	100

Using the maximum decision criterion what advice can you give Mrs. Yoghurt about quantity of Yoghurt to buy for next week.

- b. A newsstand operator assigns the probabilities to the demand for the five magazine as follow:

Event: (Daily demand copy)	10	11	12	13	14
Probability of the event	0.10	0.15	0.20	0.25	0.30

An issue sale for Rs. 50 and cost Rs. 30. If the operator cannot return unsold copies, how many copies should be ordered?

Ans: (a) Since the maximum expected monetary value is Rs. 57.75, Yoghurt Hut Ltd. should buy 300 Yoghurt for next week (b) Expected monetary value = Rs. 222.50 and 12 copies

18. 2052 Q.No. 6 (b)

The Fresh Food Store stock mangoes during the early summer season. These are flown from Calcutta each Monday and must be sold within the week following. In the past, the store has experienced the following sales of mangoes.

Quantities buyer's bought (units)	No. of weeks this occurred	P (occurrence)	Cumulative probability
20	10	0.10	1.00
25	30	0.30	0.90
40	50	0.50	0.60
60	10	0.10	0.10

The Food Store buys mangoes for Rs. 2 each and sells them for Rs. 4.

- What quantities should be bought every week to maximize expect profits?
- What is the expected value of perfect information?

[10]

Ans: (I) 40 units (II) Rs. 44

19. 2051 Q.No. 6 (a)

A distribution of the past sales of a commodity is given below.

Quantities buyer's bought (units)	No. of days occurred	(Prob. of occurrence)	Cumulative probability
20	10	0.10	1.00
25	30	0.30	0.90
40	50	0.50	0.60
60	10	0.10	0.10

Distributor buys these for Rs. 6 and sells them for Rs. 10.

- What quantities should be bought to maximize profits?
- What is the expected value for perfect information?

[10]

Ans: (I) 25 and 40 units (II) Rs. 47

20. 2050 Q.No. 6 (b)

A veterinarian purchases rabies immunization vaccine on Monday of each week. Because of the characteristics of this vaccine, it must be used by Friday or disposed of. The vaccine costs Rs. 9 per dose and the veterinarian charges Rs. 16 per dose. In the past, the veterinarian has administered rabies vaccine in the following quantities:

Quantities used per week	No. of week this occurred	Probabilities of occurrence	Cumulative probability
2,500	15	0.30	1.00
4,000	20	0.40	0.70
5,000	10	0.20	0.30
7,500	5	0.10	0.10

Using marginal analysis, determine how many doses the veterinarian should order each week. If the veterinarian is offered a forecasting model costing Rs. 5,000 should be purchased this model or not?

[10]

Ans: The cost of forecasting model is only Rs. 5,000, which is less than EVPI. Hence, the veterinarian is suggested to buy the forecasting model.

21. 2048 Q.No. 6 (b)

The Captain Table is a mail-order distributor of Fresh Cobsters. The company buys these for Rs. 4 per pound and sells them for Rs. 7.50 per pound. The per week shipment distribution is as follows:

Shipment per week pound	No. of weeks this occurred	Probability of occurrence	Cumulative probability
3,000	5	0.05	1.00
5,000	20	0.20	0.95
8,000	20	0.20	0.75
12,000	40	0.40	0.55
18,000	15	0.15	0.15

The company has been approached by a consulting firm specialization in sales forecasting. The firm has offered to provide the Company's table with a sales forecasting model, which will increase the distributor's present profit by matching purchases with sales. The cost of buying and running this model will be Rs. 7,500 a week. Should the company buy it?

[10]

Ans: Cost of uncertainty = Rs. 13,750. The company should buy it.

22. 2042 Q.No. 6 (b)

A beer distributor buys kegs for Rs. 8 each and sells them for Rs. 12 each. All the kegs left at the end of the day are worthless. Following is the distribution of sales during 100 days observations.

Kegs sold	20	21	22	23	24	Total
No. of days	5	20	30	35	10	100

- (i) Find the optimal quantity that can maximize the expected profit.
 (ii) Find the expected value of perfect information.
 (iii) What is the cost of uncertainty?

