**WINTER– 14 EXAMINATION**

Subject Code: **17532** **Model Answer**

**Important Instructions to examiners:**

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.

2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.

3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.

4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.

5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.

6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.

7) For programming language papers, credit may be given to any other program based on equivalent concept.

## Q1. a) i) State role of factor of safety in design.

1. To check the reliability of the properties of the material and change of these properties during service
2. To check the reliability of test results and accuracy of application of these results to actual machine parts
3. To check the reliability of applied load
4. To check the certainty as to exact mode of failure
5. To check the extent of simplifying assumptions
6. To check the extent of localized stresses
7. To check the extent of initial stresses set up during manufacture
8. To check the extent of life if failure occurs
9. To check the extent of loss of property if failure occurs.

**Any 4 points 1 mark each.**

**Q1 a) ii)**

**Functions of machine tool structures**

The structures, depending upon their function, may be broadly divided into the following three groups.

Group 1:- Beds and bases, upon which the various subassemblies are mounted;

Group 2:- Box type housings in which individual units are assembled, e.g., speed box housing, spindle head, etc; and

Group 3:- Parts that serve for supporting and moving the work piece and cutting tool, e.g., table, carriage, knee, tail stock, etc.

**(02 marks)**

**Requirements Machine Tool Structures**

All important mating surfaces of the structures should be machined with a high degree of accuracy to provide the desired geometrical accuracy;

1. The initial geometrical accuracy of the structures should be maintained during the whole service life of the machine tool; and
2. The shapes and sizes of the structures should not only provide safe operation and maintenance of the machine tool but also ensure that working stresses and deformations do not exceed specific limits; it should be noted that the stresses and deformations are due to mechanical as well as thermal loading.

The design features that provide for ease of manufacture, maintenance, etc. are peculiar to each structure and will, therefore, be discussed separately for different structures. However, there are two common features which are fundamental to the satisfactory fulfilment of above requirements for all structures. These are:

1) Proper selection of material, and
2) High static and dynamic stiffness. **(02 marks)**

**Q 1 a) iii)** **(04 Marks)**

| **Sr. No.** | **Slideways** | **Guide ways** |
|---|---|---|
| **1.** | It is guideways with sliding friction | It is guideways with rolling friction |
| **2.** | These are V-slideways, flat slideways, round slideways, and dovetails | These are of two types ball type or roller type |
| **3.** | A very high level of friction is encountered in slideways system because of metal to metal contact existing between members | As these guideways use rolling elements between sliding members this reduces friction |
| **4.** | These used in machine tool bed | Generally used in high precision machine tools |

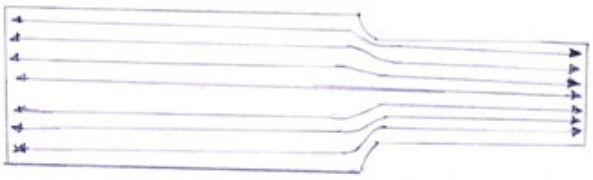
**Q1 a) iv) General Requirements of Machine Tool Design.**

1. High Productivity
2. Ability to provide the required accuracy of shape and size and also necessary surface finish.
3. Simplicity of design.
4. Safety and convenience of controls

5. Good appearance and
6. Low cost of manufacturing and operation. **(04 marks)**

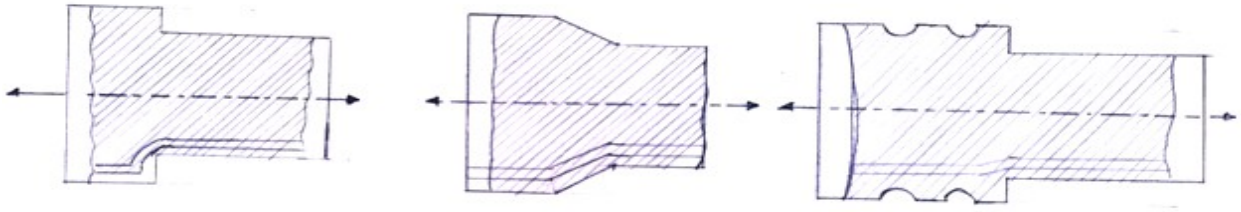
**Q1b) i) stress concentration.**

The machine component changes the shape of its cross-section, the simple stress distribution no longer holds good. This irregularity in the distribution caused by abrupt changes of form is called stress concentration.

