Gurukripa's Guideline Answers to May 2012 Exam Questions
Final Group II – Advanced Management Accounting

Question No.1 is compulsory **(4 X 5 = 20 Marks).**
Answer **any five** questions from the **remaining six** questions **(16 X 5 = 80 Marks).** [Answer any 4 out of 5 in Q.7]

Question 1(a): Relevant Cost Analysis **M 12 (5 Marks)**

A Company has decided to launch a new product X which is expected to have a demand of 10,000 units during the year at ₹ 160 per unit. The following information is furnished by the Company:

(i) Material: The manufacture of one unit of X requires one unit of each of Materials A, B and C.

Raw Material	Current Stock (Units)	Cost per unit (₹)		
		Original Cost	Current Purchase Price	Resale Value
A – Regularly being used	10,000	16	20	14
B – Old Stock (Not in use)	6,000	28	24	8
C – New Stock	–	–	48	–

(ii) Direct Labour: Skilled Labour is paid at ₹ 80 per hour. It takes 0.25 hours / unit. Skilled Labour has to be drawn from another production which has a contribution of ₹ 240 per unit, with each unit requiring 2 hours of Skilled Labour.

Unskilled Labour: 2 hours / unit at ₹ 56 per hour. There is abundant Unskilled Labour in the Factory, but according to an agreement with the Labour Union, no Unskilled Worker can be retrenched.

(iii) Variable Overhead: ₹ 10 per unit. Fixed Costs: No increase

Using Relevant Cost Approach, you are required to find out the Average Variable Cost per unit of X.

Solution: Statement of Relevant Costs for the Product

Particulars	Nature and Computation	₹
Material A	Already available and regularly used item. Hence, Current Replacement Cost, i.e. Current Purchase Price is relevant as out of pocket cost. (10,000 units × ₹ 20)	2,00,000
Material B	Total Requirement = 10,000 units 6,000 units available but not in use + 4,000 units to be purchased 6,000 units × ₹ 8 = 48,000 4,000 units × ₹ 24 = 96,000 (NRV Lost = Opportunity Cost) (Variable & Relevant Cost)	1,44,000
Material C	To be purchased, hence Variable & Relevant (10,000 units × 48)	4,80,000
Skilled Labour	Variable Cost + Opportunity Cost is relevant, for Labour having alternative use. Variable Cost = 10,000 units × 0.25 hrs p.u. × ₹ 80 ph Opportunity Cost = 10,000 units × 0.25 hrs p.u. × $\frac{₹\ 240}{2\ hrs}$	2,00,000 3,00,000
Unskilled Labour	No retrenchment possible. Hence, committed & irrelevant.	Nil
Variable OH	Variable & Relevant. (10,000 units × ₹ 10)	1,00,000
Fixed OH	Not specific and hence irrelevant.	Nil
	Total Relevant Costs for the Contract	**14,24,000**

Average Relevant Cost p.u. = $\frac{₹\ 12,24,000}{10,000\ units}$ = **₹ 142.40 p.u.**

Note: Average Relevant Cost p.u. of ₹ 142.40 < Selling Price of ₹ 160. Hence, Product X is worthwhile.

Question 1(b): Transportation IBFS **M 12 (5 Marks)**

The following table gives the unit transportation costs and the quantities demanded / supplied at different locations for a minimization problem:

Demand / Supply	C_1	C_2	C_3	C_4	Total Units
R_1	100	120	200	110	20,000
R_2	160	80	140	120	38,000
R_3	180	140	60	100	16,000
Total Units	10,000	18,000	22,000	24,000	

You are required to find out which Cell gets the 3rd allocation in the Initial Basic Feasible Solution under each of the following methods and to give the cell reference, cost per unit of that cell and the quantity allocated to that cell:

(i) North West Corner Rule
(ii) Vogal's Approximation Method
(iii) Least Cost Method

(Use the Standard Notation of C_iR_j for cell reference. (e.g. C_2R_3 means the cell at the intersection of Column 2 and Row 3)
(Note: The full solution is not required to be worked out).

Solution:

1. IBFS under North West Corner Rule

	C_1	C_2	C_3	C_4	Supply
R_1	**10000** 100	**10000** 120	200	110	20000/10000/0
R_2	160	**8000** 80	140	120	38000/8000
R_3	180	140	60	100	16000
Demand	10000/0	18000/8000/0	22000	24000	74000

3rd allocation as per North West Corner Rule = **C_2R_2,** Cost p.u. = **₹ 80 p.u**. and Quantity = **8,000 units**

2. IBFS under Vogel's Approximation Method

	C_1	C_2	C_3	C_4	Supply	Cost Differences I	II	III
R_1	**10000** 100	120	200	110	20000/10000	10	10	10
R_2	160	80	**6000** 140	120	38000/32000	40	40	40
R_3	180	140	**16000** 60	100	16000/0	40	–	–
Demand	10000/0	18000	22000/6000/0	24000/0	74000			
Cost Diff:								
I	60	40	**80**	10				
II	**60**	40	60	10				
III	–	40	**60**	10				

3rd allocation as per Vogel's Approximation Method = **C_3R_2,** Cost p.u. = **₹ 140 p.u**. and Quantity = **6,000 units**

3. IBFS under Least Cost Cell Method

	C_1	C_2	C_3	C_4	Supply
R_1	**10000** 100	120	200	110	20000/10000
R_2	160	**18000** 80	140	120	38000/20000
R_3	180	140	**16000** 60	100	16000/0
Demand	10000/0	18000/0	22000/6000	24000	74000