[10]

Ans: (i) Rs. 22 units of kegs and maximum expected profit Rs. 84.4 (ii) Rs. 4.60 (iii) Rs. 4.60

23. 2040 Q.No. 9 (b)

Here is a distribution of the past sales of a product for ABC enterprises.

Quantities buyer's bought (units)	No. of days occurred	(Prob. of occurrence)	Cumulative probability
20	10	0.10	1.00
25	30	0.30	0.90
40	50	0.50	0.60
60	10	0.10	0.10

ABC enterprise buys these for Rs. 6 and sells them for Rs. 10.

- i. What quantities should be bought to maximize expected profits?
 ii. What is the expected value for perfect information?

[10]

Ans: (i) 25 and 40 units (ii) Rs. 47

3. LINEAR PROGRAMMING**MBS****NUMERICAL QUESTIONS****1. 2071 Q.No. 11**

The advertisement department of a certain firm wishes to plan its advertising strategy to reach certain minimum percentages of high and low income groups. Two alternatives are considered. Radio and Television. Radio advertising has an exposure for high income group of 2% per programme but only 1% exposure for low income group. Television on other hand expose 3% of low income group per show and only 1% of high income group per show. Radio advertising costs Rs.1,000 per programme and television Rs.4,000 per show. If firm wants a minimal exposure of 50% of high income group and 30% of low income group, what strategy should it use for minimizing advertising cost? Formulate the problem and solve it by using simple method.

[20]

Ans: Min. Z = Rs. 30,000 at advertisement on radio = 30 and on television = 0

2. 2070 Old Q.No. 7

Solve the following linear programming problem and interpret the result using simplex method.

Maximize profit $Z = Rs.4,000X + Rs.3,200Y$

Subject to the constraints

$$2X + Y \leq 30$$

$$2X + 5Y \leq 50$$

$$2X + 3Y \leq 38$$

Where $X, Y \geq 0$ non-negative conditions.

[20]

Ans: Max Z = Rs. 64,800; X = 13; Y = 14

3. 2069 (Old) Q. No. 7

A company combines factors P and Q to form a product which must weigh 500 kgs. At least 200 kgs of P and no more than 400 kgs of Q can be used. The cost of P is Rs. 250 per kg and of Q is Rs. 100 per kg. Formulate the problem in a mathematical form and use simplex method to find the amount of factor P and Q, which should be used to minimize the cost.

[20]

Ans: Min. Z = Rs. 80,000; P = 200 kg and Q = 300 kg

4. 2068 Q.No. 11

A company produces some tables and chairs. The profit contribution on each table is Rs 64 and on each chair Rs 80. Each table requires in its construction 20 units of special type of wood while each chair requires 40 units of same type of wood in its construction. The supplier can furnish the company with a maximum of 600 units of wood each day. Only 200 man hours of wood working are available to the company each day. Each table requires 20 hours and each chair requires 8 hours of wood working labour. The final step in the production process the finishing work is performed by highly skilled employees and a maximum of 114 man hours of finishing labour is available each day. Each table requires 9 man hours and each chair requires 6 man hours of finishing time. Formulate the problem and solve the given problem by using simplex method in order to maximize the profit contribution. [20]

Ans: Total max profit = Rs.1296; No. of chairs (x_2) = 13; No. of tables (x_1) = 4

5. 2068 Old Q.No. 7

A paper mill produces two grades of wall paper W_1 and W_2 . Because of raw materials restriction, W_1 and W_2 are produced in a limited quantity. At most 400 tons of grade W_1 and at most 300 tons of grade W_2 can be produced in a week. There are 1600 production hours in a week. It requires 2 and 4 hours to produce a ton of product W_1 and W_2 respectively. The profit per ton of W_1 and W_2 are Rs. 2,000 and Rs. 5,000 respectively. Formulate the problem and use simplex method to maximize the profit? [20]

Ans: Max $Z = 1900000$; $x_1 = 200$; $x_2 = 300$

6. 2067 Q.No. 7 (Old)

Solve the following minimization problem by using simplex method.

Minimize the cost = Rs. $200x_1 + Rs. 800x_2$

Subject to the limitations

$25x_1 + 50x_2 = 750$; $x_1 \leq 100$; $x_2 \geq 70$ Where $x_1 \geq 0$ and $x_2 \leq 0$.

