JEPPIAAR ENGINEERING COLLEGE

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

QUESTION BANK

CS6704

RESOURCE MANAGEMENT TECHNIQUES

IV YEAR – VII SEM

2014 -2018 BATCH

Vision of Institution

To build Jeppiaar Engineering College as an Institution of Academic Excellence in Technical education and Management education and to become a World Class University.

Mission of Institution

M1	To excel in teaching and **learning, research and innovation** by promoting the principles of scientific analysis and creative thinking
M2	To participate in the production, **development and dissemination of knowledge** and interact with **national and international communities**
M3	To equip students with **values, ethics and life skills** needed to enrich their lives and enable them to meaningfully contribute to the **progress of society**
M4	To prepare students **for higher studies and lifelong learning**, enrich them with the **practical and entrepreneurial skills** necessary to excel as future professionals and contribute to **Nation's economy**

Program Outcomes (POs)

PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Vision of Department

To emerge as a globally prominent department, developing ethical computer professionals, innovators and entrepreneurs with academic excellence through quality education and research.

Mission of Department

M1	To create **computer professionals** with an ability to identify and **formulate the engineering problems** and also to provide **innovative solutions** through **effective teaching learning process.**
M2	To **strengthen the core-competence** in computer science and engineering and to create an ability to **interact** effectively with industries.
M3	To produce engineers with good professional skills, **ethical values** and life skills for the **betterment of the society.**
M4	To encourage students towards **continuous and higher level learning** on technological advancements and provide a platform for **employment and self-employment.**

Program Educational Objectives (PEOs)

PEO1	**To address the real time complex engineering problems using innovative approach with strong core computing skills.**
PEO2	**To apply core-analytical knowledge and appropriate techniques and provide solutions to real time challenges of national and global society**
PEO3	**Apply ethical knowledge for professional excellence and leadership for the betterment of the society.**
PEO4	**Develop life-long learning skills needed for better employment and entrepreneurship**

Program Specific Outcomes (PSOs)

Students will be able to

PSO1	An ability to understand the core concepts of computer science and engineering and to enrich problem solving skills to analyze, design and implement software and hardware based systems of varying complexity.
PSO2	To interpret real-time problems with analytical skills and to arrive at cost effective and optimal solution using advanced tools and techniques.
PSO3	An understanding of social awareness and professional ethics with practical proficiency in the broad area of programming concepts by lifelong learning to inculcate employment and entrepreneurship skills.

BLOOM TAXANOMY LEVELS(BTL)

BTL1: Remembering
BTL 2: Understanding.,
BTL 3: Applying.,
BTL 4: Analyzing.,
BTL 5: Evaluating.,
BTL 6: Creating.,

SYLLABUS

UNIT I LINEAR PROGRAMMING 9

Principal components of decision problem – Modeling phases – LP Formulation and graphic solution –Resource allocation problems – Simplex method – Sensitivity analysis.

UNIT II DUALITY AND NETWORKS 9

Definition of dual problem – Primal – Dual relation ships – Dual simplex methods – Post optimality analysis – Transportation and assignment model - Shortest route problem.

UNIT III INTEGER PROGRAMMING 9

Cutting plan algorithm – Branch and bound methods, Multistage (Dynamic) programming.

UNIT IV CLASSICAL OPTIMISATION THEORY: 9

Unconstrained external problems, Newton – Ralphson method – Equality constraints – Jacobean methods – Lagrangian method – Kuhn – Tucker conditions – Simple problems.

UNIT V OBJECT SCHEDULING: 9

Network diagram representation – Critical path method – Time charts and resource leveling – PERT.

TEXT BOOK:

1. H.A. Taha, “Operation Research”, Prentice Hall of India, 2002.

REFERENCES:

1. Paneer Selvam, ‘Operations Research’, Prentice Hall of India, 2002
2. Anderson ‘Quantitative Methods for Business’, 8th Edition, Thomson Learning, 2002.
3. Winston ‘Operation Research’, Thomson Learning, 2003.
4. Vohra, ‘Quantitative Techniques in Management’, Tata Mc Graw Hill, 2002.
5. Anand Sarma, ‘Operation Research’, Himalaya Publishing House, 2003.

RMT

C404.1	**Solve** optimization problems using simplex method
C404.2	**solve** the optimization problems using Transportation and Assignment model
C404.3	**Apply** integer programming to solve real-life applications
C404.4	**Evaluate** nonlinear programming problems using various methods.
C404.5	**Construct** Network and **Analyze** it using PERT and CPM in real time problem.

Sno	UNIT	REF.BOOK	**PAGE.NO**
1	**UNIT1**	1. H.A. Taha, "Operation Research", Prentice Hall of India, 2002.	**1-9**
2	**UNIT2**	1. H.A. Taha, "Operation Research", Prentice Hall of India, 2002.	**9-19**
3	**UNIT3**	1. H.A. Taha, "Operation Research", Prentice Hall of India, 2002.	**19-27**
4	**UNIT4**	1. H.A. Taha, "Operation Research", Prentice Hall of India, 2002.	**27-35**
5	**UNIT5**	1. H.A. Taha, "Operation Research", Prentice Hall of India, 2002.	**35-45**

UNIT I -LINEAR PROGRAMMING **9**

Principal components of decision problem – Modeling phases – LP Formulation and graphic solution –Resource allocation problems – Simplex method – Sensitivity analysis.

Q. No.	Questions	CO	Bloom's Level
1.	**What is linear programming?** Linear programming is a technique used for determining optimum utilization of limited resources to meet out the given objectives. The objective is to maximize the profit or minimize the resources (men, machine, materials and money)	C404.1	BTL1
2.	**Write the general mathematical formulation of LPP.** 1. Objective function Max or Min $Z = C_1x_1 + C_2x_2 + \ldots.. + C_nx_n$ 2. Subject to the constraints $a_{11}x_1+a_{12}x_2+\ldots\ldots\ldots\ldots + a_{1n}x_n\ (\leq=\geq)b_1$ $a_{21}x_1+a_{22}x_2+\ldots\ldots\ldots\ldots + a_{2n}x_n\ (\leq=\geq)b_2$ …………………………………………………….. …………………………………………………….. $a_{m1}x_1+a_{m2}x_2+\ldots\ldots\ldots\ldots + a_{mn}x_n\ (\leq=\geq)b_m$ 3. Non-negative constraints $x_1,x_2,\ldots.x_m \geq 0$	C404.1	BTL1
3.	**What are the characteristic of LPP?** • There must be a well defined objective function. • There must be alternative course of action to choose. Both the objective functions and the constraints must be linear equation or inequalities	C404.1	BTL1

4.	**What are the characteristic of standard form of LPP?** • The objective function is of maximization type. • All the constraint equation must be of equal type by adding slack or surplus variables • RHS of the constraint equation must be positive type • All the decision variables are of positive type	C404.1	BTL1
5	**What are the characteristics of canonical form of LPP? (NOV '07)** In canonical form, if the objective function is of maximization type, then all constraints are of $\leq$ type. Similarly if the objective function is of minimization type, then all constraints are of $\geq$ type. But non-negative constraints are $\geq$type for both cases.	C404.1	BTL1
6	**6. A firm manufactures two types of products A and B and sells them at profit of Rs 2 on type A and Rs 3 on type B. Each product is processed on two machines M1 and M2.Type A requires 1 minute of processing time on M1 and 2 minutes on M2 Type B requires 1 minute of processing time on M1 and 1 minute on M2. Machine M1 is available for not more than 6 hours 40 minutes while machine M2 is available for 10 hours during any working day. Formulate the problem as a LPP so as to maximize the profit. (MAY '07)** Maximize $z = 2x_1 + 3x_2$ Subject tot the constraints: $x_1 + x_2 \leq 400$ $2x_1 + x_2 \leq 600$ $x_1, x_2 \geq 0$	C404.1	BTL6
7	**A company sells two different products A and B , making a profit of Rs.40 and Rs. 30 per unit on them,respectively.They are produced in a common production process and are sold in two different markets, the production process has a total capacity of 30,000 man-hours. It takes three hours to produce a unit of A and one hour to produce a unit of B. The market has been surveyed and company official feel that the maximum number of units of A that can be sold is 8,000 units and that of B is 12,000 units. Subject to these limitations, products can be sold in any combination. Formulate the problem as a LPP so as to maximize the profit** Maximize $z = 40x_1 + 30x_2$ Subject tot the constraints: $3x_1 + x_2 \leq 30,000$ $x_1 \leq 8000$ $x_2 \leq 12000$ $x_1, x_2 \geq 0$	C404.1	BTL6

8	**What is feasibility region? (MAY '08)** Collections of all feasible solutions are called a feasible set or region of an optimization model. Or A region in which all the constraints are satisfied is called feasible region**.**	C404.1	BTL1
9	**What is feasibility region in an LP problem? Is ti necessary that it should always be a convex set?** A region in which all the constraints are satisfied is called feasible region. The feasible region of an LPP is always convex set**.**	C404.1	BTL1
10	**Define feasible solution? (MAY '07,NOV/DEC 2016,NOV/DEC 2017)** Any solution to a LPP which satisfies the non negativity restrictions of LPP's called the feasible solution	C404.1	BTL1
11	**Define optimal solution of LPP. (MAY '09)** Any feasible solution which optimizes the objective function of the LPP's called the optimal solution	C404.1	BTL1
12	**State the applications of linear programming** • Work scheduling • Production planning & production process • Capital budgeting • Financial planning • Blending • Farm planning • Distribution • Multi-period decision problem Inventory model Financial model	C404.1	BTL1
13	**State the Limitations of LP. (APR/MAY 2018)** • LP treats all functional relations as linear • LP does not take into account the effect of time and uncertainty • No guarantee for integer solution. Rounding off may not feasible or optimal solution. • Deals with single objective, while in real life the situation may be difficult.	C404.1	BTL1

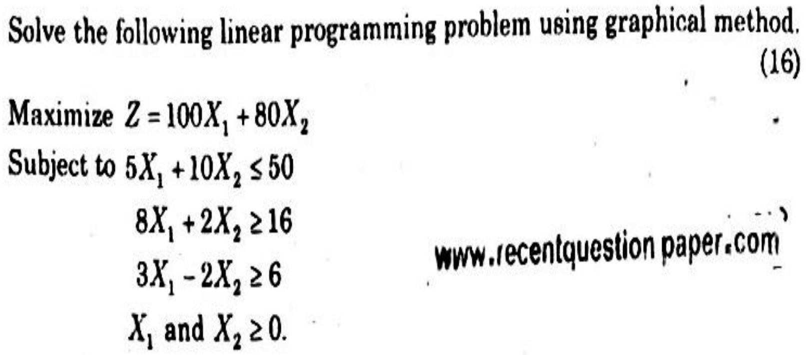
14	**What do you understand by redundant constraints?** In a given LPP any constraint does not affect the feasible region or solution space then the constraint is said to be a redundant constraint**.**	C404.1	BTL1
15	**Define Unbounded solution?** If the feasible solution region does not have a bounded area the maximum value of Z occurs at infinity. Hence the LPP is said to have unbounded solution	C404.1	BTL1
16	**Define Multiple Optimal solution?** A LPP having more than one optimal solution is said to have alternative or multiple optimal solutions.	C404.1	BTL1
17	**What is slack variable? (APR/MAY 2017)** If the constraint as general LPP be <= type then a non negative variable is introduced to convert the inequalities into equalities are called slack variables. The values of these variables are interpreted as the amount of unused resources.	C404.1	BTL1
18	**What are surplus variables?** If the constraint as general LPP be >= type then a non negative is introduced to convert the inequalities into equalities are called the surplus variables	C404.1	BTL1

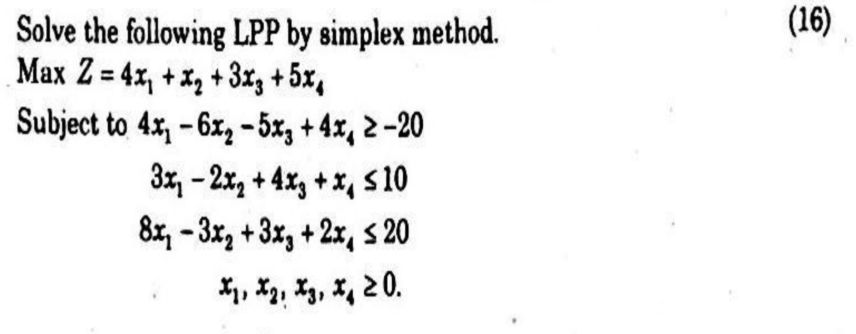
19	**Define Basic solution?** Given a system of m linear equations with n variables(m<n).The solution obtained by setting (n-m) variables equal to zero and solving for the remaining m variables is called a basic solution.	C404.1	BTL1
20	What do you mean by shadow pricing?(**NOV/DEC 2016)** **Shadow price** or **dual price** is a *quantitative technique* to analyze the**improvement in the contribution or costs by having one additional unit of a resource which is causing a bottleneck**. The maximum price that a business should be willing to pay for one additional unit of some type of resource	C404.1	BTL1
21	**Define unrestricted variable and artificial variable. (NOV '07)** - Unrestricted Variable :A variable is unrestricted if it is allowed to take on positive, negative or zero values - Artificial variable :One type of variable introduced in a linear program model in order to find an initial basic feasible solution; an artificial variable is used for equality constraints and for greater-than or equal inequality constraints	C404.1	BTL1
22	**Define basic variable and non-basic variable in linear programming.** A basic solution to the set of constraints is a solution obtained by setting any n variables equal to zero and solving for remaining m variables not equal to zero. Such m variables are called basic variables and remaining n zero variables are called non-basic variables.	C404.1	BTL1
23	**What do you understand by degeneracy?** The concept of obtaining a degenerate basic feasible solution in LPP is known as degeneracy. This may occur in the initial stage when atleast one basic variable is zero in the initial basic feasible solution**.**	C404.1	BTL1
24	**How do you identify that LPP has no solution in a two phase method?** If all $Zj – Cj \leq 0$ & then atleast one artificial variable appears in the optimum basis at non zero level the LPP does not possess any solution.	C404.1	BTL1

25	**From the optimum simplex table how do you identify that the LPP has no solution?** If atleast one artificial variable appears in the basis at zero level with a +ve value in the Xb column and the optimality condition is satisfied then the original problem has no feasible solution.	C404.1	BTL1
26	**What is the function of minimum ratio?** • To determine the basic variable to leave • To determine the maximum increase in basic variable • To maintain the feasibility of following solution	C404.1	BTL1
27	**Define degenerate basic solution?** A basic solution is said to be a degenerate basic solution if one or more of the basic variables are zero.	C404.1	BTL1
28	**Define non Degenerate Basic feasible solution?** The basic solution is said to be a non degenerate basic solution if None of the basic variables is zero.	C404.1	BTL1
29	**Solve the following LP problem by graphical method. (MAY '08)** Maximize z =6x_1 +4x_2 Subject tot the constraints: $x_1 + x_2 \leq 5$ $x_2 \geq 8$ $x_1 , x_2 \geq 0$	C404.1	BTL3
30	**Define the standard form of LPP in the matrix notation?** In matrix notation the canonical form of LPP can be expressed as Maximize Z = CX(obj fn.) Sub to AX <= b(constraints) and X >= 0 (non negative restrictions) Where C = (C1,C2,…..Cn), A = a11 a12 ….. a1n X = x1 b = b1 a21 a22….. a2n , x2 , b2 . . .	C404.1	BTL1

	. . . am1 am2…. amn xn bn		
31	What is sensitivity analysis? **(APR/MAY 2017, NOV/DEC 2017)** Sensitivity Analysis deals with finding out the amount by which we can change the input data for the output of our linear programming model to remain comparatively unchanged. This helps us in determining the sensitivity of the data we supply for the problem.	C404.1	BTL1
32	List any four application areas of Operation Research. **APR/MAY 2018** • Agriculture & Forestry. • Airline Crew Scheduling. • Bioinformatics. • Cutting & Packing Problems in the Production Industry. • Education.	C404.1	BTL1

PART – B

1	**.(NOV/DEC 2016)**  Solve the following linear programming problem using graphical method. (16) Maximize $Z = 100X_1 + 80X_2$ Subject to $5X_1 + 10X_2 \leq 50$ $8X_1 + 2X_2 \geq 16$ $3X_1 - 2X_2 \geq 6$ X_1 and $X_2 \geq 0$. **Refer Notes**	C404.1	BTL6
2	**NOV/DEC 2016)**	C404.1	BTL6

