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# M.E. MECHANICAL ENGINEERING FIRST YEAR FIRST SEMESTER, 2018

## MACHINE TOOL DESIGN

Time: **3 hour** Full Marks: **100**

Answer any ***four*** questions.

Assume suitable data if necessary.

1. Design a four speed gear box transmitting 10 hp with speeds ranging from 400 rpm with Ø=1.4. Select a suitable structural form and optimum ray diagram. The design should include the calculation of gear sizes, module and width of gear and shaft sizes. Sketch the gear box. **25**

2. a) The worktable of a positioning system is driven by a lead screw whose pitch is 6.0 mm. The lead screw is connected to the output shaft of a stepper motor through a gear box whose ratio is 5:1 (5 turns of the motor to 1 turn of the lead screw). The stepper motor has 48 step angels. The table must obey distance of 250 mm from its present position at a linear velocity of 500 mm/min. Determine (i) how many pulses are required to move the table the specified distance (ii) the required motor speed and pulse rate to achieve the desired table velocity.

b)

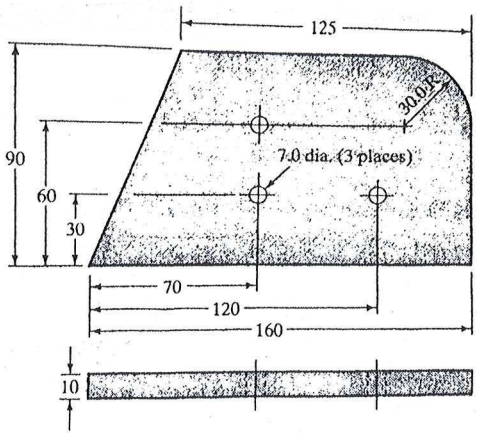


Fig. 1

Three holes 7 mm diameter, are to be drilled on the aluminium work piece using a CNC drill press as shown in Fig. 1. The feed is 0.05 mm/rev, the spindle speed is 1000 rpm. Write a manual part programme for the above drilling operations.

**10 + 15**

3. a) What is hydro-dynamic action in slides of a machine tool? Derive the expression for limiting slide velocity for having hydro-dynamic effect in machine tool bed.

b) How is the tilting of table is prevented due to radial pressure distribution and flow of oil in machine tool?

c) State the factors on which the shapes of slideways depend. What are the advantages of "Vee" slideways? **15 + 6 + 4**

4. a) What is stick-slip motion in a machine tool? Derive an expression of the stick-slip amplitude in machine tool. How is the stick-slip motion minimized? Explain.

b) Discuss about recirculating ball screw.

c) Deduce the expression of compliance of a centre lathe. Discuss the effect of different components of cutting force on compliance of a machine tool.

**12 + 4 + 9**

5. a) Explain the basic principles of design for strength and rigidity. Establish the optimum design criteria for mild steel and cast iron as work material for machine tool structure.

b) Discuss about model technique in design of machine tool structure using relationships for bending stiffness of structure and natural frequency for torsional vibrations. **13 + 12**

6. a) Discuss about application of finite element method in design of machine tool structures.

b) What is machine tool chatter? What are the sources of vibration in machine tool? Discuss about the effects of vibration on machine tool, cutting conditions, work piece and tool life. Explain the different methods of elimination of vibration in machine tool. **10 + 15**

| G-word | Function |
|---|---|
| G00 | Point-to-point movement (rapid traverse) between previous point and endpoint defined in current block. Block must include *x-y-z* coordinates of end position. |
| G01 | Linear interpolation movement. Block must include *x-y-z* coordinates of end position. Feed rate must also be specified. |
| G02 | Circular interpolation, clockwise. Block must include either arc radius or arc center; coordinates of end position must also be specified. |
| G03 | Circular interpolation, counterclockwise. Block must include either arc radius or arc center; coordinates of end position must also be specified. |
| G04 | Dwell for a specified time. |
| G10 | Input of cutter offset data, followed by a P-code and an R-code. |
| G17 | Selection of *x-y* plane in milling. |
| G18 | Selection of *x-z* plane in milling. |
| G19 | Selection of *y-z* plane in milling. |
| G20 | Input values specified in inches. |
| G21 | Input values specified in millimeters. |
| G28 | Return to reference point. |
| G32 | Thread cutting in turning. |
| G40 | Cancel offset compensation for cutter radius (nose radius in turning). |
| G41 | Cutter offset compensation, left of part surface. Cutter radius (nose radius in turning) must be specified in block. |
| G42 | Cutter offset compensation, right of part surface. Cutter radius (nose radius in turning) must be specified in block. |
| G50 | Specify location of coordinate axis system origin relative to starting location of cutting tool. Used in some lathes. Milling and drilling machines use G92. |
| G90 | Programming in absolute coordinates. |
| G91 | Programming in incremental coordinates. |
| G92 | Specify location of coordinate axis system origin relative to starting location of cutting tool. Used in milling and drilling machines and some lathes. Other lathes use G50. |
| G94 | Specify feed per minute in milling and drilling. |
| G95 | Specify feed per revolution in milling and drilling. |
| G98 | Specify feed per minute in turning. |
| G99 | Specify feed per revolution in turning. |

Common M-words Used in Word Address Format

| M-word | Function |
|---|---|
| M00 | Program stop; used in middle of program. Operator must restart machine. |
| M01 | Optional program stop; active only when optional stop button on control panel has been depressed. |
| M02 | End of program. Machine stop. |
| M03 | Start spindle in clockwise direction for milling machine (forward for turning machine). |
| M04 | Start spindle in counterclockwise direction for milling machine (reverse for turning machine). |
| M05 | Spindle stop. |
| M06 | Execute tool change, either manually or automatically. If manually, operator must restart machine. Does not include selection of tool, which is done by T-word if automatic, by operator if manual. |
| M07 | Turn cutting fluid on flood. |
| M08 | Turn cutting fluid on mist. |
| M09 | Turn cutting fluid off. |
| M10 | Automatic clamping of fixture, machine slides, etc. |
| M11 | Automatic unclamping. |
| M13 | Start spindle in clockwise direction for milling machine (forward for turning machine) and turn on cutting fluid. |
| M14 | Start spindle in counterclockwise direction for milling machine (reverse for turning machine) and turn on cutting fluid. |
| M17 | Spindle and cutting fluid off. |
| M19 | Turn spindle off at oriented position. |
| M30 | End of program. Machine stop. Rewind tape (on tape-controlled machines). |