Ans: Unbounded

7. 2066 Q.No. 9

Obtain the optimum solution using simplex technique

Maximize $Z = 2x_1 + 4x_2 + 3x_3$

Subject to the constraints,

$3x_1 + 4x_2 + 2x_3 \leq 60$

$2x_1 + x_2 + 2x_3 \leq 40$

$x_1 + 3x_2 + 2x_3 \leq 80$

All variables ≥ 0 .

Ans: $x_1 = 0$; $x_2 = 20/3$; $x_3 = 50/3$; $S_1 = 80/3$; Max $Z = 230/3$

8. 2065 Q.No. 7

Solve the following problem using simplex method.

Maximize: $Z = 3x_1 + 2x_2 + 5x_3$

Subject to the constraints, $x_1 + x_2 + x_3 \leq 9$

$2x_1 + 3x_2 + 5x_3 \leq 30$

$2x_1 - x_2 - x_3 \leq 8$ and $x_1, x_2, x_3 \geq 0$

Ans: Max. $Z = 35$ for $x_1 = 5, x_2 = 0, x_3 = 4$

9. 2064 Q.No. 7

A firm produces three products that are presented on three different machines. The time required to manufacture one unit of each of the three products and daily capacity of the machines are given in the table below:

Machine	Product (time/unit in minutes)			Machine capacity (m/c per day)
	P ₁	P ₂	P ₃	
M ₁	2	3	2	440
M ₂	4	-	3	470
M ₃	2	5	-	430

Determine the daily number of units to be manufactured of each product. The profit per unit for product P_1, P_2, P_3 is Rs. 4, Rs. 3 and Rs. 6 respectively. It is assumed that all the products are consumed in the market.

[20]

Ans: Max $Z = 3200/3; x_1 = 0; x_2 = 380/9; x_3 = 470/3$ **10. 2063 Q.No. 7**Maximize the profit = Rs. $600X_1 + Rs. 500X_2$ Subject to: $15X_1 + 20X_2 \leq 600$ $10X_1 + 5X_2 \leq 200$ $X_1 \geq 10$ $5X_1 + 5X_2 = 150$ where $X_1, X_2 \geq 0$

[20]

Ans: $X_1 = 10, X_2 = 20$ max (z) = Rs. 16,000**11. 2060 Q.No. 7**

A furniture company produces two types of products chair and table. The profit contribution on each chair is Rs. 400 and on each table is Rs. 320. The company can sell all the chairs or all the tables or any combination of tables and chairs that it can produce. Unfortunately the production capacities are severely restricted in several respects. First, a special wood, which is used as primary raw material in producing both chairs and tables, is available only in very limited quantities. The labour of highly skilled nature is required in wood working process and also in finishing process. Both types of labour are in scarce supply, so the company can produce only limited quantities of chairs and tables. Each chair requires in its construction 20 units of special wood, while each table require 10 units and maximum quantity of special wood, available is 300 units. Only 100 man hours of wood working is available. Each chair requires 4 hours of wood working labor and 10 hours of wood working labour is required to produce one table. The final step in the production process, the finishing work is also performed by highly skilled labour, and a maximum of 38 man-hours of this finishing labour is available. Each chair required two man-hours and each table three man-hours of finishing time. Formulate a linear programming model and determine how much of each product should be manufactured to maximize total profit contribution by using simplex method.

[20]

Ans: $X_1 = 13$ units; $X_2 = 4$ units; max (z) = Rs. 6,480**12. 2059 Q.No. 7**

Define 'degeneracy' in linear programming model and find the optimal solution for the following problem by using simplex.

[20]

Maximize the profit = Rs. $200A + Rs. 600B + Rs. 80C$

Subject to

 $16A + 4B + 6C \leq 500$ $4A + 3B + 0C \leq 150$ $2A + 0B + C \leq 50$ A, B, C ≥ 0

Ans: A = 0; B = 50; C = 50, max. profit = Rs. 34,000

MBA**13. 2056 Q.No. 4**

A furniture company produces table, chair and book-cases and all of the produces have to go through assembly, finishing and packing departments. The management has formulated the maximization problem as follows:

Max. $Z = 2T + 4C + 3B$ Subject to: $3T + 4C + 2B \leq 60$ (assembly constraints) $2T + 4C + 2B \leq 40$ (Finished constraints) $1T = 3C + 2B \leq 80$ (packing constraints)All variable ≥ 0

Solve above linear programming problem.