	 Solve the following LPP by simplex method. (16) Max $Z = 4x_1 + x_2 + 3x_3 + 5x_4$ Subject to $4x_1 - 6x_2 - 5x_3 + 4x_4 \geq -20$ $3x_1 - 2x_2 + 4x_3 + x_4 \leq 10$ $8x_1 - 3x_2 + 3x_3 + 2x_4 \leq 20$ $x_1, x_2, x_3, x_4 \geq 0.$ **Refer Notes**		
3	Use graphical method to solve the following LPP. Minimize Z = 3X1 + 2X2 Subject to the constraints -2X1 + X2≤ 1 X1 ≤2 2X1 + X2≤3 And X1, X2 ≥ 0. **Refer Notes**	C404.1	BTL6
4	Use simplex method to solve the following LPP. Maximize Z = 300X1 + 200X2 Subject to the constraints 5X1 + 2X2 ≤ 180 3X1 + 3X2 ≤135 X1, X2 ≥ 0 **Refer Notes**	C404.1	BTL6
5	Use simplex method to solve the following LPP. Maximize Z = 3X1 +2 X2 +5X3 Subject to the constraints X1 +2 X2 +X3 ≤ 43 3X1+ 2X3 ≤ 46 X1 + 4X2 ≤42 X1, X2, X3 ≥ 0. **Refer Notes**	C404.1	BTL6
6	Solve the following LPP by Big-M method Minimize Z = 4X1 + 2X2 Subject to the constraints 3X1 + X2 ≥ 27 X1 + X2 ≥ 21 X1 + 2X2 ≥ 30 X1, X2 ≥ 0. **Refer Notes**	C404.1	BTL6

7	**Use Simplex method to solve the LPP.** **Maximize $Z = 4X1 + X2 + 3X3+5X4$** **Subject to the constraints** $4X1 - 6X2 - 5X3+4X4 \geq -20$ $3X1 - 2X2 + 4X3+X4 \leq 10$ $8X1 - 3X2 + 3X3+2X4 \leq 20$ **And $X1, X2, X3, X4 \geq 0$.** **Refer Notes**	C404.1	BTL6
8	**Solve by graphically** **Maximize $Z = 100X1 + 80X2$** **Subject to the constraints** $5X1 + 10X2 \leq 50$ $8X1 + 2X2 \geq 16$ $3X1- 2X2 \geq 6$ **And $X1, X2 \geq 0$** **Refer Notes**	C404.1	BTL6
9	A company sells two different products A and B , making a profit of Rs.40 and Rs. 30 per unit on them, respectively. They are produced in a common production process and are sold in two different markets, the production process has a total capacity of 30,000 man-hours. It takes three hours to produce a unit of A and one hour to produce a unit of B. The market has been surveyed and company official feel that the maximum number of units of A that can be sold is 8,000 units and that of B is 12,000 units. Subject to these limitations, products can be sold in any combination. Formulate the problem as a LPP so as to maximize the profit **Refer Notes**	C404.1	BTL6
10	A firm manufactures two types of products A and B and sells them at profit of Rs 2 on type A and Rs 3 on type B. Each product is processed on two machines M1 and M2.Type A requires 1 minute of processing time on M1 and 2 minutes on M2 Type B requires 1 minute of processing time on M1 and 1 minute on M2. Machine M1 is available for not more than 6 hours 40 minutes while machine M2 is available for 10 hours during any working day. Formulate the problem as a LPP so as to maximize the profit **Refer Notes**	C404.1	BTL6
11	A company produces refrigerator in Unit I and heater in Unit II. The two products are produced and sold on a weekly basis. The weekly production cannot exceed 25 in unit I and 36 in Unit II, due to constraints 60 workers are employed. A refrigerator requires 2 man week of labour, while a heater requires 1 man week of labour, the profit available is Rs. 600 per refrigerator and Rs. 400 per heater. Formulate the LPP problem And Solve. **Refer Notes**	C404.1	BTL6

12	**Solve the following LP problem using graphical method.** **Maximize $z = 6x_1 + 8x_2$** **Subject to** **$5x_1+ 10x_2 <= 60$** **$4x_1+4x_2<=60$** **x_1 and $x_2 >=0$** **(APR/MAY 2017)**	C404.1	BTL6
13	**Solve the LPP by simplex method** **Min $z = 2x_1+x_2$** **Subject to** **$3x_2+x_3 >=3$** **$-\ 2x_2+4x_3 <=12$** **$-\ 4x_2+3x_3+8x_5 <=10$** **$x_2, X_3, X_5 >=0$** **(APR/MAY 2017)**	C404.1	BTL6
14	A manufacturer makes two components, T and A, in a factory that is divided into two shops. Shop I, which perfoms the basic assembly operation, must work 5 man-days on each component T but only 2 man-days on each component A. Shop II, which performs finishing operation, must work 3 man-days for each of component T and A it produces. Because of men and machine limitations, Shop I has 180 man-days per week available, while Shop II has 135 man-days per week. If the manufacturer makes a profit of Rs. 300 on each component T and Rs. 200 on each component A, how many of each should be produced to maximize his profit. Use simplex method. **(NOV/DEC 2017)**	C404.1	BTL6
15	Explain the types of Models. Also explain the characteristics of a good model along with the principles involved in modeling. **(NOV/DEC 2017)**	C404.1	BTL6

16	An automobile manufacturer makes auto-mobiles and trucks in a factory that is divided into two shops. Shop A, which performs the basic assembly operation must work 5 man-days on each truck but only 2 man-days on each automobile. Shop B, which performs finishing operation must work 3 man-days for each truck or automobile that it produces. Because of men and machine limitations shop A has 180 man-days per week available while shop B has 135 man-days per week. If the manufacturer makes a profit of Rs. 300 on each truck and Rs. 200 on each automobile, how many of each should he produce to maximize his profit ? **(APR/MAY 2018)**	C404.1	BTL6
17	Garden Ltd. has two product Rose and Lotus. To produce one unit of Rose, 2 units of material X and 4 units of material Y are required. To produce one unit of Lotus, 3 units of material X and 2 units of material Y are required. At least 16 units of each material must be used in order to meet the committed sales of Rose and Lotus Cost per unit of material X and material Y are Rs. 2.50 per unit and Rs. 0.25 per unit respectively. Your are required : i) To formulate mathematical model ii) To solve it for the minimum cost (Graphically). **(APR/MAY 2018)**	C404.1	BTL6

UNIT-II

UNIT II DUALITY AND NETWORKS 9

Definition of dual problem – Primal – Dual relation ships – Dual simplex methods – Post optimality analysis – Transportation and assignment model - Shortest route problem

1	**Define transportation problem.** It is a special type of linear programming model in which the goods are shipped from various origins to different destinations. The objective is to find the best possible allocation of goods from various origins to different destinations such that the total transportation cost is minimum.	C404.2	BTL1
2	**Define the following: Feasible solution** A set of non-negative decision values xij (i=1,2,….m; j=1,2…n) satisfies the constraint equations is called a feasible solution.	C404.2	BTL1
3	**Define the following: basic feasible solution** A basic feasible solution is said to be basic if the number of positive allocations are m+n-1.(m-origin and n-destination).If the number of allocations are less than (m+n-1) it is called degenerate basic feasible solution.	C404.2	BTL1
4	**Define optimal solution in transportation problem** A feasible solution is said to be optimal, if it minimizes the total transportation cost.	C404.2	BTL1
5	**. What are the methods used in transportation problem to obtain the initial basic feasible solution.** • North-west corner rule • Lowest cost entry method or matrix minima method • Vogel’s approximation method	C404.2	BTL1
6	**What are the basic steps involved in solving a transportation problem.** • To find the initial basic feasible solution To find an optimal solution by making successive improvements from the initial basic feasible solution	C404.2	BTL1

7	**What do you understand by degeneracy in a transportation problem? (NOV '07,APR/MAY 2018)** If the number of occupied cells in a m x n transportation problem is less than (m+n-1) then the problem is said to be degenerate.	C404.2	BTL1
8	**What is balanced transportation problem& unbalanced transportation problem?** **When the sum of supply is equal to demands, then the problem is said to be balanced** transportation problem. A transportation problem is said to be unbalanced if the total supply is not equal to the total demand.	C404.2	
9	**How do you convert an unbalanced transportation problem into a balanced one? (APR/MAY 2018)** The unbalanced transportation problem is converted into a balanced one by adding a dummy row (source) or dummy column (destination) whichever is necessary. The unit transportation cost of the dummy row/ column elements are assigned to zero. Then the problem is solved by the usual procedure.	C404.2	BTL1
10	**Explain how the profit maximization transportation problem can be converted to an equivalent cost minimization transportation problem. (MAY '08)** If the objective is to maximize the profit or maximize the expected sales we have to convert these problems by multiplying all cell entries by -1.Now the maximization problem becomes a minimization and it can be solved by the usual algorithm	C404.2	BTL2
11	**Determine basic feasible solution to the following transportation problem using least cost method. (MAY '09)** A B C D SUPPLY P 1 2 1 4 30 Q 3 3 2 1 50 R 4 2 5 9 20 Demand 20 40 30 10	C404.2	BTL5

12	**Define transshipment problems?** A problem in which available commodity frequently moves from one source to another source or destination before reaching its actual destination is called transshipment problems	C404.2	BTL1

$$\sum_{i=1}^{m} a_i = \sum_{j=1}^{n} b_j$$

13	**What are the necessary and sufficient conditions for a transportation problem to have a solution? (NOV/DEC 2016)** A necessary and sufficient condition for the existence of a feasible solution to the transportation problem is that	C404.2	BTL1
14	**What is the difference between Transportation problem & Transshipment Problem?** In a transportation problem there are no intermediate shipping points while in transshipment problem there are intermediate shipping points	C404.2	BTL1
15	**What is assignment problem? (NOV/DEC 2017)** An assignment problem is a particular case of a transportation problem in which a number of operations are assigned to an equal number of operators where each operator performs only one operation, the overall objective is to maximize the total profit or minimize the overall cost of the given assignment.	C404.2	BTL1
16	**. Define unbounded assignment problem and describe the steps involved in solving it?** If the no. of rows is not equal to the no. of column in the given cost matrix the problem is said to be unbalanced. It is converted to a balanced one by adding dummy row or dummy column with zero cost**.**	C404.2	BTL1
17	**Explain how a maximization problem is solved using assignment model?** The maximization problems are converted to a minimization one of the following method. (i) Since max z = min(-z) (ii) Subtract all the cost elements all of the cost matrix from the Highest cost element in that cost matrix.	C404.2	BTL2

18	**What do you understand by restricted assignment? Explain how you should overcome it?** The assignment technique, it may not be possible to assign a particular task to a particular facility due to technical difficulties or other restrictions. This can be overcome by assigning a very high processing time or cost (it can be ∞) to the corresponding cell.	C404.2	BTL1
19	**How do you identify alternative solution in assignment problem?** Sometimes a final cost matrix contains more than required number of zeroes at the independent position. This implies that there is more than one optimal solution with some optimum assignment cost.	C404.2	BTL1
20	**What is a traveling salesman problem?** A salesman normally must visit a number of cities starting from his head quarters. The distance between every pair of cities are assumed to be known. The problem of finding the shortest distance if the salesman starts from his head quarters and passes through each city exactly once and returns to the headquarters is called Traveling Salesman problem**.**	C404.2	BTL1
21	**Define route condition?** The salesman starts from his headquarters and passes through each city exactly once.	C404.2	BTL1
22	**What are the areas of operations of assignment problems?** Assigning jobs to machines. Allocating men to jobs/machines. Route scheduling for a traveling salesman	C404.2	BTL1

23	**DefineTransportation problem(TP): (NOV/DEC 2017)** Distributing any commodity from any group of supply centers, called *sources*, to any group of receiving centers, called *destinations*, in such a way as to minimize the total distribution cost (shipping cost).	C404.2	BTL1
24	**24. What are the Methods to find optimal solution** 1. The stepping-stone method 2. The Modified distribution method(MODI or u-v method)	C404.2	BTL1
25	**What are the Solution of TP:** Step 1 :Make a transportation model Step 2 : Find the initial basic feasible solution Step 3 : Find an optimal solution 26.What are the characteristics of primal and dual problem? **NOV/DEC 2016)**	C404.2	BTL1
26	**Define unbounded assignment problem and what are the rules to recognize it?** In some LP models, the values of the variables may be increased indefinitely without violating any of the constraints, meaning that the solution space is unbounded in at least one direction. As a result, the objective value may increase (maximization case) or decrease (minimization case) indefinitely. The rule for recognizing unboundedness is that if at any iteration all the constraint coefficients of any non basic variable are zero or negative, then the solution space is unbounded in that direction. The objective coefficient of that variable is negative in the case of maximization or positive in the case of minimization, then the objective value is unbounded as well.	C404.2	BTL1

27	**Define the mathematical formulation of an assignment problem.** The assignment problem can be expressed as Maximize Z = $\sum_{i=1}^{n}\sum_{j=1}^{n} cij\ xij$ Where cij is the cost of assigning ith machine to the jth job subject to the constraints xij = $\begin{cases}1, \text{if ith machine is assigned to the jth job}\\ 0, \text{if ith machnie is not assigned to the jth job}\end{cases}$ i.e) xij = 1 or 0 ⇒xij (xij – 1) = 0 ⇒ xij2 = xij $\sum_{j=1}^{n}$ xij = 1, i = 1, 2, …, n and $\sum_{i=1}^{n}$ xij =1, j = 1, 2, … , n	C404.2	BTL1
28	**How will you overcome degeneracy in a transportation problem?** If the number of occupied cells in a m x n transportation problem is less than (m+n-1) then the problem is said to be degenerate where m is the number of rows and n is the number of columns in the transportation table. To resolve degeneracy, allocate an extremely small amount (close to zero) to one or more empty cells of the transportation table, so that the total number of occupied cells becomes (m+n-1) at independent positions. The small amount is denoted by ∈.	C404.2	BTL1
29	**Explain the difference between transportation and assignment problems?** Transportation problems Assignment problems 1) supply at any source may be a Supply at any source will any positive quantity. be 1. 2) Demand at any destination may Demand at any destination be a positive quantity. will be 1. 3) One or more source to any number One source one	C404.2	BTL2

<table>
<tr><td></td><td>destination.
of destination.</td><td></td><td></td></tr>
<tr><td>30</td><td>Explain how the profit maximization transportation problem can be converted to an equivalent cost minimization transportation problem. (MAY ’08)
If the objective is to maximize the profit or maximize the expected sales we have to convert these problems by multiplying all cell entries by -1.Now the maximization problem becomes a minimization and it can be solved by the usual algorithm</td><td>C404.2</td><td>BTL2</td></tr>
<tr><td>31</td><td>Define primal and dual problem? (APR/MAY 2017, NOV/DEC 2017)
The Duality in Linear Programming states that every linear programming problem has another linear programming problem related to it and thus can be derived from it. The original linear programming problem is called “Primal,” while the derived linear problem is called “Dual.”</td><td>C404.2</td><td>BTL1</td></tr>
<tr><td>32</td><td>Write the difference between the transportation problem and the assignment problem. (APR/MAY 2017)
<table>
<tr><th>Assignment Problem</th><th>Transportation Problem</th></tr>
<tr><td>(i) Assignment means allocating various jobs to various people in the organization. Assignment should be done in such a way that the overall processing time is less, overall efficiency is high, overall productivity is high, etc.</td><td>(i) A transportation problem is concerned with transportation method or selecting routes in a product distribution network among the manufacture plant and distribution warehouse situated in different regions or local outlets.</td></tr>
<tr><td>(ii) We solve an assignment problem by using two methods.
(a) Completer enumeration method.</td><td>(ii) We use three methods for solving a transportation problem i.e., to find IBFS : (a) VAM (b) NWCR (c) LCM
Thereafter we find the optimum solution by using the MODI method.</td></tr>
</table>
</td><td>C404.2</td><td>BTL2</td></tr>
</table>

<table>
<tr><td></td><td><table><tr><td>(b) Hungarian method</td><td></td></tr><tr><td>(iii)In assignment problem management aims at assignment jobs to various people.</td><td>(iii)In transportation method, management is searching for a distribution route, which can lead to minimization of cost and maximization of profit.</td></tr></table></td><td></td><td></td></tr>
<tr><td>33</td><td>What is Dual Simplex Method ? (NOV/DEC 2017)
In dual simplex method, the LP starts with an optimum (or better) objective function value which is infeasible. Iterations are designed to move toward feasibility without violating optimality. At the iteration when feasibility is restored, the algorithm ends.</td><td>C404.2</td><td>BTL1</td></tr>
</table>

