Time Allowed: 3 Hours **Full Marks: 100**

The figures in the margin on the right side indicate full marks.

SECTION – A (Compulsory)

1. Choose the correct option: **[15 x 2=30]**

(i) What is the opportunity cost of making a component part in a factory given no alternative use of the capacity?

a) The variable manufacturing cost of the component
b) The total manufacturing cost of the component
c) The total variable cost of the component
d) Zero

(ii) X Ltd. has 1000 units of an obsolete item which are carried in inventory at the original price of ₹50,000. If these items are reworked for ₹ 20,000, they can be sold for ₹ 36,000. Alternatively, they can be sold as a scrap for ₹ 6,000 in the market. In a decision model used to analyse the reworking proposal, the opportunity cost should be taken as:

a) ₹16,000
b) ₹6,000
c) ₹30,000
d) ₹20,000

(iii) In cost plus pricing, the mark-up consists of:

a) Manufacturing cost
b) Desired ROI
c) Selling and administration cost
d) Total cost and Desired ROI

(iv) JIT relates to:

a) Time Management
b) Inventory and product handling
c) TOC recognizes that lower inventories means more defects.
d) TOC recognizes that EOQ is important.

(v) Bench marking is:

a) A continuous process
b) The practice of setting targets using external information
c) Methods to provide performance assessment
d) All the above

(vi) The following figures are extracted from the books of a company: Budgeted O/H ₹ 10,000 (Fixed ₹ 6,000, Variable ₹ 4,000) Budgeted Hours 2000
Actual O/H ₹ 10,400 (Fixed ₹ 6,100, Variable ₹ 4,300) Actual Hours 2100
Variable O/H cost variance and Fixed O/H cost variance will be:
a) 100(A) and 200(A)
b) 100(F) and 200(F)
c) 100(A) and 200(F)
d) 200(A) and 100(F)

(vii) Standard costing system consists of the following key elements:
a) Setting standards for each of the operations
b) Comparing the actual performance with the standard performance
c) Analyzing and reporting variances arising from the difference between actual and standard performance
d) All of the Above

(viii) Efficiency Ratio is: _____.
a) Available working days ÷ Budgeted working days × 100
b) Budgeted hours ÷ Maximum hours in budgeted period × 100
c) Standard hours ÷ Actual hours × 100
d) None of the above

(ix) Multiple solution exist in a Linear Programming problem when:
a) One of the constraints is redundant
b) Objective Function is parallel to one of the constraints
c) Two constraints are parallel
d) All of the above

(x) Which of the following method is used to test optimality of a solution in Transportation?
a) Modified Distribution
b) Simplex
c) VAM
d) LCM

(xi) Assignment problem can be considered as a particular case of _____.
a) Transportation problem
b) Sequencing problem
c) Queuing problem
d) All of these

(xii) Monte Carlo Simulation gets its name from which of the following?
a) Data collection
b) Model formulation
c) Random number assignment
d) Analysis

(xiii) A PERT Network has nine activities on its Critical Path. The Standard Deviation of each activity on the Critical Path is 3. The S. D of the Critical Path is_____.

a) 3
b) 9
c) 81
d) 27

(xiv) When 24 hours is required to produce a condenser of a particular type then the time required to produce the 16th unit with 85% Learning Curve is _____.

a) Between 9 and 10 hours
b) Between 12 and 14 hours
c) Between 15 and 17 hours
d) Between 18 and 20 hours

(xv) Which of the following has no relation to Business Intelligence?

a) A set of business analytics solutions to retrieve, analyse and transform data into useful business sights
b) Visualisation Tools are primarily BI Tools.
c) ABS Glue is a tool used for the purpose of Business Intelligence
d) Embedded Analytics is an important part of any Business Intelligence tool.

SECTION – B

(Answer any 5 questions out of 7 questions given. Each question carries 14 marks.)

[5 x 14 = 70]

2. Sri Company Ltd. manufactures and sells in a year 20,000 units of a particular product to definite customers at a price of ₹100 per unit. The Firm has a capacity to produce 25,000 units of the product per annum. To produce beyond 25,000 units per annum, it will have to install a New Equipment at a cost of ₹15 Lakhs. The Equipment will have a life span of 10 years and will have no residual value. There is an offer from a Client to purchase 10,000 units of the product regularly at a price of ₹90 per unit. The order, if accepted, will have to be over and above the existing level of production of 20,000 units.

The Cost Structure of the Product (per unit basis) is Direct Materials - ₹30, Direct Labour- ₹20, Variable Overhead - ₹10 and Profit - ₹20. The present total Fixed Overheads is ₹ 4,00,000.

During the coming year, it has been estimated that the cost of Direct Material, as compared to the current year will increase by 10%. Because of certain wage agreement Direct Labour Cost will increase by 25%. Fixed OH will increase by 10%. If the new order for 10,000 units is accepted, Fixed Overheads will increase further by ₹ 60,000 due to increased administrative charges.

