

M.E. MECHANICAL ENGINEERING FIRST YEAR FIRST SEMESTER - 2025
MACHINE TOOLS DESIGN

Full Marks:100

Time: 3 hrs.

*Answer any five (05) questions of the following.
 Assume any missing data/value/conditions, if necessary.
 Answer all the parts of a questions together.*

1. (a) The worktable of a positioning system is driven by a lead screw whose pitch = 6.0 mm/rev. The lead screw is connected to the output shaft of a stepping motor through a gearbox whose ration is 5:1 (5 turns of the motor to one turn of the lead screw). The stepping motor has 48 step angles. The table must move a distance of 250 mm from its present position at a linear velocity = 500 mm/min. Determine (a) how many pulses are required to move the table the specified distance and (b) the required motor speed and pulse rate to achieve the desired table velocity.

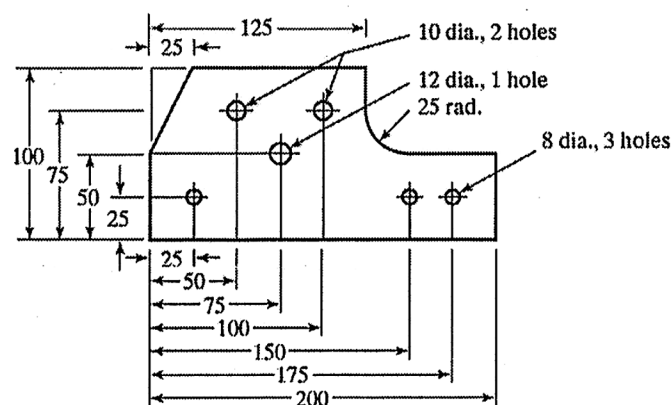
(b) With adequate diagrams, represent a plane in APT language by 05 different ways. 10 + 10 = 20

2. (a) Discuss about different types of models as may be applied in CNC machine tools application?

(b) With all necessary assumptions find out the transfer function of a simple hydraulic system.

8 + 12 = 20

3. The work part as shown in the following figure is 15 mm thick. Three drill sizes should be used as 8mm, 10mm and 12mm which are to be specified in the part program by tool turret positions T01, T02 and T03 respectively. Cutting speed for the operation is 75 mm/min and feed is 0.08 mm/rev. considering the lower left corner of the part as the origin in the x-y axis system write the program in APT language stating the (i) geometry (ii) motion and (iii) complete program. Consider appropriate data/values, if required, at any stage of programming. 20



4. (a) The most frequent case of torsional shear in machine tools design is that of a round circular shaft transmitting power. With adequate diagrams and necessary formula, show that hollow shaft is more efficient than solid one in this regard.

[Turn over

(b) Find out the angle of twist, both in radians and degrees, of a 10 mm diameter and 250 mm long shaft carrying 4.10 N-m of torque. The shaft material is steel with shear modulus of elasticity of 80 GPa.

12 + 8 = 20

5. (a) State the relationship amongst power, rotational speed and torque both in SI and US customary units. Hence, compute the torque on a shaft transmitting 1.0 hp while rotating at 1750 rpm.

(b) When the command "Mirror Image" is used in CNC programming? Considering one suitable part diagram and necessary dimension elaborate this command.

10 + 10 = 20

6. (a) How the command "Cycles" can be defined? What is canned cycle and user defined cycle or sub-routine? Discuss with adequate diagram the canned cycle for peck drilling operation.

(b) What are the major components of a closed loop control system in CNC? Discuss in brief.

12 + 8 = 20

7. (a) Develop, systematically, the transfer function of a spring-mass-dashpot system.

(b) A tensile force of 9500 N is applied to a 12 mm diameter round bar. Compute the direct tensile stress in the bar.

In the above problem, compute the total deformation if the original length of the bar is 3600 mm. The bar is made up of steel having a modulus of elasticity of 207 GPa.

12 + 8 = 20