PART-B

<table>
<tr><td>1</td><td>How do you convert the unbalanced assignment problem into a balanced one? (MAY ’08)
Since the assignment is one to one basis , the problem have a square matrix. If the given problem is not square matrix add a dummy row or dummy column and then convert it into a balanced one (square matrix). Assign zero cost values for any dummy row/column and solve it by usual assignment method.
<table><tr><td>1.Find the minimum cost distribution plan to satisfy demand for cement at three cremation sites from available capacities at three cement plants given the following transportation costs(in Rs) per tone of cements moved from plants to sites From</td><td colspan="3">To constmetium sites</td><td>Capacity tones/ months</td></tr><tr><td>P1</td><td>Rs.300</td><td>Rs.360</td><td>Rs.425</td><td>Rs.600</td></tr><tr><td>P2</td><td>Rs.390</td><td>Rs.340</td><td>Rs.310</td><td>Rs.300</td></tr></table></td><td>C404.2</td><td>BTL1</td></tr>
</table>

P3	**Rs.255**	**Rs.295**	**Rs.275**	**Rs.1000**
Demand tones/months	**400**	**500**	**800**	

Refer Notes

2

Solve the following assignments problems

	I	II	III	IV	V
A	**10**	**5**	**9**	**18**	**11**
B	**13**	**19**	**6**	**12**	**14**
C	**3**	**2**	**4**	**4**	**5**
D	**18**	**9**	**12**	**17**	**15**
E	**11**	**6**	**14**	**19**	**10**

Refer Notes

C404.2

3

.Solve the TP where cell entries are unit costs. Use vogel's approriments method to fnd the initial basic solution

	D1	**D2**	**D3**	**D4**	**D5**	**AVAILABLE**
O1	**68**	**35**	**4**	**74**	**15**	**18**
O2	**57**	**88**	**91**	**3**	**8**	**17**
O3	**91**	**60**	**75**	**45**	**60**	**19**
O4	52	53	24	7	82	13
O5	51	18	82	13	7	15
Required	16	18	20	14	14	

Refer Notes

C404.2

BTL6

4

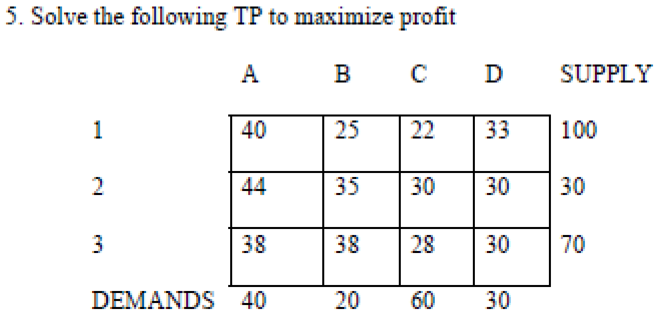
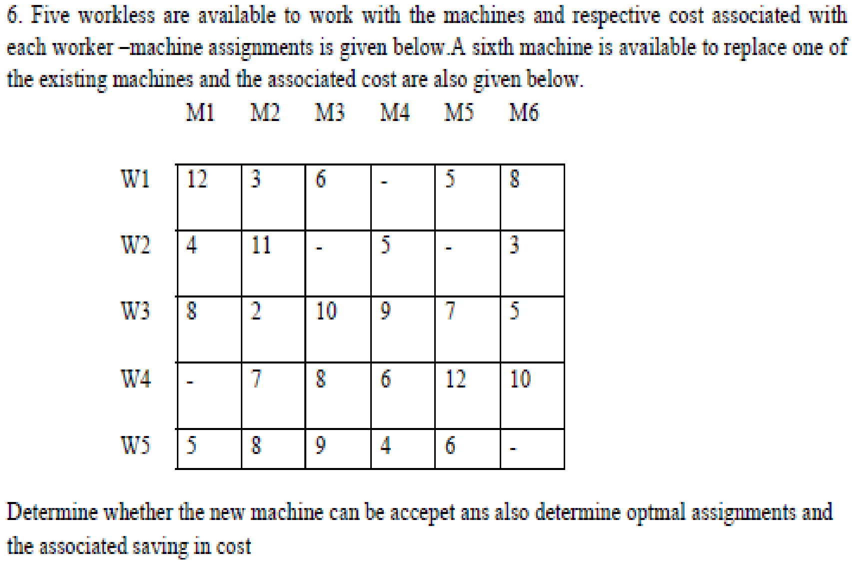
A small garments making units has five tailors stitching five different types of garments all the five tailors are capable of stiching all the five types of garments .the output per day per tailor and the profit(Rs.)for each type of garments are given below.

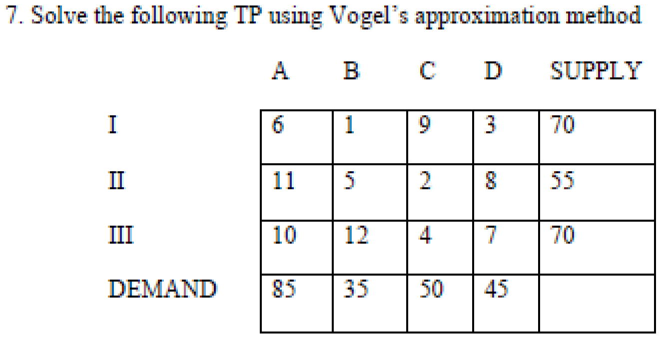
	1	2	3	4	5
A	7	9	4	8	6
B	4	9	5	7	8
C	8	5	2	9	8
D	6	5	8	10	10
E	7	8	10	9	9
PROFIT per garment	2	3	2	3	4

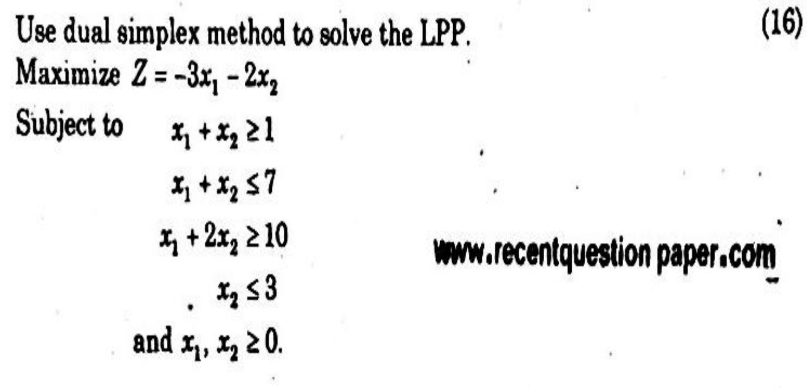
Refer Notes

C404.2

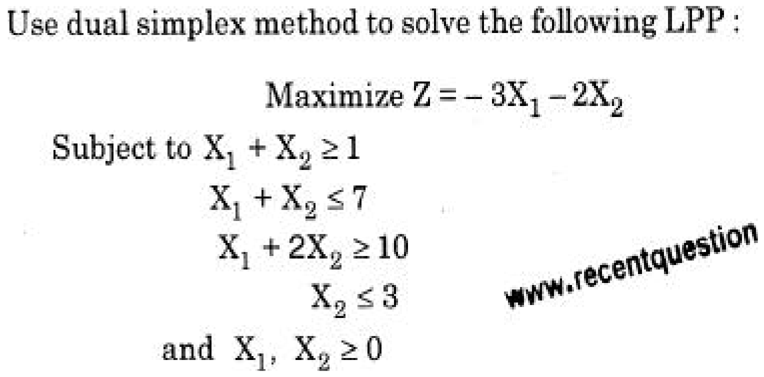
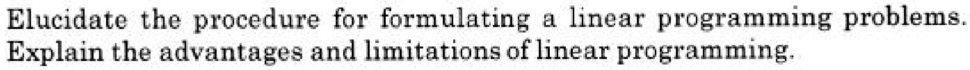
<table>
<tr><td>5</td><td>Which type of garments should be assigned to which tailor in order to maximize profit, assuming that there are no others constructs

Refer Notes</td><td>C404.2</td><td>BTL1</td></tr>
<tr><td>6</td><td>
5. Solve the following TP to maximize profit
<table>
<tr><th></th><th>A</th><th>B</th><th>C</th><th>D</th><th>SUPPLY</th></tr>
<tr><td>1</td><td>40</td><td>25</td><td>22</td><td>33</td><td>100</td></tr>
<tr><td>2</td><td>44</td><td>35</td><td>30</td><td>30</td><td>30</td></tr>
<tr><td>3</td><td>38</td><td>38</td><td>28</td><td>30</td><td>70</td></tr>
<tr><td>DEMANDS</td><td>40</td><td>20</td><td>60</td><td>30</td><td></td></tr>
</table>
Refer Notes</td><td>C404.2</td><td>BTL6</td></tr>
<tr><td>7</td><td>
6. Five workless are available to work with the machines and respective cost associated with each worker –machine assignments is given below.A sixth machine is available to replace one of the existing machines and the associated cost are also given below.
<table>
<tr><th></th><th>M1</th><th>M2</th><th>M3</th><th>M4</th><th>M5</th><th>M6</th></tr>
<tr><td>W1</td><td>12</td><td>3</td><td>6</td><td>-</td><td>5</td><td>8</td></tr>
<tr><td>W2</td><td>4</td><td>11</td><td>-</td><td>5</td><td>-</td><td>3</td></tr>
<tr><td>W3</td><td>8</td><td>2</td><td>10</td><td>9</td><td>7</td><td>5</td></tr>
<tr><td>W4</td><td>-</td><td>7</td><td>8</td><td>6</td><td>12</td><td>10</td></tr>
<tr><td>W5</td><td>5</td><td>8</td><td>9</td><td>4</td><td>6</td><td>-</td></tr>
</table>
Determine whether the new machine can be accepet ans also determine optmal assignments and the associated saving in cost

Refer Notes</td><td>C404.2</td><td>BTL5</td></tr>
<tr><td>8</td><td>
7. Solve the following TP using Vogel's approximation method
<table>
<tr><th></th><th>A</th><th>B</th><th>C</th><th>D</th><th>SUPPLY</th></tr>
<tr><td>I</td><td>6</td><td>1</td><td>9</td><td>3</td><td>70</td></tr>
<tr><td>II</td><td>11</td><td>5</td><td>2</td><td>8</td><td>55</td></tr>
<tr><td>III</td><td>10</td><td>12</td><td>4</td><td>7</td><td>70</td></tr>
<tr><td>DEMAND</td><td>85</td><td>35</td><td>50</td><td>45</td><td></td></tr>
</table>
Refer Notes</td><td>C404.2</td><td>BTL6</td></tr>
</table>

<table>
<tr><td>9</td><td>8. Solve the assignment problem
<table><tr><th></th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th></tr><tr><td>A</td><td>12</td><td>10</td><td>15</td><td>22</td><td>18</td><td>8</td></tr><tr><td>B</td><td>10</td><td>18</td><td>25</td><td>15</td><td>16</td><td>12</td></tr><tr><td>C</td><td>11</td><td>10</td><td>3</td><td>8</td><td>5</td><td>9</td></tr><tr><td>D</td><td>6</td><td>14</td><td>10</td><td>13</td><td>13</td><td>12</td></tr><tr><td>E</td><td>8</td><td>12</td><td>11</td><td>7</td><td>13</td><td>10</td></tr></table>Refer Notes</td><td>C404.2</td><td>BTL6</td></tr>
<tr><td>10</td><td>9. Find the IBFS of the following TP by VAM and hence find the optimum solutions
<table><tr><th></th><th>P</th><th>Q</th><th>R</th><th>SUPPLY</th></tr><tr><td>A</td><td>5</td><td>1</td><td>7</td><td>10</td></tr><tr><td>B</td><td>6</td><td>4</td><td>6</td><td>80</td></tr><tr><td>C</td><td>3</td><td>2</td><td>5</td><td>15</td></tr><tr><td>DEMAND</td><td>45</td><td>20</td><td>40</td><td></td></tr></table>Refer Notes</td><td>C404.2</td><td>BTL1</td></tr>
<tr><td>11</td><td>10. Solve the following assignment problems
<table><tr><th></th><th>M1</th><th>M2</th><th>M3</th><th>M4</th></tr><tr><td>J1</td><td>18</td><td>24</td><td>28</td><td>32</td></tr><tr><td>J2</td><td>8</td><td>13</td><td>17</td><td>18</td></tr><tr><td>J3</td><td>10</td><td>15</td><td>19</td><td>22</td></tr></table>Refer Notes</td><td>C404.2</td><td>BTL6</td></tr>
<tr><td>12</td><td>11. Solve the following TP
<table><tr><th></th><th>D1</th><th>D2</th><th>D3</th><th>D4</th><th>SUPPLY</th></tr><tr><td>S1</td><td>6</td><td>1</td><td>9</td><td>3</td><td>70</td></tr><tr><td>S2</td><td>11</td><td>5</td><td>2</td><td>8</td><td>55</td></tr><tr><td>S3</td><td>10</td><td>12</td><td>4</td><td>7</td><td>70</td></tr><tr><td>DEMANDS</td><td>85</td><td>35</td><td>50</td><td>45</td><td></td></tr></table>Refer Notes</td><td>C404.2</td><td>BTL6</td></tr>
<tr><td>13</td><td>
Use dual simplex method to solve the LPP. (16)
Maximize $Z = -3x_1 - 2x_2$
Subject to $x_1 + x_2 \geq 1$
$x_1 + x_2 \leq 7$
$x_1 + 2x_2 \geq 10$
$x_2 \leq 3$
and $x_1, x_2 \geq 0$.
www.recentquestion paper.com</td><td>C404.2</td><td>BTL6</td></tr>
</table>

<table>
<tr><td></td><td>Refer Notes</td><td></td><td></td></tr>
<tr><td>14</td><td>(NOV/DEC 2016)
solve the following LPP by dual simplex method
Maximize $Z = -3X1 -2X2$
Subject to the constraints
$X1 + X2 \geq 1$
$X1 + X2 \leq 7$
$X1 + 2X2 \geq 10$
And $X1, X2 \geq 0$.
Refer Notes</td><td>C404.2</td><td>BTL6</td></tr>
<tr><td>15</td><td>Using dual simplex method solve the LPP
Minimize $z = 2x_1 + x_2$
Subject to
$3x_1 + x_2 >= 3$
$4x_1 + 3x_2 >= 6$
$x_1 + 2x_2 >= 3$
and $x_1, x_2 >= 0$. (APR/MAY 2017)</td><td>C404.2</td><td>BTL6</td></tr>
<tr><td>16</td><td>Solve the transportation problem :
<table>
<tr><th></th><th>1</th><th>2</th><th>3</th><th>4</th><th>Supply</th></tr>
<tr><td>I</td><td>21</td><td>16</td><td>25</td><td>13</td><td>11</td></tr>
<tr><td>II</td><td>17</td><td>18</td><td>14</td><td>23</td><td>13</td></tr>
<tr><td>III</td><td>32</td><td>27</td><td>18</td><td>41</td><td>19</td></tr>
<tr><td>Demand</td><td>6</td><td>10</td><td>12</td><td>15</td><td></td></tr>
</table>
(APR/MAY 2017)</td><td>C404.2</td><td>BTL6</td></tr>
</table>

17	 Use dual simplex method to solve the following LPP : Maximize $Z = -3X_1 - 2X_2$ Subject to $X_1 + X_2 \geq 1$ $X_1 + X_2 \leq 7$ $X_1 + 2X_2 \geq 10$ $X_2 \leq 3$ and $X_1, X_2 \geq 0$ **(NOV/DEC 2017)**	C404.2	BTL6
18	 Elucidate the procedure for formulating a linear programming problems. Explain the advantages and limitations of linear programming. **(NOV/DEC 2017)**	C404.2	BTL6

19

Find the initial basic feasible solution for the following transportation problem by VAM. **(APR/MAY 2018)**

	D1	D2	D3	D4	Availability
S1	11	13	17	14	250
S2	16	18	14	10	300
S3	21	24	13	10	400
Requirements	200	225	275	250	

C404.2

BTL6

<table>
<tr><td>20</td><td>Solve the assignment proble (profit in rupees). (APR/MAY 2018)
<table>
<tr><th></th><th>P</th><th>Q</th><th>R</th><th>S</th></tr>
<tr><td>A</td><td>51</td><td>53</td><td>54</td><td>50</td></tr>
<tr><td>B</td><td>47</td><td>50</td><td>48</td><td>50</td></tr>
<tr><td>C</td><td>49</td><td>50</td><td>60</td><td>61</td></tr>
<tr><td>D</td><td>63</td><td>64</td><td>60</td><td>60</td></tr>
</table>
</td><td>C404.2</td><td>BTL6</td></tr>
</table>

UNIT-III

INTEGER PROGRAMMING 9

Cutting plan algorithm – Branch and bound methods, Multistage (Dynamic) programming.

