CIM - IAT 1 March 2018 Solution

1)

a) Production capacity: Refers to the number of products that a production facility can produce under certain operating conditions.

$$PC = \frac{(WS_W HR_P)}{n_m}$$

b) Plant capacity: the number of total production output a plant can deliver under certain conditions.

c) Work-in-Progress: (WIP) is the amount of product currently located in the factory that is either being processed or is between processing operations.

$$WIP = \frac{PC\ U}{S_W H}(MLT)$$

d) Availability: The availability is sometimes used as a measure of-reliability for equipment. It is especially germane for automated production equipment. Availability is defined using two other reliability terms, the mean lime between failures (MTBF) and the mean time to repair (MTTR).

$$Availability = \frac{MTBF - MTTR}{MTBF}$$

Utilization refers to the amount of output of a production facility relative to its capacity.

$$U = \frac{Output}{Capacity}$$

e) MLT: IS the total time required to process a given part throughout the plant.

$$MLT = \sum_{i=1}^{n_m} (T_{sui} + QT_{oi} + T_{noi})$$

f) WIP-TIP ratio :

$$TI\,P\ ratio = \frac{MLT}{n_m T_0}$$

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$$WI\,P\ ratio = \frac{WIP}{Number\ of\ machine\ proces\sin g}$$

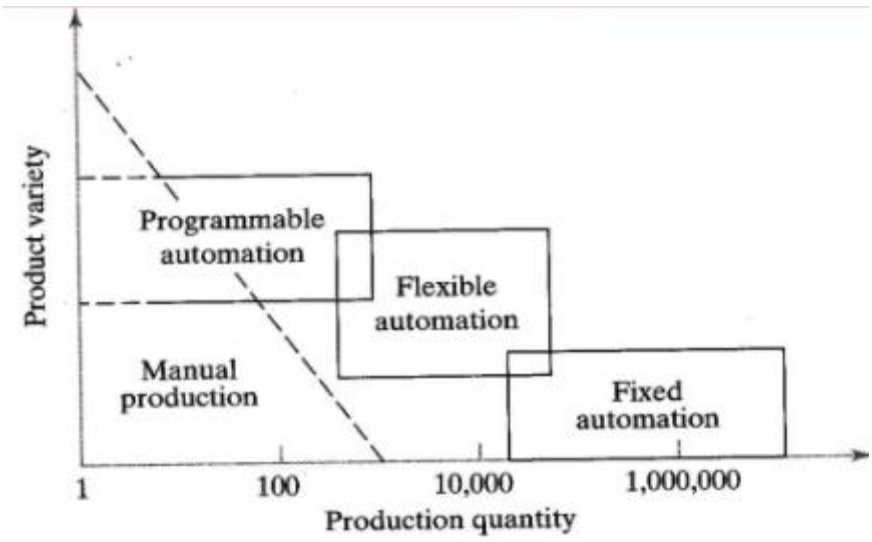
$$Number\ of\ proces\sin g\ machine = WU\frac{QT_0}{T_{su} + QT_0}$$

2) Automation is defined as " a technology concerned with the application of mechanical,electronics and computer based systems to operate and control production ".

(1) **Fixed Automation:-** It is the automation in which the sequence of processing or assembly operations to be carried out are fixed by the equipment configuration. In fixed automation, the sequence of operations (which are simple) are integrated in a piece of equipment. Therefore, it is difficult to automate changes in the design of the product. It is used where high volume of production is required Production rate of fixed automation is high. In this automation, no new products are processed for a given sequence of assembly operations. Features:- i) High volume of production rates, ii) Relatively inflexible in product variety (no new products are produced). Ex:- Automobile industries … etc.

