6TH SEM./MECH/MECH(PROD.)/ MECH(MAIN.) / DME/MECH(IND.INT)/ MECH(SAND.) /AUTO/ 2022(S)

TH-1 Industrial Engineering & Management

Full Marks: 80 Time- 3 Hrs

Answer any five Questions including Q No.1& 2
Figures in the right-hand margin indicates marks

1. Answer **All** questions 2 x 10

   a. What are the three times estimate in PERT analysis?

   b. Define plant layout.

   c. State the significance of ISO certification.

   d. What are the limitations of the graphical method in solving LPP?

   e. Define CPM.

   f. State the uses of inventory.

   g. What is the need of inspection?

   h. Define Quality & Control.

   i. What do you mean by operation research?

   j. State the three objectives of plant maintenance.

2. Answer **Any Six** Questions 6 x 5

   a. State the advantages & disadvantages of master scheduling.

   b. What are the factors which affect the quality of manufacturing?

   c. Compare PERT with CPM.

   d. Explain ABC analysis.

   e. Describe different types of over heads.

   f. Give symptoms of a bad plant layout.

   g What are the characteristics if ISO-9000?

3 Explain different factors influencing plant location. 10

4 Find the critical path and the duration of project completion for the data given in table. 10

Activity	Predecessor	Duration
A	-	7
B	-	13
C	A	10
D	A	17
E	B	3
F	D, E	26

5 What are the different types of control chart? Discuss about $\bar{X}$- Chart & P- Chart 10

6 Find the graphical solution of LPP for the following condition 10

Min Z = 60x + 40y

Subject to

$$30x + 10y \geq 240$$
$$10x + 10y \geq 160$$
$$20x + 60y \geq 480$$
$$x, y \geq 0$$

7 Write short notes on: 10

a Scheduling

b Breakdown Maintenance

c Six Sigma

d Job Order production

1. **A What are the three time estimate in PERT analysis**

Estimates of Time used in PERT: PERT is based on the assumption that operation time cannot be estimated accurately because of the lack of past data and uncertainties involved in working. To take these uncertainties into account, PERT uses three time estimates for each activities.

(i) Optimistic time (t): It is the shortest time in which an activity can be completed assuming that everything goes exceptionally well. It has low probability of occurrence.

(ii) Most likely time (t): It is the most likely time required to complete the activity taking into consideration all favourable and unfavourable elements. This estimate of time lies between the optimistic and pessimistic time.

(iii) Pessimistic time (t): It is the time which an activity will take to complete if everything turns out to be against expectation (i.e., under adverse conditions). Similar to optimistic time it has low probability of occurrence.

B. Plant Layout

A plant layout is an arrangement of facilities and services in the plant. It outlines realtionship between production centres and departments.

Paint layout can be defined as an optimum arrangement of industrial facilities, including personnel, equaipments, storage, space, material handling equipments and all other supporting services, in an existing or proposed plants, plants layout can also be defined as: A technique of locating machines, processes and plant services within the factory in order to secure the greatest possible output of high quality at the lowest possible total cost of production.

D. what are the limitation of the graphical method in solving LPP

I. When the decision variables are more than two, the graphical method becomes inadequate to solve the problem.
II. In many situations all relations may not hold good in linear variable, e.g., production cost may not be linear function of output.
III. The solution many times is in fractions which may not remain optimal when rounded-off.
IV. All coefficients and constraints are stated with certainly.

E. Define CPM

The critical path method (CPM) is a technique where you identify tasks that are necessary for project completion and determine scheduling flexibilities. A critical path in project management is the longest sequence of activities that must be finished on time in order for the entire project to be complete.

F. State the uses of inventory

(v) To take advantages of quantity discounts.

(vi) To utilize to advantage price fluctuations.

(vii) To ensure against scarcity of materials in the market.

(viii)To have a better utilization of men and machinery.

G. What are the need of Inspection

I. Inspection separates defective components from non-defective ones and thus ensures the adequate quality of products.

II. Inspection locates defects in raw materials and flaws in processes which otherwise cause problems at the final stage. For example, detecting the parts not having proper tolerances during processing itself, will minimize the troubles arising at the time of assembly.