3rd allocation as per Least Cost Cell Method = **C_1R_1,** Cost p.u. = **₹ 100 p.u**. and Quantity = **10,000 units**

Question 1(c): Marginal Costing Basics – Reverse Working **M 12 (5 Marks)**

XY Ltd makes two products X and Y, whose respective Fixed Costs are F_1 and F_2.You are given that the Unit Contribution of Y is one fifth less than the Unit Contribution of X, that the total of F_1 and F_2 is ₹ 1,50,000, that the BEP of X is 1,800 units (for BEP of X, F_2 is not considered) and that 3,000 units is the Indifference Point between X and Y.(i.e. X and Y make equal profits at 3,000 unit volume, considering their respective Fixed Costs). There is no inventory build up as whatever is produced is sold.

You are required to find out the values of F_1, and F_2 and Unit Contributions of X and Y.

Solution: Let Contribution per unit of Product X and Y be ₹ A and B respectively.

From the given information, B = A – $\frac{1}{5}$A. So, B= $\frac{4}{5}$A

BEP of Product X = $\frac{\text{Fixed Cost}}{\text{Contribution p.u.}}$ = $\frac{F1}{A}$ = 1,800 (given). So, F_1 = 1,800A

Indifference Point = $\frac{\text{Change in Fixed Cost}}{\text{Change in Contribution p.u.}}$ = $\frac{F1-F2}{A-B}$ = $\frac{F1-F2}{A-\frac{4}{5}A}$ = $\frac{F1-F2}{\frac{1}{5}A}$ = 3,000 (given). So, $F_1 - F_2$ = 600A

So, we have the following equations –

$F_1 + F_2$ = 1,50,000 ..... (1) (given)

F_1 = 1,800A .....(2)

$F_1 - F_2$ = 600A .....(3)

Substituting (2) in (3), we have F_2 = 1,800A – 600A = 1,200A

Substituting (2) and F_2 as computed above in (1), we have, $F_1 + F_2$ = 1,50,000

So, 1,800A + 1,200A = 1,50,000. Hence, **A = $\frac{1,50,000}{3,000}$ = ₹ 50 p.u.**

So, B = $\frac{4}{5}$A = $\frac{4}{5}$ × 50 = **₹ 40 p.u.**

Thus, F_1= 1,800A = 1,800 × 50 = **₹ 90,000** and F_2 = 1,200A = 1,200 × 50 = **₹ 60,000**

Question 1(d): VA & NVA Identification **M 12 (5 Marks)**

State whether each of the following independent activities is Value – Added or Non – Value – Added:

(i) Polishing of Furniture used by a Systems Engineer in a Software Firm.	**Non–Value Added**
(ii) Maintenance by a Software Company of Receivables Management Software for a Banking Company.	**Value Added**
(iii) Painting of Pencils manufactured by a Pencil Factory.	**Value Added**
(iv) Cleaning of Customer's Computer Key Boards by a Computer Repair Centre.	**Value Added**
(v) Providing Brake Adjustments in Cars received for service by a Car Service Station.	**Value Added**

Question 2(a): Transfer Pricing – Final Product required by Transferring Division itself **M 12 (10 Marks)**

AB Ltd makes Component C and Billing Machines. Division A makes Component 'C' that is used in the Final Assembly of the Machine in Division B. (One unit of Component C is used per Machine). Component C has an outside market also. A and B operate as profit centres and each Division can take its own decisions. The following data is given in the existing scenario for Divisions A and B, under which Division A has enough special and external demand to use its capacity and hence is offering B rates of ₹ 800 /unit for quantity up to 750 units and ₹ 900 /unit for more than 750 units, so that its outside contribution is not affected by transfers to B. A and B can sell any quantity up to the maximum indicated under 'units sold', without affecting their future demands.

	Division A		Division B	
	External Market (Normal Sales)	(Special Sales)	External Market (Normal Sales)	
Selling Price (₹/u)	1,000	800	4,000	
Variable Manufacturing Cost (₹/u)	600	600	1,500*	(*excluding Component C)
Variable Selling Cost (₹/u)	100**	–	200**	(**Not incurred on inter division tfrs)
Total Variable Cost (₹/unit)	700	600	1,700**	(*excluding Component C)
Contribution (₹/unit)	300	200		
Units sold	1,250	750	900	
Production capacity	2,000 units		900 units	

For the next period, A requires for its own use in its selling outlets, 50 units of Billing Machines produced by B. B's Manager proposes as follows:

- **Option I – B will supply 50 Machines to A on its Variable Manufacturing Cost basis provided A supplies to B, 500 units of Component C at A's Variable Manufacturing Cost basis.**
- **Option II – Both A and B resort to Total Variable Cost per unit basis applicable to normal external sale, though neither A nor B incurs any Selling Cost on inter division transfers. A will be given 50 Machines for its use. A will have to supply B all the 900 units that B requires.**

- **Option III – Both A and B use the External Market Selling Price (i.e. 1,000 and 4,000 ₹/unit for 900 units of Component 'C' and 50 Machines respectively).**

Required:
From a financial perspective, advise Division A's Manager what he should choose. Support your advice with relevant figures. What is the change in the rate of discount per unit given by B to A (based on Unit Transfer Price to Market Price Ratio) from Option I to Option II?