(2) **Programmable Automation:-** It is the automation in which the equipment is designed to accommodate various product configurations in order to change the sequence of operations or assembly operations by means of control program. Different types of programs can be loaded into the equipment to produce products with new configurations (i.e., new products). It is employed for batch production of low and medium volumes. For each new batch of different configured product, a new control program corresponding to the new product is loaded into the equipment. This automation is relatively economic for small batches of the product. Features:- i) High investment in general purpose, ii) Lower production rates than fixed automation, iii) Flexibility & Changes in products configuration, iv) More suitable for batch production. Ex:- Industrial robot, NC machines tools… etc.

(3) **Flexible Automation:-** A computer integrated manufacturing system which is an extension of programmable automation is referred as flexible automation. It is developed to minimize the time loss between the changeover of the batch production from one product to another while reloading. The program to produce new products and changing the physical setup i.e., it produces different products with no loss of time. This automation is more flexible in interconnecting work stations with material handling and storage system. Features:- i) High investment for a custom engineering system. ii) Medium Production rates iii) Flexibility to deal with product design variation, iv) Continuous production of variable mixtures of products. Ex:- Flexible manufacturing systems (FMS)



3) The need for automation are:

(i) To Increase the Productivity Rate of Labour

(ii) To Decrease the Cost of Labour

(iii) To Minimize the Effect of Shortage of Labour

(iv) To Obtain High Quality of Products

(v) A Non-automation nigh Cost is Avoided

(vi) To Decrease the Manufacturing Lead Time

(vii) To upgrade the Safety of Workers.

(viii) Reduction of in-process inventory.

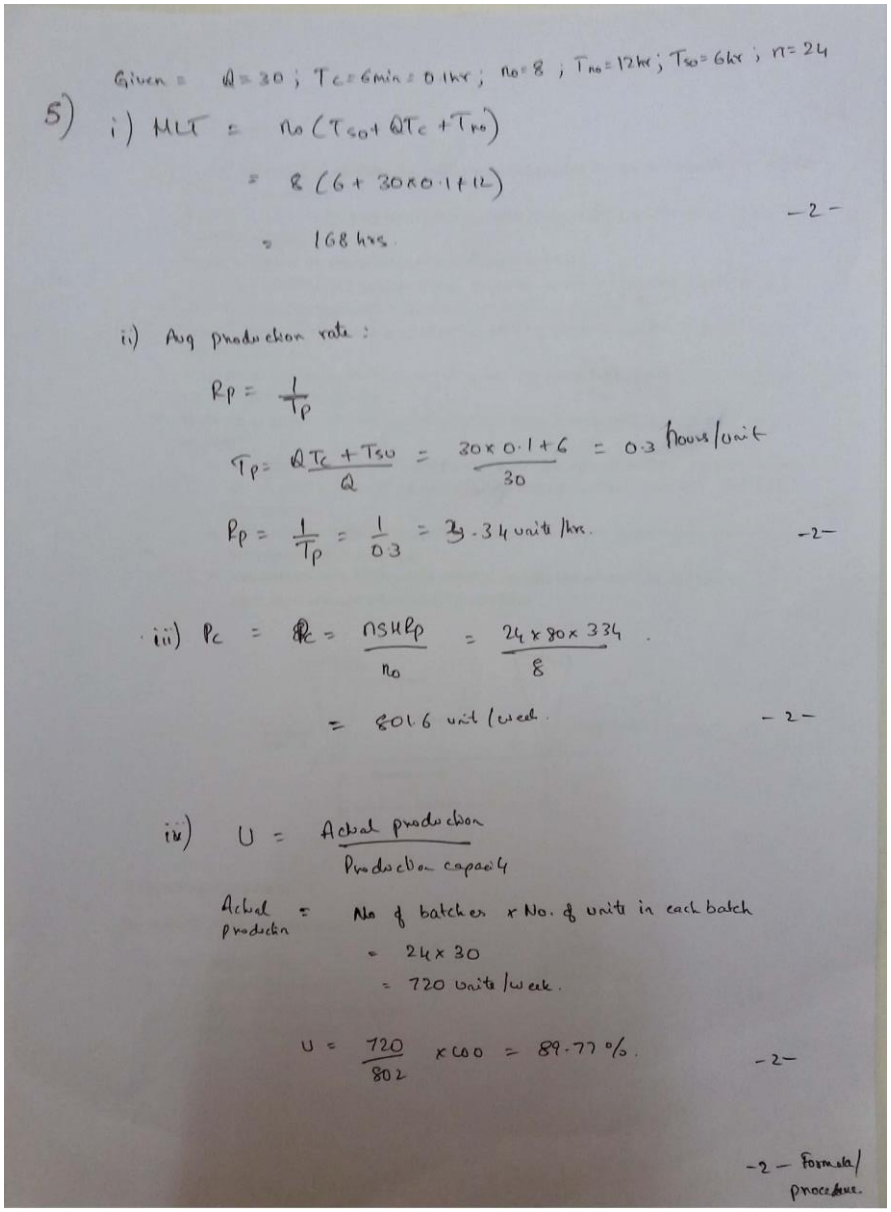
(ix) To obtain product variety much easily.

