DETAILS EXPLANATIONS

[PART : A]

1. Forecasting method such as the delphi,market survey,historical life cycle analogy are known as qualitative forecasting techniques. These are subjective and based on the opinion and judgment of consumers and experts. They are appropriate when past data are not available and are usually applied to intermediate or long range decisions.

Quantitative forecasting models like last period demand,simple and weighted moving averags,simple exponential smoothing,time series analysis and regression analysis are used to forecast furture data as a function of past data. The are appropriate when past data are available. These mehods are usually applied to short or intermeidate-range decisions.

2. Given that

$$t_i = 0.016 \text{ m}$$
$$t_f = 0.010 \text{ m}$$
$$R = 0.2 \text{ m}$$

Bite angle is determined as

$$\tan\theta = \sqrt{\frac{t_i - t_f}{R}}$$

$$\theta = 9.836^o$$

3. Blanking is a sheet metal operation in which blanks are sheared (shear) from a metal sheet to be used for further processing.

Stretch forming is another method of producing bent (bending) sheets without any local buckling and Wrinkling.

Coining is a cold working closed die forging operation (by compressive stress) on a sheet used for making coins, medals, etc.

Deep drawing is used for making deep cups, shells, from metal blanks by slowly descending the punch over stock sheet in which both tension and compression occur.

4. The size of riser should be designed for minimum possible volume, but should maintain a solidification time longer than that of casting. A special measure for riser design, freezing ratio, R, is defined as

$$R = \frac{(A/V)_{casting}}{(A/V)_{riser}}$$

Where A and V represent the surface area and volume of components under subscripts casting and riser. For proper functioning of the riser, its metal should solidify after solidification of metal in the mold cavity. Therefore, the freezing ratio must be greater than 1.

5. Pressure should not fall below the atmospheric pressure anywhere in the molten metal stream. Otherwise, the gases originating from the baking of organic compounds in the mold will enter the molten metal stream producing porous casting. This phenomenon is known as aspiration effect. Vena contract is generated in the molten stream that creates vacuum around this point. To avoid this, a smooth curve at entry is provided.

6. The solidification time is given by $t_s \propto \left(\frac{V}{A}\right)^2$

For a sphere of diameter d, $t_s \propto d^2$

Therefore, for the given two cases, $t_{s2} = \left(\frac{10}{5}\right)^2 \times 12 = 2^2 \times 12 = 48$

7. Alloying elements in steels, such as aluminium, chromium, vanadium, and molybdenum, form very hard nitrides when they come in contact with nitrogen. In nitriding, also called carbo-nitriding or gas cyaniding, the steel is put in a sealed container with ammonia gas and then heated to nitriding temperature between 500°C to 575°C for a duration 8 - 40 hours (the slowest case hardening process). This significantly increases wear resistance and fatigue life of the component. The portion of workpiece which is not to be case hardened is covered with tin.

8. ***Consumable electrode*** acts as electrode and filler both, for example steel, cast iron, copper, brass, Al, bronze. Metal arc welding uses consumable electrodes.

Non-consumable electrode acts as electrode only, such as carbon graphite for direct current and tungsten for AC. Tungsten arc welding uses non-consumable electrodes

9. Given that,

$$I = 5000 \text{ A}$$
$$R = 200\ \mu\Omega$$
$$t = 0.2 \text{ s}$$

Heat generated is given by

$$Q = I^2Rt$$
$$= 5000^2 \times 200 \times 0.2 = 1000 \text{ J}$$

10.

- Lay Lay represents the direction of predominant surface pattern produced and it reflects the machining operation used to produce it.
- Waviness Waviness refers to the irregularities which are outside the roughness width cut-off values. It is the widely spaced component of the surface texture. Waviness height is the peak-to valley distance of the surface profile.