Solution: **1. Cost – Benefit Analysis of various Options from A's Viewpoint**

Particulars	Amount
Option I:	1,05,000
(a) **Cost of Buying** 50 M/c at VMC of Division B (600 Tfr in Cost of B + 1,500 own VMC of B)	
(b) **Opportunity Cost** of transferring 500 units to Division B at **below** External Price applicable for outside customers (₹ 800 pu) upto 750 units = 500 units × (External MP 800 **less** Given TP 600)	1,00,000
Net Cost of Option I	**2,05,000**
Option II:	1,20,000
(a) **Cost of Buying** 50 M/c at TVC of Division B (700 Tfr in Cost of B + 1,700 own TVC of B)	
Note: Tfr in Cost of B is taken at Total Variable Cost of C for Normal External Sales i.e. 700 pu (given)	
(b) **Opportunity Cost** of transferring 900 units to Division B at **below** External Price applicable for outside customers, i.e. ₹ 800 pu upto 750 units and ₹ 1,000 pu for next 150 units	
First 750 units × (External MP 800 **less** Given TP at TVC 700)	75,000
Next 150 units × (External Contribution 300 **less** Internal Contribution being SOH saved 100)	30,000
Net Cost of Option II	**2,25,000**
Option III:	2,00,000
(a) **Cost of Buying** 50 M/c at External MP of Division B 4,000	
(b) **Additional Contribution** on Internal Transfer (assuming uniform TP 1,000 on all 900 units), as under –	
First 750 units × (Internal TP 1,000 **less** External MP for Special Sales 800)	1,50,000
Next 150 units × (Additional Contribution being SOH saved 100)	15,000
Net Cost of Option III	**35,000**

Hence, from a financial perspective, Option III is preferable for Manager A, due to least costs.

2. Computation of Discount Rate and Change therein

Particulars	Option I	Option II	Option III
Unit Transfer Price by B to A	VMC = 2,100	TVC = 2,400	MP = 4,000
Discount (based on MP of 4,000)	4,000 – 2,100 = 1,900	4,000 – 2,400 = 1,600	Nil
% of Discount (TP ÷ MP)	**47.5%**	**40%**	**Nil**

Change in Rate of Discount per unit = 47.5% – 40.0% = **7.50%**

Question 2(b): Material Cost Variances **M 12 (6 Marks)**

The standard set for a chemical mixture of a Company is as under:

Material	Standard Mix (%)	Standard Price ₹ / kg
A	80	50
B	20	100

Standard Yield in Production is 75%.

The actual quantity produced was 1,800 kg of output from the following:

Material	Standard Mix (%)	Standard Price ₹ / kg
A	1,400	60
B	600	90

Calculate the Total Material Price, Mix and Yield Variances, indicating whether they are Favourable (F) or Adverse (A or U).

Solution: **Working Notes:**

1. Computation of Standard Quantity (SQ)

Yield = 75%.

Since Actual Output is 1,800 kg, SQ= $\frac{1,800 \text{ kg}}{75\%}$ = 2,400 kg

Material	A	B
Standard Mix	80%	20%
Std Quantity	1,920 kg	480 kg

2. Computation of Revised Actual Quantity (RAQ)

Total AQ = 1,400 + 600 = 2,000 kg RM

Material	A	B
Standard Mix	80%	20%
RAQ	1,600 kg	400 kg

3. Variance Computation Chart

Particulars	Col.(1): SQ × SP	Col.(2): RAQ × SP	Col.(3): AQ × SP	Col.(4): AQ × AP
Material A	1,920 × ₹ 50 = 96,000	1,600 × ₹ 50 = 80,000	1,400 × ₹ 50 = 70,000	1,400 × ₹ 60 = 84,000
Material B	480 × ₹ 100 = 48,000	400 × ₹ 100 = 40,000	600 × ₹ 100 = 60,000	600 × ₹ 90 = 54,000
Total	**(WN 1) ₹ 1,44,000**	**(WN 2) ₹ 1,20,000**	**₹ 1,30,000**	**₹ 1,38,000**

Material **Yield** Variance = ₹ 1,44,000 – ₹ 1,20,000 = ₹ 24,000 F + Material **Mix** Variance = ₹ 1,20,000 – ₹ 1,30,000 = ₹ 10,000 A + Material **Price** Variance = ₹ 1,30,000 – ₹ 1,38,000 = ₹ 8,000 A

Material **Usage** Variance = ₹ 24,000 – ₹ 10,000 = ₹ 14,000 F + Material **Price** Variance b/fd as above ₹ 8,000 A

Total Material Cost Variance
= ₹ 14,000 – ₹ 8,000 = ₹ 6,000 F

Material–wise Breakup of Variances:

Particulars	Material A	Material B	Total
(a) **Yield** Variance = Col. (1) – Col. (2)	₹ 16,000 F	₹ 8,000 F	₹ 24,000 F
(b) **Mix** Variance = Col. (2) – Col. (3)	₹ 10,000 F	₹ 20,000 A	₹ 10,000 A
(c) **Usage** Variance (a+b) = Col. (1) – Col. (3)	₹ 26,000 F	₹ 12,000 A	₹ 14,000 F
(d) **Price** Variance = Col. (3) – Col. (4)	₹ 14,000 A	₹ 6,000 F	₹ 8,000 A
(e) Total Material **Cost** Variance (c+d)= Col. (1) – Col. (4)	₹ 12,000 F	₹ 6,000 A	₹ 6,000 F

Question 3(a): Pricing Decision based on Cost Behaviour – Export Order Pricing **M 12 (8 Marks)**

