

B.E.
Sixth Semester Examination, Dec.-2009
Industrial Engineering (ME312E)

Note : Answer any *five* questions. All questions carry equal marks.

Q. 1. (a) Define motion study. State the different charts which are used as a tool of motion study.

Ans. Motion Study : Motion study may be defined as the systematic investigation (i.e., recording and critical examination) of existing method of doing a job in order to develop and install an easy, rapid, efficient, effective and less fatiguing procedure for doing the same job and at lower costs. This is generally achieved by eliminating unnecessary motions involved in a certain procedure or by changing the sequence of operation or the process itself.

Various charts which are used as a tool of motion study are :

1. Therbligs : Therbligs were suggested by Gilbreth and are used to describe the basic elements of movements or fundamental hand motion of the work cycle. Every therblig is represented by a symbol, a definite colour and with a word or two to record the same. **Example :** Therblig Grasp has symbol U, red color and is denoted by the word G.

2. S.I.M.O. (Simultaneous Motion Cycle) Chart : It is an externally detailed left and right-hand operation chart. It shows on a common time scale the simultaneous minute movements performed by the two hands of an operator. Besides hands, the movement of other limbs of an operator may also be recorded. The time scale is represented by winks (1/2000 of a minute).

SIMO chart is generally used for micromotion analysis of (a) Short cycle repetitive jobs (b) High order skill jobs and finds applications in jobs like components assembler, packaging, repetitive use of jigs and fixtures, inspection etc.

Q. 1. (b) For a particular job 20 observations were taken by a time study analyst. Check the whether these number of observations are sufficient for $\pm 5\%$ accuracy with 95% confidence level. Determine the minimum number of readings required.

Time in min. (X)	0.06	0.07	0.08	0.09	0.10
Frequency (f)	2	3	10	3	2

Ans. Given :

$$n^0 = 20 \quad n^1 = ?$$

$$\Sigma x = 20 \quad \Sigma x^2 = 126$$

Time (X)	Frequency (f)	ΣX	Σx^2
0.06	2	2	4
0.07	3	3	9
0.08	10	10	100
0.09	3	3	9
0.10	2	2	4
		20	126

Thus, sample size for 95% confidence level and $\pm 5\%$

$$n = 400 \left[\frac{\sqrt{n^1 \Sigma x^2 - (\Sigma x)^2}}{\Sigma x} \right]$$

n = Number of observation

n^1 = Number of cycles to be timed.

Σx = Sum of observation

Σx^2 = Sum of square of observation

$$20 = 400 \left[\frac{\sqrt{n'(126) - (20)^2}}{20} \right]$$

$$\Rightarrow 1 = \{n'(126) - 400\}$$

$$\Rightarrow n' = \frac{400}{126} = 3.17$$

3 cycle must be taken.

Q. 2. (a) Discuss the factors on which productivity depends.

Ans. Factors on which Productivity Depends :

Factors Effecting National Productivity :

- (i) Human resources
- (ii) Technology and capital investment
- (iii) Government regulations

Factors Affecting Productivity in Manufacturing & Services :

- (iv) Product system design
- (v) Machinery & equipment
- (vi) Skill & effectiveness of the worker
- (vii) Production volume.

(i) Human Resources : Employees need to be motivated to be productive. Pay alone is not enough; they need to have good, safe, working conditions and to be recognized the most vital part of the enterprise.

(ii) Technology & Capital Investment : Technology is the major factor is long range continuing productivity improvement. Government can promote R & D in industries & universation.

(iii) Government Regulations : Government can do much to eliminate unneeded regulations and to make cost-benefit analysis to determine the necessary regulations such as those on health & safety.

Q. 2. (b) Distinguish between job evaluation and merit rating. In what way merit rating is dependent on job evaluation?

Ans. Job Evaluation : Job evaluation is a systematic process of evaluating different jobs of an organization. Depending upon the characteristics and requirements of a job, job evaluation determines its relative worth

and attaches a value to it. These relative values of jobs assist in deciding wage rates and salaries for different jobs.

Merit Rating : Merit rating is a systematic and orderly approach to assess the relative worth of an employee working in an organisation in terms of his job performance, integrity, leadership, intelligence, behaviour etc.

Merit rating determines the extent to which an employee meets job requirements. Job evaluation and merit rating are two complementary aspects of a sound personnel policy. The first determines a suitable wage structure for the job and the second (i.e., merit rating), decides the reward an employee should get in addition to his wages; depending upon his merits.

Q. 3. (a) Describe direct and indirect costs.

Ans. Cost may be defined as the amount of expenditure (actual or notational) incurred on or attributable to a given thing.