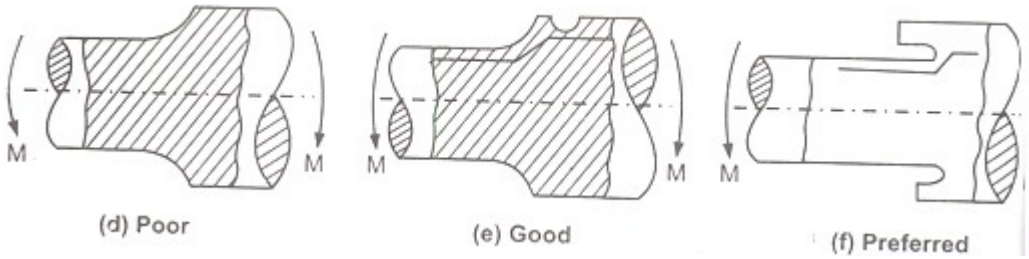


**Methods to reduce effect of stress concentration.**

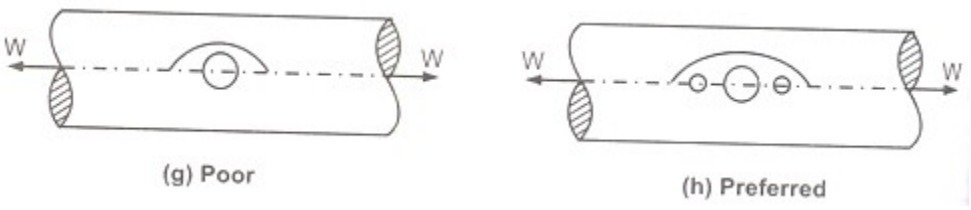
1) The following fig shows that stresslines tend to bunch up and cut very close to the edges or sharp corner, in order to improve fillets may be provided



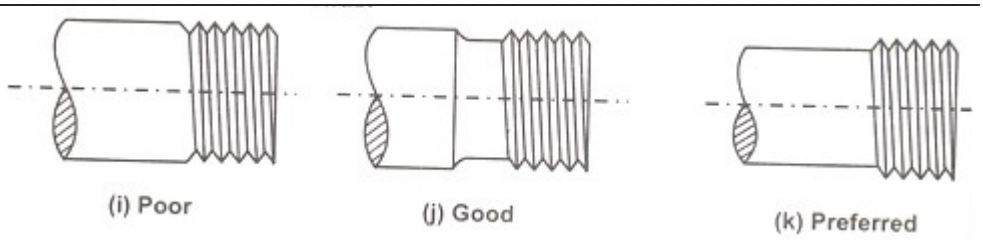
2) Reducing stress concentration in case of cylindrical members with shoulders.




3) Reducing stress concentration in case of cylindrical members with holes.




4) Reducing stress concentration in case of cylindrical members with threads.




**Definition 2 marks and 1 mark each for 4 methods.**

**Q1.B) ii)**

1. The operation of the machine tool, a majority of its structures are subjected to compound loading and their resultant deformation consists of torsion, bending and tension or compression.
2. Under simple tensile or compressive loading, the strength and stiffness of an element depend only upon the area of cross-section.
3. The deformation and stresses in elements subjected to torsion and bending depend, additionally, upon the shape of the cross-section.
4. A certain volume of metal can be distributed in different ways to give different values of the moment of inertia and sectional modulus.
5. The shape that provides the maximum moment of inertia and sectional modulus will be considered best as it will ensure minimum values of stresses and deformation.
6. The box-type section has the highest torsional stiffness and in the overall assessment seems best suited both in terms of strength and stiffness. The additional advantage that goes in its favor is the ease of proper mating with other surfaces. All considerations combined point towards the overwhelming superiority of the box-type profile over others for machine tool structures.
7. The machine tool bed and other structures cannot be made in the form of a closed-box profile. There must be apertures for bearings, opening for free flow of chips and other purposes. Thus the actual profiles of machine tool structures differ from a closed box profile. The apertures and openings in the structure have an adverse effect upon its strength and stiffness. **Proper explanation 6 marks.**

**Q2. Attempt any four of the following.**

**A)**

**1) Tensile Stress:-**

When a body is subjected to equal and opposite axial pull forces, the stress produced is called as tensile stress.

$$\sigma_t = \frac{W}{A}$$

Where, W = Axial tensile force

A = Cross – sectional area of rod = $\frac{\Pi}{4}d^2$

d= Diameter of rod

**2) Compressive Stress:-**

1. When a body is subjected to equal and opposite axial push forces the stress produced is called as compressive stress.

$$\sigma_t = \frac{W}{A}$$

Where, W = Axial compressive force

A = Cross – sectional area of rod = $\frac{\Pi}{4}d^2$

**3) Bending Stress:-**

1. When the beam is subjected to bending moment (M), the stress induced is called as bending stress.
2. The bending stress is nothing but, a tensile or compressive stress. The fibres above the neutral axis are subjected to compressive stress, whereas fibers below the neutral axis are subjected to tensile stress.
3. The bending stress induced at extreme fibre i.e. at greatest distance from neutral axis is given by.

$$\sigma_{b\,max} = \frac{M}{I}.y_{max}$$

Also,

$$\sigma_{b\,max} = \frac{M}{\left[\frac{I}{y_{max}}\right]} = \frac{M}{Z}$$

Where, Z = Section modulus = $\frac{I}{y_{max}}$

I = Moment of inertia of cross-section

M = Bending moment acting in the beam

$y_{max}$ = Distance of extreme (outermost) fibre from neutral axis.