A Company is operating at 60% of its capacity with a Turnover of ₹ 43.20 Lakhs. If the Company works at 100% capacity, the Sales–Cost relation is:

Factory Cost is two – third of Sales Value. Prime Cost is 75% of Factory Cost. Administration and Selling Expenses (75% Variable) are 20% of the Sales Value. Factory Overhead will vary according to operating capacity as given below:

Operating Capacity (%)	60	80	100	120
Factory Overheads (in ₹ Lakhs)	9.90	10.80	12	15

The Company has planned to operate at 80% of its capacity. Moreover, it has received an Export Order and its execution will involve 40% of the capacity. The Prime Cost of the order is estimated at ₹ 6 Lakhs and the shipping involved will be around ₹ 1 Lakh. Administration and Selling Expenses will be avoided on the Export Order. Taking the same percentage of profits as on the domestic sales, determine the Minimum Price to be quoted for the Export Order.

Solution: Turnover at 60% Capacity = ₹ 43.20 Lakhs. So, Turnover at 100% = $\frac{₹\ 43.20\ \text{Lakhs}}{60\%}$ = ₹ 72 Lakhs.

1. Profit Statement at 100% level is determined as below –

Particulars		Computation	₹ Lakhs
	Sales	As above	72.00
Less:	Factory Cost (a) Prime Cost	75% of 48.00 = 36.00	
	(b) POH	(given) = 12.00	(2/3rd of 72.00) = 48.00
	Gross Profit		**24.00**
Less:	Administration & Selling	Variable 75% = 10.80	
		Fixed 25% = 3.60	20% of Sales 72.00 = 14.40
	Profit at 100% level		**9.60**

Note: Profit as a percentage of Sales = 9.60 ÷ 72.00 = **13.33%**

2. Cost Sheet for Export Order

Particulars	Nature and Computation	₹ Lakhs
Prime Cost	Specific and Out of Pocket Costs	6.00
Factory Overheads	Incremental Costs from 80% to 120%	15 – 10.80 = 4.20
Shipping	Specific and Out of Pocket Costs	1.00
Variable Administration & Selling Exps	Avoided on export order , Hence NIL	NIL
Total Relevant Costs	(at 100 – 13.33 = 86.67%)	11.20
Add: Profit required	at 13.33% **(Refer WN 1)**	1.72
Minimum Price for Export Order		**12.92**

Note: It is assumed that the Profit Percentage at 100% capacity as computed above will apply for Export Order also.

Question 3(b): Transportation **M 12 (3 Marks)**

In a Transportation Problem for Cost Minimization, there are 4 Rows indicating quantities demanded and this totals up to 1,200 units. There are 4 columns giving quantities supplied. This totals up to 1,400 units. What is the condition for a solution to be degenerate?

Solution:

1. Since Row and Column Quantities are not equal, there is a need for inserting a **Dummy Row** (with Quantity of 200 units, being the difference in Row and Column Quantities) in order to obtain the IBFS.
2. Degeneracy occurs if the Number of Allocations in IBFS < (No. of Rows + No. of Columns – 1) = 4 + 4 – 1 = 7.
3. So, if Number of Allocations < 7, the IBFS will be degenerate. (**Note:** This generally happens when a Row and Column Quantity Condition is satisfied by a single allocation.)

Question 3(c): Need for ABC System **M 12 (5 Marks)**

State with brief reason whether you would recommend an Activity Based System of Costing in each of the following independent situations:

Company K produces one product. The Overhead Costs mainly consist of Depreciation.	ABC is needed by organisations for product costing where there is a great diversity in product range. Since, Company K produces only one product, ABC is not absolutely necessary. Moreover, if Overhead consists mainly of Depreciation, there is no scope for ABC based Cost Reduction.
Company L produces 5 different products using different production facilities.	When there is diversity in product range and products use different amounts of OH resources (as different production facilities are involved), ABC improves product costing by avoiding over–costing or under–costing of products. It also helps in identifying non–value adding activities in the production process for elimination. Hence, ABC System is recommended in this case.
A Consultancy Firm consisting of Lawyers, Accountants and Computer Engineers provides Management Consultancy services to Clients.	ABC System uses the cost of activities as the basis for assigning cost of services to jobs. With a refined Costing System, a Service Organization can have more accurate cost information for services. This helps them to adjust their pricing policies for services. Hence, ABC can be used for the Consultancy Firm.
Company S produces two different labour intensive products. The Contribution per unit in both products is very high. The BEP is very low. All the work is carried on efficiently to meet the target costs.	Company S is Highly labour intensive, and does not have great diversity of products. All the work is carried on efficiently and hence, allocation of cost can be based on Direct Labour Hours. ABC is not required as chances of over–costing or under–costing of products is less. Moreover, since Target Costs are achieved, non–value adding activities have already been identified and eliminated.

Question 4(a): Marginal Costing – Key Factor – Product Mix Decision **M 12 (8 Marks)**

Ezee Ltd makes two products, E and Z. All units produced are sold. There is no inventory buildup. Production facilities may be used inter-changeably for both the products. Sales Units are the Limiting Factor. The following information is given:

	Present Level			Proposed Increase		
	E	Z	Total	E	Z	Total
Contribution ₹ / unit	25	20				
Fixed Cost ₹			46,000			47,500
Sales Units (nos)	3,000	2,000	5,000			4,000

For increase in quantities above 4,000 units for each product, there will be an increase in Variable Selling Costs, (for the increased portion only), thereby reducing the Contribution per unit to the following figures:

Units	Contribution per unit (₹)	
	E	Z
4001-5000	20	15
5001-6000	15	10
Above 6000	No sales possible.	