Analyse whether the concern should accept the order or instead of that try to secure order for the balance unused capacity, as available now, through some Sales Promotion Expenses which will be ₹50,000 per annum. Ignore financial charges for the new investment. [14]

3. (a) Division A is a profit centre which produces three products X, Y and Z. Each product has an external market. The details are as follows:

Particulars	X	Y	Z
External market price per unit (₹)	48	46	40
Variable cost of production in division A (₹)	33	24	28
Labour hours required per unit in division A	3	4	2

Product Y can be transferred to Division B, but the maximum quantity that might be required for transfer is 300 units of Y

	X	Y	Z
The maximum external sales are:	800 units	500 units	300 units

Instead of receiving transfers of Product Y from Division A, Division B could buy similar product in the open market at a slightly cheaper price of ₹45 per unit.

Calculate the transfer price be for each unit for 300 units of Y, if the total labour hours available in Division A are:

a. 3800 hours

b. 5600 hours. [7]

(b) Company X is forced to choose between two machines A and B. The two machines are designed differently but have identical capacity and do exactly the same job. Machine A costs ₹1,50,000 and will last for 3 years. It costs ₹40,000 per year to run. Machine B is an 'economy' model costing only ₹1,00,000, but will last only for 2 years, and costs ₹60,000 per year to run. These are real cash flows. The costs are forecasted in rupees of constant purchasing power. Ignore tax. Opportunity cost of capital is 10%.

Recommend which machine Company X should buy? [7]

4. (a) Modern Co produces 3 products, A, B and C, details of which are shown below:

Particulars	A	B	C
Selling price per unit (₹)	120	110	130
Direct material cost per unit (₹)	60	70	85
Variable overhead (₹)	30	20	15
Maximum demand (units)	30,000	25,000	40,000
Time required on the bottleneck resource (hours per unit)	5	4	3

There are 3,20,000 bottleneck hours available each month.

Calculate the optimum product mix based on the throughput concept [7]

(b) Discuss the underlying principles of Total quality management. [7]

5. (a) A company manufacturing a special type of fencing tile 12" × 8" × 1/2" used a system of standard costing. The standard mix of the compound used for making the tiles is:

1,200 kg. of material A @ ₹0.30 per kg.

500 kg. of Material B @ ₹0.60 per kg

800 kg. of Material C @ ₹0.70 per kg

The compound should produce 12,000 square feet of tiles of 1/2" thickness. During a period in which 1,00,000 tiles of the standard size were produced, the material usage was:

Kg		₹
7,000	Material A @ ₹ 0.32 per kg.	2,240
3,000	Material B @ ₹ 0.65 per kg.	1,950
5,000	Material C @ ₹ 0.75 per kg.	3,750
15,000		7,940

Prepare the cost figures for the period showing Material price, Mixture, Sub-usage Variance. [7]

(b)

Item	Budget	Actual
No. of working days	20	22
Output per man hour	1.0 Units	0.9 Units
Overhead cost	₹1,60,000	₹1,68,000
Man-hours per day	8,000	8,400

Calculate Overhead Variances. [7]

6. (a) A company possesses two manufacturing plants each of which can produce three products x, Y and Z from a common raw material. However, the proportions in which the products are produced are different in each plant and so are the plant's operating costs per hour. Data on production per hour costs are given below, together with current orders in hand for each product.

	Product			Operating cost/ hour in ₹
	X	Y	Z	
Plant A	2	4	3	9
Plant B	4	3	2	10
Orders on hand	50	24	60	

Develop a LPP to minimise the cost [7]

(b) The manager of a book store has to decide the number of copies of a particular tax law book to order. A book costs ₹ 60 and is sold for ₹ 80. Since some of the tax laws change year after year, any copies unsold while the edition is current must be sold for ₹ 30. From past records, the distribution of demand for this book has been obtained as follows:

Demand (No of copies)	15	16	17	18	19	20	21	22
Proportion	0.05	0.08	0.20	0.45	0.10	0.07	0.03	0.02

Using the following sequence of random numbers, generate the demand for 20 time periods (years). Calculate the average profit obtainable under each of the courses of action open to the manager. Recommend the optimal policy.

14	02	93	99	18	71	37	30	12	10
88	13	00	57	69	32	18	08	92	73

[7]

7. (a) Draw a network from the following activities. Evaluate the critical path and total duration of the project.

