Mechanical Engineering.

CADM - V - Unit.

Q1) Describe opitz coding system.

Optiz is the most widely used coding classification system and was developed by H. optiz of west Germany. An optiz coding system uses the following sequences.

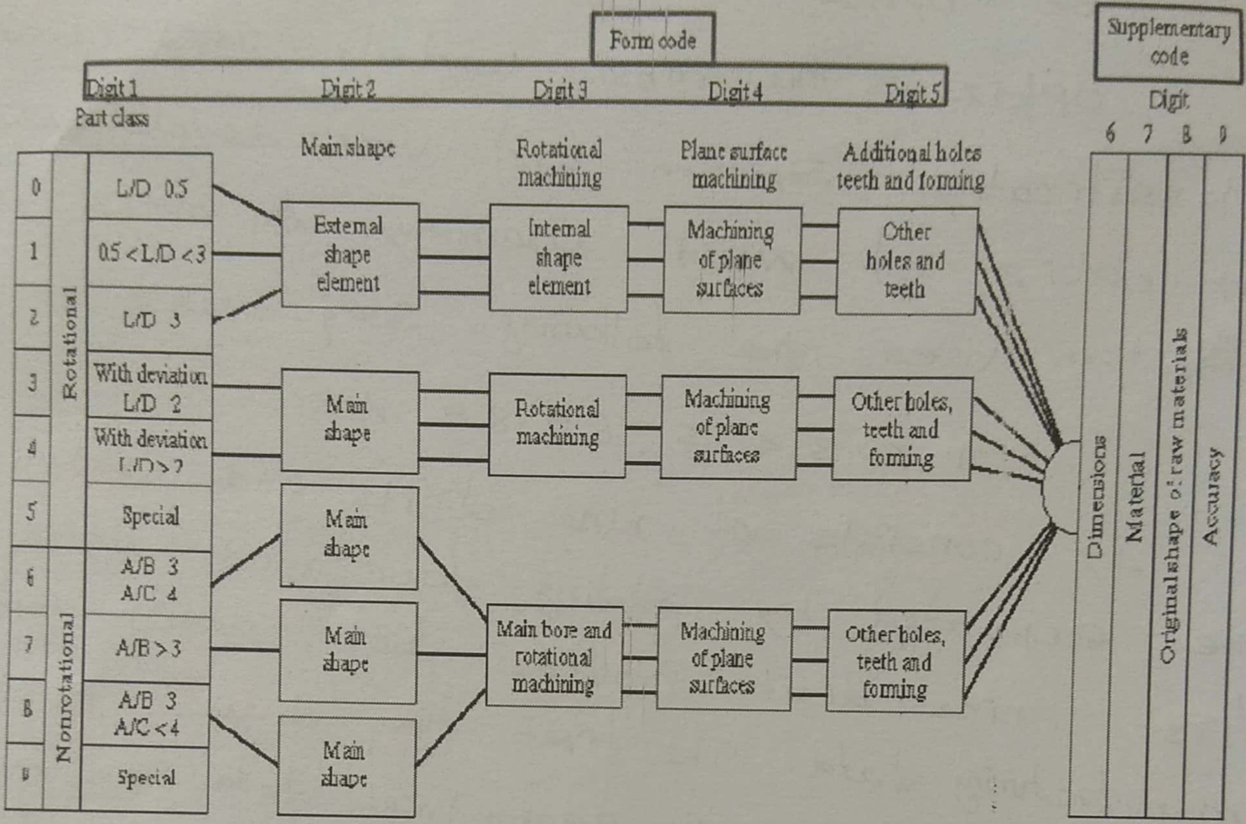
1 2 3 4 5 6 7 8 9 A B C D.

It consists of nine digits and extension can be expanded by adding four more digits. The first nine digits provide both design and manufacturing data. The first five digits "12345" are intended to convey geometrical data and are known as form code. The next four digits "6789" convey some of the features of manufacturing and are known as "supplementary codes". The additional four digits "ABCD" are intended for the type of an operation sequence, and they are known as sec. Codes. These are dependent on the needs of the Company, its equipment details, type of work.

Description of form codes and supplementary codes.

Digit	Description.
1.	Conveys shape of part either rotational or non-rotational. i. Rotational parts are represented by length-to-diameter ratio. ii. Non-rotational parts are represented by aspect ratio.