**4) Transverse Shear Stress:-**

1. When a section is subjected to two equal and opposite forces acting tangentially across the section such that, it tends to shear off across the section. The stress produced is called as transverse shear stress.
2. It is given by,

$$\tau = \frac{W}{A}$$

Where, W = Force applied tangentially

A = Area of cross-section = $\frac{\Pi}{4} d^2$

d= Diameter of rivet

**5) Torsional Shear Stress:-**

1. When a machine component is under the action of two equal and opposite couples i.e. twisting moment or torque, then component is said to be torsion and the stresses set up due to torsion are called as torsional shear stress.
2. It is zero at the neutral axis and maximum at outer fibers.
3. Torsional shear stress is given by, basic torsion equation,

$$\frac{T}{J} = \frac{\tau}{r}$$

i.e.

$$\tau = \frac{T.\tau}{J}$$

Where,

r = Distance of outermost fibre from neutral axis = $\frac{d}{2}$

J = Polar moment of inertia of cross-section = $\frac{\Pi}{64} d^4$

**6) Crushing Stress:-**

1. It is defined as the localized compressive stress at the surface of contact between two components of a machine, which are relatively at rest.
2. Here, there is no relative motion between the two components.
3. Consider a riveted joints subjected to lad W,

$$\sigma_{ck} = \frac{\text{Load}}{\text{Projected area of contact}} = \frac{W}{d.t.n}$$

Where, d = Diameter of rivet

t = Thickness of plate

n = Number of rivet

**7) Bearing Stress:-**

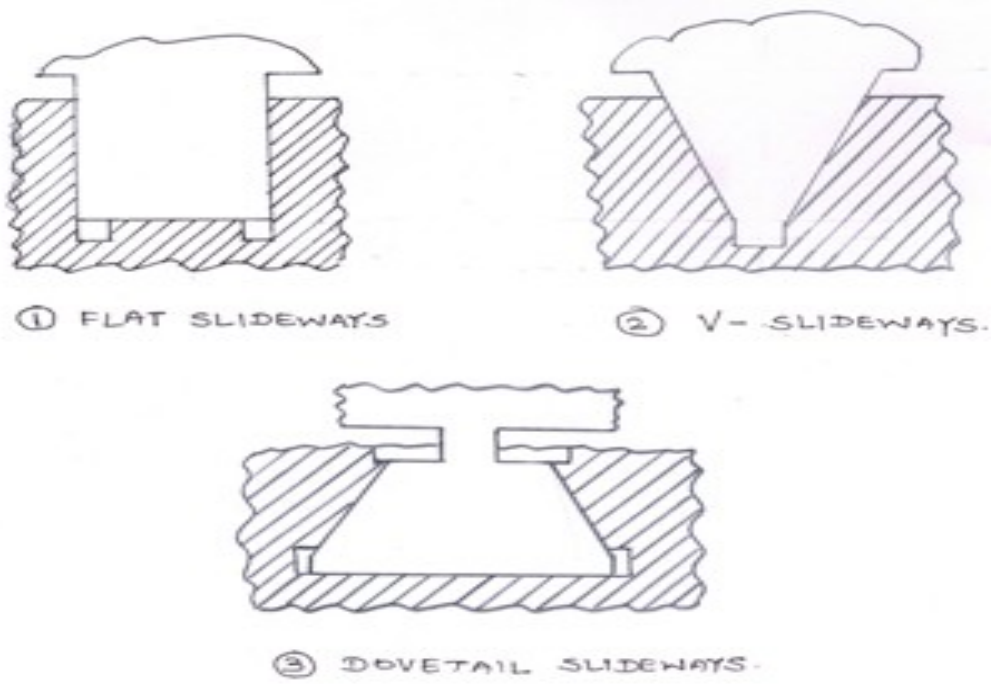
1. It is defined as, the localized compressive stress at the surface of contact between two members of a machine part, which have relative motion between them.
2. The bearing stress is taken into account in design of machine elements like,
   A. Screwed Joint
   B. Crank pin and large end bearings in I. C. engines.
   C. Small end of connecting rod and piston pin etc.

Bearing Stress (pressure) = $\frac{\text{Load}}{\text{Projected area of contact}} = \frac{W}{l \times d}$

**Any 4 stresses 1 mark each.**

**B) Classification: According to:**

1. Type of friction
2. Lubrication done
3. Material used
4. Joints to the bed
5. Direction of motion of sliding
6. Shapes of guides. **(02 marks**




**2 marks for any two.**

**D)**

The Speed chart only depicts the range ratio of transmission groups but gives no information about transmission rations. **(01 mark)**

In order to determine the transmission ratios of all transmissions and the rpm values of speed-box shafts, it is necessary to plot the speed chart.

The lines joining points of adjacent shafts in a speed chart depict the transmission rations. If:

1. The line is horizontal, it corresponds to transmission ratio $i = 1$, i.e., no speed change,

2. The line is inclined upward, it depicts $i > 1,$ i.e., speed increase, and
3. The line is inclined downward, it depicts $i < 1,$ i.e., speed reduction.

While plotting the speed chart it is desirable to have the minimum transmission ratio, i.e. maximum speed reduction in the last transmission group. In this case the remaining shafts of the speed box run at a relatively higher rpm and are, therefore, loaded less.

