Ref. No.: Ex/ME/T/413/2019

B.E. MECHANICAL ENGINEERING FOURTH YEAR FIRST SEMESTER EXAM. 2019

METAL CUTTING AND MACHINE TOOLS

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

Assume suitable data if necessary.

1. a) Discuss about continuous chips and discontinuous chips. Find out the velocity relationship in metal cutting operations. What is chip reduction coefficient? **4 + 4 + 2**

Or

Determine the values of the side rake angle and back rake angle of a single point turning tool whose geometry is specified as

0^0 - 10^0 - 8^0 - 10^0 - 30^0 - 75^0 – 1 mm (ORS).

Discuss about selection of rake angle and principle cutting edge angle of a single point turning tool. **5 + 5**

b) Explain the use of ring as a dynamometer for measuring forces in metal cutting. Find out the locations of the strain gauges in rings for measuring cutting force and thrust force. What are orthogonal cutting and oblique cutting? State the conditions for them. **8 + 7**

Or

Derive the expression for shear angle relationship using Merchant's first solution. The following data from an orthogonal cutting test is available with single point cutting tool having rake angle of 15^0 are:
Cutting ratio= 0.383
Uncut chip thickness = 0.5 mm
Width of cut = 1.8 mm
Yield stress of the material in shear= 280 N/mm^2.
Average coefficient of friction at the chip-tool interface= 0.7
Determine the normal force and tangential force at the chip- tool interface. **7 + 8**

2. a) An HSS twist drill during its life can drill 200 holes in 20 mm thick brass plate at a speed of 200 rpm. Another drill of same type can drill 100 holes when speed is 300 rpm. How many holes can be drilled by another drill of same type at a speed of 400 rpm? In all cases feed is same. **10**

Or

Discuss about diffusion wear and adhesion wear. Discuss Zorev's method for finding out the critical point on the flank wear vs. cutting time plot. **5 + 5**

b) Discuss the method used by Boothroyd for determining the temperature distribution in metal cutting. Explain the purposes of cutting fluid in metal cutting. What is mist cooling? Explain it. **5 + 6 + 4**

Or

Derive an expression for optimum cutting speed for a given feed for minimum cost in metal cutting operation. **15**

[Turn over

3. Answer any one:

a) Design a 12 speed gear box having maximum rpm = 360 and minimum rpm = 30. The hp of the motor is 10. **20**

b) Discuss about machine tool chatter.
Name and explain the formative motions in machine tools.
Explain the use of deferential mechanism for grinding a hob.
Sketch and explain elementary structure (E_{11}) and complex structure (C_{22}) of a machine tool. **5 + 5 + 5 + 5**

4. Answer any one:

a) What are open loop positioning systems in NC machine tool? Explain with suitable sketch.
The worktable of a positioning system is driven by a lead screw whose pitch = 6.0 mm. The lead screw is connected to the output shaft of a stepper motor through a gearbox whose ratio is 5: 1. The stepper 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 (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.
Discuss about coordinate system used in NC for flat and prismatic work. **7 + 8 + 5**

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

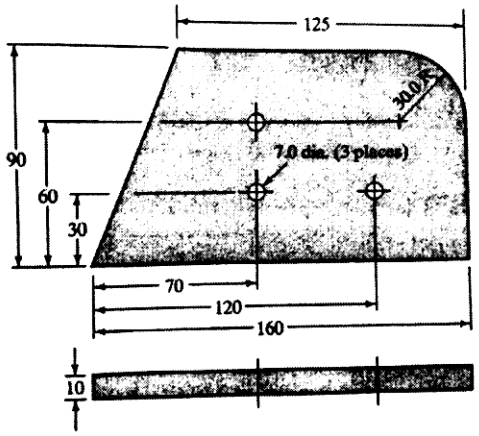

Figure 1

Discuss about interpolation methods in NC machine tools. **14 + 6**

5. With the help of a neat sketch explain the process optimization adaptive control system. **10**

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).