Basic Structure of Opitz System



Opitz Form Code (Digits 1 through 5)

Digit 1		Digit 2		Digit 3		Digit 4		Digit 5	
	Part class		External shape, external shape elements		Internal shape, internal shape elements		Plane surface machining		Auxiliary holes and gear teeth
0	Rotational parts: L/D ≤ 0.5	0	Smooth, no shape elements	0	No hole, no breakthrough	0	No surface machining	0	No gear teeth: No auxiliary hole
1	Rotational parts: 0.5 < L/D < 3	1	Stepped to one end or smooth: No shape elements	1	Smooth or stepped to one end: No shape elements	1	Surface plane and/or curved in one direction, external	1	No gear teeth: Axial, not on pitch circle diameter
2	Rotational parts: L/D ≥ 3	2	Stepped to one end or smooth: Thread	2	Smooth or stepped to one end: Thread	2	External plane surface related by graduation around the circle	2	No gear teeth: Axial on pitch circle diameter
3	Rotational parts	3	Stepped to one end or smooth: Functional groove	3	Smooth or stepped to one end: Functional groove	3	External groove and/or slot	3	No gear teeth: Radial, not on pitch circle diameter
4	Rotational parts	4	Stepped to both ends: No shape elements	4	Stepped to both ends: No shape elements	4	External spline (polygon)	4	No gear teeth: Axial and/or radial and/or other direction
5	Rotational parts	5	Stepped to both ends: Thread	5	Stepped to both ends: Thread	5	External plane surface and/or slot, external spline	5	No gear teeth: Axial and/or radial on PCD and/or other directions
6	Nonrotational parts	6	Stepped to both ends: Functional groove	6	Stepped to both ends: Functional groove	6	Internal plane surface and/or slot	6	With gear teeth: Spur gear teeth
7	Nonrotational parts	7	Functional cone	7	Functional cone	7	Internal spline (polygon)	7	With gear teeth: Bevel gear teeth
8	Nonrotational parts	8	Operating thread	8	Operating thread	8	Internal and external polygon, groove and/or slot	8	With gear teeth: Other gear teeth
9	Nonrotational parts	9	All others	9	All others	9	All others	9	With gear teeth: All others

2 Represents external shape.

3. Rotational machining, this digit represents internal shape features for rotational parts and rotational shape feautres for non-rotational parts.

4. Plane machined surfaces (e.g. slots, flats ... etc)

5. Gear teeth, Auxiliary holes, and other features

6. Dimensions.

7. Material of work or part.

8. Actual shape of raw material.

9. Accurary.

Example:- 1

The code of a part is 03121, then the meaning of the code is as follows.

0 — L/D ratio of part is ≤ 0.5

3 — stepped to one end with smooth functional groove.

1 — No shape element.

2 - External plane surface related by graduation around the circle

1 — No auxiliary hole.

Q2) what is group technology (GT). Explain the stages involved and advantages.

Group technology is a branch of CAD/CAM which examines the parts and the assemblies by grouping them into similar items to simplify design, manufactring, Purchasing and other business Process.

GT consists of two stages. which involves examining the parts and grouping the similar items.

First stage:- The parts or design are examined thoroughly to check the similarities b/w them. for the Similarity to exist, all the parts should be similar in shape, geometry and dimensions and should have similar Production processes. if the part satisfies one of the above two similarities, it can be grouped together

Ex:- if a company manufactures 1000 parts, they can be grouped into 30-60 families, according to their similarities.

Second stage:- The identified similar parts are grouped into families or batches. Thus by grouping the parts into small batches of different parts. a large batch can be Produced which reduces the overall manufacturing cost material handing and machining times. Thus resulting in effective Production Planning. The manufacturing efficiency is achieved resulting in reduced setup times, lower work-in process inventory. improved tool control, better Scheduling and the use of Standardized process plans.

Advantages of GT.

1. Product Design:- The combination of parts classification and coding system with the computerized design retrieval system helps in improving the product design.

2. Tooling and setups:- This technology helps in standardization of mainly two areas of manufacturing i.e. tooling and setups. In case of tooling, jigs and fixtures are designed in groups which helps in holding each and every part in the part family. This is done. by using special adapters in the workholding devices. most of the setup time is reduced, due to the processing of similar parts processed on them.