(x) Can be implemented in regions where human activity isn’t feasible.

4) The types of Production system are:

- Job shop production
- Batch production
- Mass production
- **Job shop production:** The distinguishing feature of job shop production is low volume. The manufacturing lot sizes are small, often one of a kind. Job shop production is commonly used to meet specific customer orders, and there is a great variety in the type of work the plant must do. Therefore, the production equipment must be flexible and general-purpose to allow for this variety of work. Also, the skill level of job shop workers must be relatively high so that they can perform a range of different work assignments. Examples of products manufactured in a job shop include space vehicles, aircraft, machine tools, special tools and equipment, and prototypes of future products. Construction work and shipbuilding are not normally identified with the job shop category, even though the quantities are in the appropriate range. Although these two activities involve the transformation of raw materials into finished products, the work is not performed in a factory.
- **Batch production:** This category involves the manufacture of medium-sized lots of the same item or product. The lots may be produced only once, or they may be produced at regular intervals. The purpose of batch production is often to satisfy continuous customer demand for an item. However, the plant is capable of a production rate that exceeds the demand rate. Therefore, the shop produces to build up an inventory of the item. Then it changes over to other orders. When the stock of the first item becomes depleted, production is repeated to build up the inventory again. The manufacturing equipment used in batch production is general-purpose but designed for higher rates of production. Examples of items made in batch-type shops include industrial equipment, furniture, textbooks, and component parts for many assembled consumer products (household appliances, lawn mowers, etc.). Batch production plants include machine shops, casting foundries, plastic molding factories, and press working shops. Some types of chemical plants are also in this general category.
- **Mass production:** This is the continuous specialized manufacture of identical products. Mass production is characterized by very high production rates, equipment that is completely dedicated to the manufacture of a particular product, and very high demand rates for the product. Not only is the equipment dedicated to one product, but the entire plant is often designed for the exclusive purpose of producing the particular product. The equipment is special-purpose rather than general-purpose. The investment in machines and specialized tooling is high. In a sense, the production skill has been transferred from the operator to the machine. Consequently, the skill level of labour in a mass production plant tends to be lower than in a batch plant or job shop.

5.



Given = Q = 30 ; T_c = 6min = 0.1hr ; n_o = 8 ; T_{no} = 12hr ; T_{so} = 6hr ; n = 24

5) i) MLT = $n_o(T_{so} + QT_c + T_{no})$

= 8 (6 + 30×0.1 + 12)

= 168 hrs. -2-

ii) Avg production rate :

$R_p = \frac{1}{T_p}$

$T_p = \frac{QT_c + T_{so}}{Q} = \frac{30 \times 0.1 + 6}{30} = 0.3$ hours/unit

$R_p = \frac{1}{T_p} = \frac{1}{0.3} = 3.34$ units/hrs. -2-

iii) $P_c = R_c = \frac{nSHR_p}{n_o} = \frac{24 \times 80 \times 334}{8}$

= 801.6 unit/week. -2-

iv) $U = \frac{\text{Actual production}}{\text{Production capacity}}$

Actual production = No of batches × No. of units in each batch

= 24 × 30

= 720 units/week.