Direct Cost : Direct cost is the cost which can be identified directly with the manufacture of product. It is the amount paid or money spent on direct materials e.g., a HSS bit for making a turning tool for lathe; Fe, Ni, Cr, etc. to make alloy steels.

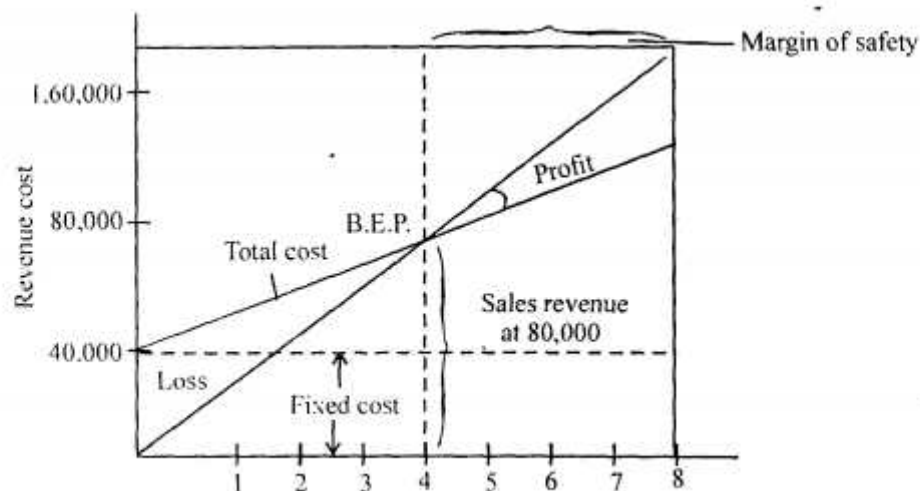
Indirect Cost : It is the cost which is necessary for the production process but is not directly used in the product itself. e.g., it does not become an integral part of the product, e.g. cotton waste, greases, oils, sandpaper, etc.

Q. 3. (b) A company is producing certain type of circuit breakers. The cost of land, building etc., is Rs. 40,000/-. The variable cost is Rs. 10/- per unit production. If the sales price of the product is Rs. 20/- per unit, what should be the minimum production level.

If the firm is operating at present so that production is 8,000 units, what is the firm's profit and margin of safety?

Ans. Given :

Fixed cost	$F = \text{Rs. } 40,000$
Variable cost	$V = \text{Rs. } 10 \text{ per unit}$
Sales price	$S = \text{Rs. } 20 \text{ per unit}$



Production volume Q

$$F + QV = QS$$

$$Q = \frac{F}{S - V}$$

$$Q_{BEP} = \frac{40,000}{20 - 10} = 4000 \text{ units}$$

Margin of Safety,

Margin of safety = Present sales - Break even sales

In ratio term,

$$\text{M/S ratio} = \frac{\text{Margin of safety}}{\text{Present sales}}$$

Thus, for 8000 units of production

$$\begin{aligned} \text{M/S} &= \text{Production value} - \text{BEP production} \\ &= 8000 - 4000 \\ &= 4000 \text{ units} \end{aligned}$$

In rupees term,

$$\begin{aligned} \text{M/S} &= 4000 \times \text{sales price} \\ &= 4000 \times 20 \\ &= 80,000 \end{aligned}$$

$$\text{M/S ratio} = \frac{80,000}{1,60,000} = 0.5$$

Production Volume for Given Point :

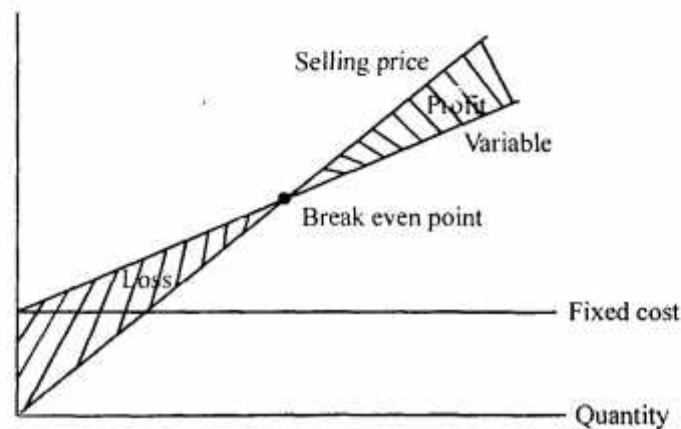
Fixed cost + variable cost = sales - profit