(i) For the present level, find the Break-Even Point with the present product mix.

(ii) What is the minimum number of incremental units to be sold to recover the Additional Fixed Cost of ₹ 47,500 to be incurred? (Present Product Mix need not be maintained).

(iii) If you are allowed to choose the best product mix for the incremental level, (while taking the present mix given in the First Table above for the present level), what would be the individual product quantities and the corresponding Total Contributions, the Total Average Contribution per unit and the Total Profits for the complete production?

Solution: **1. Computation of BEQ with Present Mix of 3 : 2**

Particulars	E	Z	Total
(a) Contribution per unit	₹ 25	₹ 20	
(b) Sales Mix Ratio	3	2	
(c) Overall Contribution Ratio (a X b)	75	40	115
(d) To achieve BEQ, Required Contribution = Fixed Cost of ₹ 46,000 to be earned in the ratio of 75 : 40	₹ 30,000	₹ 16,000	₹ 46,000
(e) Hence, Required BEQ = (d ÷ a)	**1,200 units**	**800 units**	**2,000 units**

2. Statement of Product Ranking at different sale quantity levels

Particulars	Product E			Product Z		
Sale Quantity (units)	Upto 4000	4001 – 5000	5001 – 6000	Upto 4000	4001 – 5000	5001 – 6000
Contribution pu (₹)	25	20	15	20	15	10
Ranking	**I**	**II**	**III**	**II**	**III**	**IV**

3. Minimum Addnl Quantity to recover Additional Fixed Costs (as per ranking preference in Working Note 2)

(a) Additional Fixed Cost to be recovered	47,500
(b) **I Rank:** Additional 1,000 units of E with Contribution of ₹ 25 per unit. (25 × 1000)	(25,000)
(c) Balance Fixed Costs to be Recovered (a – b)	22,500
(d) **II Rank:** Additional 1,000 units of either E or Z with Contribution of ₹ 20 p.u. (20 × 1000)	(20,000)
(e) Balance Fixed Costs to be Recovered (c – d)	2,500
(f) **II Rank:** Additional units of either E or Z (as per previous decision) with Contribution of ₹ 20 p.u. **Note:** Number of units to be sold = ₹ 2,500 ÷ ₹ 20 p.u = 125 units	(2500)

Number of Units from which All Fixed Costs are recovered is as under –

Particulars	E	Z
Option I	Given 3,000 + WN 3(b) 1,000 + WN 3(d) 1,000 = **5,000 units**	Given 2,000 + WN 3(f) 125 = **2,125 units**
Option II	Given 3,000 + WN 3(b) 1,000 + WN 3(f) 125 = **4,125 units**	Given 2,000 + WN 3(d) 1,000 = **3,000 units**

4. Computation of Optimum Product Mix, etc.

(a) Total Quantity to be sold = 5,000 units + 4000 units =	9,000 units
(b) From the Ranking Table, the **Optimum Combination** will be (in units)	E = 5,000 & Z = 4,000 uts
(c) **Total Contribution:** E (4,000 units X ₹ 25) + (1,000 units X ₹ 20) = 1,20,000 Z (4,000 units X ₹ 20) 80,000	**₹ 2,00,000**
(d) **Total Average Contribution per unit** = (2,00,000 ÷ 9,000 units)	₹ 22.22 per unit
(e) **Total Profits** = Total Contribution 2,00,000 less Fixed Cost 93,500	**₹ 1,06,500**

Question 4(b): Linear Programming – Multiple Optimal Solutions **M 12 (8 Marks)**

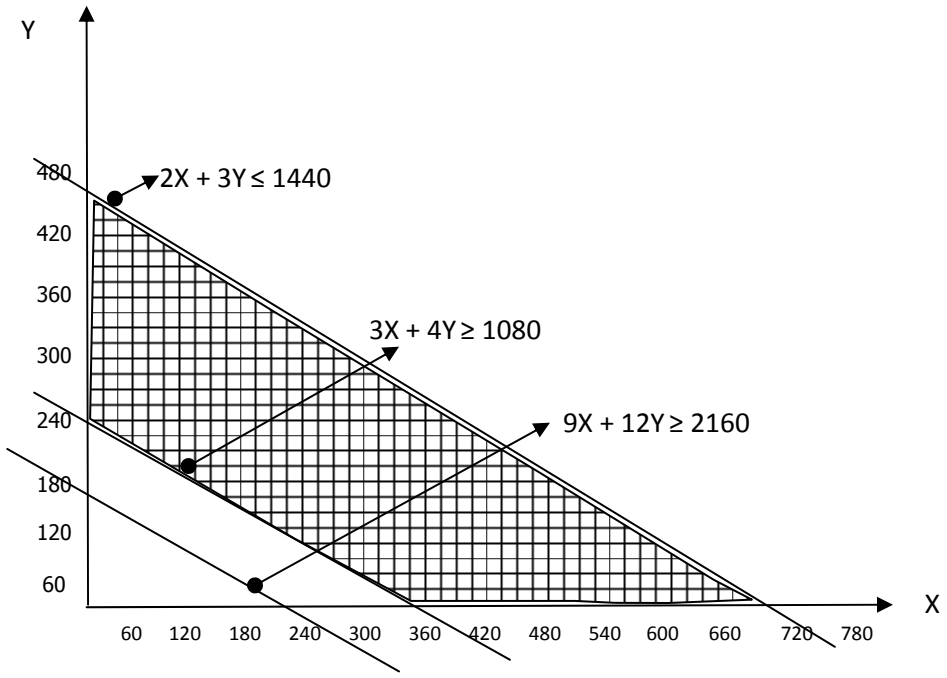
The following linear program is presented to you:

Objective : Maximize Z = 30X + 45Y **Subjective to: (i) 2X + 3Y ≤ 1,440** **(ii) 9X + 12Y ≥ 2,160** **(iii) 3X + 4Y ≥ 1,080** **(iv) X, Y ≥0.**	**Required:** **Draw the Graph taking quantities of X and Y in the respective axes in steps of 60 units (scale 1 cm. = 60 units).** **Determine the optimality and offer your comments on the solution and the constraints.**

Solution:
Since two points are required / sufficient to depict a straight line, each of the above inequations are depicted graphically by determining atleast two co–ordinates / points in the graph. The co–ordinates are determined by setting one variable = 0 and determining the other variable, as under –

Constraint	When X = 0	When Y = 0	Co–ordinates
2X + 3Y = 1,440	Y = 480	X = 720	(0, 480), (720, 0)
9X + 12Y = 2,160	Y = 180	X = 240	(0, 180), (240, 0)
3X + 4Y = 1,080	Y = 270	X = 360	(0, 270), (360, 0)
X, Y = 0			Horizontal and Vertical Axes

Feasible Solution and Optimal Points (0, 270), (0, 480), (720, 0) and (360, 0)



Point	Value of Z = 30X + 45Y
(0, 270)	30 (0) + 45 (270) = 12,150
(0, 480)	30 (0) + 45 (480) = **21,600** (max)
(720, 0)	30 (720) + 45 (0) = **21,600** (max)
(360, 0)	30 (360) + 45 (0) = 10,800

Comments:

- Since, there are two points at which maximum value is obtained, there are two possible solutions, i.e. X = 0, Y = 480, (or) alternatively X = 720, Y = 0.
- Multiple Optimal Solutions as above occur, when the slope of the Objective Function (Slope = Ratio of Co–efficients of X and Y) is the same as Slope of any one of the Constraints.
- In the above case, Slope of Objective Function is 30 : 45, i.e. 2:3, which is the same as that of the 1st Constraint. Hence, it is a case of Multiple Optimal Solution.
- Also, for obtaining solution, it is sufficient that **atleast one constraint** has ≤ condition for a Maximisation Objective, i.e. 1st Constraint in this case.

Question 5(a): Key Factor – Make vs Buy – Second Shift Working Evaluation **M 12 (8 Marks)**

A machine manufacturing Company needs four components A,B,C and D. The components may be procured from outside. The Cost, Market Price for the components and other information are given below:

Number of units required	3,000	3,500	2,000	3,000
Following Figures in ₹ per unit	A	B	C	D
Direct Material	120	140	150	120
Direct Wages	60	80	120	80
Direct Expenses at ₹ 40 per Machine Hour	80	60	80	80
Fixed Cost	40	40	30	50
Total Cost	300	320	380	330
Market Price	300	320	400	270

There are constraints on machine time in manufacturing all the components. Total Machine Hours available is only 12,000.
It is possible to use the machine time in a Second Shift which will attract 20% Extra Wages and other Fixed OH at ₹ 6,000 for every 1,000 hours or part thereof.
With relevant supporting figures, advise the best course of action to maximize the profits.
(Note: Students need not work out the complete profitability statement).

Solution: **1.Time Allocation in I Shift**

Particulars	A	B	C	D
(a) Number of Units	3,000	3,500	2,000	3,000
(b) Market Price = Cost of Buy	300	320	400	270
(c) Variable Costs if made internally				
Direct Materials	120	140	150	120
Direct Wages	60	80	120	80
Direct Expenses	80	60	80	80
Variable Costs of Make	**260**	**280**	**350**	**280**
(d) Savings in Own Make p.u. (b – c)	40	40	50	(10)
(e) Machine Hours required p.u.	$\frac{80}{40}$ = 2.00	$\frac{60}{40}$ = 1.50	$\frac{80}{40}$ = 2.00	$\frac{80}{80}$ = 1.00
(f) Savings per machine hour, if made	20	26.67	25	**NA**
(g) Rank (for own production)	**III**	**I**	**II**	**NA**
(h) Allocation of 12,000 m/c hours	(12,000 – 5,250 – 4,000) = 2,750 hours	3,500 × 1.5 = 5,250 hours	2,000 × 2 = 4,000 hours	–
(i) Possible Prodn in I Shift (h / e)	1,375 units	3,500 units	2,000 units	
Fixed Cost p.u.	40	40	30	50
Profit p.u.	**Nil**	**Nil**	**20**	**(60)**

Note: It is preferable to buy Component D since Cost of Buying is less than Variable Cost of own production.