Activity	Immediate predecessor activity	Duration (days)
A	—	10
B	A	5
C	A	4
D	A	7
E	B,C	6
F	C,D	4
G	E,F	7

[7]

(b) The usual Learning Curve model is $Y = ax^b$ where
Y is the average time per unit for x units and 'a' is the time for first unit x is the cumulative number of units
b is the learning coefficient and is equal to (log 0.8)/(log 2) = – 0.322 for a learning rate of 80%
Given that a = 10 hours, you are required to Calculate:
(i) The average time for 20 units.
(ii) The total time for 30 units.
(iii) The time for units 31 to 40.
Given that log 2 = 0.301, Antilog of 0.5811 = 3.812
log 3 = 0.4771, Antilog of 0.5244 = 3.345.
log 4 = 0.6021, Antilog of 0.4841 = 3.049. [7]

8. (a) The demand (rides per day) of Roller Coaster Ride in an Entertainment Park in one of the metro cities is given the equation q = - 450p + 41500, where p = Price per ride in ₹. Suggest what price should have been charged to maximize the total revenue? [7]

(b) From the following past data of Sales (in lakhs Rupees) of a company estimate the same for the year 2025.

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Sales	15.3	14.6	16.8	17.3	17.2	20.9	22.3	20	23.1	24.5

Assume the trend line to be linear. Calculate the monthly rate of increase of Sales. [7]

STRATEGIC COST MANAGEMENT

Time Allowed: 3 Hours **Full Marks: 100**

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SECTION – A (Compulsory)

1. Choose the correct option: **[15 x 2=30]**

(i) What is the opportunity cost of making a component part in a factory given no alternative use of the capacity?

a) The variable manufacturing cost of the component
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Answers:

i	ii	iii	iv	v	vi	vii	viii	ix	x
d	b	b	b	d	c	d	c	b	a
xi	**xii**	**xiii**	**xiv**	**xv**					
a	c	b	b	c					

SECTION – B

(Answer any 5 questions out of 7 questions given. Each question carries 14 marks.)

[5 x 14 = 70]

2. Sri Company Ltd. manufactures and sells in a year 20,000 units of a particular product to definite customers at a price of ₹100 per unit. The Firm has a capacity to produce 25,000 units of the product per annum. To produce beyond 25,000 units per annum, it will have to install a New Equipment at a cost of ₹15 Lakhs. The Equipment will have a life span of 10 years and will have no residual value. There is an offer from a Client to purchase 10,000 units of the product regularly at a price of ₹90 per unit. The order, if accepted, will have to be over and above the existing level of production of 20,000 units.

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Analyse whether the concern should accept the order or instead of that try to secure order for the balance unused capacity, as available now, through some Sales Promotion Expenses which will be ₹50,000 per annum. Ignore financial charges for the new investment. [14]

Answer:

1. **Present and Revised Cost and Profit Structure**

Particulars	Present	Revised
(a) Sale Price p.u.	Given = ₹100	
(b) Direct Material Cost p.u.	Given = ₹30	₹30 + 10% = ₹33
(c) Direct Labour Cost p.u.	Given = ₹20	₹20 + 25% = ₹25
(d) VOH p.u.	Given = ₹10	No Change = ₹10
(e) Variable Cost p.u. (b + c + d)	₹60	₹ 68
(f) Fixed OH (Total)	Given = ₹4,00,000	₹ 4,00,000 + 10% = ₹4,40,000

2. **Options available to the company**

Option	Description
I	Continue at present level of 20,000 units
II	Incur Additional SOH and sell up to full capacity = 20,000 + 5,000 = 25,000 units
III	Buy New equipments, accept special offer of 10,000 units at ₹ 90 p.u = 20,000 + 10,000 = 30,000 units
IV	Accept both Options II and III, and sell 20 ,000 + 5,000 + 10,000 = 35,000 units

3. Profit Analysis under different options

Particulars	Option I	Option II	Option III	Option IV
(a) Sale Quantity	20,000 units	25,000 units	30,000 units	35,000 units
(b) Sale Price p.u.	₹100	₹100	20,000 units at ₹100 & 10,000 units at ₹90	25,000 units at ₹100 & 10,000 units at ₹90
(c) Sale Revenue (a × b)	₹20,00,000	₹25,00,000	₹29,00,000	₹34,00,000
(d) VC at ₹68 p.u. (WN 1)	₹13,60,000	₹17,00,000	₹20,40,000	₹23,80,000
(e) Contribution (c – d)	₹6,40,000	₹8,00,000	₹8,60,000	₹10,20,000
(f) Fixed Costs				
Given (WN 1f)	₹4,40,000	₹4,40,000	₹4,40,000	₹4,40,000
Additional SOH	-	₹50,000	-	₹50,000
Additional AOH	-	-	₹60,000	₹60,000
Department on New Equipment	-	-	₹1,50,000	₹1,50,000
Total Fixed Costs	₹4,40,000	₹4,90,000	₹6,50,000	₹7,00,000
(g) Profit (e – f)	₹2,00,000	₹3,10,000	₹2,10,000	₹3,20,000
(h) Rank I Priority	(iv)	(ii)	(iii)	(i)

Note: Depreciation on New Equipments = ₹15,00,000/10 years = ₹1,50,000.