$$F + VQ = SQ - P$$

$$Q = \frac{F + P}{S - V}$$

Q. 4. (a) Explain by means of a block diagram how the selling price of a product is arrived at.

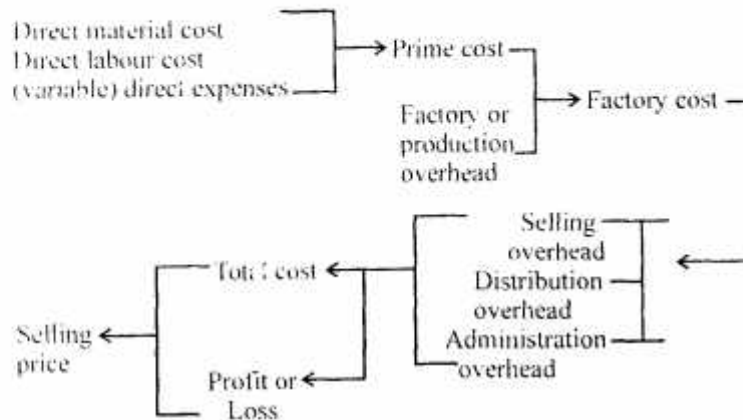
Ans.



Selling Price :

Selling price of a product

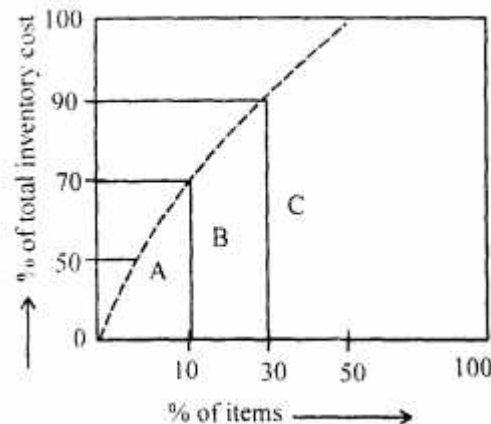
$$= \text{Total cost} \pm \text{Profit of loss}$$



Q. 4. (b) Explain how total cost of inventory can be efficiently controlled by "ABC Analysis" technique.

Ans. **ABC Analysis :** ABC analysis furnishes the following information :

1. A-items are high valued but are limited or few in number. They need careful and close inventory control. Such items being costly are purchased in small quantity oftenly and just before their use. This of course increases the procurement cost and involves a little risk of non-availability.
2. B- Items are medium valued and their number lies between A and C-items. Such items need moderate control. They are more important than C-items. They are purchased on the basis of past requirements, a record of receipt and issues is kept and a procurement order is placed as soon as quantity touches re-order point.
3. C- items are low valued, but maximum numbered items. These do not need any control, rather controlling them is uneconomical. These are the least important items like clips, all pins, rubber bands etc. They are generally procured just before the finish and future requirement of such items is never calculated.



Q. 5. (a) Define SQC. Discuss in short the practical devices used as tools of statistical control in industry.

Ans. SQC : SQC is defined as the technique of applying statistical methods based on theory of probability to establish quality standards and to maintain it in the most economical manner. It is a data driven approach and is applicable to outgoing products like during shipping.

Practical Devices used as Tool in SQC :

1. Histogram : It is a representation of distribution of variable data represented by a series and equal width columns of varying height. It is used for visual communication about process and for helping in making decision about where to focus the effort for improvement.

2. Control Chart : These are basically line graphs with control limits that record the number of defects for each period (shift, week etc). These are used to monitor the performance or ongoing process and to get a working in advance to prevent the manufacturing of defective parts.

3. Scatter Diagram : It is a graphical technique for studying relationship between two sets of associated data.

4. Pareto Chart : It is a technique of arranging data according to priority or importance and using it in the problem solving framework. This helps to find out important few from many trivial.

5. Cause & Effect Diagrams : It represent a relationship between a given effect and its potential cause and is used as a tool for problem solving. It is used to identify the potential root cause of the problem.

Q. 5. (b) Discuss advantages and limitations of acceptance sampling? Discuss single and double sampling plans.

Ans. Accepting Sampling : This statistical sampling procedure purports to answer questions such as : (i) are the supplier's goods to be accepted or reject, (ii) If accepted, what kind of risk do we incur in terms of bad quality.

Acceptance sampling is drawing a small component or items from the lot for inspection and checking its acceptability.

Advantages of Acceptance Sampling :

1. It reduces the cost of inspection.
2. It reduces tiredness among workers.
3. Many of the acceptance tests require destructive testing of the item and therefore a sampling procedure is must in such cases.
4. The acceptance sampling procedure either accepts or rejects the incoming lot in total. Such an outright rejection of the lot by the consumer often results in remarkable quality improvement on the supplier side.
5. Acceptance sampling makes the inspector carrying out sampling inspection more responsible towards his job, because a mistake in calling an item good or bad way decide the acceptance or rejection of an entire consignment rather than that of only one item. This greater responsibility forces the inspector to do better jobs.