Keeping in mind the restrictions,

$$i_{max} \leq 2, \quad \text{and} \quad i_{max} \leq \frac{1}{4}$$

The maximum number of intervals between the ends of lines joining points on two adjacent shafts is also restricted.

**3 mark**

**E)**

**Definition:** Quality contributes to the performance of the product, through the extend of contribution varies from product to product.

Importance of aesthetic or Appearance:

1. The appearance should contribute to the performance of the product.
2. The appearance should reflect the function of the product.
3. The appearance should reflect the quality of the product.
4. The appearance should not be at too much of extra cost, unless it is a prime requirement.
5. The appearance should achieved by the effective and economical use of materials.
6. The appearance should be suitable to the environment, in which the product is used.

**Q3. Attempt any 2 of the following:**

**a) Meaning:**

Machine tool parts, such as beds, columns, box-type housings, over arms, carriages, tables, etc. are known as machine tool structures. **(02 marks)**

**Factors affecting on the machine toll structure.**

It can be seen that a circular hole of diameter d affects the length of approximately twice the diameter i.e., affected length $l_1 = 2d$. An elongated aperture affects the stiffness even more and the length of the disturbed range is approximately $l_2 = l + d$, where $l$ is the length of the aperture. The reduction in the static and dynamic stiffness of a structure can be partially compensated by using suitable cover plates.

The reduction in the bending stiffness due to apertures can be compensated to a large extent by using suitable cover plates. However, for symmetrically placed apertures, the effects can be taken into account by multiplying the tensional stiffness with a reduction coefficient k.

**(03 marks)**

The following guidelines can be of help:

1. Bending stiffness is most affected by aperture in walls, perpendicular to the plane of bending;
2. Apertures of equal dimensions have less effect on the torsional stiffness of a structure with wider walls;
3. Form among the aperture dimensions, its width has maximum effect on stiffness;
4. If there are a number of apertures in a structure, the effect of those apertures that are considerably smaller than the dominant one can be neglected; and

If there are two apertures of more or less the same size in opposite walls of a structure, the reduction coefficient k is multiplied by another coefficient k' = 0.7 – 0.95; the larger value of k' = 0.95 being used for apertures in wide walls when $b_0$ = 0.5 B and $t_0$ = (0.3 – 0.5)L. **3 marks**

Q3) b) **Hydrodynamic slideways**

In hydrodynamic slideways liquid friction conditions between sliding surfaces are achieved due to hydrodynamic action of the lubricant film. A sufficiently large hydrodynamic force which is capable of lifting the guided member is possible only at high sliding speeds. Hydrodynamic slide ways are, therefore, used mainly where the sliding motion represents the primary cutting motion, e.g., vertical boring and turning mills and planning machines. Hydrodynamic action is possible between sliding bodies only if they are inclined to each other, i.e., they form a wedge.

**(04 marks)**

**Hydrostatic Slideways**

In hydrostatic slideways liquid-friction conditions at the interface of mating surfaces are achieved by supplying a lubricant under pressure, which is large enough to raise the sliding body and precludes metal-to-metal contact. Hydrostatic slideways are distinguished by:

1. High load capacity at all sliding speeds, including zero speed.
2. No starting friction, extremely low running friction and consequently almost negligible wear,
3. High stiffness
4. Good damping, and
5. High uniformity and accuracy of feed and setting motions.

One of the drawbacks of hydrostatic slideways is the difficulty in fixing the moving member in a desired position. However, the single major factor which goes against these slideways is their high cost on account of an elaborate lubricating system. This restricts their application to sophisticated and expensive machine tools, such as grinding machines, heavy-duty horizontal boring machines, programme-controlled and copying machines, etc.