Decision: Option IV is preferable, due to maximum profits. If it is not possible, the Firm may choose Option II.

3. (a) Division A is a profit centre which produces three products X, Y and Z. Each product has an external market. The details are as follows:

Particulars	**X**	**Y**	**Z**
External market price per unit (₹)	**48**	**46**	**40**
Variable cost of production in division A (₹)	**33**	**24**	**28**
Labour hours required per unit in division A	**3**	**4**	**2**

Product Y can be transferred to Division B, but the maximum quantity that might be required for transfer is 300 units of Y

	X	**Y**	**Z**
The maximum external sales are:	**800 units**	**500 units**	**300 units**

Instead of receiving transfers of Product Y from Division A, Division B could buy similar product in the open market at a slightly cheaper price of ₹45 per unit.

Calculate the transfer price be for each unit for 300 units of Y, if the total labour hours available in Division A are:

a. 3800 hours

b. 5600 hours. **[7]**

Answer:

(a) Computation of contribution per labour hour from external sales:

	X	Y	Z
Market price (₹)	48	46	40
Variable cost (₹)	33	24	28
Contribution (₹)	15	22	12
Labour hours required	3	4	2
Contribution per labour hour (₹)	5	5.50	6
Ranking	III	II	I

a. Computation of transfer price when the capacity is 3800 hours:

Allocation of Hours if the capacity is 3800 labour hours

Particulars	X	Y	Z
External Sales (Units)	800	500	300
Labour hours required per Unit	3	4	2
Hours needed for External Sales	2400	2000	600
Allocation of Hours if the capacity is 3800 hours as per ranking	1200 (Bal. fig.)	2000	600

The existing capacity is not sufficient, even, to produce the units to meet the external sales. In order to transfer 300 units of Y, 1200 hours are required in which division A has to give up the production of X [since lowest ranking] to the extent of 1200 hours (1200 hours ÷ 3 labour p.a. =400 units).

Transfer price for 300 units of Y will, therefore, work out to

Variable Cost of Y (₹24) + [{(Contribution loss for X (₹5 × 1200 hours = 6,000)} ÷300] = 24 + 20 = ₹44

b. Computation of transfer price when the capacity is 5600 labour hours:

Allocation of Hours if the capacity is 5600 hours

Particulars	X	Y	Z
External Sales (Units)	800	500	300
Labour hours required per Unit	3	4	2
Hours needed for External Sales	2400	2000	600
Balance of hours (Surplus)		600	

Labour Hours needed for 300 units of Y = 300 × 4= 1200 Surplus Labour Hours Available= 5600 – 5000= 600 Short fall in Labour Hours= 1200 – 600 = 600

The short fall 600 hours may have to be diverted from X resulting in a contribution loss of ₹3,000 (600 × ₹5)

Transfer price for 300 units of Y will, therefore, work out to

Variable Cost of Y (₹24) + [{Contribution loss for X (₹5 × 600 hours = 3,000)} ÷ 300] = ₹24 + ₹10 = ₹34.

(b) Company X is forced to choose between two machines A and B. The two machines are designed differently but have identical capacity and do exactly the same job. Machine A costs ₹1,50,000 and will last for 3 years. It costs ₹40,000 per year to run. Machine B is an 'economy' model costing only ₹1,00,000, but will last only for 2 years, and costs ₹60,000 per year to run. These are real cash flows. The costs are forecasted in rupees of constant purchasing power. Ignore tax. Opportunity cost of capital is 10%.

Recommend which machine Company X should buy? [7]

Answer:

(b)

Compounded present value of 3 years @ 10%		2.486
P.V. of Annual running cost of Machine A for 3 years	₹40,00 × 2.486	₹99,440
Compounded present value of 2 years @ 10%		1.735
P.V. of Annual running cost of Machine B for 2 years	₹60,000× 1.735	₹1,04,100

Statement Showing Evaluation of Machine A and B

Particulars	Machine A	Machine B
Cost of purchase	₹1,50,000	₹1,00,000
Add: P.V. of running cost	₹99,440	₹1,04,100
P.V. of Cash outflow	**₹2,49,440**	**₹2,04,100**
Equivalent present value of annual cash outflow / EAC	2,49,440 ÷ 2.486 = ₹1,00,338	2,04,100 ÷ 1.735 = ₹ 1,17,637

Recommendation: Since the annual cash outflow of Machine B is higher, purchase of Machine A is recommended.

4. (a) Modern Co produces 3 products, A, B and C, details of which are shown below:

Particulars	A	B	C
Selling price per unit (₹)	**120**	**110**	**130**
Direct material cost per unit (₹)	**60**	**70**	**85**
Variable overhead (₹)	**30**	**20**	**15**
Maximum demand (units)	**30,000**	**25,000**	**40,000**
Time required on the bottleneck resource (hours per unit)	**5**	**4**	**3**

There are 3,20,000 bottleneck hours available each month.