[20]

Ans: Table = 0; Chair = 20/3; Bookcase = Rs. 50/3; Max (z) = Rs. 230/3

14. 2055 Q.No. 6

Use the simplex method to find the value of x_1 and x_2 which maximizes the function:

 $P = -2x_1 - 8x_2$ for the following: $5x_1 + 10x_2 = 150$ $0 \leq x_1 \leq 20$ $x_2 \geq 14$

[20]

Ans: $X_1 = 2$ units, $X_2 = 14$ units, max (z) = Rs. -116

15. 2054 Q.No. 6

An investor wants to allocate his portfolio among five different types of securities. The expected returns, denoted by $E(R)$ and standard deviations of expected return, denoted by σ (s.d.) of five different types of securities are as given below:

Risk return characteristics			
Types of securities	Proportion	$E(R)$	σ
Speculative stock	X_1	14%	10%
Mutual fund	X_2	10%	5%
Preference stock	X_3	8%	4%
Long term bond	X_4	7%	2%
Bank savings account	X_5	5%	0%

The investor's objective is to maximize his expected return, although the realization of this objective must be conditioned by the existence of several constraints which are as follows:

- He cannot allocate more than 100% of his total portfolio.
- He is also unwilling to hold a portfolio with a combined standard deviation in excess of 6%.
- The proportion invested in speculative stock must be limited to 0.4.
- He cannot invest negative amounts in any types of security.

Solve the problem by simplex method.

[20]

Ans: $X_1 = 0.2$; $X_2 = 1.2$; $X_3 = 0$; $X_4 = 0$; $X_5 = 98$, Maximum expected return = 506.

16. 2052 Q.No. 5

A publisher sells a deluxe hardcover and paperback edition of the same textbook for Rs. 15, Rs. 9 and Rs. 5 respectively. Costs to the publisher are Rs. 12, Rs. 7 and Rs. 3.60 per book respectively.

Deluxe requires 8 minutes of printing time while other two require 5 minutes each only. Deluxe cover requires 12 minutes of binding time but hardcover and paperback requires 10 and 2 minutes respectively. Both the printing and binding operations have 4800 minutes available each week. How many of each type of books should be produced in order to maximize profit? [20]

Ans: $X_1 = 3600/11$ units; $X_2 = 0$; $X_3 = 4800/11$ units, Max (z) = Rs. 17520/11

17. 2051 Q.No. 5

A company makes three products, A, B and C, each of which is produced from three main elements, E_1 , E_2 and E_3 . The products are packed in 100 kgs. The contribution for a bag of A is Rs. 30, for a bag of B Rs. 50 and for a bag C Rs. 40. Each product utilizes the number of pound of each elements shown.

Product	Element		
	E_1	E_2	E_3
A	2	0	3
B	3	2	2
C	0	5	4

There are following limits on the amounts of the elements available.

E_1 - 800 kgs.; E_2 - 1,000 kgs.; E_3 - 1,500 kgs.

How will you determine how much of each product should be produced to maximize contribution? [20]

Ans: A = 8900/41; B = 5000/41; C = 6200/41, max (Z) = Rs. 765,000/41

18. 2050 Q.No. 5

Bentwood Manufacturing Company produces a bent wood rocking chair and a bentwood coffee table, each of superior styling and quality. The profit contribution on each chair is Rs. 40 and on each table is Rs. 32. The company can sell at the prevailing prices either all the chairs or all the tables, or any combination of chairs and tables that it can produce.

Unfortunately, the production capabilities of the Bentwood plant are severely restricted in several respects. First, a special rosewood which is used as the primary raw material in both the chairs and the tables is available only in very limited quantities. Then, labour of highly skilled nature is required in the wood working process and also in the finishing process. Both types of labour are in scarce supply. Burdened by these constraints, the company can