Q. No.	Questions	CO	Bloom's Level
1.	**Define Integer Programming Problem (IPP)? (DEC '07)** A linear programming problem in which some or all of the variables in the optimal solution are restricted to assume non-negative integer values is called an Integer Programming Problem (IPP) or Integer Linear Programming	C404.3	BTL1
2.	**Explain the importance of Integer programming problem?** In LPP the values for the variables are real in the optimal solution. However in certain problems this assumption is unrealistic. For example if a problem has a solution of 81/2 cars to be produced in a manufacturing company is meaningless. These types of **problems require** integer values for the decision variables. Therefore IPP is necessary to round off the fractional values**.**	C404.3	BTL1
3.	**List out some of the applications of IPP? (MAY '09) (DEC '07) (MAY '07) NOV/DEC 2016)** • IPP occur quite frequently in business and industry. • All transportation, assignment and traveling salesman problems are IPP, since the decision variables are either Zero or one.	C404.3	BTL1

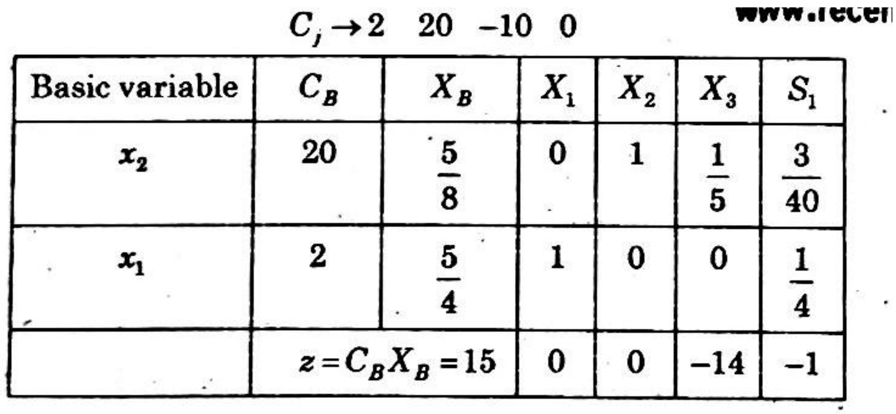
	• All sequencing and routing decisions are IPP as it requires the integer values of the decision variables. • Capital budgeting and production scheduling problem are PP. In fact, any situation involving decisions of the type either to do a job or not to do can be treated as an IPP. All allocation problems involving the allocation of goods, men, machines, give rise to IPP since such commodities can be assigned only integer and not fractional values		
4	**List the various types of integer programming? (MAY ’07, APR/MAY 2018)** Mixed IPP Pure IPP	C404.3	BTL1
5	**What is pure IPP?** In a linear programming problem, if all the variables in the optimal solution are restricted to assume non-negative integer values, then it is called the pure (all) IPP.	C404.3	BTL1
6	**What is Mixed IPP?** In a linear programming problem, if only some of the variables in the optimal solution are restricted to assume non-negative integer values, while the remaining variables are free to take any non-negative values, then it is called A Mixed IPP.	C404.3	BTL1
7	**What is Zero-one problem?** If all the variables in the optimum solution are allowed to take values either 0 or 1 as in ‘do’ or ‘not to do’ type decisions, then the problem is called Zero-one problem or standard discrete programming problem	C404.3	BTL1
8	**What is the difference between Pure integer programming & mixed integer integer programming.** When an optimization problem, if all the decision variables are restricted to take integer values, then it is referred as pure integer programming. If some of the variables are allowed to take integer values, then it is referred as mixed integer integer programming	C404.3	BTL1
9	**Explain the importance of Integer Programming? (APR/MAY 2018)** In linear programming problem, all the decision variables allowed to take any non-negative real values, as it is quite possible and appropriate to have fractional values in many situations. However in many situations, especially in business and industry, these decision variables make sense only if they have integer values in the optimal solution. Hence a new procedure has been developed in this direction for the case of LPP subjected to additional restriction that the decision variables must have integer values.	C404.3	BTL2

10	**Why not round off the optimum values in stead of resorting to IP? (MAY '08)** There is no guarantee that the integer valued solution (obtained by simplex method) will satisfy the constraints. i.e. ., it may not satisfy one or more constraints and as such the new solution may not feasible. So there is a need for developing a systematic and efficient algorithm for obtaining the exact optimum integer solution to an IPP.	C404.3	BTL1
11	**What are methods for solvingIPP? (MAY '08,NOV/DEC 2016)** Integer programming can be categorized as (i) Cutting methods (ii) Search Methods	C404.3	BTL1
12	**What is cutting method?** A systematic procedure for solving pure IPP was first developed by R.E.Gomory in 1958. Later on, he extended the procedure to solve mixed IPP, named as cutting plane algorithm, the method consists in first solving the IPP as ordinary LPP.By ignoring the integrity restriction and then introducing additional constraints one after the other to cut certain part of the solution space until an integral solution is obtained**.**	C404.3	BTL1
13	**What is search method?** It is an enumeration method in which all feasible integer points are enumerated. The widely used search method is the Branch and Bound Technique. It also starts with the continuous optimum, but systematically partitions the solution space into sub problems that eliminate parts that contain no feasible integer solution. It was originally developed by A.H.Land and A.G.Doig.	C404.3	BTL1
14	**Explain the concept of Branch and Bound Technique?** The widely used search method is the Branch and Bound Technique. It starts with the continuous optimum, but systematically partitions the solution space into sub problems that eliminate parts that contain no feasible integer solution. It was originally developed by A.H.Land and A.G.Doig.	C404.3	BTL2
15	**Define the general format of IPP?** The general IPP is given by Maximize $Z = CX$ Subject to the constraints $AX \leq b$, $X \geq 0$ and some or all variables are integer.	C404.3	BTL1
16	**Explain an algorithm for Gomory's Fractional Cut algorithm? (NOV/DEC 2017)**	C404.3	BTL2

	1. Convert the minimization IPP into an equivalent maximization IPP and all the coefficients and constraints should be integers. 2. Find the optimum solution of the resulting maximization LPP by using simplex method. 3. Test the integrity of the optimum solution. 4. Rewrite each X_{Bi} 5. Express each of the negative fractions if any, in the k^{th} row of the optimum simplex table as the sum of a negative integer and a non-negative fraction**.** 6. Find the fractional cut constraint 7. Add the fractional cut constraint at the bottom of optimum simplex table obtained in step 2. 8. Go to step 3 and repeat the procedure until an optimum integer solution is obtained.		
17	**What is the purpose of Fractional cut constraints?** In the cutting plane method, the fractional cut constraints cut the unuseful area of the feasible region in the graphical solution of the problem. i.e. cut that area which has no integer-valued feasible solution. Thus these constraints eliminate all the non-integral solutions without loosing any integer-valued solution**.** **18.A manufacturer of baby dolls makes two types of dolls, doll X and doll Y. Processing of these dolls is done on two machines A and B. Doll X requires 2 hours on machine A and 6 hours on Machine B. Doll Y requires 5 hours on machine A and 5 hours on Machine B. There are 16 hours of time per day available on machine A and 30 hours on machine B.**	C404.3	BTL1
18	**The profit is gained on both the dolls is same. Format this as IPP?** Let the manufacturer decide to manufacture x_1 the number of doll X and x_2 number of doll Y so as to maximize the profit. The complete formulation of the IPP is given by Maximize $Z = x_1+x_2$ Subject to $2 x_1 + 5 x_2 \leq 16$ $6 x_1+ 5 x_2 \leq 30$ and ≥ 0 and are integers	C404.3	BTL5
19	**Explain Gomory's Mixed Integer Method?** The problem is first solved by continuous LPP by ignoring the integrity condition. If the values of the integer constrained variables are integers, then the current solution is an optimal solution to the given mixed IPP. Else select the source row which corresponds to the largest fractional part among these basic variables which are constrained to be integers. Then construct the Gomarian constraint from the source row. Add this secondary constraint at the bottom of the optimum simplex table and use dual simplex	C404.3	BTL2

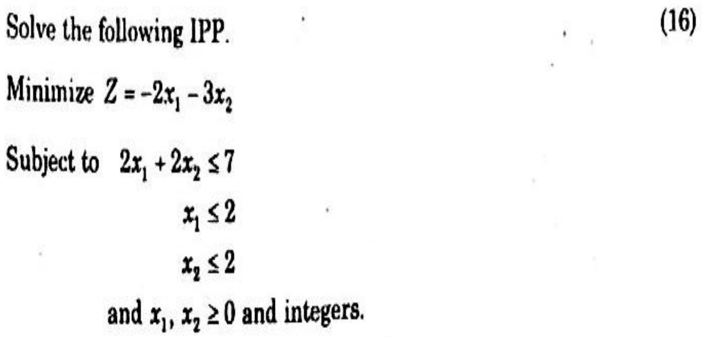
	method to obtain the new feasible optimal solution. Repeat this procedure until the values of the integer restricted variables are integers in the optimum solution obtained.		
20	**What is the geometrical meaning of portioned or branched the original problem?** Geometrically it means that the branching process eliminates portion of the feasible region that contains no feasible-integer solution. Each of the sub-problems solved separately as a LPP**.**	C404.3	BTL1
21	**What is standard discrete programming problem?** If all the variables in the optimum solution are allowed to take values either 0 or 1 as in 'do' or 'not to do' type decisions, then the problem is called standard discrete programming problem**.**	C404.3	BTL1
22	**What is the disadvantage of branched or portioned method?** It requires the optimum solution of each sub problem. In large problems this could be very tedious job**.**	C404.3	BTL1
23	**How can you improve the efficiency of portioned method?** The computational efficiency of portioned method is increased by using the concept of bounding. By this concept whenever the continuous optimum solution of a sub problem yields a value of the objective function lower than that of the best available integer solution it is useless to explore the problem any further consideration. Thus once a feasible integer solution is obtained, its associative objective function can be taken as a lower bound to delete inferior sub-problems. Hence efficiency of a branch and bound method depends upon how soon the successive sub-problems are fathomed.	C404.3	BTL1
24	**What are the condition of branch and bound method** 1.The values of the decision variables of the problem are integer 2.The upper bound of the problem which has non-integer values for its decision variables is not greater than the current best lower bound 3. The problem has an infeasible solution	C404.3	BTL1
25	**What are Traditional approach to solving integer programming problems**. ➢ Feasible solutions can be partitioned into smaller subsets ➢ Smaller subsets evaluated until best solution is found. ➢ Method is a tedious and complex mathematical process	C404.3	BTL1
26	**What are the condiitions that are helpful in computation in ILP.** The most important factor affecting computation in ILP is the number of integer variables and the feasible range in which they apply. It may be	C404.3	BTL1

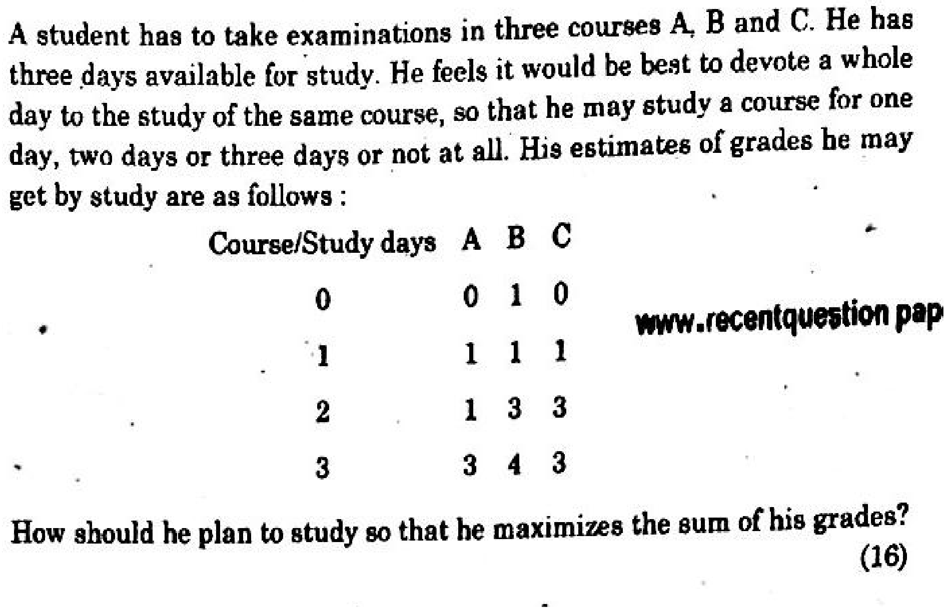
	advantageous to reduce the number of integer variables in the ILP model as much as possible. The following suggestions may provide helpful: ✓ Approximate the integer variables by continuous ones whenever possible. ✓ For the integer variables, restrict their feasible ranges as much as possible. Avoid the use of nonlinearity in the model		
27	**What is a fractional cut?** In the cutting plane method, the fractional cut constraints cut the unused area of the feasible region in the graphical solution of the problem. i.e. cut that area which has no integer-valued feasible solution. Thus these constraints eliminate all the non-integral solutions without loosing any integer-valued solution. A desired cut which represents a necessary condition for obtaining an integer solution is referred to as the fractional cut because all its coefficients are fractions.	C404.3	BTL1
28	**. What is mixed integer problem?** In the mixed integer programming problem only some of the variables are integer constrained, while other variables may take integer or other real values. The problem is first solved as a continuous LPP by ignoring the integer condition. If the values of the integer constrained variables are integers then the current solution is an optimal solution to the given mixed IPP. Otherwise select the source row which corresponds to the largest fractional part fk among those basic variables which are constrained to be integers. Then construct Gomorian constraint from the source row.	C404.3	BTL1
29	**What is dynamic programming? (NOV/DEC 2017)** Dynamic programming is the mathematical technique of optimization using multistage decision process. It is a process in which a sequence of interrelated decisions has to be made. It provides a systematic procedure for determining the combination of decisions which maximize overall effectiveness.	C404.3	BTL1
30	**What is the need for dynamic programming.** Decision making process consists of selecting a combination of	C404.3	BTL1

<table>
<tr>
<td></td>
<td>plans from a large number of alternative combinations. This involves lot of computational work and time. Dynamic programming deals with such situations by dividing the given problem into sub problems or stages. Only one stage is considered at a time and the various infeasible combinations are eliminated with the objective of reducing the volume of computations. The solution is obtained by moving from one stage to the next and is completed when the final stage is reached.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>List some characteristics of dynamic programming problems.
The characteristics of dynamic programming problems may be outlined as:
✓ Each problem can be divided into stages, with a policy decision required at each stage.
✓ Each stage has number of states associated with it.
✓ The effect of the policy decision at each stage is to transform the current state into a state associated with the next stage.
The current state of the system is described by state variables.</td>
<td>C404.3</td>
<td>BTL1</td>
</tr>
<tr>
<td>32</td>
<td>List different types of Integer programming problems.
(APR/MAY 2017)
0-1 integer linear programming
Mixed-integer programming</td>
<td>C404.3</td>
<td>BTL1</td>
</tr>
<tr>
<td>33</td>
<td>Write the Gomory's constraint for the all integer programming problem whose simplex table (with non integer solution) given below :
(APR/MAY 2017)

$C_j \rightarrow 2 \quad 20 \quad -10 \quad 0$
<table>
<tr><th>Basic variable</th><th>C_B</th><th>X_B</th><th>X_1</th><th>X_2</th><th>X_3</th><th>S_1</th></tr>
<tr><td>x_2</td><td>20</td><td>$\frac{5}{8}$</td><td>0</td><td>1</td><td>$\frac{1}{5}$</td><td>$\frac{3}{40}$</td></tr>
<tr><td>x_1</td><td>2</td><td>$\frac{5}{4}$</td><td>1</td><td>0</td><td>0</td><td>$\frac{1}{4}$</td></tr>
<tr><td></td><td colspan="2">$z = C_B X_B = 15$</td><td>0</td><td>0</td><td>−14</td><td>−1</td></tr>
</table>

Refer Notes</td>
<td>C404.3</td>
<td>BTL1</td>
</tr>
</table>

PART-B

1.	Find the optimum integer solution to the following LPP. Maximize Z = X1 + X2 Subject to the constraints 3 X1 + 2 X2 ≤ 5 X2 ≤ 2 X1, X2 ≥ 0 and are integers.	C404.3	BTL1
2.	. Solve the following ILPP. Maximize Z = X1 + 2X2 Subject to the constraints 2 X2 ≤ 7 X1 + X2 ≤ 7 2X2 ≤ 11 X1, X2 ≥ 0 and are integers	C404.3	BTL6
3.	(NOV/DEC 2016)  Solve the following IPP. (16) Minimize $Z = -2x_1 - 3x_2$ Subject to $2x_1 + 2x_2 \le 7$ $x_1 \le 2$ $x_2 \le 2$ and $x_1, x_2 \ge 0$ and integers.	C404.3	BTL6
4	. (NOV/DEC 2016)	C404.3	BTL1