3 materials Handling :- The machine layouts of GT enables an effective material flow which helps in reducing the moving time and waiting time of the components.

4. Production and Inventory Control.
As the equipment is grouped into cells. it helps in reducing the number of production centers, as a result, Production scheduling. is simplified. It also reduces the complexity of work flow, setup times, Production lead times, work- in- process and delay in the process.

5. Employee satisfaction :- It enhances the attitude of workers, as the level of Job satisfaction increases to a great extent, It also improves the workpart. quality, which is taken care by the worker.

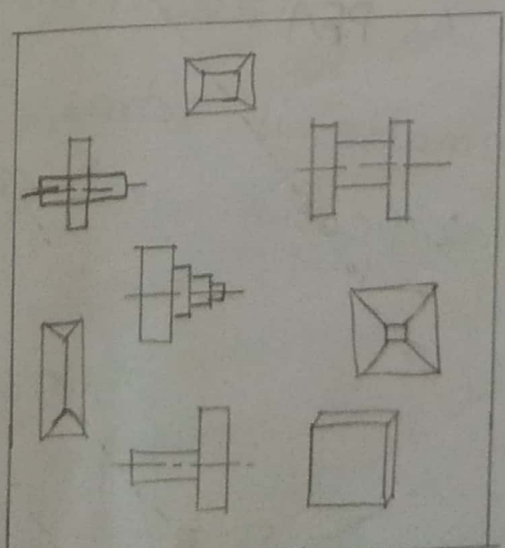
6. Process planning procedures :- The standardization achieved by GT, minimises the cost and time of the process planning function. The above benefits are obtained, by using an automated process planning system.

Q3) List out the methods for part family formation.

Ans: There are three methods used to group the parts into part family ie., Part family formation. They are

1. Visual Inspection
2. Parts classification and coding
3. Production Flow Analysis (PFA)

1. Visual Inspection: It is the simplest and commonly used method for part family formation. In this method, parts are classified based on their physical appearance, photographs and/or drawings of parts. Among the three methods of grouping this method is treated as least expensive, least sophisticated and also less accurate method.



Fig(1): Visual Inspection method

2. Parts classification and coding Method:

In this method an alphanumeric Value is assigned to the parts which are classified, based on their Similarities in design and/or manufacturing attributes. Then the parts are grouped according to the assigned code values. This method of grouping of parts consumes lot of time, is the most sophisticated method to adopt.

3. Production Flow Analysis (PFA):

In this method, parts and machines are arranged into part families and machine cells respectively, based on the similarities in route sheets of various parts, which contains sequence of operations to be performed on different machines. This method is also called as the route sheet inspection method, as it considers the information present in route sheet. As PFA uses manufacturing data for part formation, it solves the issues which occur in classification and coding process.

Q4, List and explain the various types of machines used in FMS.

Ans:

Flexible manufacturing systems use the following types of machines.

1. Machining and turning centres
2. Sheet-metal processsing machines
3. Indexing machines
4. Inspection machines.

1. Machining and Turning Centres:

A machining centre is an advanced development, in the machine tools automation A machining centre is generally a vertical milling machine that is mounted with advanced units like automatic tool changer containing more than 100 tools, automatic material loading and unloading system, multiple spindle axes and pallets. In FMS, units are controlled either by an integrated or central computer.

2. Sheet-Metal Processing Machines:

In FMS, CNC sheet metal Processing machines are used to perform hot and cold working operations like blanking, piercing, bending, forming etc.

(Q5)

3. Indexing Machines

Indexing is defined as the motion or movement of an object (tool, workpiece, machine parts) to a new location quickly and Precisely. NC, CNC or robot assisted indexing mechanisms are used in FMS to perform Various multiple operations.

4. Inspection Machines:

Inspection process can be carried out during work Process or in a specialized station established Inspection. The following inspection machines are used in FMS.

i, Co-ordinate measuring machines
ii, Contact and non-contact Inspection devices.
iii, Machine vision-system.

In FMS, along with the above machines, there are other machines which perform Various activities such as cleaning of parts and equipment, supplying central coolant and removing chip accumulation.