Limitations of Acceptance Sampling : In certain cases 100% inspection is unavoidable. For instance in Nuclear Power Plant equipment and accessories to the smallest valve or conduit need to be inspected for quality on a 100% basis. We cannot afford to take a sample and based on that accept a consignment, because, however tight a sampling procedure, there is still a chance that few defective items might enter into the nuclear power plant. Therefore only 100% inspection can ensure the requirements of nuclear power plant.

Double Sampling Plan : It consist of taking first a sample of size n_1 and inspecting it for defective. If the number of defective is less than or equal to the cut-off number c_1 then accept the lot, if they are more than c_2 , reject the lot. If the number of defectives are in between c_1 and c_2 than take another sample of a different size n_2 . If the number of defectives in the combined sample of $n_1 + n_2$ is less than or equal to c_2 , accept the lot; otherwise reject it.

Single Sampling Plan : In single sampling plan, a lot is accepted or rejected on the basis of a single sample drawn from that lot.

Q. 6. (a) What are the various strategies associated with aggregate planning?

Ans. Aggregate Planning : The aggregate plan is made within the broad frame work of the long-range plan. Usually, the planning horizon for such plans ranges from a month to a year.

Various Strategies associated with aggregate planning are :

- (i) Overtime and undertime.
- (ii) Hiring and lay off; working single or multiple shifts.
- (iii) Carrying inventories to meet the peak demands.
- (iv) Having backlog of order.
- (v) Sub-contracting to other companies.
- (vi) Turning down to some sales demands.

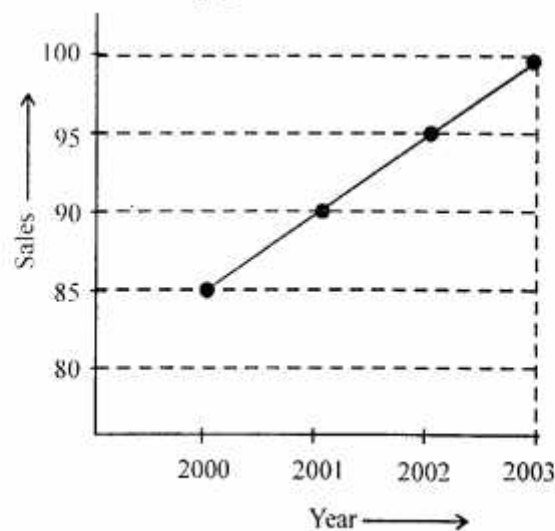
Each of these strategies has a cost factor associated with it.

Q. 6. (b) What is forecasting? Explain the different techniques of forecasting.

Ans. Forecasting : Forecasting means estimation of type, quantity and quality of future work, e.g., sales, etc. It represent a commitment on the part of the sales department and each of its divisions of expected sales.

Techniques of Forecasting :

(a) Extrapolation : it is the easiest method of forecasting. If sales or production capacities needs in the past years have been 85,90, 95 units, then in the coming year we would expect a sales/production capacity requirement of 100 units as illustrated in the fig. given below ;



(b) Moving Average Method : This is a discrete averaging method where periods in the past beyond a certain number are considered irrelevant for the analysis.

Example :

Months	Sales Unit
Jan.	50
Feb.	40
March	90
Apr.	45
May	55
June	60
July	55
Aug.	50
Sep.	45
Oct.	50

Total of 10 months = 540 units

Forecast for Nov. = $\frac{540}{10} = 54$

Now, if the observed sales for Nov. happen to be 60;

The forecast for Dec. = $\frac{540 + 60 - 54}{10} = 55$ units.

(c) Forecasting by Exponential Smoothing : It can be expressed as,

$$F_t = \alpha D_{t-1} + (1 - \alpha) F_{t-1}$$

Where,

F_t = Forecast for the period t,

D_{t-1} = Demand for the period before t i.e. (t-1)

F_{t-1} = Forecast for the period (t-1)

α = Smoothing factor

$$= \frac{2}{(\text{Number of periods in the moving average} + 1)}$$

Q. 7. How value engineering helps to improve productivity?

Ans. The notion of 'value' is intimately connected with that of wealth. The word 'value' has two meanings; value sometimes express :

- (i) The utility of some particular object.
- (ii) The power of purchasing other goods.