	 A student has to take examinations in three courses A, B and C. He has three days available for study. He feels it would be best to devote a whole day to the study of the same course, so that he may study a course for one day, two days or three days or not at all. His estimates of grades he may get by study are as follows : Course/Study days A B C 0 0 1 0 1 1 1 1 2 1 3 3 3 3 4 3 www.recentquestion pap How should he plan to study so that he maximizes the sum of his grades? (16) 		
5	Solve the following mixed integer linear programming problem using Gomarian's cutting plane method. Maximize $Z = X1 + X2$ Subject to the constraints $3 X1 + 2 X2 \leq 5$ $X2 \leq 2$ $X1, X2 \geq 0$ and X1 is an integer.	C404.3	BTL6
6	Solve the following mixed integer programming problem. Maximize $Z = 7X1 + 9 X2$ Subject to the constraints $-X1 + 3X2 \leq 6$ $7X1 + X2 \leq 35$ and $X1, X2, \geq 0$, X1 is an integer.	C404.3	BTL6
7	Solve the following mixed integer programming problem. Maximize $Z = 4X1 + 6X2 + 2X3$ Subject to the constraints $4X1 - 4X2 \leq 5$ $-X1 + 6X2 \leq 5$ $-X1 + X2 + X3 \leq 5$ and $X1, X2, X3 \geq 0$, and X1 , X3 are integers.	C404.3	BTL6
8	. Use Branch and bound algorithm to solve the following ILPP Maximize $Z = 11X1 + 4X2$ Subject to the constraints $-X1 + 2X2 \leq 4$ $5X1 + 2X2 \leq 16$ $2X1 - X2 \leq 4$	C404.3	BTL6

	$X1, X2 \geq 0$ and are non negative integers		
9	Use Branch and bound algorithm to solve the following ILPP Maximize $Z = X1 + 4X2$ Subject to the constraints $2X1 + 4X2 \leq 7$ $5X1 + 3X2 \leq 15$ $X1, X2 \geq 0$ and are integers.	C404.3	BTL6
10	Use Branch and bound algorithm to solve the following ILPP Maximize $Z = 2X1 + 2X2$ Subject to the constraints $5X1 + 3X2 \leq 8$ $X1 + 2X2 \leq 4$ $X1, X2 \geq 0$ and are integers.	C404.3	BTL6
11	**Find the optimum integer solution to the following linear programming problem :** **Maximize** $z = x_1 + 2x_2$ **Subject to** $2x_2 \leq 7$ $x_1 + x_2 \leq 7$ $2x_1 = 11$ **and** $x_1, x_2 \geq 0$ **and are integers.** **(16)** **(APR/MAY 2017)**	C404.3	BTL6
12	**Use Branch and Bound method to solve the following :** **Maximize** $z = 2x_1 + 2x_2$ **Subject to** $5x_1 + 3x_2 \leq 8$ www.recentquest $x_1 + 2x_2 \leq 4$ **and** $x_1, x_2 \geq 0$ **and integers.** **(APR/MAY 2017)**	C404.3	BTL6

<table>
<tr>
<td>13</td>
<td>Obtain an optimum basic feasible solution to the following transportation problem :
<table>
<tr><th></th><th></th><th>To</th><th></th><th>Available</th></tr>
<tr><td></td><td>7</td><td>3</td><td>2</td><td>2</td></tr>
<tr><td>From</td><td>2</td><td>1</td><td>3</td><td>3</td></tr>
<tr><td></td><td>3</td><td>4</td><td>6</td><td>5</td></tr>
<tr><td>Demand</td><td>4</td><td>1</td><td>5</td><td>10</td></tr>
</table>
(NOV/DEC 2017)</td>
<td>C404.3</td>
<td>BTL6</td>
</tr>
<tr>
<td>14</td>
<td>Solve the following assignment problem for maximization given the profit matrix (profit in rupees) :
<table>
<tr><th></th><th></th><th colspan="4">Machines</th></tr>
<tr><th></th><th></th><th>P</th><th>Q</th><th>R</th><th>S</th></tr>
<tr><td></td><td>A</td><td>51</td><td>53</td><td>54</td><td>50</td></tr>
<tr><td>Job</td><td>B</td><td>47</td><td>50</td><td>48</td><td>50</td></tr>
<tr><td></td><td>C</td><td>49</td><td>50</td><td>60</td><td>61</td></tr>
<tr><td></td><td>D</td><td>63</td><td>64</td><td>60</td><td>60</td></tr>
</table>
(NOV/DEC 2017)</td>
<td>C404.3</td>
<td>BTL6</td>
</tr>
<tr>
<td>15</td>
<td>Solve the following LPP using dynamic programming approach :
Max $Z = 3X_1 + 5X_2$
subject to $X_1 \le 4$
$X_2 \le 6$
$3X_1 + 2X_2 \le 18$
and $X_1, X_2 \ge 0$
(NOV/DEC 2017)</td>
<td>C404.3</td>
<td>BTL6</td>
</tr>
<tr>
<td>16</td>
<td>Use Branch and Bound method to solve the following :
Maximize $Z = 2X_1 + 2X_2$
Subject to $5X_1 + 3X_2 \le 8$
$X_1 + 2X_2 \le 4$
and $X_1, X_2 \ge 0$ and integer.
(NOV/DEC 2017)</td>
<td>C404.3</td>
<td>BTL6</td>
</tr>
</table>

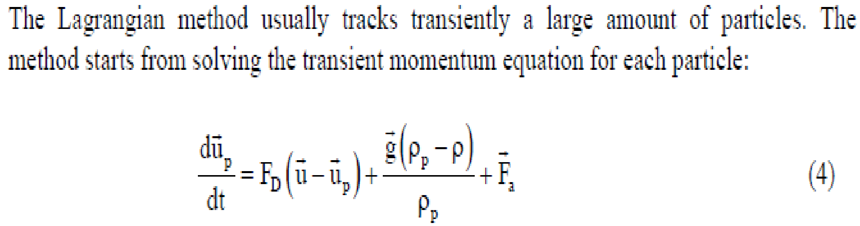
17	Use Branch and Bound technique to solve the following : Maximize Z = x_1 + $4x_2$ Subjects to constraints $2x_1 + 4x_2$ 5 7 $5x_1 + 3x_2$ ^{5} 15 $x_{1,}$ x_2 ?.0 and integers. **(APR/MAY 2018)**	C404.3	BTL6
18	Solve the following mixed integer programming problem by Gomo plane algorithm : Maximize Z = $x_1 + x_2$ Subject to $3x_1 + 2x_2$ 5. 5 x_2 5. 2 and x_1, x_2 0 and x_1 an integer. **(APR/MAY 2018)**	C404.3	BTL6

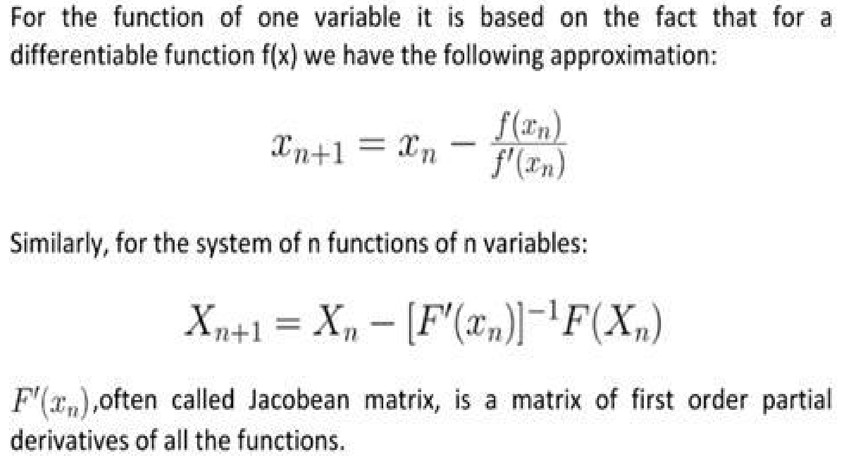
UNIT-IV

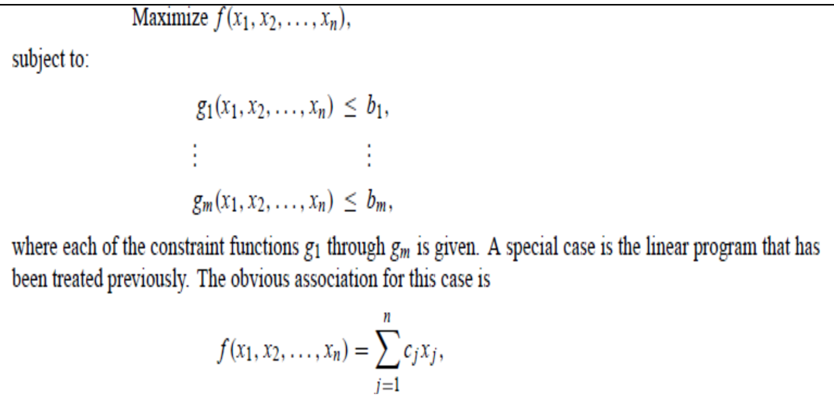
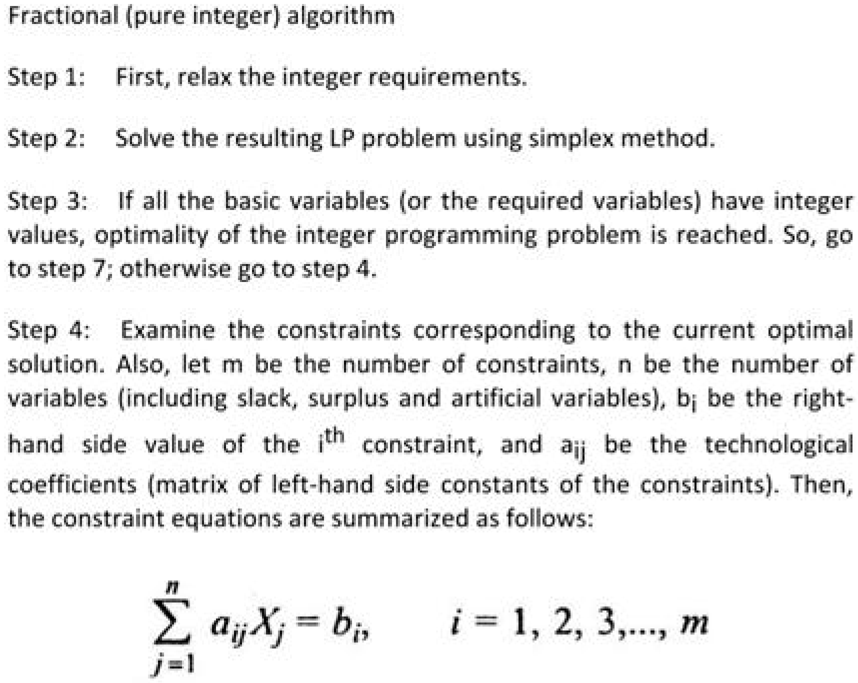
CLASSICAL OPTIMISATION THEORY

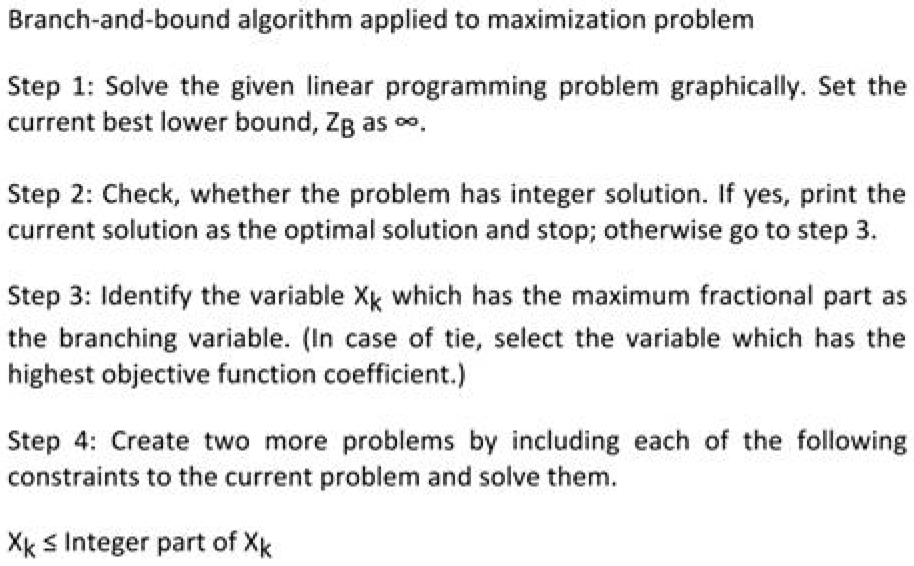
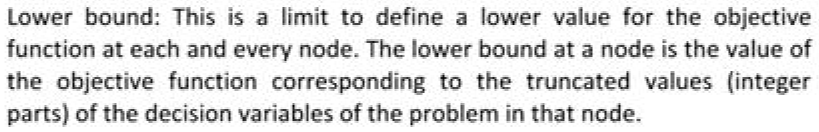
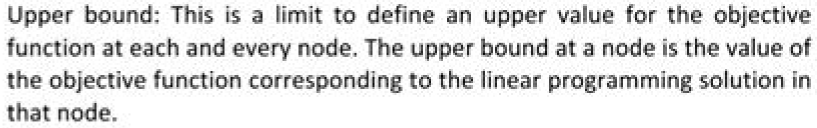
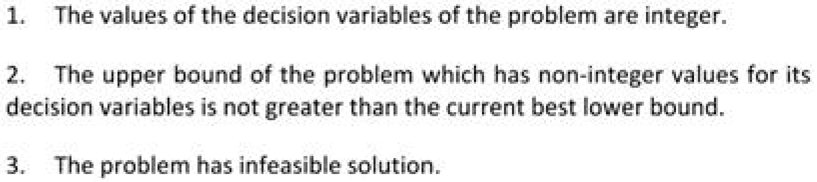
Unconstrained external problems, Newton – Ralphson method – Equality constraints – Jacobean methods – Lagrangian method – Kuhn – Tucker conditions – Simple problems.

Q. No.	Questions	CO	Bloom's Level
1.	**Discuss the different types of nonlinear programming problems.** • Price elasticity	C404.4	BTL6

	- Product-mix problem - Graphical nillustration - Global and local optimum		
2.	**Explain the application areas of nonlinear programming problems.** - Transportation problem - Product mix problem - NP Problems	C404.4	BTL2
3.	**Define the Lagrangean model.** Times New Roman  The Lagrangian method usually tracks transiently a large amount of particles. The method starts from solving the transient momentum equation for each particle: $$\frac{d\vec{u}_p}{dt} = F_D\left(\vec{u}-\vec{u}_p\right) + \frac{\vec{g}\left(\rho_p-\rho\right)}{\rho_p} + \vec{F}_a \qquad (4)$$	C404.4	BTL1
4	**What is Newton Ralphson method? (APR/MAY 2018)** Newton and Joseph Raphson, is a method for finding successively better approximations to the roots (or zeroes) of a real-valued function	C404.4	BTL1
5	**Define KKT (APR/MAY 2018)** The Karush–Kuhn–Tucker (KKT) conditions (also known as the Kuhn–Tucker conditions) are first order necessary conditions for a solution in nonlinear programming to be optimal, provided that some regularity conditions are satisfied. Allowing inequality constraints, the KKT approach to nonlinear programming generalizes the method of Lagrange multipliers, which allows only equality constraints. The system of equations corresponding to the KKT conditions is usually not solved directly, except in the few special cases where a closed-form solution can be derived analytically.	C404.4	BTL1
6	**Define Jacobean method.**	C404.4	BTL1

	 For the function of one variable it is based on the fact that for a differentiable function f(x) we have the following approximation: $x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$ Similarly, for the system of n functions of n variables: $X_{n+1} = X_n - [F'(x_n)]^{-1} F(X_n)$ $F'(x_n)$,often called Jacobean matrix, is a matrix of first order partial derivatives of all the functions.		
7	**What are the Kuhn-Tucker conditions. (APR/MAY 2018)** 1.L10inearity constraint qualification. 2.Line11ar independence constraint qualification (LICQ): 3.Manga12sarian–Fromovitz constraint qualification (MFCQ): 3.Constant 13rank constraint qualification (CRCQ): 4.Constant po14sitive linear dependence constraint qualification (CPLD): 15	C404.4	BTL1
8	**Define nonlinear programming.** Nonlinear programming is the process of solving an optimization problem defined by a system of equalities and inequalities, collectively termed constraints, over a set of unknown real variables, along with an objective function to be maximized or minimized, where some of the constraints or the objective function are nonlinear	C404.4	BTL1
9	**Explain format of non linear programming** Let n, m, and p be positive integers. Let X be a subset of Rn, let f, gi, and hj be real-valued functions on X for each i in {1, …, m} and each j in {1, …, p}. A nonlinear minimization problem is an optimization problem of the form	C404.4	BTL2