Calculate the optimum product mix based on the throughput concept [7]

Answer:

(a)

Step1: Computation of Rate per Factory Hour

Serial	Particulars	A	B	C
1	Selling price per unit (₹)	120	110	130
2	Direct material cost per unit (₹)	60	70	85
3	Throughput per unit (₹) (1 – 2)	60	40	45
4	Time required on the bottleneck resource (hours per unit)	5	4	3
5	Return per Factory Hour (₹) (3 ÷ 4)	12	10	15
6	Ranking (on the basis of 5)	II	III	I

Step 2: Allocation of Hours according to Ranking

Description	Hours Allocated	Balance
Total of Bottleneck Hours Available		3,20,000
Hours allocated for C (40,000 units × 3 hours per unit) [Rank I]	1,20,000	2,00,000
Hours allocated for A (30,000 units × 5 hours per unit) [Rank II]	1,50,000	50,000
Hours allocated for B (Being the balance) [Rank III]	50,000	-

Step 3: Optimum Product MIX

No. of units of B that can be made in balance hours = (50,000 hours ÷ 4 hours per unit) = 12,500 units

Therefore, Optimum Product MIX:

A = 30,000 units

B = 12,500 units

C= 40,000 units

(b) Discuss the underlying principles of Total quality management. [7]

Answer:

TQM is a vision based, customer focused, prevention oriented, continuous improvement strategy based on scientific approach adopted by cost conscious people committed to satisfy the customers first time every time. It aims at Managing an organization so that it excels in areas important to the customer.

- **Customer Focus:** The first of the Total Quality Management principles puts the focus back on the people buying your product or service. Your customers determine the quality of your product. If your product fulfills a need and lasts as long or longer than expected, customers know that they have spent their money on a quality product. When you understand what your customer wants or needs, you have a better chance of figuring out how to get the right materials, people, and processes in place to meet and exceed their expectations

- **Total Employee Commitment:** You can't increase productivity, processes, or sales without the total commitment of all employees.
- **Process Approach:** Adhering to processes is critical in quality management. Processes ensure that the proper steps are taken at the right time to ensure consistency and speed up production.
- **Integrated System:** Typically, a business has many different departments, each with their own specific functions and purposes. These departments and functions should be interconnected with horizontal processes that should be the focus of Total Quality Management. But sometimes these departments and functions operate in isolated silos. In an integrated system, everybody in every department should have a thorough understanding of policies, standards, objectives, and processes. Integrated systems help the company to look for continual improvement in order to achieve an edge over the competition.
- **Strategic and Systematic Approach:** The International Organization for Standardization (ISO) describes this principle as: "Identifying, understanding and managing interrelated processes as a system contributes to the organization's effectiveness and efficiency in achieving its objectives." Multiple processes within a development or production cycle are managed as a system of processes in an effort to increase efficiency.
- **Continual Improvement:** Optimal efficiency and complete customer satisfaction do not happen in a day– your business should continually find ways to improve processes and adapt your products and services as customer needs shift.
- **Fact-based Decision-making:** Analysis and data gathering lead to better decisions based on the available information. Making informed decisions leads to a better understanding of customers and your market.
- **Communications:** Everybody in your organization needs to be aware of plans, strategies and methods that will be used to achieve goals. There is a greater risk of failure if you don't have a good communication plan.

5. (a) A company manufacturing a special type of fencing tile 12" × 8" × 1/2" used a system of standard costing. The standard mix of the compound used for making the tiles is:
1,200 kg. of material A @ ₹0.30 per kg.
500 kg. of Material B @ ₹0.60 per kg
800 kg. of Material C @ ₹0.70 per kg
The compound should produce 12,000 square feet of tiles of 1/2" thickness. During a period in which 1,00,000 tiles of the standard size were produced, the material usage was:

Kg		₹
7,000	Material A @ ₹ 0.32 per kg.	2,240
3,000	Material B @ ₹ 0.65 per kg.	1,950
5,000	Material C @ ₹ 0.75 per kg.	3,750
15,000		7,940

Prepare the cost figures for the period showing Material price, Mixture, Sub-usage Variance. [7]

Answer:

(a) **Step (i): Number of tiles for 12,000 sq ft.**

Area of one tile =12" × 8" = 96" = (96÷144) sq ft = 2/3 sq ft

Step (ii): Standard and Actual Material for 1,00,000 tiles

	Standard Data			Actual Data		
Material	Quantity	Price ₹	Value ₹	Quantity	Price ₹	Value ₹
A	(1200 ÷ 18,000) × 1,00,000= 6,666.67	0.30	2,000	7,000	0.32	2,240
B	(500 ÷ 18,000) × 1,00,000= 2,777.77	0.60	1,667	3,000	0.65	1,950
C	(800 ÷ 18,000) × 1,00,000= 4,444.44	0.70	3,111	5,000	0.75	3,750
Total	13,888.89		6,778	15,000		7,940