**(04 marks)**

**Q3) c)**

**Effect of vibration on cutting conditions:-**

1. Chip thickness variation effect
2. Penetration rate variation effect
3. Cutting speed variation effect

**(04 marks)**

**Effect of vibration of tool life:-**

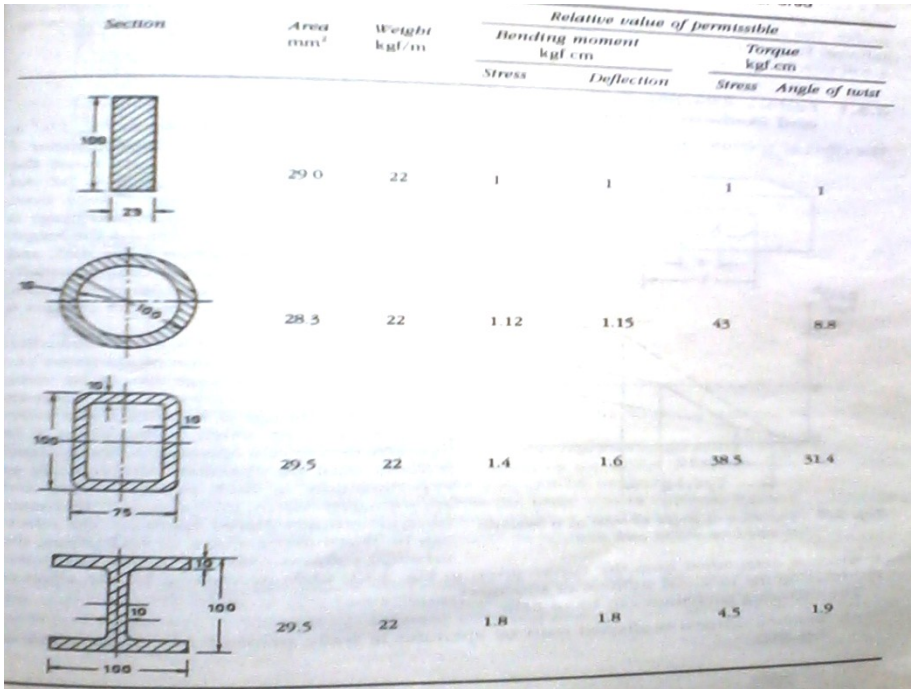
Cutting variables are affected by vibration, therefore tool life also affected by vibration. Tool life my decreased to 25% of the value compared to case without vibration.

**(04 marks)**

**Q.4 a) Attempt any THREE of the following:**

**i) Application of different types of profiles used in machine tool structure.** **(04 marks)**

During the operation of machine tool, a majority of its structures are subjected to compound loading and their resultant deformation consists of torsion, bending and tension or compression. Under simple tensile or compressive loading, the strength and stiffness of an element depend upon the area of cross section. However the deformation and stresses in elements subjected to torsion and bending depend, additionally, upon the shape of the cross section. A certain volume of metal can be distributed in different ways to give different values of the moment of inertia and sectional modules. The shape that provides the maximum moment of inertia and sectional modules will be considered best as it will ensure minimum values of stresses and deformation. The stiffness of four different sections of equal cross sectional area is compared in table



| Section | Area mm² | Weight kgf/m | Relative value of permissible Bending moment kgf cm | | Torque kgf cm | |
|---|---|---|---|---|---|---|
| | | | Stress | Deflection | Stress | Angle of twist |
| | 29.0 | 22 | 1 | 1 | 1 | 1 |
| | 28.3 | 22 | 1.12 | 1.15 | 43 | 8.8 |
| | 29.5 | 22 | 1.4 | 1.6 | 38.5 | 31.4 |
| | 29.5 | 22 | 1.8 | 1.8 | 4.5 | 1.9 |

From table it is seen that the box type section has highest tensional stiffness and in overall assessment seems best suited both in terms of strength and stiffness. The additional advantage that goes in its favour is the ease of proper mating with other surfaces. All considerations combined point towards the overwhelming superiority of the box type profile over others for machine tool structures.

In most of the cases the machine tool bed and other structures cannot be made in the form of a closed-box profile. There must be apertures for bearings, openings for free flow of chips and other purposes. Thus the actual profiles of machine tool structures differ from a closed-box profile. The apertures and openings in the structure have as adverse effect upon its strength and stiffness.

**ii) Selection range of spindle speed.** **(04 marks)**

The spindle speed for principle cutting movements depends on:

a) Properties of work piece material

b) 'Form stability' and wear resistance of tool materials

c) Shape of cutting tools

d) Type of operation performed, whether turning, drilling, screwing, facing or milling.

e) 'Process capability' of the machine i.e. the capability of the machine to hold a definite spectrum of tolerance and surface finish.

**iii) Essential requirement for layout of stepped drive** **(04 marks)**

The layout of a ray diagram depends on the fixation of;

a) Greatest amount of r.p.m.

b) Least output r.p.m.

c) Number of steps of the transference

d) The manner of subdivision of steps

e) The number of stages in which the steps are to be obtained.

**iv) Function of knob** **(02 Marks)**

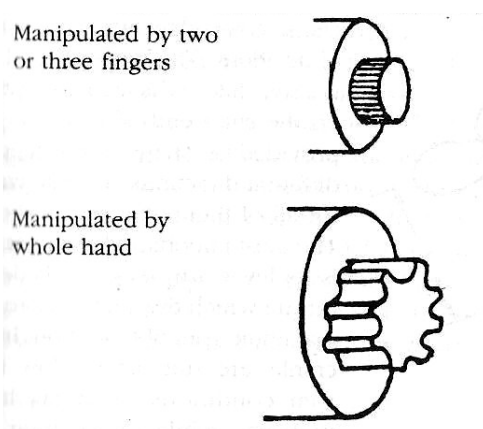
Knobs are control members which can be operated freely by gripping with fingers of one hand. Knobs may be used;

1. For making fine adjustments; these are known as continuous function knobs, and

2. As selectors; these are known as switching knobs

The design parameters includes such as small knobs are knurled whereas large knobs have section on their periphery. Switching knobs for step functions may be either of the type as S or bar shaped. The former are generally used in instruments where the force required for switching is not large. Bar shaped knobs are use for witching the electric motor of the main drive and other step switching operations requiring relatively large switching force.