III. Inspection prevents further work being done on semi-finished products already detected as spoiled.

IV. Inspection makes sure that the product works and it works without hurting anybody, i.e., its operation is safe.

V. Inspection detects sources of weakness and trouble in the finished products and thus checks the work of designers.

VI. Inspection builds up the reputation of the concern as it helps reducing the number of complaints from the customers.

H. Define Quality and Control

Quality

Quality is a relative term and is generally explained with reference to the end use of the product. For example, a gear used in a sugarcane juice extracting machine though not of the same material and without possessing good finish, tolerance and accuracy as that of a pear used in the head stock of a sophisticated lathe may be considered of good quality if it works satisfactorily in the juice extracting machine. Thus, a component is said to be of good quality if it works well in the equipment for which it is meant Quality is thus defined as fitness for purpose. Taking another example, a good quality car lifting jack may prove itself a bad quality product when tried on a five or seven-and a half tonner (vehicle).

Control

Control is a system for measuring and checking (inspection) a phenomenon. It suggests when to inspect, how often to inspect and how much to inspect. In addition it incorporates a feedback machanism which explores the causes of poor quality and takes corrective action.

Control differs from 'Inspection' as it ascertains quality characteristics of an item, compares the same with prescribed quality standards and separates defective items from non-defective one. Inspection, however, does not involve any mechanism to take corrective action.

I. **what do you mean by operation research ?**
II. Operation research signifies research on operations. Operation research can be defined as the application of scientific methods to industrial problems, leading to recommendations that in turn leads to action.
III. It employs mathematical logic to complex problems requiring managerial decisions.
IV. Operational research is the organised application of modern scientific method, mathematics and computer techniques to solve business or industrial problems.
V. It provides optimum solution to organizational problems.

J. **State the three objective of plant ~~layout~~** maintenance .

I. To achieve minimum breakdown and to keep the plant in good working condition at the lowest possible cost.
II. Machines and other facilities should be kept in such a condition which permits them to be used at their optimum (profit making) capacity without any interruption or hindrance.
III. Maintenance division of the factory ensures the availability of the machines, buildings and services required by other sections of the factory for the performance of their functions at optimum return on investment whether this investment be in material, machinery or personnel.

2 .

A. State Advantages and disadvantages of Master Scheduling.

Advantages of Master Scheduling :

I. Master schedule is the basis of all subsequent scheduling techniques.
II. It is simple and easy to understand.
III. It can be kept running.
IV. It involves less cost to make and maintain.
V. Can be maintained by non-technical staff.
VI. A certain percentage of total weekly capacity can be allocated for rush orders.

Disadvantages of Master Scheduling:

I. It provides only overall picture.
II. It does not give detailed information.

B. What are the factors which affect the quality of manufacture? Ans. Factors which affect the quality of manufacture:

I. Type of customers in the market.

II. Intended life, environmental conditions. reliability, importance of continuity of service.
III. Profit considerations.
IV. Economic considerations and feasibility.
V. Special requirements of the product such as strength. fatigue resistance life, interchangeability of the manufacture of item etc.
VI. The type and quality raw material, machines, tools, measuring instruments etc. used for the manufacturing of the product.
VII. Type of maintenance practice of machines and tools used for manufacturing.
VIII. Type of process selected and its process control during manufacturing.
IX. Expertise and experience of the operators.
X. Type of shipment, storage etc. of raw, semi finished and finished goods.
XI. Type of inspection during manufacturing.

C. Compare PERT and CPM

CPM

I. CPM is used where the emphasis is on optimising resource allocation & minimizing overall cost for a given project on execution time. CPM stands for Critical Path Method.
II. CPM is activity oriented
III. CPM marks critical activities.
IV. It uses single time estimate.
V. CPM is employed to these projects where minimum overall costs is of primary importance. There is better utilization of resources.
VI. Suitable for problems in industrial plant maintenance, civil construction projects etc.
VII. CPM is used where the emphasis is on optimising resource allocation & minimizing overall cost for a given project on execution time.
VIII. CPM terminology employs words like arrow diagram, nodes. and float.
IX. A deterministic model with well known as activity time based on past experience.
X. The use of dummy activities is not necessary. The arrow diagram thus becomes slightly simpler.

PERT

I. PERT is used where the emphasis is on shortening project execution time without too much concern for cost implication. PERT stands for programme Evaluation Review Technique.
II. An event oriented technique.
III. PERT basically does not demarcate between critical and non-critical activities.
IV. Three time estimates are used to make allowances for uncertainties.
V. PERT find applications in projects where resources (men, materials & specially money) are always made available as and when required.
VI. Especially suitable in defence projects, R and D where the activity times cannot be readily the predicted.