Step (iii): Revised Standard quantities (RSQ) for 1,00,000 tiles

RSQ for A = (15000÷13888.89) × 6666. 67 = 7200

RSQ for B = (15000÷13888.89) × 2777.77 = 3000

RSQ for C = (15000÷13888.89) × 4444.44 = 4800

Step (iv): Analysis of Computed Data

Material	SQSP	RSQSP	AQSP	AQAP
A		7,200 × 0.3 = 2,160	7,000 × 0.3 = 2,100	
B		3,000 × 0.6 = 1,800	3,000 × 0.6 = 1,800	
C		4,800 × 0.7 = 3,360	5,000 × 0.7 = 3,500	
Total	6,778	7,320	7,400	7,940

Step (v): Computation of Variances

a. Material Sub-Usage Variance = (SQSP – RSQSP) = (6778 - 7320) = ₹542 (A)

b. Material Mix Variance = (RSQSP – AQSP) = (7320 - 7400) = ₹80 (A)

c. Material Usage Variance = (SQSP – AQSP) = (6778 - 7400) = ₹622 (A)

d. Material Price Variance = (AQSP-AQAP) = (7400 - 7940) = ₹540 (A)

e. Material Cost Variance = (SQSP – AQAP) = (6778 – 7940) = ₹1162 (A)

(b)

Item	Budget	Actual
No. of working days	**20**	**22**
Output per man hour	**1.0 Units**	**0.9 Units**
Overhead cost	**₹1,60,000**	**₹1,68,000**
Man-hours per day	**8,000**	**8,400**

Calculate Overhead Variances. **[7]**

Answer:

Computations

SR = Budgeted FOH ÷ Budgeted Hours
= ₹1,60,000 ÷ (20 working days × 8000 man hours)
= 1,60,000 ÷ 1,60,000 = ₹1

RBH = (22 working days × 8000 man hours) = 1,76,000 AH = (22 working days × 8400 man hours) = 1,84,800 AQ = 1,84,800 × 0.9 = 1,66,320
SH = (AQ ÷ Units per hour) = (166320 ÷ 1unit per hour) = 166320

(1)	(2)	(3)	(4)	(5)
SRSH	SRAH	SRRBH	SRBH	ARAH
₹1 × 1,66,320	₹1 × 1,84,800	₹1 × 1,76,000		
₹1,66,320	₹1,84,800	₹ 1,76,000	₹1,60,000	₹ 1,68,000

SRSH = Standard Cost of Standard Fixed Overheads = ₹1,66,320
SRAH = Standard Cost of Actual Fixed Overheads (or)
Fixed Overheads absorbed or recovered = ₹1,84,800 SRRBH = Revised budgeted Fixed overheads = ₹1,76,000
SRBH = Budgeted Fixed overheads = ₹1,60,000
ARAH = Actual Fixed Overheads = ₹1,68,000

Step 2: Computations

FOH Efficiency Variance = (SRSH – SRAH) = (166320 – 184800) = ₹18,480(A)
FOH Capacity Variance = (SRAH – SRRBH) = (184800 – 176000) = ₹8,800 (F)
FOH Calendar Variance = (SRRBH- SRBH) = (176000 – 160000) = ₹16,000(F)
FOH Volume Variance = (SRSH – SRBH) = (166320 – 160000) = ₹6,320 (F)

FOH Budget Variance = (SRBH – ARAH) = (1,60,000 – 1,68,000) = ₹8,000 (A)
FOH Cost Variance = (SRSH – ARAH) = (1,66,320 – 1,68,000) = ₹1,680 (A)

6. (a) A company possesses two manufacturing plants each of which can produce three products x, Y and Z from a common raw material. However, the proportions in which the products are produced are different in each plant and so are the plant's operating costs per hour. Data on production per hour costs are given below, together with current orders in hand for each product.

	Product			Operating cost/ hour in ₹
	X	Y	Z	
Plant A	**2**	**4**	**3**	**9**
Plant B	**4**	**3**	**2**	**10**
Orders on hand	**50**	**24**	**60**	

Develop a LPP to minimise the cost **[7]**

Answer:

(a) Let a be no. of hours of plant A in use
Let b be no. of hours of plant B in use
Objective function: Min Z = 9a + 10b
Subject to constraints:
$2a + 4b \geq 50$
$4a + 3b \geq 24$
$3a + 2b \geq 60$
And $a, b \geq 0$

(b) The manager of a book store has to decide the number of copies of a particular tax law book to order. A book costs ₹ 60 and is sold for ₹ 80. Since some of the tax laws change year after year, any copies unsold while the edition is current must be sold for ₹30. From past records, the distribution of demand for this book has been obtained as follows:

Demand (No of copies)	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
Proportion	**0.05**	**0.08**	**0.20**	**0.45**	**0.10**	**0.07**	**0.03**	**0.02**

Using the following sequence of random numbers, generate the demand for 20 time periods (years). Calculate the average profit obtainable under each of the courses of action open to the manager. Recommend the optimal policy.