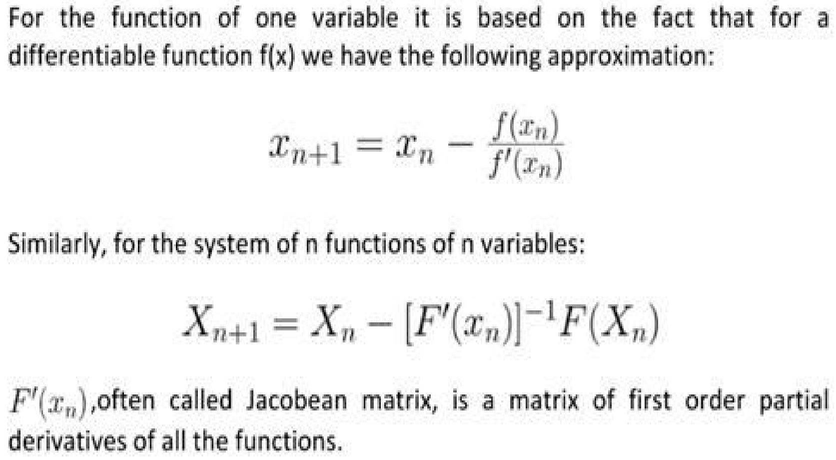
	 Maximize $f(x_1, x_2, \ldots, x_n)$, subject to: $g_1(x_1, x_2, \ldots, x_n) \leq b_1$, $\vdots \qquad \vdots$ $g_m(x_1, x_2, \ldots, x_n) \leq b_m$, where each of the constraint functions g_1 through g_m is given. A special case is the linear program that has been treated previously. The obvious association for this case is $f(x_1, x_2, \ldots, x_n) = \sum_{j=1}^{n} c_j x_j$,		
10	**What is the condition to be checked for minimization type objective function?** The stationary point will be given the minimum objective function value if the sign of each of the last (n – m) principal minor determinants of the bordered Hessian matrix is the same as that of $(-1)^m$, ending with the (2m+1)th principal minor determinant.	C404.4	BTL1
11	**What re the optimisation problems** - Constrained optimisation problems - Un Constrained optimisation problems	C404.4	BTL1
12	**what are steps for gomary algorithms**  Fractional (pure integer) algorithm Step 1: First, relax the integer requirements. Step 2: Solve the resulting LP problem using simplex method. Step 3: If all the basic variables (or the required variables) have integer values, optimality of the integer programming problem is reached. So, go to step 7; otherwise go to step 4. Step 4: Examine the constraints corresponding to the current optimal solution. Also, let m be the number of constraints, n be the number of variables (including slack, surplus and artificial variables), b_i be the right-hand side value of the i^{th} constraint, and a_{ij} be the technological coefficients (matrix of left-hand side constants of the constraints). Then, the constraint equations are summarized as follows: $\sum_{j=1}^{n} a_{ij}X_j = b_i, \qquad i = 1, 2, 3, \ldots, m$	C404.4	BTL1

13	**What are the steps for branch and bound algorithm.**  Branch-and-bound algorithm applied to maximization problem Step 1: Solve the given linear programming problem graphically. Set the current best lower bound, Z_B as ∞. Step 2: Check, whether the problem has integer solution. If yes, print the current solution as the optimal solution and stop; otherwise go to step 3. Step 3: Identify the variable X_k which has the maximum fractional part as the branching variable. (In case of tie, select the variable which has the highest objective function coefficient.) Step 4: Create two more problems by including each of the following constraints to the current problem and solve them. $X_k \leq$ Integer part of X_k	C404.4	BTL1
14	**Define lower bound in optimisation.**  Lower bound: This is a limit to define a lower value for the objective function at each and every node. The lower bound at a node is the value of the objective function corresponding to the truncated values (integer parts) of the decision variables of the problem in that node.	C404.4	BTL1
15	**Define upper bound in optimization**  Upper bound: This is a limit to define an upper value for the objective function at each and every node. The upper bound at a node is the value of the objective function corresponding to the linear programming solution in that node.	C404.4	BTL1
16	**What are condition of branch and bound method**  1. The values of the decision variables of the problem are integer. 2. The upper bound of the problem which has non-integer values for its decision variables is not greater than the current best lower bound. 3. The problem has infeasible solution.	C404.4	BTL1
17	**What is the condition to be checked for maximization type objective function?** The stationary point will be given the maximum objective function value if the sign of each of the last (n – m) principal minor determinants of the bordered Hessian matrix is the same as that of $(-1)^{m+1}$, ending with the (2m+1)th principal minor determinant	C404.4	BTL1
18	**What are the steps to implement Jacobean method?**	C404.4	BTL1

	The possible ways to implement this algorithm: (i) Define a function that calculates values at a given location. (ii) Define a function that evaluates a Jacobean matrix. (iii) Select a "best guess" starting value. (iv) Evaluate the function and Jacobean at the current location. (v) Find inverse Jacobean matrix. (vi) Calculate the next position. (vii) Iterate through steps 4 – 6 until the root is found with desired precision.		
19	**What are the condition for Kuhn-Tucker conditions.** 1.Linearity constraint qualification. 2.Linear independence constraint qualification (LICQ):	C404.4	BTL1
20	**What are the KKTcondition?** 1. They give insight into what optimal solutions to NLPs look like. 2. They provide a way to set up and solve small problems. 3. They provide a method to check solutions to large problems. 4. The Lagrangian values can be seen as shadow prices of the constraints.	C404.4	BTL1
21	**Solve the problem by kkt condition** maximize $f(x_1, x_2) = x_1 + 2x_2 - x_2^3$ subject to $x_1 + x_2 \le 1$ $x_1 \ge 0$ $x_2 \ge 0$	C404.4	BTL3
22	**What are the requirements of newton's method** • Converges quadratically near the optimum . • Sensitive to initial point . • Requires matrix inversion. • Requires first and second order derivatives .	C404.4	BTL1

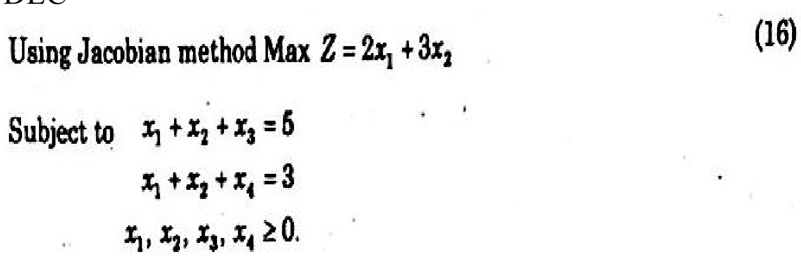
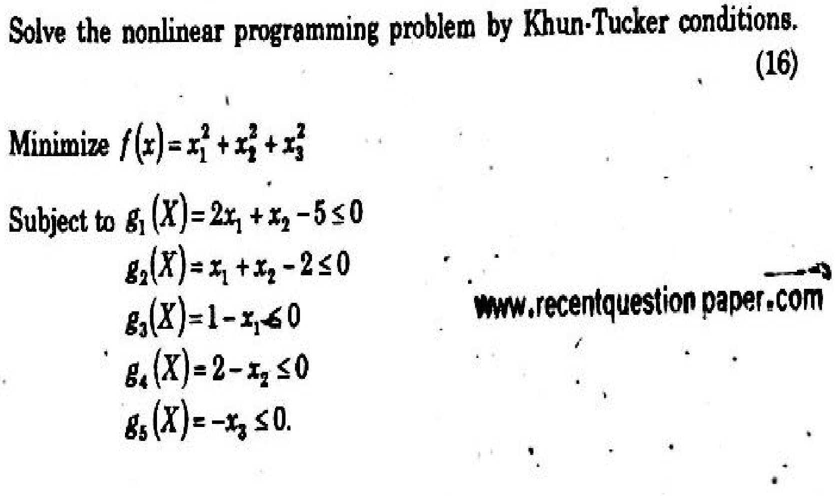
23	**what are the methods of one dimentional unconstrained optimization?** - Analytical method - Newton's method - Golden-section search method	C404.4	BTL1
24	**what are the methods of one dimentional unconstrained optimization?** - Analytical method - Gradient method	C404.4	BTL1
25	**.(NOV/DEC 2016)** **Write down the Lagraugian function for Khun-Tucker method for following non linear programming with inequality constraints.** The form for nonlinear programming: Maximize or minimize Z = f(X_1, X_2, ….., X_j,……, X_n) subject to G_i(X_1, X_2, ….., X_j,……, X_n) = b_i, i = 1, 2, ….., m, $X_j \geq 0$, j = 1, 2, ….., n.	C404.4	BTL1
26	**How do classical optimization problems determine points of maxima and minima?** Classical optimization theory uses differential calculus to determine points of maxima and minima extrema) for unconstrained and constrained functions. The methods may not be suitable for efficient numerical computations, but the underlying theory provides the basis for most nonlinear programming algorithms.	C404.4	BTL1
27	**What is the necessary condition for an n variable function to have extrema?** A necessary condition for X0 to be an extreme point of f(x) is that ∇f(X0) = 0.	C404.4	BTL1
28	**What is the sufficient condition for a function to have extrema?** A sufficient condition for a stationary point X0 to be an extremum is that Hessian matrix H evaluated at X0 satisfy the following conditions:	C404.4	BTL1

	✓ H is positive definite if X0 is minimum point. H is negative definite if X0 is maximum point.		
29	**List the types of constrained problems.** There are 2 types of constrained problem ✓ Equality constraints Inequality constraints	C404.4	BTL1
30	**Mention the steps involved in Lagrangean method.** Step 1: Form the Lagrangean function. Step 2: The first partial derivative of L with respect to Xj is obtained, where j varies from 1 to n, and also with respect to ϕi, where i varies from 1 to m. then equate them to 0. Step 3: Solution to equations in step 2 are found. Step 4: The bordered Hessian square matrix [HB] of size n + m is formed. Step 5: The stationary points (X1*, X2*, ….., Xj*,……, Xn*) are tested for maximization/minimization objective function.	C404.4	BTL1
31	**Write down the necessary condition for general non linear programming problem by Lagrange's multiplier method for equal constraints.** The form for nonlinear programming: Maximize or minimize Z = f($X_1, X_2, \ldots, X_j, \ldots, X_n$) subject to $G_i(X_1, X_2, \ldots, X_j, \ldots, X_n) = b_i$, i = 1, 2, ….., m, $X_j \geq 0$, j = 1, 2, ….., n. **(APR/MAY 2017)**	C404.4	BTL1
32	**Define the Jacobian matrix J and the control matrix C.**	C404.4	BTL1

	 For the function of one variable it is based on the fact that for a differentiable function f(x) we have the following approximation: $x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$ Similarly, for the system of n functions of n variables: $X_{n+1} = X_n - [F'(x_n)]^{-1}F(X_n)$ $F'(x_n)$,often called Jacobean matrix, is a matrix of first order partial derivatives of all the functions. **(APR/MAY 2017)**		

PART-B

Q. No.	Questions	CO	Bloom's Level
1.	1. Solve the following non linear programming problem using Langrangean multipliers method. Minimize $Z=4X_1^2+2X_2^2+X_3^2-4X_1X_2$ Subject to $X_1+X_2+X_3=15$ $2X_1-X_2+2X_3=20$ X_1,X_2 AND $X_3 \geq 0$ **Refer Notes**	C404.4	BTL6
2.	2. Solve the following non linear programming problem using Kuhn-Tucker conditions. Maximize $Z=8X_1+10X_2- X_1^2-X_2^2$ Subject to $3X_1+2X_2\leq 6$ X_1 and $X_2\geq 0$	C404.4	BTL6

	Refer Notes		
3.	Explain the Lagrangean method and steps involved in it with an example **Refer Notes**	C404.4	BTL6
4	3. Explain the Kuhn-Tucker method and steps involved in it with an example. **Refer Notes**	C404.4	BT6
5	4. Explain the Newton-Raphson method in detail and justify how it is used to solve the non linear equations. **Refer Notes**	C404.4	BTL6
6	What is Jacobian method? Explain the steps how Jacobian matrix is generated **Refer Notes**	C404.4	BTL1
7	(NOV/DEC  Using Jacobian method Max $Z = 2x_1 + 3x_2$ (16) Subject to $x_1 + x_2 + x_3 = 5$ $x_1 + x_2 + x_4 = 3$ $x_1, x_2, x_3, x_4 \geq 0.$ 2016) **Refer Notes**	C404.4	BTL6
8	**NOV/DEC 2016)**  Solve the nonlinear programming problem by Khun-Tucker conditions. (16) Minimize $f(x) = x_1^2 + x_2^2 + x_3^2$ Subject to $g_1(X) = 2x_1 + x_2 - 5 \leq 0$ $g_2(X) = x_1 + x_2 - 2 \leq 0$ $g_3(X) = 1 - x_1 \leq 0$ $g_4(X) = 2 - x_2 \leq 0$ $g_5(X) = -x_3 \leq 0.$ **Refer Notes**	C404.4	BTL6

9	Maximize $f(x)=x_1^2+2x_2^2+10x_3^2+5x_1x_2$ Subject to $g_1(x)=x_1+x2_2^2+3x_2x_3-5=0$ $g_2(x)=x_1^2+5x_1x_2+x_3^2-75=0$ Apply the Jacobian method to find $\partial f(x)$ in the feasible neighbourhood of the feasible point $(1,1,1)$. Assume that the feasible neighbourhood is specified by $\partial g_1=-0.1$, $\partial g_2=.02$ and $\partial x_1=.01$. (16) **(APR/MAY 2017)**	C404.4	BTL6
10	Solve the nonlinear programming problem by Lagrangian multiplier method. Minimize $z=x_1^2+3x_2^2+5x_3^2$ Subject to the constraints $x_1+x_2+3x_3=2$ $5x_1+2x_2+x_3=5$ (16) $x_1, x_2, x_3 \geq 0.$ **(APR/MAY 2017)**	C404.4	BTL6
11	Illustrate Newton — Raphson method with suitable example. **(APR/MAY 2018)**	C404.4	BTL6
12	Illustrate Kuhn — Tucker Conditions with an example. **(APR/MAY 2018)**	C404.4	BTL6

UNIT-V

OBJECT SCHEDULING: **9**

Network diagram representation – Critical path method – Time charts and resource leveling – PERT