11. Merits AJM offers the following advantages :

- Suitable for brittle and fragile materials, such as germanium, silicon, glass, ceramics, and mica.
- Preferred specially for drilling, cutting, deburring,etching, and cleaning.
- Low capital cost

12. Given that,

$$\alpha = 25^\circ$$
$$\lambda = 27^\circ$$

Shear angle is given by

$$2\phi + \lambda - \alpha = 90^\circ$$
$$\phi = 44^\circ$$

13. Given that $n = 0.2$

$$V_2 = \frac{V_1}{2}$$

Using Taylor's tool life equation : $V_c T^n = C$

$$T_2 = T_1\left(\frac{V_1}{V_2}\right)^{1/n} = 32T_1$$

14. Slip gauges are used in the manufacturing shops as length standards. They are not used for regular and continuous measurement. These are rectangular blocks having cross-section usually 32 mm × 9 mm but of thickness in standard series. Measuring surface of the gauge blocks is finished to a very high degree of flatness and accuracy.

The gauges are wrung together by bringing them into contact with each other at right angles and then pressing them with a twisting motion and simultaneously turning them parallel. If gauges are in a good condition, wringing will take place easily.

15. Tolerance is 0.050 – 0.020 = 0.030 mm

10% of the tolerance is 0.003 mm. Therefore, the size of GO gauge is

$$24.000 + 0.020 + 0.003 = 24.023 \text{ mm}$$

Similarly, the size of NO GO gauge is

$$24.000 + 0.060 - 0.003 = 24.057 \text{ mm}$$

16.
- Fixed Cost Costs that remain relatively constant regardless of the level of activity are known as fixed costs or indirect costs. It is considered as preparation expenses to produce a product or service.
- Variable Cost Costs that are generally proportional to output are called variable costs, or direct costs. Such costs are relatively easy to determine.

17. In exponential smoothing method, the foreeast for time period t is related to the demand for the previous piriod D_{t-1} and forecast or previous period F_{t-1}, using smoothing constant μ as

$$F = F_{t-1} + \mu(D_{t-1} - F_{t-1})$$
$$= 86 + 0.4(82 - 86) = 84.4$$

18. Break-even point is calculated as

$$Q^* = \frac{F}{p - V}$$

$$= \frac{120000}{28 - 6} = 5000$$

19. Aggregate production planning is concerned with the determination of production, inventory, and work force levels to meet fluctuating demand requirements over a planning horizon that ranges from six months to one year.

20.
- Deterministic Demand The inventory model using the assumption of constant and known demand for the item and lead time are called deterministic models. Here, the stock is replenished as soon as the stock reaches the point of exhaustion. In such a situation, there is no need to maintain any extra stock.
- Probabilistic Demand When the demand over a period is uncertain, but can be predicted by a probability distribution, the demand is called probabilistic demand.

[PART : B]

21. FSN Analysis In FSN analysis, the items are classified into Fast, Slow-moving, and Non-moving items, based on their issue rates or consumption pattern. This analysis enables in controlling the obsolescence. High consumption items desired attention for their uninterrupted procurement. Nonmoving items (almost nil consumption) indicate obsolete inventories due to changes in their specifications.

GOLF Analysis GOLF analysis is carried out mainly based on the source of material. GOLF stands for Government, Ordinary, Local and Foreign. This classification helps in describing the special procedure to be followed for procurement of materials from specialized sources.

XYZ Analysis XYZ analysis is based on the value of the inventory undertaken during the closing of annual accounts. X items are those having high value, whereas Z items are of low value. This analysis is used to identify items causing locking up money in the stock.