14	**02**	**93**	**99**	**18**	**71**	**37**	**30**	**12**	**10**
88	**13**	**00**	**57**	**69**	**32**	**18**	**08**	**92**	**73**

[7]

Answer:

(b)

Table showing Range of Random Numbers

Demand (No. of copies)	Probability	Cumulative Probability	Random No. Range
15	0.05	0.05	00-04
16	0.08	0.13	05-12
17	0.20	0.33	13-32
18	0.45	0.78	33-77
19	0.10	0.88	78-87
20	0.07	0.95	88-94
21	0.03	0.98	95-97
22	0.02	1.00	98-99
Total	1.00		

Given that Cost of a book = ₹60 and Selling Price = ₹80
So profit per sold book = 80 – 60 = ₹20
Also selling price of each unsold book = ₹30

Simulated demand for the next 20 years and corresponding calculation of number of unsold books for different inventory levels

Year	Random Number	Expected demand in Nos.	No. of books unsold if stock* is		
			16	17	18
1	14	17	-	-	1
2	02	15	1	2	3
3	93	20	-	-	-
4	99	22	-	-	-
5	18	17	-	-	1
6	71	18	-	-	-
7	37	18	-	-	-
8	30	17	-	-	1
9	12	16	-	1	2
10	10	16	-	1	2
11	88	20	-	-	-
12	13	17	-	-	1
13	00	15	1	2	3
14	57	18	-	-	-
15	69	18	-	-	-
16	32	17	-	-	1
17	18	17	-	-	1
18	08	16	-	1	2
19	92	20	-	-	-
20	73	18	-	-	-
Total			2	7	18

[*Note: Stock figures of 16, 17 & 18 are chosen based on the simulated demand figures.]

Computation of Profit

No. of Books in stock	No. of Books sold during 20 years	Profit (₹)	Average Profit (₹/Year)
15	15 × 20 = 300	6000	₹300
16	16 × 20 – 2 = 318	(318 × 20) – 2 × 30 = 6300	₹315
17	(17 × 20) – 7 = 333	(333 × 20) –7 × 30 = 6450	₹322.5
18	(18 × 20) – 18 = 342	(342 × 20) – 18 × 30 = 6300	₹315

Recommendation: As average profit is maximum (i.e. ₹322.50) when there is a stock of 17 books, the optimal policy is to place an order of 17 books.

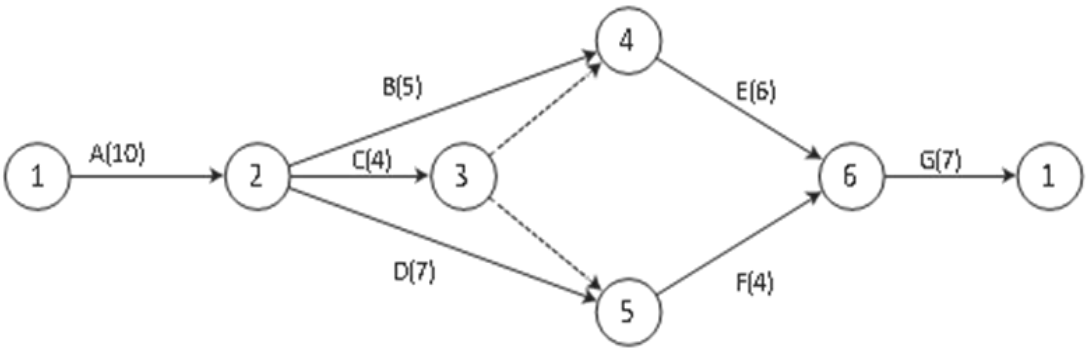
7. (a) Draw a network from the following activities. Evaluate the critical path and total duration of the project.

Activity	Immediate predecessor activity	Duration (days)
A	—	10
B	A	5
C	A	4
D	A	7
E	B,C	6
F	C,D	4
G	E,F	7

[7]

Answer:

The network is drawn as follows:



Network diagram

Various paths Duration of paths (days)

(i) 1-2-4-6-7 10 + 5 + 6 + 7 = 28

(ii) 1-2-3-4-6-7 10 + 4 + 0 + 6 + 7 = 27

(iii) 1-2-3-5-6-7 10 + 4 + 0+4 + 7 = 25

(iv) 1-2-5-6-7 10 + 7 + 4 + 7 = 28

Critical paths are 1 - 2 - 4 - 6 - 7 and 1-2-5-6-7 with duration of 28 days and are marked with double lines.