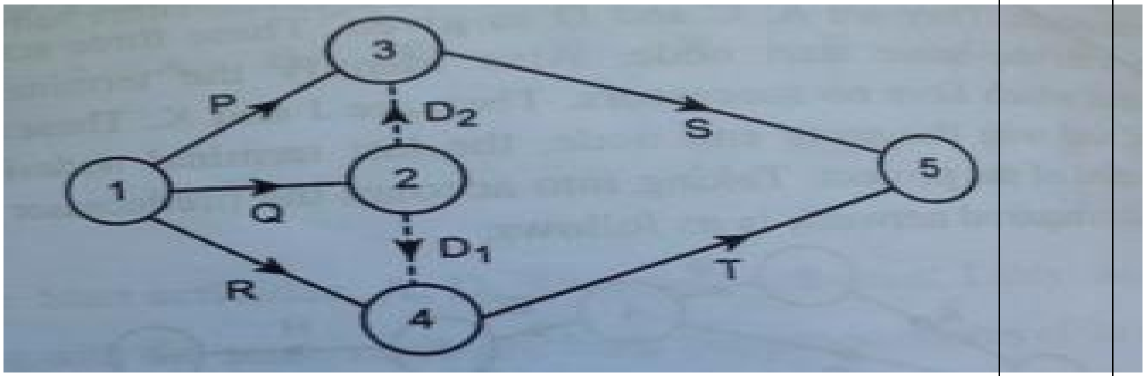
Q. No.	Questions	CO	Bloom's Level
1.	**What do you mean by project?** A project is defined as a combination on inter related activities with limited resources namely men, machines materials, money and time all of which must be executed in a defined order for its completion.	C404.5	BTL1
2.	**. What are the three main phases of project?** Planning – This phase involves a listing of tasks or jobs that must be performed to complete a project under considerations. Scheduling – This phase involves the laying out of the actual activities of the projects in a logical sequence of time in which they	C404.5	BTL1

	have to be performed. Control – This phase consists of reviewing the progress of the project whether the actual performance is according to the planned schedule and finding the reasons for difference, if any, between the schedule and performance.		
3.	**What are the two basic planning and controlling techniques in a network analysis?** • Critical Path Method (CPM) • Programme Evaluation and Review Technique (PERT)	C404.5	BTL1
4	**What are the advantages of CPM and PERT techniques?** • It encourages a logical discipline in planning, scheduling and control of projects • It helps to effect considerable reduction of project times and the cost • It helps better utilization of resources like men,machines,materials and money with reference to time • It measures the effect of delays on the project and procedural changes on the overall schedule**.**	C404.5	BTL1
5	**What is the difference CPM and PERT (APR/MAY 2018)** CPM • Network is built on the basis of activity • Deterministic nature • One time estimation PERT • An event oriented network • Probabilistic nature Three time estimation	C404.5	BTL1
6	**What is network?** A network is a graphical representation of a project's operation and is composed of all the events and activities in sequence along with their inter relationship and inter dependencies	C404.5	BTL1
7	**What is Event in a network diagram?** An event is specific instant of time which marks the starts and end of an activity. It neither consumes time nor resources. It is represented by a circle.	C404.5	BTL1
8	**Define activity?** A project consists of a number of job operations which are called activities. It is the element of the project and it may be a process, material handling, procurement cycle etc.	C404.5	BTL1
9	**Define Critical Activities?** In a Network diagram critical activities are those whose if consumer	C404.5	BTL1

	more than estimated time the project will be delayed.		
10	**Define non critical activities?** Activities which have a provision such that the event if they consume a specified time over and above the estimated time the project will not be delayed are termed as non critical activities.	C404.5	BTL1
11	**Define Dummy Activities?** When two activities start at a same time, the head event are joined by a dotted arrow known as dummy activity which may be critical or non critical**.**	C404.5	BTL1
12	**Define duration?** It is the estimated or the actual time required to complete a trade or an activity.	C404.5	BTL1
13	**Define total project time?** It is time taken to complete to complete a project and just found from the sequence of critical activities. In other words it is the duration of the critical path**.**	C404.5	BTL1
14	**Define Critical Path?(NOV/DEC 2016)** It is the sequence of activities which decides the total project duration. It is formed by critical activities and consumes maximum resources and time.	C404.5	BTL1
15	**Define float or slack? (MAY ’08)** Slack is with respect to an event and float is with respect to an activity. In other words, slack is used with PERT and float with CPM. Float or slack means extra time over and above its duration which a non-critical activity can consume without delaying the project.	C404.5	BTL1
16	**. Define total float? (MAY ’08)** The total float for an activity is given by the total time which is available for performance of the activity, minus the duration of the activity. The total time is available for execution of the activity is given by the latest finish time of an activity minus the earliest start time for the activity. Thus Total float = Latest start time – earliest start time.	C404.5	BTL1
17	**Define free float? (MAY ’08)** This is that part of the total float which does not affect the subsequent activities. This is the float which is obtained when all the activities are started at the earliest	C404.5	BTL1
18	**Define Independent float? (MAY ’07) (MAY ’08)** If all the preceding activities are completed at their latest, in some cases, no float available for the subsequent activities which may therefore	C404.5	BTL1

	become critical. Independent float = free – tail slack.		
19	**Define Interfering float?** Sometimes float of an activity if utilized wholly or in part, may influence the starting time of the succeeding activities is known as interfering float. Interfering float = latest event time of the head - earliest event time of the event	C404.5	BTL1
20	**Define Optimistic?** Optimistic time estimate is the duration of any activity when everything goes on very well during the project	C404.5	BTL1
21	**Define Pessimistic? (APR/MAY 2018)** Pessimistic time estimate is the duration of any activity when almost everything goes against our will and a lot of difficulties is faced while doing a project	C404.5	BTL1
22	**Define most likely time estimation?** Most likely time estimate is the duration of any activity when sometimes thing go on very well, sometimes things go on very bad while doing the project.	C404.5	BTL1
23	**What is a parallel critical path?** When critical activities are crashed and the duration is reduced other paths may also become critical such critical paths are called parallel critical path.	C404.5	BTL1
24	**What is standard deviation and variance in PERT network? (NOV '07)** The expected time of an activity in actual execution is not completely reliable and is likely to vary. If the variability is known we can measure the reliability of the expected time as determined from three estimates. The measure of the variability of possible activity time is given by standard deviation, their probability distribution Variance of the activity is the square of the standard deviation	C404.5	BTL1
25	**Compare direct cost and indirect cost? (NOV '07)** Direct cost is directly depending upon the amount of resources involved in the execution of all activities of the project. Increase in direct cost will decrease in project duration. Indirect cost is associated with general and administrative expenses, insurance cost, taxes etc. Increase in indirect cost will increase in project duration.	C404.5	BTL2
26	**What is meant by resource analysis?** Resources are required to carry out the project tasks. They can be equipment, facilities, funding which are required for the completion of a project activity. The lack of resource will therefore be a constraint on the completion of a project activity.	C404.5	BTL1

	Resource scheduling, availability and optimization are considered key to successful project management.		
27	. **What are the three time estimates used in the context of PERT? How are the expected duration of an activity and its standard deviation calculated?** Optimistic time estimate or least time estimate (t_o or a) Pessimistic time estimate or greatest time estimate (t_p or b) Most likely time estimate (t_m or b) Expected Duration = $(t_e+4t_m+t_p)/6$ Standard deviation = $(t_p-t_o)/6$	C404.5	BTL1
28	**Define a dummy arrow used in a network and state two purposes for which it is used.** Dummy activity is a hypothetical activity which requires zero time and zero resources for completion. Dummy arrow represents an activity with zero duration. It is represented by dotted line and is inserted in the network to clarify activity pattern under the following situations: i. It is created to make activities with common starting and finishing events distinguishable, and ii. To identify and maintain the proper precedence relationship between activities those are not connected by events.	C404.5	BTL1
29	**What are the advantages of PERT.** ✓ It compels managers to plan their projects critically and analyse all factors affecting the progress of the plan. The process of the network analysis requires that the project planning be conducted on considerable detail from the start to the finish. ✓ It provides the management a tool for forecasting the impact of schedule changes and be prepared to correct such situations. The likely trouble spots are located early enough so as to apply some preventive measures or corrective actions. ✓ A lot of data can be presented in a highly ordered fashion. The task relationships are graphically represented for easier evaluation and individuals in different locations can easily determine their role in the total task requirements. The PERT time (Te) is based upon 3-way estimate and hence is the most objective time in the light of uncertainties and results in greater degree of accuracy in time forecasting.	C404.5	BTL1

30	**.(NOV/DEC 2016)** **If there are five activities P, Q, R, S and T such that P, Q, R have no immediate predecessors but S and T have immediate predecessors P, Q and Q, R respectively. Represent this situation by a network.** 	C404.5	BTL1
31	**Draw the network for the project whose activities and their precedence relationship are as given below :** Activities : A B C D E F G H I Precedence : – A A – D B, C, E F E G, H **(APR/MAY 2017)**	C404.5	BTL1
32	**State the rules for network construction.** **(APR/MAY 2017)** A network is a graphical representation of a project's operation and is composed of all the events and activities in sequence along with their inter relationship and inter dependencies	C404.q5	BTL1
33	What is CPM ? **(NOV/DEC 2017)** The critical path method (CPM) is a step-by-step methodology, technique or algorithm for planning projects with numerous activities that involve complex, interdependent interactions. CPM is an important tool for project management because it identifies critical and non-critical tasks to prevent conflicts and bottlenecks.	C404.4	BTL1
34	Write about PERT. **(NOV/DEC 2017)** Program evaluation and review technique (PERT) is a technique adopted by	C404.4	BTL1

<table>
<tr><td></td><td>organizations to analyze and represent the activity in a project, and to illustrate the flow of events in a project. PERT is a method to evaluate and estimate the time required to complete a task within deadlines.</td><td></td><td></td></tr>
</table>

PART-B

<table>
<tr><td>1.</td><td>1. A project schedule has the following characteristics
<table>
<tr><td>Activity</td><td>0 – 1</td><td>0 – 2</td><td>1 – 3</td><td>2 – 3</td><td>2 – 4</td><td>3 – 4</td><td>3 – 5</td><td>4 – 5</td><td>4 - 6</td><td>5 - 6</td></tr>
<tr><td>Time</td><td>2</td><td>3</td><td>2</td><td>3</td><td>3</td><td>0</td><td>8</td><td>7</td><td>8</td><td>6</td></tr>
</table>
(i). Construct Network diagram.
(ii). Compute Earliest time and latest time for each event.
(iii). Find the critical path. Also obtain the Total float, Free float and slack time and Independent float
Refer Notes</td><td>C404.5</td><td>BTL6</td></tr>
<tr><td>2.</td><td>.A project schedule has the following characteristics.
<table>
<tr><td>Activity</td><td>1 – 2</td><td>1 – 3</td><td>2 – 4</td><td>3 – 4</td><td>3 – 5</td><td>4 – 9</td><td>5 – 6</td><td>5 – 7</td><td>6 – 8</td><td>7 - 8</td><td>8 – 10</td><td>9 - 10</td></tr>
<tr><td>Time</td><td>4</td><td>1</td><td>1</td><td>1</td><td>6</td><td>5</td><td>4</td><td>8</td><td>1</td><td>2</td><td>5</td><td>7</td></tr>
</table>
(i). Construct Network diagram
(ii). Compute Earliest time and latest time for each event.
(iii). Find the critical path. Also obtain the Total float, Free float and slack time and Independent float.
Refer Notes</td><td>C404.5</td><td>BTL6</td></tr>
<tr><td>3.</td><td>A small project is composed of seven activities whose time estimates are listed in the table as follows:
<table>
<tr><td>Activity</td><td>Preceding Activities</td><td>Duration</td></tr>
<tr><td>A</td><td>----</td><td>4</td></tr>
<tr><td>B</td><td>----</td><td>7</td></tr>
<tr><td>C</td><td>----</td><td>6</td></tr>
<tr><td>D</td><td>A,B</td><td>5</td></tr>
<tr><td>E</td><td>A,B</td><td>7</td></tr>
</table></td><td>C404.5</td><td>BTL6</td></tr>
</table>

F	C,D,E	6
G	C,D,E	5

(I). Draw the network and find the project completion time.
(ii). Calculate the three floats for each activity

Refer Notes

4

Calculate the total float, free float and independent float for the project whose activities are given below:

Activity	1 – 2	1 – 3	1 – 5	2 – 3	2 – 4	3 – 4	3 – 5	3 – 6	4 - 6	5 - 6
Key	8	7	12	4	10	3	5	10	7	4

Refer Notes

C404.5 BTL6

5

Draw the network for the following project and compute the earliest and latest times for each event and also find the critical path.

Activity	1 – 2	1 – 3	2 – 4	3 – 4	4 – 5	4 – 6	5 – 7	6 – 7	7 - 8
Immediate Predecessor	---	---	1 – 2	1 – 3	2 – 4	2 – 4 & 3 - 4	4 – 5	4 – 6	6 – 7 & 5 - 7
Time	5	4	6	2	1	7	8	4	

Refer Notes

C404.5 BTL2

6

The following table lists the jobs of a network with their time estimates:

Job(I, j)	Duration		
	Optimistic (to)	Most likely(tm)	Pessimistic (tp)
1 – 2	3	6	15
1 – 6	2	5	14
2 – 3	6	12	30
2 – 4	2	5	8
3 – 5	5	11	17
4 – 5	3	6	15
6 – 7	3	9	27
5 – 8	1	4	7
7 – 8	4	19	28

(i). Draw the project network.
(ii). Calculate the length and variance of the Critical Path.
(iii). What is the approximate probability that the jobs on the critical path will be completed by the due date of 42 days?
(iv). What due date has about 90 % chance of being met?

Refer Notes

C404.5 BTL6

<table>
<tr>
<td>7</td>
<td>
A small project is composed of 7 activities, whose time estimates are listed in the table below. Activities are identified by their beginning (i) and (j) node numbers.

<table>
<tr><th rowspan="2">Job(I, j)</th><th colspan="3">Duration</th></tr>
<tr><th>Optimistic (to)</th><th>Most likely(tm)</th><th>Pessimistic (tp)</th></tr>
<tr><td>1 – 2</td><td>1</td><td>1</td><td>7</td></tr>
<tr><td>1 – 3</td><td>1</td><td>4</td><td>7</td></tr>
<tr><td>1 – 4</td><td>2</td><td>2</td><td>8</td></tr>
<tr><td>2 – 5</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>3 – 5</td><td>2</td><td>5</td><td>14</td></tr>
<tr><td>4 – 6</td><td>2</td><td>5</td><td>8</td></tr>
<tr><td>5 – 6</td><td>3</td><td>6</td><td>15</td></tr>
</table>

(i). Draw the project network and identify all the paths through it.
(ii). Find the expected duration and variance for each activity. What is the expected project length?
(iii). Calculate the variance and standard deviation of the project length. What is the probability that the project will be completed atleast 4 weeks earlier than expected time?
Refer Notes
</td>
<td>C404.5</td>
<td>BTL6</td>
</tr>
<tr>
<td>8</td>
<td>
The following table lists the jobs of a network along with their time estimates.

<table>
<tr><th>Activity</th><th>1 – 2</th><th>1 – 3</th><th>2 – 4</th><th>3 – 4</th><th>3 – 5</th><th>4 – 9</th><th>5 – 6</th><th>5 – 7</th><th>6 – 8</th><th>7 - 8</th></tr>
<tr><td>Time</td><td>4</td><td>1</td><td>1</td><td>1</td><td>6</td><td>5</td><td>4</td><td>8</td><td>1</td><td>2</td></tr>
</table>

(i). Draw the project network.
(ii). Calculate the length and variance of the critical path after estimating the earliest and latest event times for all nodes.
(iii). Find the probability of completing the project before 41 days?
Refer Notes
</td>
<td>C404.5</td>
<td>BTL6</td>
</tr>
<tr>
<td>9</td>
<td>
The time estimates (in weeks) for the activities of a PERT network are given below:

<table>
<tr><th rowspan="2">Job(I, j)</th><th colspan="3">Duration</th></tr>
<tr><th>Optimistic (to)</th><th>Most likely(tm)</th><th>Pessimistic (tp)</th></tr>
<tr><td>1 – 2</td><td>1</td><td>1</td><td>7</td></tr>
<tr><td>1 – 3</td><td>1</td><td>4</td><td>7</td></tr>
<tr><td>1 – 4</td><td>2</td><td>2</td><td>8</td></tr>
<tr><td>2 – 5</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>3 – 5</td><td>2</td><td>5</td><td>14</td></tr>
</table>
</td>
<td>C404.5</td>
<td>BTL6</td>
</tr>
</table>

4 – 6	2	5	8
5 – 6	3	6	15

(i). Determine the expected project length.

(ii). Calculate the standard deviation and variance of the project.

(iii). If the project due date is 19 weeks, what is the probability of not meeting the due date?