22. Economic lot size (Build-up) is determined as

$$Q^* = \sqrt{\frac{2AD}{h\,(1-d/p)}}$$
$$= 1180 \text{ units}$$

Thus, the number of production runs is

$$R = \frac{D}{Q^*}$$
$$= 22.37$$

The incremental cost, that is, total inventory cost is determined as

$$T(Q^*) = \sqrt{2ADh\left(1-\frac{d}{p}\right)}$$
$$= \text{Rs. } 1284.5$$

23. Given that, $\lambda = 0.5$ per minute

$$\mu = \frac{1.5}{2} = 0.75 \text{ per minute}$$

Hence, $$\rho = \frac{\lambda}{\mu} = 0.714$$

The probability that a random part arrival finds that there are already 6 parts in the system is

$$P = \rho^{n(}1 - \rho)$$
$$= 0.714^{10}(1 - 0.714) = 0.0378$$

24. Let x_1 and x_2 is the daily production of P and Q respectively, then,

$$x_1 + 2x_2 \leq 2000$$
$$x_1 \leq 1500$$
$$x_2 \leq 600$$

Maximize the profit $P = 3x_1 + 5x_2$

Solving by graphical methods gives solution matching with options

$$x_1 = 800$$
$$x_2 = 600$$

25.

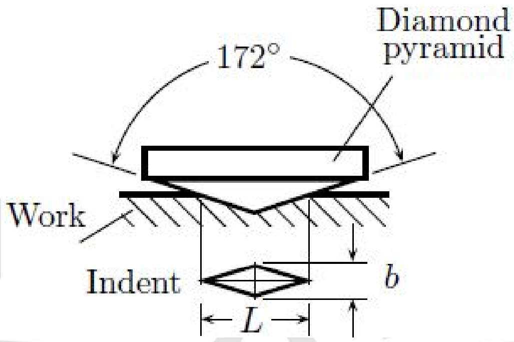

Figure : Knoop hardness test.

Let L and b (= L/7.11) be the long and short diagonals of the indent. The uncovered projected area of indentation is determined as

$$A = Lb — \times \frac{1}{2} Lb = \frac{L^2}{14.2}$$

Knoop hardness number is calculated by dividing the load with uncovered projected area:

$$HK = \frac{14.2P}{L^2}$$

Indentation of Knoop hardness test is very small, in the range of 0.01 – 0.10 mm, therefore, surface prepar attion is very important. It is mostly used for testing micro-hardness of small parts, thin sections, or case depth work, and brittle materials.

26. • Shrinkage Allowance Shrinkage of metals during cooling consists of two stages:

(i) Liquid Shrinkage

Liquid shrinkage occurs during cooling in liquid state. This is compensated in castings by providing risers. The extra molten metal is kept in risers that can flow into mold cavity during liquid shrinkage.

(ii) Solid Shrinkage

Solid shrinkage occurs during cooling in solid state, and thus, depends upon thermal expansion coefficient. Shrinkage allowances in patterns are provided against this solid shrinkage.

• Machining Allowance Machining allowance is the excess in dimensions of castings to take care of machining. It depends upon the cast material, type of molding used, class of surface finish, complexity of details and, obviously, the overall dimensions of the job. Molding sand has greater strength in compression than in tension, therefore, heavier and intricate sections should be included.

27. • Open Die Forging Open die forging is the simplest forging process in which the material is shaped by manipulating the work material between blows of specially shaped tools or hammer in open die. The process is flexible but unsuitable for large scale production due to slowness and dependency on the skill of the operator. Therefore, it is most often used in preparing work material for subsequent forging operations. Fullering is an open forging operation used to produce a shape with length much greater than its cross-section by simultaneously elongating the workpiece.

• Closed Die Forging Closed die forging, sometimes called impression die forging, uses closed shaped dies to control the flow of metal. The heated metal is positioned in the lower cavity and on it one or more blows are struck by the upper die. This makes the metal to flow and completely fill the die cavity. Excess metal is squeezed out around the periphery of the cavity in the form of flash which is trimmed off later.

28. In punching operation of the disc, the clearance is provided eu the punch. Diaruetral clearance is determined as

$$C_d = 0.0032t\pi$$
$$= 0.0032 \times 5 \times 250$$
$$= 4 \text{ mm}$$

Thus, the punch diameter should be $d_p = d + c_d$

$$= 76 + 4$$
$$= 80 \text{ mm}$$

29. As 3000 units are required in 365 days, therefore, 8 days quantity is

$$\text{Reorder level} = \frac{3650}{365} \times 10$$
$$= 100 \text{ units}$$

30. • Activity An activity is a physically identifiable part of a project which consumes both time and resources. It is represented by an arrow in a network diagram. Tail of an arrow represents the start of activity while head of the arrow represents its completion of the activity. This representation also includes description and estimated completion time over the arrow.