Value differs both from price and cost in the sales that it is the cost proportionate to the function, i.e.,

$$\text{Value} = \frac{\text{Function (or utility)}}{\text{Cost}}$$

It can therefore be seen that the value of a product can be increased either by increasing its utility with the same cost for the same function.

Function specifies the purpose of the product or what the product does, what is its utility, etc. There can be three functions of a product, namely :

- (i) Primary function
- (ii) Secondary function
- (iii) Tertiary function.

Taking an example of 'painting a merchant navy ship'; the primary function is to save the ship against corrosion & deterioration. The secondary purpose is to make it recognizable i.e., from the colour one should be able to identify the company it belongs to. The tertiary function is to impart or brilliant appearance. In all to increase the productivity.

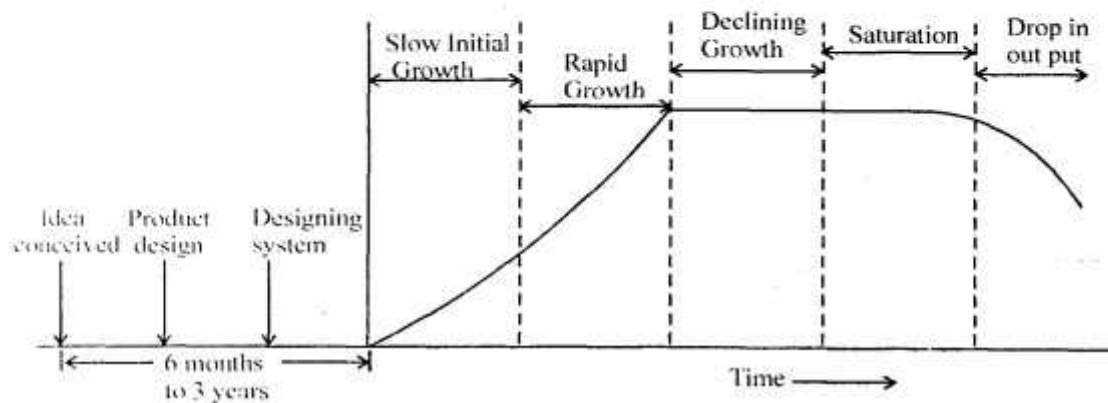
Q. 8. Write short notes on the following :

- (i) **Product Live Cycle**
- (ii) **Data Flow diagram**
- (iii) **Organizational and information system structure.**

Ans. (i) Product Live Cycle : It is important to understand the various phases in the life-cycle of a production system. Life cycle of production has different phases, which are same as that of human beings. We can identify eight distinct phases fig.

1. Birth of production system.
2. Product design and process selection.
3. Design of the system.
4. Maximizing of the system.
5. Start up the system.
6. System in the steady state.
7. Revision of the system.
8. Termination of the system.

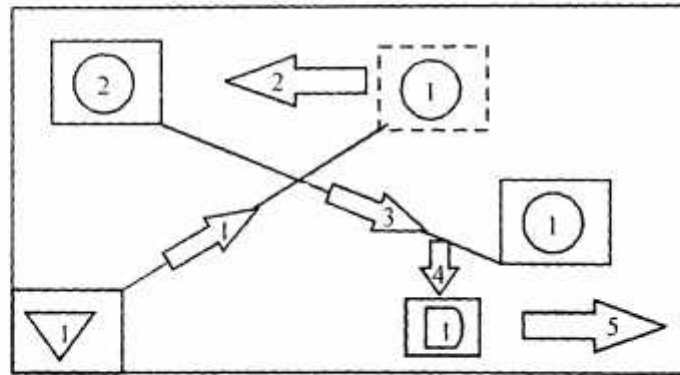
Some typical products at various levels of product life-cycle are shown.



(ii) **Data Flow Diagram** : A flow diagram is a drawing or a diagram which is drawn to scale. It shows the relative position of production machinery, jigs, gangway and marks the paths followed by men and material.

Steps in Drawing a Flow Diagram :

- (i) Draw to scale the plan of the work area.
- (ii) Mark the relative position of machine tools, bench, store, racks, inspection etc.
- (iii) From different observation, draw actual movement can be marked in different colours.



(iii) **Organizational and Information System Structure** : Management information system may be defined as a formal method of making available to management the accurate and timely information necessary to facilitate the decision making process and enable the organisation's planning, control.

Objectives :

- (i) To provide the desired information available in the right form at the right time.
- (ii) To supply the desired information at reasonable cost.
- (iii) To keep the information up to date.
- (iv) To store important and confidential information properly.

Function of an Organisational Information System :

- Determination of information needs.
- Information gathering.
- Information processing.
- Information utilization.