**Sketches of knob**




**(02 Marks)**

**b) Attempt any ONE of the following:**

**i) Spindle Unit:** **(02 Marks)**

A spindle unit is a rotating axis of the machine, which often has a shaft at its heart. The shaft itself is called a spindle, it also often refer to the entire rotary unit, including not only the shaft itself, but its bearings and anything attached to it (chuck, etc)

**Functions Spindle unit** **(02 Marks)**

1. Centering the workpiece

2. Clamping the workpiece or cutting tool, as the case may be. Such that the workpiece or cutting tool is reliably held in position during machining operation, and

3. Imparting rotary motion or rotary cum translator motion to the cutting tool or workpiece

**Two requirements of spindle unit** **(02 Marks)**

1. The spindle should rotate with high degree of accuracy. The accuracy of rotation is determined by the radial and axial run out of the spindle nose, and these must not exceed certain permissible values which are specified depending upon the required machining accuracy. The rotational accuracy is influenced maximum by the stiffness and accuracy of spindle bearings, particularly the one located at the front end.

2. The spindle unit must have high static stiffness. The stiffness of the unit is made up of the stiffness of the spindle unit proper and the spindle bearings. Machining accuracy is influenced by bending, axial as well as torsional stiffness.

**ii) stepped regulation of speed in machine tool** **(03 Marks)**

Speed boxes, i.e. gear boxes are employed for stepped regulation of the rpm of the main drive. The same can be applied to the feed boxes but later have some special design features. In stepped regulation of speed only certain discrete values of the spindle rpm are available on the machine tool. The various series of rpm values will have different operational characteristics.

**Various laws of stepped regulations.** **(03 Marks)**

**a)** The rpm values constitute an arithmetic progression

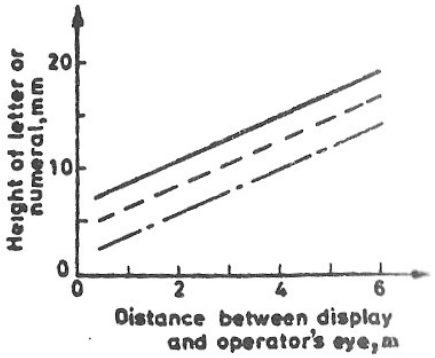
b) The rpm values constitutes a Geometric Progression

c) The rpm values constitutes a Harmonic Progression

d) The rpm values constitutes a Logarithmic Progression

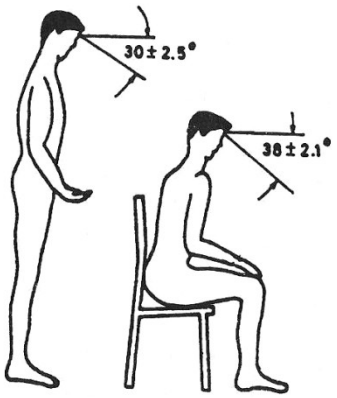
**Q.5 Attempt any FOUR of the following:**

**a) Location of display** **(02 Marks)**




A display is a feedback device that informs the operator about what is occurring or has occurred. In a large number of machine tools this feedback is provided by sense of perception of the operator. For instance, the sound occurring during metal removal operation and the type of chip formed act as auditory and visual displays about the process. The role of display in the man-machine system has considerably increased and certain aspects of display design and location should be treated as an integral part of the design of machine.

**Example:** Displays are of two types – qualitative and quantitative. Qualitative display serves mostly for distinguishing between two or more operational states. The simplest example of such a display is the on/off switch, in which the word "on" or "off" may be written to indicate a particular state.



Recommended range of location of displays

Another example of qualitative display is safety device in which red bulb may be lighted or a buzzer may be activated when particular parameters exceeds prespecified safe limit.

Quantitative displays as the name implies provide quantitative information about a process. Analogue displays are better suited for check readings and for systems in which immediate adjustments are made on the basis of display information. Digital displays have the advantage of providing exact information and are preferred when precise readings at regular intervals are required. Fixed pointer moving scale type display are suitable for continuously monitoring the change in a process, while fixed dial moving pointer displays are more suited for setting the values of the controlling parameters of the process. **(02 Marks)**

**Q 5) b) Role of vibration dampers and isolators** **(04 Marks)**

Isolators de-couple (or isolate) to some degree the input energy from a protected mass or structure. Some of this energy does filter through typical isolation systems, but isolator output parameters are normally optimized to reduce the response to a pre-determined acceptable level. Isolators do not necessarily aim to absorb as much energy as possible, but rather to cause the dangerous input energy to bypass the isolated mass as much as possible. Most isolators consist of a combination of spring and damping components of some type.

Shock isolators generally aim to minimize the reaction force (acceleration) to a protected mass during a transient shock event within determined acceleration and/or position constraints. These shock events are often quantified in terms of a time history (position, velocity, or acceleration versus time.) Vibration isolators generally aim to reduce the reaction force (acceleration) of a protected mass during a continuous vibration environment usually caused by an external power influence

Proper isolation of vibration helps to achieve the following objectives:

1) Longer bearing life

2) Longer machinery maintenance costs.