VII. PERT is used where the emphasis is on shortening project execution time without too much concern for cost implication.

VIII. PERT terminology uses words like network diagram, events, and slack.

IX. A probablistic model with uncertainly in at activity duration.

X. The uses of dummy activities is required for representing the proper sequencing.

D. Explain ABC analysis

ABC analysis divides inventories into three groupings in terms of percentage of number of items and percentage of total value. It is based on pareto analysis. In ABC analysis important items (high usage valued items) are grouped in 'A', while trivial items (low usage valued items) are grouped in 'C' and the remaining middle items are considered 'B' items. The inventory control is exercised on the principle of management by exception i.e., rigorous controls are exercised on 'A' items and routine loose controls for 'C' items and moderate control on 'B' item. The items classified by virtue of their uses as :

Category	% of item	% of value
A- High value items	10%	70%
B- Medium value items	20%	20%
C- Low value items	70%	

A-Items: In the total inventory items, A items, are few in number and thus represents a small percentage of the total items. However due to high cost and huge consumption, they represent a large percentage of company's total expenditure. It is Y common that approx. 10% of the total quantity of items represents 70% of the amount spent on these items. These items need accurate, careful records, careful handling and storage under tight control. Minimum and maximum limit and re-order point is set for A items such items should be thought of in advance and purchased well in time. A detailed record of receipt and issue should be kept and proper handling of facilities should be provided for them.

Such items being costly are purchased in small quantity oftenly and just before their use. This, of course, increase the procurement cost and involve little risk of non-availability. However, inventory holding cost decreases and problems of storage and caretaking are minimised.

B-Items: These are middle level items which do not require as detailed and close control as A items, but they need more attention and control than C-items. These items usually represent 20% of the total quantity of the items and represent 15% to 20% of the total expenditure on items.

C-Items:

These are numerous in expensive items. They generally represent 70% to 75% of the total quantity and 5 to 10% of the total expenditure on materials.

E. Describe different types of over heads.

Types of Overheads

There are three main types of overhead that businesses incur. The overhead expenses vary depending on the nature of the business and the industry it operates in.

1. Fixed overheads

Fixed overheads are costs that remain constant every month and do not change with changes in business activity levels. Examples of fixed overheads include salaries, rent, property taxes, depreciation of assets, and government licenses.

2. Variable overheads

Variable overheads are expenses that vary with business activity levels, and they can increase or decrease with different levels of business activity. During high levels of business activity, the expenses will increase, but with reduced business activities, the overheads will substantially decline or even be eliminated.

Examples of variable overheads include shipping costs, office supplies, advertising and marketing costs, consultancy service charges, legal expenses, as well as maintenance and repair of equipment.

3. Semi-variable overheads

Semi-variable overheads possess some of the characteristics of both fixed and variable costs. A business may incur such costs at any time, even though the exact cost will fluctuate depending on the business activity level. A semi-variable overhead may come with a base rate that the company must pay at any activity level, plus a variable cost that is determined by the level of usage.

F. Give symptoms of bad plant layout.

I. Congestion of materials, components and assemblies.
II. Excessive amount of work in process
III. Poor utilization of space.
IV. Long production cycle and delay in delivery.
V. Mental and physical strain on operators.
VI. Long transportation lines.

VII. Difficulties in maintaining effective supervision and control.
VIII. Excessive handling by skilled operators.
IX. Production bottlenecks of certain machine while similar or identical machines have idle time.

A bad plant layout would lead to loss of efficiency, waste of time and energy, inconveniences and botherations in the actual operations and in the process of production. A bad layout does not ensure orderly and efficient arrangement of work facilities and personnel.

G. What are the characteristics of ISO-9000 ?

I. A customer focus, as the customer is the primary focus of business.
II. Involvement of people.
III. ISO 9000 can be implemented in any type and size of organization.
IV. It is independent of the product, size and country.
V. It has international acceptance and recognition.
VI. It ensures consistent improvement in quality.
VII. Long term relationship between producer and customers.
VIII. Allows a wide flexibility, but at the same time are rigid too.

3. Explain different factors influencing plant location.

Factors influencing Plant Location

In practice, the choice of plant location should be based on following considerations

1. Availability of Raw material : An ideal location is one where the main raw-material required to manufacture the product is adequately available. This will ensure regular supply of the material and will also reduce the transportation costs. The technical and delivery problems associated with raw-material can be reviewed and discussed from time to time. Alternately, the per unit cost of raw-material should come out to be minimum at the ideal plant location.