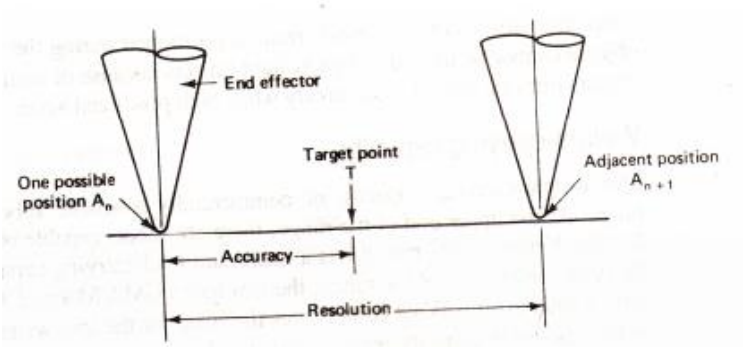
$U = \frac{720}{802} \times 100 = 89.77\%$. -2-

-2 — Formula/ procedure.

6) Robot specifications:

- Number of axes: This specifies the number of independent degrees of freedom that wrist end can manipulate.
- Capacity: It refers to the load carrying ability of the robot. Higher the load carrying capacity lower the accuracy.
- Speed: It refers to the distance moved by the tool in unit time.
- Operating environment: it represents the environment where a robot can work effectively.
- Work volume: is the space which the robot can manipulate its wrist.
- Reach & stroke: The distance covered by the end of the wrist to the centre of the body of robot is called reach.
  The distance covered by the wrist and along with the corresponding link without touching the work part is called as stroke.

- Performance parameters: the performance of a robot is measured in terms of of robots moment.
    - Spatial resolution: it refers to the smallest possible moment which a robot can move in its work volume. It depends on two factors: Control resolution mechanical inaccuracies
    - Accuracy: the ability to position the wrist end at a desired target with in robots work volume is called as accuracy.
    - Repeatability: the ability of the robot to position the wrist of the robot at the same point again and again is called as repeatability.



7) Classification of a robot:

Based on the physical configuration:

- Polar configuration
- cylindrical configuration
- Cartesian co-ordinate configuration
- jointed arm configuration

Based on the type of drive system

- Hydraulic drive system
- Pneumatic drive system
- Electric drive system

Based on the control system and dynamic performance

- Limited sequence robots
- Playback robots with point to point control
- Playback robots with continuous Path controls
- Intelligent robots

Based on position of robots

- Mobile robots
- Stationary robots

Based on area of application

- Domestic robots
- industrial robots
- defence robots
- research robots

Based on the type of controllers

- On off controller
- Proportional controller
- Integral controllers
- Proportional plus integral controllers
- Proportional plus derivative controllers
- Proportional + integral + derivative controller

Based on the type of end effectors

- Grippers
- tools

Based on the type of programming methods

- Manual programming
- Walk through programming
- Lead through programming
- Offline programming

8.

8) O11

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N010    G21   G40   G49   G80
N020    G94
N030    G50   S3000
N040    G91   G28   Z0
N050    G28   X0    Y0
N060    M06   T0101
N070    M03   S2000
N080    G90   G00   X 30   Y40
N090    M01
N100    G01   Z-10  F80
N110    G01   X 80   Y50   F50
N120    G01   X 80   Y70
N130    G01   X 20   Y70
N140    G01   X 20   Y90
N150    G01   X 80   Y90
N160    G01   Z5
N170    G28   Z 0
N180    G28   X0   Y0
N190    M06   T0102
N200    M03   S1000
N210    G99   G73  X20 Y30  Z-20  P200  R1  F30
N220                X50 Y30
N230                X 80 Y30
N240    G00   Z5
N250    G28   X0  Y0
N260    M05   M30
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[Reference as left bottom corner]

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- 2 -

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[Reference can be taken as centre]