3) Improved working conditions for the workers.

4) Improved plant layout.

In vibrations isolating systems damping can be provided in the following ways:

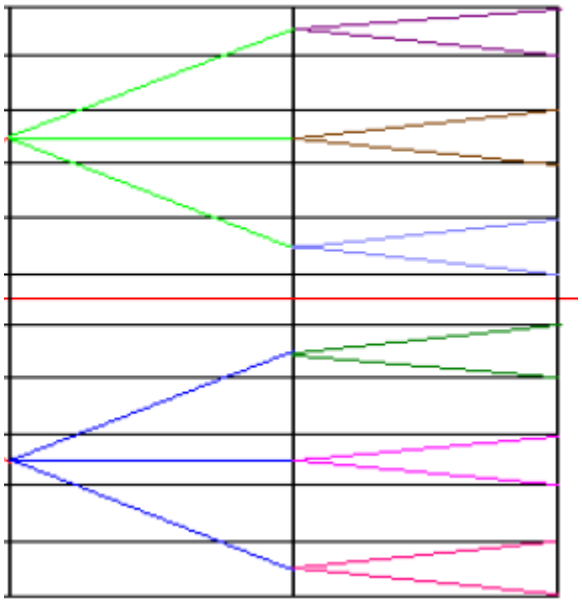
1) Fluid damping.

2) Solid damping.

3) Sliding friction damping.

4) Vibration can be reduced by replacing or repairing defective parts of the machine. Unbalanced rotors, gears, pulleys etc. try to produce vibrations and should be repaired in time.

**Q 5) c) Feasibility of Structural formula 3(2) 2(1) for** $\varnothing = 1.41$ **(Explain 04 Marks)**



The structural diagrams are drawn from the structural formulae which is a graphical tool used to find the range ratio of transmission groups. The structural diagram gives information about the number of shafts and the number of gears on each shaft. The order of changing transmissions in individual groups to get the desired spindle speed and The transmission range and characteristics of each group. The ray diagrams are incorporated to make the design more feasible with respect to the transmission ratio and number of teeth used in gearbox.

**Q 5) d) Advantages of G.P. Series** **(04 Marks)**

a) Constant loss of economic cutting speed in whole rpm range.

b) Constant loss of productivity in whole rpm range.

c) Better Design features

d) Range of operational speeds are decided on the basis of preferred numbers of G. P. series.

**Q 5 e) General requirements of machine tool design.** **(04 Marks)**

1. High Productivity

2. Ability to provide the required accuracy of shape and size and also necessary surface finish

3. Simplicity of design

4. Safety and convenience of control

5. Good appearance

6. Low cost of manufacturing and operation

**Q 5) f) Antifriction guideways-** These are Guideways with Rolling Friction. **(04 Marks)**

**Advantages over conventional guide ways.**

1. Low friction as compared to slideways

2. Uniformity of motion even at slow speeds due to virtual absence of the stick-slip phenomenon.

3. High stiffness if the rolling members are preloaded, and

4. Possibility of using high velocities of motion.

**Q.6 Attempt any FOUR of the following:**

**a) Representation of speed on structural diagram** **(04 Marks)**

This diagram represents the speeds at output as well as intermediate shafts of gear box and is developed from the kinematic arrangement of the drive. Shafts are shown by vertical equidistant and parallel lines. The speeds are plotted vertical on a logarithmic scale with log Φ as a unit. Transmission engaged at definite speeds of the driving and

divan shafts are shown on the diagrams by rays connecting the points on the shaft lines representing these speeds. For transmission ratio of 1, the ray is horizontal. It is inclined up for transmission ration greater than unity and inclined down for transmission ratio less than unity.

Speed structure diagrams indicate the distributive connections between input and output points and are of two types:

a) Wide (open) diagrams b) Narrow (crossed) diagrams

In open diagram, paths do not cross each other and in crossed diagram, the paths cross each other

