BACHELOR OF ENGINEERING IN MECHANICAL ENGINEERING, 2017

(4th Year, 2nd Semester)

ADVANCED MANUFACTURING

Time: Three hours Full Marks: 100

Answer **any *five*** questions

Assume suitable data, if needed.

Some common G-Words (codes) and M- Words (codes) are given in

Table -1, which may be used, if needed.

1 a) Illustrate the concepts of *CIM* and *concurrent engineering*. **(5)**

b) State about *NC*, *CNC* and *DNC machine tools*. **(5)**

c) Define *automation* and hence state about three basic types of automation in the context of automated manufacturing systems. Mention about typical features of each type as well. **(10)**

Or

Compare *A (4) level* of automation with *A (5) level*. **(10)**

2. a) A stepper motor with 48 step angles is coupled to a lead screw through a gear reduction of 5:1 (5 rotations of the motor for each rotation of the lead screw), in an open loop NC positioning system. The lead screw pitch is 6 mm. The worktable driven by lead screw must move a distance of 250 mm at a feed rate of 500 mm/min. Determine i) the number of pulses required to move the table the required distance ii) the required motor speed and iii) pulse rate to achieve the desired feed rate. **(10)**

b) The mechanical inaccuracies in the open-loop NC/CNC positioning system are described by a normal distribution with standard deviation = 0.005 mm. The range of the worktable axis is 1000 mm and there are 16 bits in the memory register used by the digital controller to store the programmed position. Determine *control resolution*, *accuracy* and *repeatability* of the positioning system. Use data given in **Q. No. 2a**, if required. **(5)**

c) With a neat sketch explain *closed loop NC positioning system* which uses an *optical encoder*. **(5)**

3. a) Write the NC part program in word address format for drilling 4 holes in the part shown in **Figure-1**. Select and show three axes and their origins. The drill will be operated at a feed rate of 0.06 mm/rev and spindle speed of 600 rpm. Explain each instruction in the part program. **(9)**

b) Write the part program to completely mill the outside edges of the part shown in **Figure-1**. A 25 mm diameter end milling cutter with 4 teeth will be used for the operation. The cutter has side tooth engagement length of 40 mm. The cutter will operate at a speed of 900 rpm and feed rate of 55 mm/min. Make necessary assumptions, if needed and mention them. Explain each instruction in the program. Also select and show the axes and their origins. Show the cutter path as well. Use **either** word address format **or** APT for writing the program. **(11)**

4. a) Under which circumstances or background, did rapid prototype techniques emerge? How do these techniques differ from other manufacturing processes? **(5)**

b) Show a schematic diagram to illustrate the steps involved in a generative manufacturing process. **(5)**

c) Name some typical raw materials which are used in fused deposition modeling and selective laser sintering. Mention some applications of these processes as well. **(5)**

d) State about the considerations for adopting rapid prototype technology. **(5)**

5. Discuss about ***any two*** of the following generative manufacturing processes with necessary sketches: **(10x2=20)**

i) Stereo-lithography with photo-polymerization

ii) 3-D printing

iii) Laminated object manufacturing

6. a) Show in a sketch the general configuration of an automated production line and explain the same with mention of *transfer line,* as well. **(5)**

b) A 20-station transfer line has an ideal cycle time of 1.0 min. Station breakdowns occur with a probability of 0.005. Assume that station breakdowns are the only reason for line stops. Average downtime = 5.0 min per line stop. Determine i) ideal production rate in pc/hr ii) frequency of line stops iii) average actual production rate in pc/hr iv) line efficiency and v) proportion downtime. **(10)**

c) For a 20-station transfer line, determine line efficiencies and actual average production rates for i) one storage buffer ii) three storage buffers. Ideal cycle time of each stage=1.2 min; all the stations in the line have the same probability of stopping: p = 0.005: down time is constant when a break down occurs and it is 8 min. Assume infinite buffer capacity. **(5)**

7. a) Discuss about various applications of AGVS. **(5)**

b) Discuss about *traffic control* in AGVS. Also explain: *availability* and *traffic factor* in the context of vehicle-based transport system. **(7)**

c) Discuss about *imbedded guide wire method* of vehicle guidance technology. **(3)**

d) An automated guided vehicle system has an average travel distance = 300 m and average empty distance = 200 m. Load and unload times are each 30s and speed of the AGV = 1m/s. Traffic factor = 0.9 How many vehicles are needed to satisfy a delivery requirement of 30 del/hr? Assume availability A = 0.95. **(5)**

8. Answer ***any four*** of the followings: **(5x4 = 20)**

i) Discuss about *slip casting* as a shaping process for ceramics.

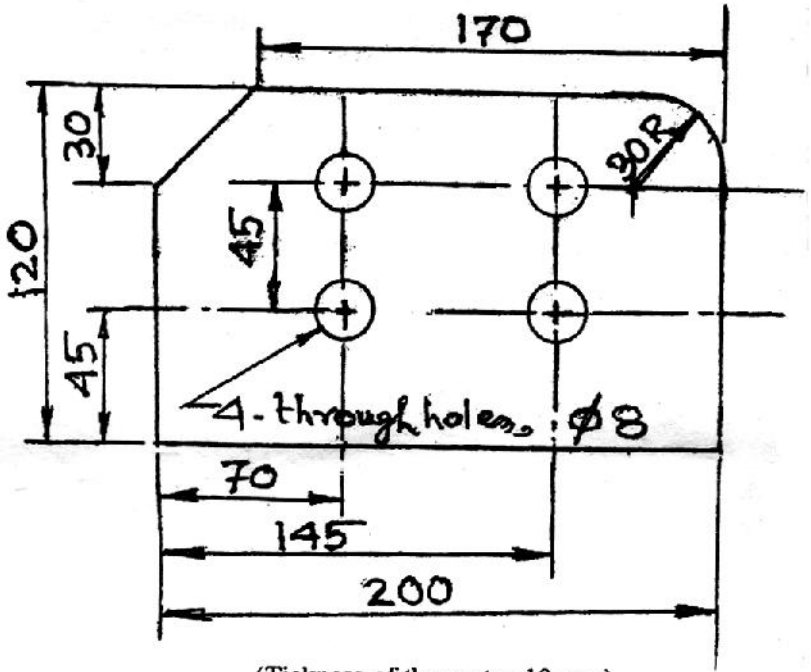
ii) Explain the working principle of *walking beam transfer line* with necessary sketches.

iii) Write a short note on **either** *CAPP* **or** *Interpolation* in NC and its types.

iv) Explain with block diagram the computer tasks in computer assisted part programming.

v) Discuss about *vehicle safety in AGVS.*

vi) Name and state about *four basic types of statement* in the APT language for NC-CNC programming.



(Tickness of the part = 10 mm)

Figure -1 (For question nos. 3a and 3b)

Table - 1

Common G-words (Preparatory Word)

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).