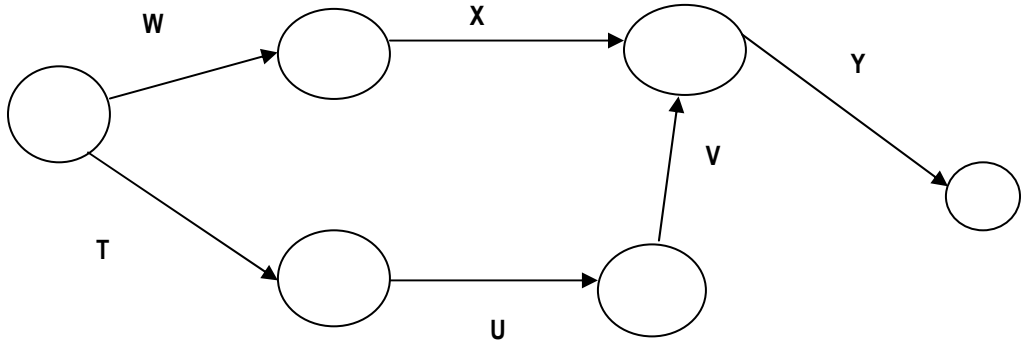
2. Effect of Second Shift Working

(a) Time required in II Shift for Component A = (3,000 – 1,375) units at 2 hours p.u.	3,250 hours
(b) Incremental Fixed Costs = ₹ 6,000 × 4 =	₹ 24,000
(c) Revised Savings p.u. in own make considering 20% Extra Wages = 40 – 20% of ₹ 60	₹ 28
(d) Revised Total Savings for II Shift Production of (3,000 – 1,375) = 1,625 units	₹ 45,500

As the Total Savings for II Shift Production is more than the Incremental Fixed Costs, **II Shift is worthwhile.**

Question 5(b): Network Analysis – Crashing **M 12 (8 Marks)**

The following Network and Table are presented to you:



Activity	Normal Duration (Days)	Normal Cost (₹)	Crash Duration (Days)	Crash Cost (₹)
T	8	2,250	6	2,750
U	16	1,875	11	2,750
V	14	2,250	9	3,000
W	12	3,000	9	3,750
X	15	1,000	14	2,500
Y	10	2,500	8	2,860

Perform step by step crashing and reduce the project duration by 11 days while minimizing the crashing cost. What would be the cost of the crashing exercise?

Solution: **1. Paths Table**

Path	Normal Days	Min Days	Duration after Stage		
			I	II	III
W – X – Y	12+15+10 = 37	9+14+8 = 31	37 days	37 days	37 – 1 = 36 days
T – U – V – Y	8+16+14+10 = 48	6+11+9+8 = 34	48 – 5 = 43 days	43 – 5 = 38 days	38 – 1 = 37 days

2. Slope Table, i.e. Crash Costs per day

Activity	T	U	V	W	X	Y
Crash Costs per day	250	175	150	250	1500	180

Note: Crash Costs per day = (Crash Costs – Normal Costs) ÷ (Normal Time – Crash Time)

3. Crashing Table

Stage	Evaluation	Decision & Crash Costs	Cum. Crash Costs
I	Critical Path is T-U-V-Y. Activity V has least slope and can be crashed for maximum 5 days. Also, difference between the Paths = 48 – 37 = 11 days.	Crash V for 5 days Cost: 5 × 150 = 750	750
II	Critical Path is T-U-V-Y. Activity U has least slope among activities that have not been crashed, and can be crashed for 5 days. Also, difference in duration between the Paths = 43 – 37 = 6 days.	Crash U for 5 days Cost: 5 × 175 = 875	1,625
III	Critical Path is T-U-V-Y. Common Activity – Y – has least slope among uncrashed activities and can be crashed for a maximum of 2 days, but to meet given requirement of crashing 11 days, it is enough to crash Y by one day	Crash Y for 1 day Cost: 1 × 180 = 180	**1,805**

Question 6(a): New Product Launch Decision – Effect of Inventory Carrying Costs **M 12 (8 Marks)**

PQR Ltd is considering introducing a new product at a price of ₹ 105 per unit. PQR Ltd's Controller has complied the following Incremental Cost Information based on an estimate of 1,20,000 units of sales annually for the new product:

Direct Material Cost	**₹ 36,00,000**
Direct Labour Cost	**₹ 24,00,000**
Flexible Manufacturing Support	**₹ 12,00,000**
Sales Commission	**10% of Sales**
Capacity-related Cost	**₹ 20,00,000**

The average inventory levels for the new product are estimated as follows:

Raw Materials:	**2 months' production**
Work-in-Progress (100% complete for Materials and 50% complete for Labour and Flexible Manufacturing Support)	**1 month production**
Finished Goods	**2 months' production**

Annual Inventory Carrying Costs not included in the Flexible Manufacturing Support listed earlier are estimated to be 12% of Inventory Value. In addition, the Sales Manager expects the introduction of new product to result in a reduction in sales of existing product from 3,00,000 to 2,40,000 units. The Contribution Margin for the existing product is ₹ 20 per unit.
Prepare a statement showing the budgeted impact on PQR's profits on the introduction of the new product. Should the new product be introduced?