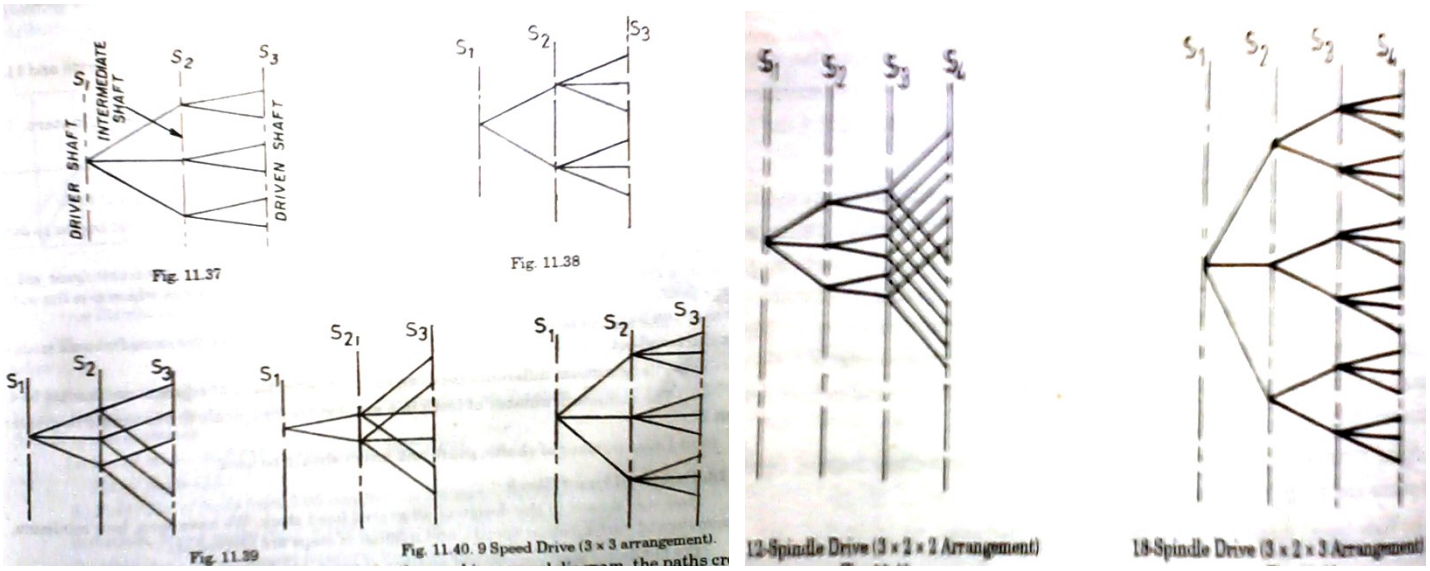



Fig. 11.37 Fig. 11.38 Fig. 11.39 Fig. 11.40. 9 Speed Drive (3 × 3 arrangement). 12-Spindle Drive (3 × 2 × 2 Arrangement) 18-Spindle Drive (3 × 2 × 3 Arrangement)

**b) Different types of bearings used for spindle support. (04 Marks)**

Both sliding and rolling friction bearings are used in spindle supports. The various types of bearings are as follows:

1. Roller bearings.

   i) Ball Bearings

   ii) Roller Bearings

2. Plain Bearings

**c) Ergonomic features of drilling machine. (04 Marks)**

**Ergonomics of drilling machine should ensure following safety features:**

1. Secure the work piece by clamping it to the table or holding it in a vise.

2. Clear the table of unnecessary clutter.
3. Wear safety glasses.
4. Do not wear gloves while drilling.
5. Constrain long hair (wear a hat).
6. Constrain loose clothing (roll up your sleeves).
7. When the tool is about to break through, ease up on the feed force.
8. Remove chip fragments only when the machine spindle is stopped.
9. Never remove long stringy chips with your bare hands.

10. Machine Guarding required
11. Do not support the work piece by hand – use work holding device.
12. Use brush to clean the chip
13. No adjustments while the machine is operating
14. Ensure for the cutting tools running straight before starting the operation.
15. Never place tools on the drilling table
16. Avoid loose clothing and protect the eyes.
17. Ease the feed if drill breaks inside the work piece.

**d) Stick slip phenomena in machine tool guide ways (04 Marks)**

In a machine tool either the table holding the work piece or the saddle holding the cutting tool moves very slowly over suitable guides and at the same time is subjected to heavy forces caused by cutting and clamping. In such sliding cases often a time dependent intermittent motion is noted which causes consecutive sticking and slippling of the slide at regular intervals. This regularly repeated motion is known as stickslip motion.

This stick slip motion when exits is found to worsen surface finish and dimensional accuracy of the product and also reduces the overall life of the machine tool and the cutting tools.

Therefore for satisfactory machining performance it is essential to eliminate or reduce the stickslip motion. This requires of being acquainted with the stickslip characteristics and the role of various parameters on it.

The principle agents which are responsible for stickslip motion under low speed and large forces are the elasticity of the sliding elements and the frictional characteristics at the sliding surfaces.

**e) Application and properties of four materials used in machine tool construction (02+02 Marks)**

Following are the materials used in machine tool construction

**1. Synthetic Rubber**- used for seals packaging and belts; Bakelite for control levers and knobs

**2. Malleable** iron: Malleable iron is an iron- Carbon alloy which solidifies in as cast condition in graphite free structure. It is good ductile with good castability. Used in tools for hand wheel and hand cranks, Shifting lever etc.
**3. Meehanite**- Is basically a cast iron produced by controlled process with the addition of certain alloying elements. There are various grades of meehanite suitable for individual application.

**4. Gray Cast iron**- Good for absorbing the vibration. The physical property of castings mainly depends upon the relative amount of graphite and cementite that is present in the cast iron. Gray cast iron is the least expensive of all metals that could be used for castings hence it is considered. Major structural components of machine tools such as bed, saddle, headstock, tailstock body, base, column, slides gearbox body as also smaller components such as bracket

housing cover pulleys etc are made up of gray cast iron in preference to steel due to its excellent stability and better damping properties against vibration.