Q5) A Flexible manufacturing cell has just been created. After considering a number of designs, the system engineer chose a layout that consists of two machining workstations plus a load/unload station. In detail, the layout consists of:. The load/unload station is station 1. Station 2 performs milling operations and consists of one server (one CNC drill press). The three stations are connected by a part handling system, that has one work carrier. The mean transport time in the system is 4 min. The FMC produces three parts A, B and C. The part mix fractions and process routings for the three parts are presented in the table below. The operation frequency $f_{ijk} = 1.0$ for all operations. Determine (i) max production rate of the FMC. ii) corresponding production rates of each product. iii) Utilization of each machine in the system and iv) number of busy servers at each station.

Given that

mean transport time $(t_{n+1}) = 4$ min.

operation frequency $(f_{ijk}) = 1$.

i) Max Production Rate (R_p).

The max production rate can be determined at the bottleneck station.

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Part j	Part Mix P_j	Operation k	Description	Station i	Process time t_{ijk}
A	0.4	1	Load	1	3.
		2	Mill	2	20
		3	Drill	3	12
		4	Unload	1	2
B	0.4	1.	Load	1	3
		2	Mill	2	15
		3	Drill	3	30
		4	Unload	1	2
C	0.2.	1	Load	1	3
		2	Mill	2	14
		3	Drill	3	22
		4	Unload.	1	2

Determination of bottleneck station:-

Work load, $WL = \sum_j \sum_k t_{ijk} \; f_{ijk} \; P_j$

At load and Unload stations.

$WL_1 = (3+2)(0.4)(1.0) + (3+2)(0.4)(1) + (3+2)(0.2)(1)$

$= 2+2+1 = 5$ min.

At milling station.

$WL_2 = 20(0.4)(1) + 15(4)(1) + 14(0.2)(1)$

$= 8+6+2.8$.

$= 16.8$ min.

At drilling station.

$WL_3 = 12(0.4)(1.0) + 30(0.4)(1) + 22(0.2)(1.0)$.

$= 4.8 + 12 + 4.4$

$= 21.2$ min.

All the parts have similar routing

$(1 \to 2 \to 3 \to 1)$.

∴ Mean number of transports $n_t = 3$.

$WL_{n+1} = WL_4 = n_t \times t_{n+1}$.

At part handling system.

$WL_4 = 3 \times 4$.

$= 12$ min.

The largest value of $\frac{WL_i}{S_i}$ indicates the bottleneck station.

where S_i = servers for station

As mentioned in the Problem.

$S_1 = 1$, $S_2 = 1$, $S_3 = 1$, $S_4 = 1$.

Station 1, $\frac{WL_1}{S_1} = \frac{5}{1} = 5$ min.

Station 2, $\frac{WL_2}{S_2} = \frac{16.8}{1} = 16.8$ min.

Station 3, $\frac{WL_3}{S_3} = \frac{21.2}{1} = 21.2$ min.

Station 4, $\frac{WL_4}{S_4} = \frac{12}{1} = 12$ min.

The largest value of $\frac{WL_i}{S_i}$ is at station 3

i.e $\frac{WL}{S} = 21.2$ min.

Max production rate $R_p = \frac{S}{WL} = \frac{1}{21.2}$

$= 0.0471$ pc/min $= 2.82$ pc/hr.

ii) Corresponding Production Rates of Each Product

$R_{pj} = P_j R_p$

$P_{pA} = 0.4 \times 2.82 = 1.128$ pc/hr.

$R_{pB} = 0.4 \times 2.82 = 1.128$ pc/hr.

$R_{pC} = 0.2 \times 2.82 = 0.564$ pc/hr.

iii) Utilization of Each Station.

$U_i = \frac{WL}{S_i} \times R_p$

Station 1, $U_1 = \frac{5}{1} \times 0.0471 = 0.2355 = 23.55\%$

Station 2, $U_2 = \frac{16.8}{1} \times 0.0471 = 0.7912 = 79.12\%$

Station 3, $U_3 = \frac{21.2}{1} \times 0.0471 = 0.9985 = 99.85\%$

Station 4 $U_4 = \frac{12}{1} \times 0.0471 = 0.5652 = 56.52\%$

iv) Number of Busy servers at Each station.

$BS_i = WL_i [R_p]$

Station 1, $BS_i = 5 \times 0.0471 = 0.2355$

Station 2 $BS_2 = 16.8 \times 0.0471 = 0.7912$

Station 3 $BS_3 = 21.2 \times 0.0471 = 0.9985$

Station 4 $BS_4 = 12 \times 0.0471 = 0.5652.$