Refer Notes

10

The following table lists the jobs of a network along with their time estimates

Job(I, j)	Duration		
	Optimistic (to)	Most likely(tm)	Pessimistic (tp)
1 – 2	2	5	14
1 – 3	9	12	15
2 – 4	5	14	17
3 – 4	2	5	8
4 – 5	6	6	12
3 – 5	8	17	20

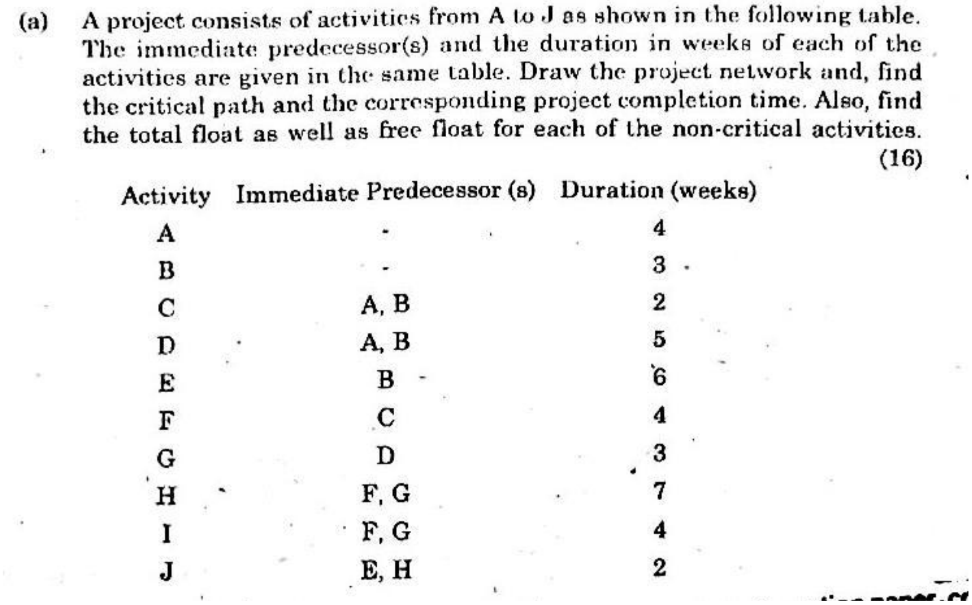
Draw the network. Calculate the length and variance of the critical path and find the probability that the project will be completed within 30 days

Refer Notes

C404.5

BTL6

11



(a) A project consists of activities from A to J as shown in the following table. The immediate predecessor(s) and the duration in weeks of each of the activities are given in the same table. Draw the project network and, find the critical path and the corresponding project completion time. Also, find the total float as well as free float for each of the non-critical activities. (16)

Activity	Immediate Predecessor (s)	Duration (weeks)
A	-	4
B	-	3
C	A, B	2
D	A, B	5
E	B	6
F	C	4
G	D	3
H	F, G	7
I	F, G	4
J	E, H	2

Refer Notes

C404.5

BTL6

12

.(NOV/DEC 2016)

C404.5

BTL6

<table>
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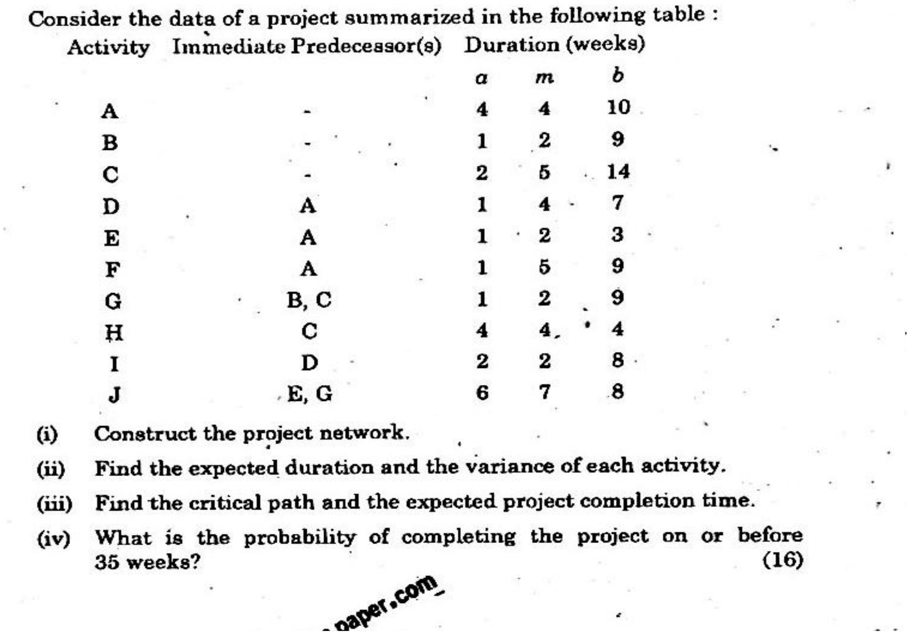
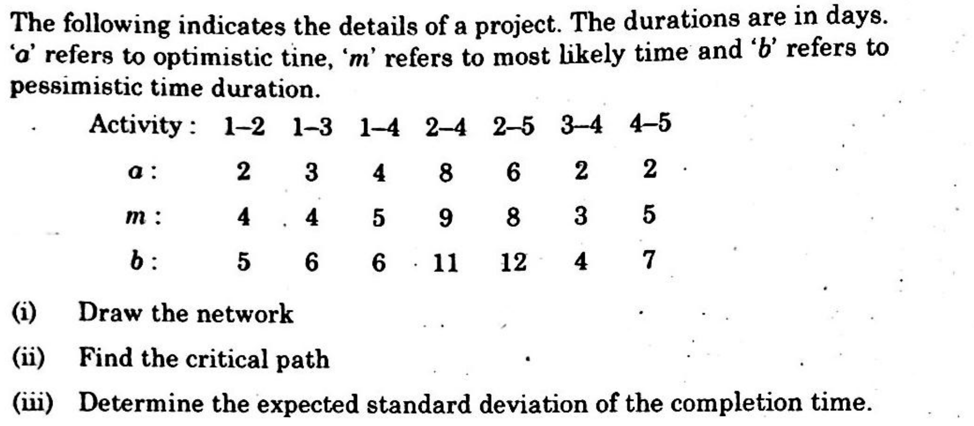
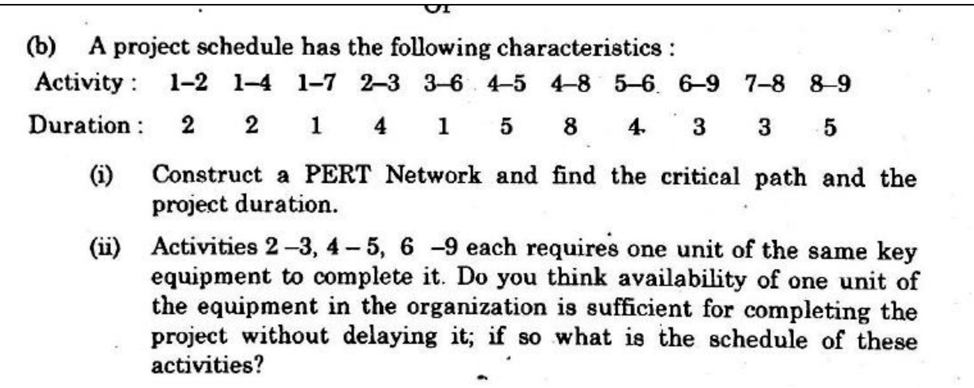
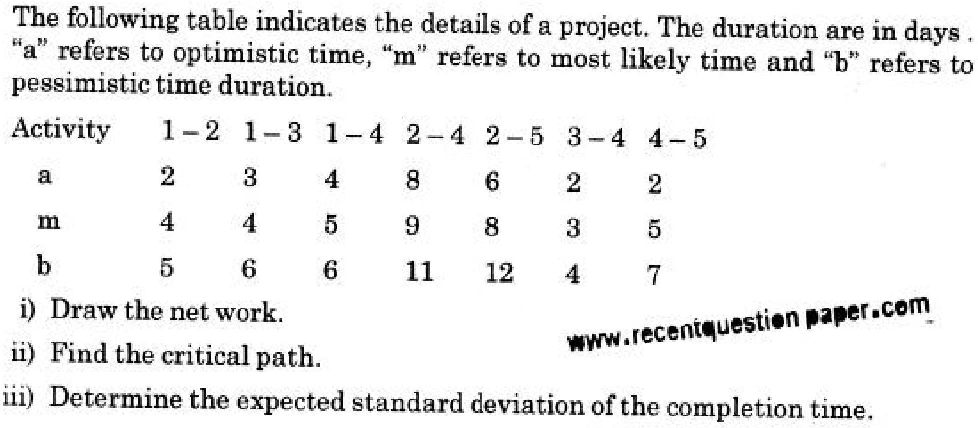
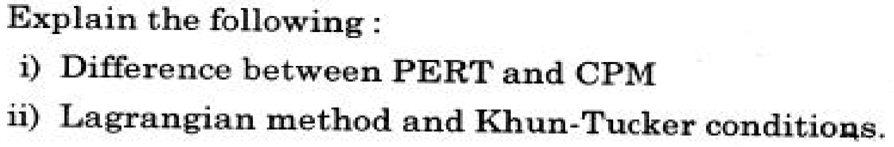

Consider the data of a project summarized in the following table :
<table>
<tr><th>Activity</th><th>Immediate Predecessor(s)</th><th colspan="3">Duration (weeks)</th></tr>
<tr><td></td><td></td><td>a</td><td>m</td><td>b</td></tr>
<tr><td>A</td><td>-</td><td>4</td><td>4</td><td>10</td></tr>
<tr><td>B</td><td>-</td><td>1</td><td>2</td><td>9</td></tr>
<tr><td>C</td><td>-</td><td>2</td><td>5</td><td>14</td></tr>
<tr><td>D</td><td>A</td><td>1</td><td>4</td><td>7</td></tr>
<tr><td>E</td><td>A</td><td>1</td><td>2</td><td>3</td></tr>
<tr><td>F</td><td>A</td><td>1</td><td>5</td><td>9</td></tr>
<tr><td>G</td><td>B, C</td><td>1</td><td>2</td><td>9</td></tr>
<tr><td>H</td><td>C</td><td>4</td><td>4</td><td>4</td></tr>
<tr><td>I</td><td>D</td><td>2</td><td>2</td><td>8</td></tr>
<tr><td>J</td><td>E, G</td><td>6</td><td>7</td><td>8</td></tr>
</table>
(i) Construct the project network.
(ii) Find the expected duration and the variance of each activity.
(iii) Find the critical path and the expected project completion time.
(iv) What is the probability of completing the project on or before 35 weeks? (16)

Refer Notes
</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>
A small project consists of jobs as given in the table below. Each job is listed with its normal time and a minimum or crash time (in days). The cost (in Rs.per day) for each job is also given:
<table>
<tr><th>Job (i-j)</th><th>Normal Duration (in days)</th><th>Minimum (crash) Duration (in days)</th><th>Cost of Crashing (Rs. per day)</th></tr>
<tr><td>1-2</td><td>9</td><td>5</td><td>20</td></tr>
<tr><td>1-3</td><td>8</td><td>5</td><td>25</td></tr>
<tr><td>1-4</td><td>15</td><td>10</td><td>30</td></tr>
<tr><td>2-4</td><td>5</td><td>3</td><td>10</td></tr>
<tr><td>3-4</td><td>10</td><td>6</td><td>15</td></tr>
<tr><td>4-5</td><td>2</td><td>1</td><td>40</td></tr>
</table>
a) What is the normal project length and the minimum project length?
b) Determine the minimum crashing cost of schedules ranging from normal length down to, and including, the minimum length schedule. That is, if L = Length of the schedule, find the costs of schedules which are L, L-1, L-2 and so on.
Overhead costs total Rs.60 per day. What is the optimum length schedule in terms of both crashing and overhead cost? List the schedule duration of each job for your solution
Refer Notes
</td>
<td>C404.5</td>
<td>BTL6</td>
</tr>
</table>

<table>
<tr>
<td>14</td>
<td>The following information is available.
<table>
<tr><th>Activity</th><th>No. of Days</th><th>No. of men reqd. per day</th></tr>
<tr><td>A 1-2</td><td>4</td><td>2</td></tr>
<tr><td>B 1-3</td><td>2</td><td>3</td></tr>
<tr><td>C 1-4</td><td>8</td><td>5</td></tr>
<tr><td>D 2-6</td><td>6</td><td>3</td></tr>
<tr><td>E 3-5</td><td>4</td><td>2</td></tr>
<tr><td>F 5-6</td><td>1</td><td>3</td></tr>
<tr><td>G 4-6</td><td>1</td><td>8</td></tr>
</table>
a) Draw the network and find the critical path.
b) What is the peak requirement of Manpower? On which day(s) will this occur?
If the minimum labour available on any day is only 10, when can the project be completed
Refer Notes</td>
<td>C404.5</td>
<td>BTL6</td>
</tr>
<tr>
<td>15</td>
<td>
The following indicates the details of a project. The durations are in days. ‘a’ refers to optimistic tine, ‘m’ refers to most likely time and ‘b’ refers to pessimistic time duration.
<table>
<tr><th>Activity :</th><th>1–2</th><th>1–3</th><th>1–4</th><th>2–4</th><th>2–5</th><th>3–4</th><th>4–5</th></tr>
<tr><td>a :</td><td>2</td><td>3</td><td>4</td><td>8</td><td>6</td><td>2</td><td>2</td></tr>
<tr><td>m :</td><td>4</td><td>4</td><td>5</td><td>9</td><td>8</td><td>3</td><td>5</td></tr>
<tr><td>b :</td><td>5</td><td>6</td><td>6</td><td>11</td><td>12</td><td>4</td><td>7</td></tr>
</table>
(i) Draw the network
(ii) Find the critical path
(iii) Determine the expected standard deviation of the completion time.
(APR/MAY 2017)</td>
<td>C404.5</td>
<td>BTL6</td>
</tr>
</table>

<table>
<tr><td>16</td><td>

(b) A project schedule has the following characteristics :
<table>
<tr><td>Activity :</td><td>1–2</td><td>1–4</td><td>1–7</td><td>2–3</td><td>3–6</td><td>4–5</td><td>4–8</td><td>5–6</td><td>6–9</td><td>7–8</td><td>8–9</td></tr>
<tr><td>Duration :</td><td>2</td><td>2</td><td>1</td><td>4</td><td>1</td><td>5</td><td>8</td><td>4</td><td>3</td><td>3</td><td>5</td></tr>
</table>
(i) Construct a PERT Network and find the critical path and the project duration.
(ii) Activities 2 –3, 4 – 5, 6 –9 each requires one unit of the same key equipment to complete it. Do you think availability of one unit of the equipment in the organization is sufficient for completing the project without delaying it; if so what is the schedule of these activities?
(APR/MAY 2017)
</td><td>C404.5</td><td>BTL6</td></tr>
<tr><td>17</td><td>

The following table indicates the details of a project. The duration are in days . "a" refers to optimistic time, "m" refers to most likely time and "b" refers to pessimistic time duration.
<table>
<tr><td>Activity</td><td>1 – 2</td><td>1 – 3</td><td>1 – 4</td><td>2 – 4</td><td>2 – 5</td><td>3 – 4</td><td>4 – 5</td></tr>
<tr><td>a</td><td>2</td><td>3</td><td>4</td><td>8</td><td>6</td><td>2</td><td>2</td></tr>
<tr><td>m</td><td>4</td><td>4</td><td>5</td><td>9</td><td>8</td><td>3</td><td>5</td></tr>
<tr><td>b</td><td>5</td><td>6</td><td>6</td><td>11</td><td>12</td><td>4</td><td>7</td></tr>
</table>
i) Draw the net work.

ii) Find the critical path.
iii) Determine the expected standard deviation of the completion time.
(NOV/DEC 2017)
</td><td>C404.5</td><td>BTL6</td></tr>
<tr><td>18</td><td>

Explain the following :
i) Difference between PERT and CPM
ii) Lagrangian method and Khun-Tucker conditions.
(NOV/DEC 2017)
</td><td>C404.5</td><td>BTL6</td></tr>
<tr><td>19</td><td>
Draw the network from the following activity and find the critical path and total duration of project.
<table>
<tr><td>Activity</td><td><i>Immediate Predecessors</i></td><td><i>Duration (Weeks)</i></td></tr>
<tr><td>A</td><td>-</td><td>3</td></tr>
<tr><td>B</td><td>-</td><td>8</td></tr>
<tr><td>C</td><td></td><td>9</td></tr>
</table>
</td><td>C404.5</td><td>BTL6</td></tr>
</table>

<table>
<tr>
<td></td>
<td>
<table>
<tr><td>D</td><td>B</td><td>6</td></tr>
<tr><td>E</td><td>C</td><td>10</td></tr>
<tr><td>F</td><td>C</td><td>14</td></tr>
<tr><td>G</td><td>C,D</td><td>11</td></tr>
<tr><td>H</td><td>F,G</td><td>10</td></tr>
<tr><td>I</td><td>E</td><td>5</td></tr>
<tr><td></td><td></td><td>4</td></tr>
<tr><td></td><td>H</td><td>1</td></tr>
</table>
(APR/MAY 2018)
</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>
A project has the following activities and other characteristics : Time estimate (in weeks)
<table>
<tr><th>Activity</th><th>Preceding Activity</th><th>Most Optimistic</th><th>Most Likely</th></tr>
<tr><td>A</td><td>—</td><td>4</td><td>7</td></tr>
<tr><td>B</td><td></td><td>1</td><td>5</td></tr>
<tr><td>C</td><td>A</td><td>6</td><td>12</td></tr>
<tr><td>D</td><td>A</td><td>2</td><td>5</td></tr>
<tr><td>E</td><td>C</td><td>5</td><td>11</td></tr>
<tr><td>F</td><td>D</td><td>3</td><td>6</td></tr>
<tr><td>G</td><td>B</td><td>3</td><td>9</td></tr>
<tr><td>H</td><td>E, F</td><td>1</td><td>4</td></tr>
<tr><td>I</td><td>G</td><td>4</td><td>19</td></tr>
</table>
Required :
i) Draw the PERT network diagram
ii) Identify the critical path
iii) Prepare the activity schedule for the project
</td>
<td>C404.5</td>
<td>BTL6</td>
</tr>
</table>

	iv) Determine the mean project completion time (^{3}) v) Find the probability that the project is completed in 36 weeks (4) **(APR/MAY 2018)**		