2. Nearness to the potential market : Marketing of its product efficiently is also an important function of an enterprise. If the plant is located near the market then the management can keep close touch with the changes in market environment and formulate its production policies accordingly. But with expansion of markets both on national and international levels this aspect has now become of secondary importance. But the reduction in marketing costs still remains an important consideration for location to be near the market. The transportation and other overheads are likely to increase with distance between plant and the market. Also in case of factory being nearer to the market the risk of damage in transportation, loss of demand due to change in fashions etc. is also reduced. Glass, chemical and drug factories are mainly affected by this consideration.

3. Location should be near to the source of operating power : In some industries continuous and adequate supply of power is of great significance e.g. nylon fiber plant. There are some industries for which cheap electricity may be more important. In such situation location of the plant near to hydro-power stations will provide cheap electricity e.g. paper and pulp mills, flour mills etc.

4. Supply of labor : Labor is one of the most important inputs in an industrial enterprise. There should be regular and cheap supply of labor, specifically for unskilled labor. in modern times with brisk movement of labor force from one place to other this factor is also of secondary importance. But if there is adequate supply of local labor near the plant then naturally it will be available at cheaper rates.

5. Transport and Communication facilities : Transport is very important for bringing raw materials, fuel from different places. Also transport is required to supply the finished products to markets. The region well connected with Rail, Road, Water and Air transport system is considered to be more appropriate for the location of plants. Similarly good communication facilities viz. Postal and Telecommunication links are of great significance towards the success of an enterprise. Regions with good communication system should be given priority for the selection of sites. Similarly, Industries producing goods for export may be located near ports or airports.

6. Integration with other group of companies : New enterprise owned or operated by a single group of companies should be so located that its work can be integrated with the work of the associated establishments.

7. Suitability of land and climate : Sub-soil of the location should be able to support the load likely to be placed on it. Similarly, the climatic conditions viz, humidity, temperature and other atmospheric conditions should be favorable for the plant e.g. damp climate is favorable for textile and cotton industries. These conditions also determine heating and ventilating requirements.

8. Availability of housing, amenities and other services : Good housing facility, adequate number of shops, theaters, cinemas, restaurants, local passenger transport and rail services and sufficient availability of gas, water supply, drainage, disposal of waste, fire fighting services can easily attract goods toff.

9. Local building and planning regulations: Proposed location should not infringe local regulations and bye-laws. A discussion with the survey department of the local authority is

most desirable. Laws for the construction of buildings, local taxes c:c , should be taken into consideration for the selection of site.

10. Safety requirements : industries like nuclear power stations, explosive in nature, chemical process likely to pollute the atmosphere should be located in remote areas. Safety from enemy during the war periods also affects location decision.

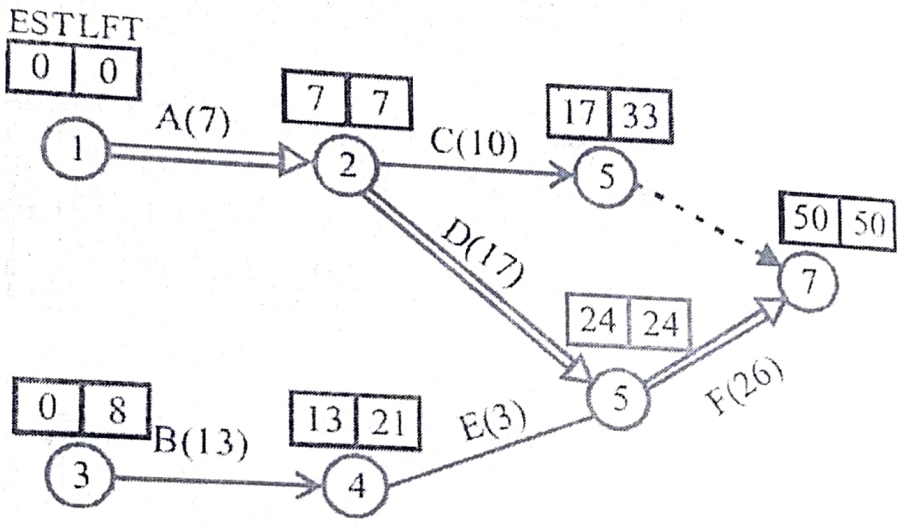
4.