An activity has two terminal events which can be starting or completion points of other activities. Thus, an activity can have two types of associated activities:

(i) ***Predecessor Activity :*** All those activities which must be completed before the start of activity under consideration, are called its predecessor activities.

(ii) ***Successor Activity :*** All those activities which have to follow the activity under consideration are called its successor activities.

A dummy activity is used to maintain the predefined precedence relationship only during the construction of the project network. It does not consume any time and resource, therefore, it is represented by a dotted arrow. For example, the dummy activity shown in Fig. 19.6 indicates that the activity 4-5 is the predecessor of the activity 6-8.

Dummy activities can be used to maintain precedence relationships only when actually required. Their use should be minimized in the network diagram

- Event Beginning and ending of an activity are represented as events. Each event is shown as a node represented by a circle. An unbroken chain of activities between any two events is called a path. Numbers should be so assigned to the events that they reflect the logical sequence of events in the network.

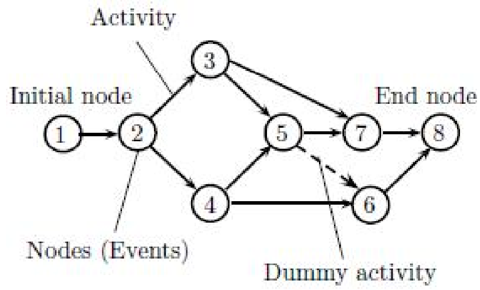

Figure : Elements of Project Network

31. For dependent demand situations, normal reactive inventory control systems, such as economic order quantity models, are not suitable because they result in high inventory costs and unreliable delivery schedules.

Unavailability of even one component can cause discontinuity in the production. Material requirement planning4 (MRP) is a special technique to plan the requirement of materials for production. It deals with the materials which directly depend upon the requirement of production. This technique employs production plan or schedule to arrange for the raw materials, rather than depending upon EOQ models. MRP is a simple system of calculating arithmetically the requirement of input materials at different points of time based on the actual production plan. It can be simply defined as a planning and scheduling system to meet time-phased material requirements for production operations, without any probability.

Bill of materials (BOM) is a detailed list of materials required to produce a product. It is constructed in a way that reflects the manufacturing process so that it can be used in material requirement planning. Figure shows a product structure which consists of three assemblies: A, B and C. There are five materials (1 to 5) required to produce this product.

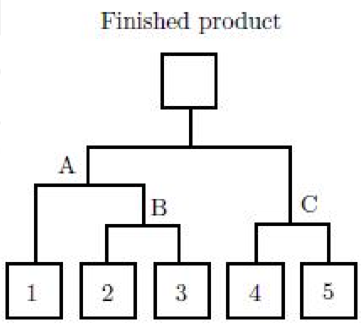

Figure : Product Structure

Using product structure, the bill of materials recognizes the dependence of certain components on subassemblies, which in turn depend on the final product.

32. Standard time is equal to actual time multiplied by rating factor plus allowances

$$ST = \frac{16\times60\times0.9}{108}\times\frac{120}{100}\times\left(1+\frac{20}{100}\right)$$

$$= 11.52 \text{ min}$$

[PART : C]

33. ***The following are the requisite properties of molding sand:***

- Refractoriness Refractoriness is the capability to withstand higher temperature of the molten metal.Graphite can withstand 4200°C (melting point) while silica, upto 1700°C. Higher grain size of sand gives higher refractoriness.
- Green Strength Molding sand containing moisture is called green sand. Green strength is the capabilityof green sand to withstand its own weight.
- Dry Strength Drying of green sand is done at temperature around 240°C. Dry strength is the ability of dry sand to withstand against self-weight and pressure of molten metal. Fine grains provide larger surface area (per unit mass) for the binder to act upon, thus provide better strength.
- Collapsibility Collapsibility is the property of sand to withstand expansion or contraction of the molten mental, thus reducing expansion defects in the castings
- Permeability Permeability is the capability of permitting the gas evolved during the molding process. Bulk density of a sand mix depends upon the shape and size of the grains. It will be very low if grains are of equal size with smooth and round shape. Such grains will result in an increased void and higher permeability. Fine grains would have lower permeability but better surface finish for casting to be produced. Permeability decreases with increase in the amount of ramming.