Solution: **1. Computation of Value of Inventory**

Particulars	Units	Material		Labour		Flexible Mfring Support	
		%	EU	%	EU	%	EU
Raw Material: ($\frac{1,20,000}{12}$ × 2 months)	20,000	100%	20,000				
WIP: ($\frac{1,20,000}{12}$ × 1 month)	10,000	100%	10,000	50%	5,000	50%	5,000
Finished Goods: ($\frac{1,20,000}{12}$ × 2 months)	20,000	100%	20,000	100%	20,000	100%	20,000
Total Inventory Quantity on EU basis			50,000		25,000		25,000
Cost p.u. (Annual Cost ÷ 1,20,000 uts)			₹ 30		₹ 20		₹ 10
Cost of Inventory (EU X Cost pu)			₹ 15,00,000		₹ 5,00,000		₹ 2,50,000

Grand Total Cost Inventory = **₹ 22,50,000**

2. Impact of New Product on Profits

	Particulars	₹
	Sale Value (1,20,000 units × ₹ 105)	1,26,00,000
Less:	Direct Material + Direct Labour + Flexible Manufacturing Support = 36 + 24 + 12	72,00,000
	Sales Commission (1,26,00,000 × 10%)	12,60,000
	Contribution before Inventory Carrying Costs and Opportunity Costs	41,40,000
Less:	Contribution foregone on Existing Product [(3,00,000 – 2,40,000) × ₹ 20]	12,00,000
Less:	Inventory Carrying Cost (22,50,000 × 12%) **(WN 1)**	2,70,000
	Additional Net Contribution (assuming Capacity related costs are already being incurred)	**26,70,000**

Conclusion: Since the new product increases the Contribution, it can be produced.

Question 6(b): Explain the features of a Balanced Score Card. **M 12 (4 Marks)**

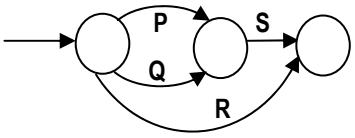
Solution: **Refer Page 14.11, Q.9 (RTP, M 07, N 10)**

Question 6(c): Classify the following under Category (CC) – Cost Control or Category (CR) – Cost Reduction. **M 12 (4 Marks)**

(i) Costs exceeding Budgets or Standards are investigated.	Cost Control(CC)
(ii) Preventive Function	Cost Reduction (CR)
(iii) Corrective Function	Cost Control(CC)
(iv) Measures to standardize for increasing productivity	Cost Reduction (CR)
(v) Provision of proper Storage Facilities for Materials.	Cost Reduction (CR)
(vi) Continuous comparison of actual with the standards set	Cost Control(CC)
(vii) Challenges the standards set	Cost Reduction (CR)
(viii) Value Analysis.	Cost Reduction (CR)

Question 7(a): Network Analysis – Basics **M 12 (4 Marks)**

The following is a part of a Network. What are activities P and Q called? How would you rectify the situation?



Solution:–

(a) Activities P and Q are called **Duplicate Activities**, since they have same Head and Tail Event.

(b) To rectify this error, a Dummy Activity, which consumes no resource, time and cost, is introduced in any of the two duplicate activities. It is represented by dotted lines in the Network Diagram.

(c) This will avoid any activity from having common starting and finishing events.

Question 7(b): Assignment – Reverse Working **M 12 (4 Marks)**

The following Matrix was obtained after performing Row Minimum Operations on Rows R_1 and R_2 in an Assignment Problem for Minimization. Entries "XX" represent some positive numbers. (It is not meant that all "XX" numbers are equal). State two circumstances under which an Optimal Solution is obtained just after the Row Minimum and Column Minimum Operations. (Use Cell References as C_i R_j for uniformity, e.g. C_1 R_1 represents the cell at intersection of Column 1(C_1) and Row 1 (R_1), etc.)

	C1	C2	C3
R1	0	XX	XX
R2	XX	0	XX
R3	XX	XX	XX

Solution: In both the following situations, Optimal Solution can be obtained just after Column Operations –

1. Entry at C_3 R_3 should be the **minimum** of that C_3 Column, so that C_3 R_3 becomes Zero after Column Operations.
2. All Entries in Column C_3 are **equal**, such that all entries in that Column become Zero after Column Operations.

Question 7(c): Simulation – Random Number Table **M 12 (4 Marks)**

A Refreshment Centre in a Railway Station has 2 Counters – (i) Self-Service (opted by 60% of the Customers) and (ii) Attended Service (opted by 40% of the Customers). Both Counters can serve one person at a time. The arrival rate of customers is given by the following probability distribution:

No. of Arrivals	1	3	4	0	2
Probability	0.10	0.30	0.05	0.20	0.35

Formulate the Associated Interval of 2 digit Random Numbers for generating the – (1) Type of Service, and (2) Arrival Rate.

Solution: **1. Random Nos. for Type of Services**

Counters	Probability	Cum. Probability	Random / Intervals
Self–Service	0.60	0.60	0–59
Attended Service	0.40	1.00	60–99

2. Random Nos. of Arrival Rate

No. of Arrivals	Probability	Cum. Probability	Random / Intervals
0	0.20	0.20	0–19
1	0.10	0.30	20–29
2	0.35	0.65	30–64
3	0.30	0.95	65–94
4	0.05	1.00	95–99

Question 7(d): Define the following terms (The first three relate to a Manufacturing Plant.) **M 12 (4 Marks)**

Maximum Capacity (Theoretical Capacity)	Maximum Possible Capacity based on Equipment Vendor's specifications.
Practical Capacity	Capacity that can be effectively utilized, i.e. Maximum Capacity less Normal and Unavoidable Idle Time.
Normal Capacity	Capacity based on Sales Expectations (i.e. Past Average Sales)
Principal Budget Factor	Key Factor = Principal Budget Factor (Refer Page 7.4. Q.No. 10.)

Question 7(e): Suggest suitable Cost Units for the following services: **M 12 (4 Marks)**

Services	Cost Units
(i) Hospital	No. of Beds / Patient, No. of Bed – Days.
(ii) Hotel	No. of Guest Days
(iii) Transport	No. of Kilometers traveled, or Passenger Kilometres.
(iv) Staff Canteen	No. of Staffs