Find the critical path and the duration of project completion for the data given in table.

Activity	Predecessor	Duration
A	–	7
B	–	13
C	A	10
D	A	17
E	B	3
F	D, E	26

Ans.

Activity	Predecessor	Duration
A	–	7
B	–	13
C	A	10
D	A	17
E	B	3
F	D, E	26



Critical path of the project is 1 – 2 – 6 – 7

Duration of the project completion is = Duration of the critical path = 7 + 17 + 26 = 50 days.

(a) Write short notes on : Six Sigma

: are Different types of Control Chart ? Discuss about X-Chart and P-Chart

f control chart

re various types of control chart used for different types of data and for specific es. Selecting the right type of chart is the first priority. Let us discuss some of the charts an be used for the following types of data.

te data – When your data is in the form of an attribute or count form of data we will trol charts like

U chart

C chart

Attribute data are the number of defects, defective units, etc.

Numerical data – When your data is in the form of a continuous type of data we will use control charts like

X bar chart

R bar chart

S bar chart

Examples like measurement of length, weight, temperature, etc.

Control Chart

X Chart:

I. It shows changes in process average and is affected by changes in process variability.
II. It is a chart for the measure of central tendency.
III. It shows erratic or cyclic shifts in the process.
IV. It detects steady progress changes, like tool wear
V. It is the most commonly used variable chart.
VI. When used along with R-chart: it tells when to leave the process alone and when to chase and when to chase and go for the causes leading to variation.
VII. it secures information in establishing or modifying processes, specifications or inspection procedures, and it controls the quality of incoming material.
VIII. X and R charts when used together form a powerful instrument for diagnosing quality problems.

P-Chart:

I. It can be a fraction defective chart or % defective chart (100p).
II. Each item is classified as good (non defective) or bad (defective).
III. This chart is used to control the general quality of the component parts and its checks if the fluctuations in product quality (level) are due to chance cause alone.
IV. It can be used even if sample size is variable (i.e.. different for all samples), but calculating control limits for each sample is rather cumbersome.

P-chart is plotted by calculating, first, the fraction defective and then the control limits. The process is said to be in control if fraction defective values fall within the control limits. In case the process is out of control an investigation to hunt for the cause becomes necessary.

6. $x, y \geq 0$.

(c) Find the graphical solution of LPP for the following condition.

Min Z = 60x + 40y

subject to

30x + 10y ≥ 240
10x + 10y ≥ 160
20x + 60y ≥ 480
x, y ≥ 0.

Ans. Mimimize, Z = 60x + 40y

Subject to

30x + 10y ≥ 240
10x + 10y ≥ 160
20x + 60y ≥ 480
x, y ≥ 0.

To solve the problem by graphical method, the constraints i.e., inequalities are converted temporarily into equations i.e.,

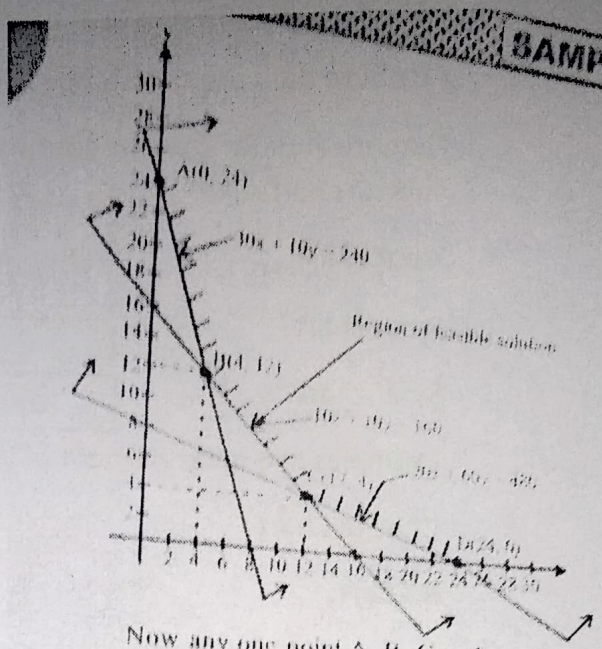
30x + 10y = 240 ....(1)
10x + 10y = 160 ....(2)
20x + 60y = 480 ....(3)

In equation (1), substitute, x = 0, then y = 24
substitute, y = 0, then x = 8

In equation (2), substitute, x = 0, then y = 16
substitute, y = 0, then x = 16

In equation (3), substitute, x = 0,
then y = 8
substitute, y = 0, then x = 24

The constraint equations are plotted on the graph as follows :



Now any one point A, B, C or D may give the optimum solution.