To access permeability, a permeability number (PN) is defined as the rate of flow of air through a standard specimen under standard pressure.

Mathematically,
$$PN = V \times H/p \times A \times t$$
$$= 501.28/\ p \times t$$

where V is the volume of air (2000 m^3), t is the time (minutes), H is the height of sand specimen (5.08 cm), p is the air pressure (g/cm^2), and A is cross-sectional area of the sand specimen (20.268 cm^2).

34. Given that : h = 150 mm ; A_1 = 450 mm^2 ; Q = 4.5 × 10^5 mm^3/s ; g = 9.8 × 10^3 mm/s^2

Therefore, at entry of the pouring basin, $A_1v_1 = 4.5 \times 10^3$

$$v_1 = 1000 \text{ mm/s}$$

But
$$v_1 = \sqrt{2gh_1}$$
$$h_1 = \frac{v_1^2}{2g}$$
$$= \frac{1000^2}{9\times 9.81}$$
$$= 50.96 \text{ mm}$$

At exit of the sprue,
$$v_2 = \sqrt{2g\times(h+h_1)}$$
$$= \sqrt{2\times 9.81\times(150+50.96)}$$
$$= 1985.69 \text{ mm/s}$$

For constant Q
$$A_2v_2 = 4.5 \times 10^5$$
$$A_2 = 226.62 \text{ mm}^2$$

35. Types of Flames Arc is generated in the form of flames whose structure depends upon the ratio of acetylene and oxygen.

The oxyacetylene flame can be of three types :

- Natural Flame Neutral flame is produced by stoichiometric ratio of C_2H_2 and O_2 resulting in complete combustion. This is the most preferred flame in gas welding. The flame suitable for mildsteel, gray cast iron, alloy steel, lead, and copper bronze.
- Carburized Flame Carburized flame is developed when less oxygen is provided to the gas. This flame is composed of three cones: white inner cone (2900°C), reddish feather middle cone, blue outer cone. Excess carbon can diffuse into base metals and can deleteriously affect the weld properties. Gas welding of steels with carburized flame can make them hard and brittle. Free carbons can cause poor corrosion resistance in stainless steels.

  This flame is used for oxygen-free copper alloys, high carbon steels, cast irons, high speed steels, cemented carbides, aluminium alloys, nickel alloys, etc.
- Oxydized Flame Oxydized flame uses excess oxygen and produces a loud noise. It is composed of only two cones: inner (3300°C, maximum overall) and outer. This flame is less luminous as compared to carburized flame. Since oxygen is a rapid supporter of combustion, therefore, oxidizing flame is never used for general purpose welding, specially of ferrous alloys. However, oxidized flame is some times used for welding of copper and zinc base alloys where oxide film is necessary to check vaporization of zinc and also to reduce further oxidation.

Stelliting is deposition of stellite (an alloy of cobalt, tungsten, and chromium) during the process of oxyacetylene welding or electric arc welding when it is done on the bodies requiring hard and wear resistance surface, such as cutting tools, lathe centers, rock drills, press tools, punches, dies.

36.