(b) The usual Learning Curve model is $Y = ax^b$ where

Y is the average time per unit for x units and 'a' is the time for first unit x is the cumulative number of units

b is the learning coefficient and is equal to (log 0.8)/(log 2) = – 0.322 for a learning rate of 80%

Given that a = 10 hours, you are required to Calculate:

(i) The average time for 20 units.

(ii) The total time for 30 units.

(iii) The time for units 31 to 40.

Given that log 2 = 0.301, Antilog of 0.5811 = 3.812
log 3 = 0.4771, Antilog of 0.5244 = 3.345.
log 4 = 0.6021, Antilog of 0.4841 = 3.049. **[7]**

Answer:

(i) $Y = aX^b$

$Y = 10(20)^{-0.322}$

Taking logarithm on both sides $\text{Log } Y = \log 10 + \log 20^{(-0.322)}$

$\text{Log } Y = \log 10 - (0.322) \log 20$

$= 1 - (0.322) \log 20$

$= 1 - (0.322) \times (1.3010)$

$= 1 - 0.41892 = 0.5811$

$\text{Log } Y = 0.5811$

$Y = \text{Anti log } (0.5811) = 3.812$ hrs (average time for 20 units)

(ii) $\text{Log } Y = \log 10 + \log 30^{(-0.322)}$

$\text{Log } Y = 1 - (0.322) \times (1.4771)$

$= 1 - (0.4756)$

$= 0.5244$

$Y = \text{anti log } (0.5244) = 3.345$ hrs (average time for 30 units)

Total time for 30 units = 3.345 × 30 = 100.35 hrs

(iii) $\text{Log } Y = \log 10 + \log 40^{(-0.322)}$

$= 1 - (0.322) \times (1.6021)$ $\text{Log } Y = 0.4841$

$Y = \text{anti log } (0.4841) = 3.049$ hrs

Total time for 40 units = 40 × 3.049 = 121.96 hrs

Time from 31 to 40 units = 121.96 – (100.35) = 21.61 hrs

8. (a) The demand (rides per day) of Roller Coaster Ride in an Entertainment Park in one of the metro cities is given the equation q = - 450p + 41500, where p = Price per ride in ₹. Suggest what price should have been charged to maximize the total revenue? **[7]**

Answer:

(a) Total Revenue is algebraically expressed as a function of price as follows

$R(p) = \text{Price per ride} \times \text{Demand}$ Or, $R(p) = p \times q$ Or, $R(p) = p(- 450p + 41500)$ Or, $R(p) = 41500p - 450p^2$

Differentiating both sides with respect to 'p' we get

$d/dp[R(p)] = 41500 - 900p$----------(i)

As per the necessary condition of optimization, $d/dp, [R(p)] = 0$ Or, $41500 - 900p = 0$ Or, $p = 46.11$

To ascertain whether the value of p obtained corresponds to a maxima, we have to take help of sufficient condition written above.

Again differentiating both sides of (i) with respect to 'p' we get, d2/dp2[R(p)] = - 900 < 0
So there exist a Maxima at p = 46.11
Thus the price to be charged to maximize the Total Revenue is ₹46.11/-

(b) From the following past data of Sales (in lakhs Rupees) of a company estimate the same for the year 2025.

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Sales	15.3	14.6	16.8	17.3	17.2	20.9	22.3	20	23.1	24.5

Assume the trend line to be linear. Calculate the monthly rate of increase of Sales. [7]

Answer:

(b) Let the best fit Linear Trend line to the given data be y = a + bx
(Origin at the middle of the years 2014 & 2015 and x unit = 6 months)
Normal equations are $\Sigma y = a.n + b.\Sigma x$----------(1) where n = No. of years = 10 (here)
$\Sigma xy = a.\Sigma x + b.\Sigma x^2$----------(2)
Using the values (from calculations below) of Σy, Σx and n in equation (1) we get 192 = a.10 + b.0 Or, a = 19.2 Also using the values (from calculations below) of Σxy, Σx and Σx^2 and putting in the equation (2) we get, 177 = a.0 + b.330 Or, b = 0.536

Calculations for fitting Straight Line Trend

Year	Sales (y in ₹Millions)	x	x^2	xy
2010	15.3	-9	81	- 137.7
2011	14.6	-7	49	- 102.2
2012	16.8	-5	25	- 84
2013	17.3	-3	9	- 51.9
2014	17.2	-1	1	- 17.2
2015	20.9	1	1	20.9
2016	22.3	3	9	66.9
2017	20.0	5	25	100
2018	23.1	7	49	161.7
2019	24.5	9	81	220.5
Total	192	0	330	177

So the required equation of Straight Line Trend is y = 19.2 + 0.536x
(Origin = At the middle of 2014 & 2015, x unit = 6 months)
For the year 2025, x = 21. So the estimated sales for the year 2025 = 19.2 + 0.536 × 21 = ₹30.456 Million.
Yearly rate of increase in Sales = b = 0.536. So monthly rate of increase in Sales = b/12 = ₹0.0467 Million.