For point A (0, 24)

$Z_{min} = 60x + 40y = 60 \times 0 + 40 \times 24 = 960$

For point B (4, 12)

$Z_{min} = 60x + 40y = 60 \times 4 + 40 \times 12 = 720$

For point C (12, 4)

$Z_{min} = 60x + 40y = 60 \times 12 + 40 \times 4 = 880$

For point D (24, 0)

$Z_{min} = 60x + 40y = 60 \times 24 + 40 \times 0 = 1440$

Therefore point 'B' represents the optimum solution with x = 4 and y = 12

7. Write short notes on:

a. Scheduling :

Scheduling is the process of arranging, controlling and optimizing work and workloads in a production process or manufacturing process. Scheduling is used to allocate plant and machinery resources, plan human resources, plan production processes and purchase materials.

It is an important tool for manufacturing and engineering, where it can have a major impact on the productivity of a process. In manufacturing, the purpose of scheduling is to keep due dates of customers and then minimize the production time and costs, by telling a production facility when to make, with which staff, and on which equipment. Production scheduling aims

to maximize the efficiency of the operation, utilize maximum resources available and reduce costs.

In some situations, scheduling can involve random attributes, such as random processing times, random due dates, random weights, and stochastic machine breakdowns. In this case, the scheduling problems are referred to as "stochastic scheduling."

b. Breakdown Maintenance:

Breakdown maintenance, also known as reactive maintenance, is a type of corrective maintenance carried out upon unexpected machine failure that needs to be repaired or replaced to resume business operation. It is commonly performed when materials or machine parts are disposable, cannot be restored, or are easily available.

The Advantages

Breakdown maintenance can provide convenience when safety is not at risk due to equipment failure. It is effective for facility management into which non-critical equipment and short-life assets including batteries, fuse, light bulb, and other disposable items are to be replaced. Also, the company would benefit from the following:

minimally demanded workforce;

greatly reduced maintenance costs; and

easily detected replacement needs.

Having efficient stock and inventory management procedures is necessary to determine which materials or components should be kept on-premises in case of machine failure.

c. Six Sigma:

Six Sigma is a method that offers organizations tools to improve their capabilities in managing their businesses. This increase in performance and decreasing process variation, it is possible to reduce defect rates, improve employee morale, and improve the quality of products or services, which all contribute to a higher level of profitability.

Six Sigma is a set of management tools and techniques designed to improve the capability of the business process by reducing the likelihood of error. Six sigma is a data-driven approach that uses a statistical methodology for eliminating defects, defect reduction and profits improvement.

Digital transformation has become the hottest buzzword of this decade. New technologies and tools are supporting the transformation journey of companies big and small as they compete to get a bigger slice of business in a fast-paced competitive environment. Yet, is it enough to smooth a company's transformative process? Can a standalone technology implementation remove a bottleneck in the production process or support troubleshooting a service design flaw? Although digital transformation fast-tracks a company's growth, it has to

be equally supported by management methods of quality control and business transformation.

D. Job order production :

Definition: Job order production is the process of manufacturing custom or unique products for specific customers. Sometimes job order production is also called job order manufacturing or custom production because each order or job is a customize order placed by the customer. Most of the time custom jobs are only produced once.

Many manufacturers specialize in mass-producing custom products. Customers come to the manufacturer with a specific design or product in mind and the manufacturer develops and creates the custom product. A good example of a custom manufacturer is a print shop or studio. A customer might visit his local print shop with a design for 100 graduation invitations.

This design has a custom logo, font, and picture of the graduate. Printing these invitations would be considered one job because the print shop would have to setup its presses one time in order to print all 100 invitations. The process of designing and printing custom invitations is considered job order production.

Example

Take our graduation invitation example for instance. The print shop will most likely only produce this job once. It's unlikely that the customer will come back in the future and want more of the same invitations printed. Some custom jobs are produced more regularly however. A good example of this is event fliers. The local coffee shop might have weekly events that it needs fliers for. The print shop can simply change a template from the last job and create a new custom order.