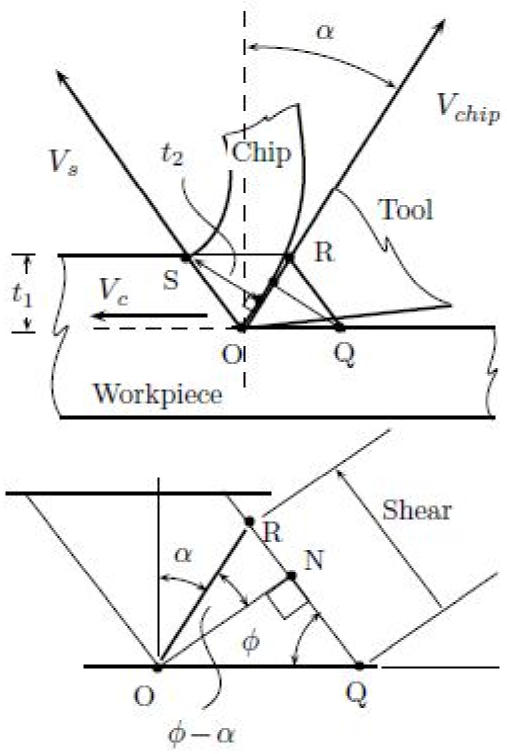

Figure : Chip formation and shear strain

Cutting ratio or chip thickness ratio (r) in orthogonal cutting is defined as the ratio of uncut thickness (t_1) to chip thickness (t_2):

$$r = \frac{t_1}{t_2}$$

Width of the shear plan can he determined as

$$SO = \frac{t_2}{\cos(\phi - \alpha)}$$

$$= \frac{t_1}{\sin\phi}$$

Therefore, the cutting ratio (r) is determined as

$$r = \frac{t_1}{t_2}$$

$$= \frac{\sin\phi}{\cos(\phi - \alpha)}$$

$$\tan\phi = \frac{r\cos\alpha}{1 - r\sin\alpha}$$

37.

- Basic Principle In plasma-arc machining (PAM) operates by directing a high velocity plasma stream at the work, thus melting it and blowing the molten metal through the kerf. The temperatures generated in the process are very high (≈10000^{o}C).
- Basic Elements A plasma is generated by subjecting a flowing gas to the electron bombardment of an arc. For this, the arc is set up between the electrode and the anodic nozzle. A gas (e.g. nitrogen, argon, hydrogen or their mixture) is forced to flow through this arc. The plasma flows through a water-cooled nozzle to direct the stream to the desired location. Gases or water are often directed to surround the plasma jet to help confine the arc and clean the kerf of molten metal as it forms. Underwater plasma cutting also reduces noise and helps in getting rid of plasma fumes and glare.
- Merits PAM offers the following advantages :

  (a) MRR higher than EDM and LBM.

  (b) Suitable also for electricity non-conducive materials.

  (c) Suitable for the plates of thickness upto 150 mm.
- Demerits PAM has the following limitations :

  (a) Emission of ultraviolet and infrared radiations.

  (b) Metallurgical transformations in work surface.

  (c) Expensive equipments.

  (d) Requires skilled operators.
- Applications The process is extensively used for profile cutting of metals such as stainless steel, aluminium, Monel, and super alloy plates, which are difficult to cut by oxyfuel techniques.

38. Given that,

$$R = 1.2$$

$$r_R = 8 \text{ min}$$

$$\text{Allowances} = 10\%$$

$$\text{Time available} = 8 \times 60 = 480 \text{ min}$$

The normal time is $t_n = t_R \times R = 9.6$ min

Standard time is $t_s = t_n \times \left(1 + \frac{10}{100}\right) = 10.56$ min

Number of jobs in given time is $n = \frac{480}{10.56} = 45.4545$

39. Service level is a measure of the degree of stock-out protection provided by a given amount of safety inventory. Given that the expecited value of the lead time demand is

$$= \frac{80 \times 0.2 + 100 \times 0.25 + 120 \times 0.30 + 140 \times 0.25}{0.20 + 0.25 + 0.30 + 0.25} = 112$$

The reorder level is $= 112 \times 1.25 = 140$

Thus, the reorder level (140) is equal to the maximum lead time demand (140). therefore, the service level is $\frac{140}{140} = 100\%$.

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