# B.E. 7th (ME) Semester Examination, 2009

**Subject: NC/CNC Machine Tools (ME 705/10)**

Time: 3 hours F. M. 70

Attempt any **six questions** taking **three** from each half
Questions are of equal value

# First Half

1 (a) Show the control block diagram of the machine drive unit (MDU) of a CNC m/c tool
(b) Derive the dynamic model of the MDU in the Laplace domain.
(c) Explain the role of the attenuation factor in speed control of the MDU.

2 (a) Derive the expression for the path error in a two axis control loop following a linear trajectory.

(b) A straight-cut milling of aluminum is performed at an angle of 45° on the XY plane with a feed rate of 450 mm /min. The system BLU=0.01 mm and the open-loop gain of the two axes are matched to 15 $s^{-1}$ with an accuracy of ± 10%. Calculate the maximum path error.

3 (a) Give the control loop diagrams of ***Reference Pulse*** and ***Sampled Data*** CNC systems.
(b) Compare the above two CNC systems.
(c) Present the flowchart for the software DDA linear interpolator used in reference pulse systems.

4 (a) Write the *Direct Search (with error control) interpolation algorithm* and present the same in a flowchart.
(b) Show the steps of interpolation (table and the graph) for circular trajectory of radius 5 BLU.

5 (a) Write the algorithm of a *reference word interpolator* used in Sampled Data system. Present the algorithm in a flowchart.
(b) How the interpolation error is minimized in the interpolation algorithm.

## SECOND HALF

(Answer any THREE questions, all questions carry equal marks, two marks are reserved for overall performance)

6 a) Draw a neat labeled diagram to show how position of a CNC machine work-table can be accurately controlled by a servo-system.

b) Now explain with a numerical example, how an exact position like X=50 mm for the work-table is achieved with a servo-system. Assume the following data : the gain of the amplifier = 25 v output / volt input; gain of the motor = 2 rev. per second / volt input; gain of the lead-screw= 0.5 mm per rev. Total movement of the machine work-table = 500 mm and corresponding voltage reading is from 0 volt to 25 volt.

[4+7]

7 a) Explain how the power of a DC servo-motor is controlled with the help of PWM chip.

b) Draw the time response curve of a servo-motor at loaded and no-load conditions. What is the significance of this curve, particularly in CNC machine application.

c) What do you mean by plugging method of stopping a DC servomotor and what is the function of the zero-stop switch ?

[4+3+4]

8 a) Explain the functioning of an absolute encoder for CNC machines taking a particular example.

b) Suppose a 18 hole disc incremental encoder is fitted to the X-axis of a CNC machine work-table. If the pitch of the lead-screw = 0.5 mm determine the rate of receiving signals in seconds to attain a speed of 40 mm per minute.

c) What is gray code? Explain why is it important for encoders?

[4+4+3]

9 a) What do you mean by cutter-radius compensation for CNC machines?

b) Write a complete program for the job as shown in Fig.A to be machined on a CNC milling. Six holes are to be cut on a plate of dimension 300 x 250 x 20 mm. For this a tool of diameter 4 mm has to move along the circular path to cut the holes, keeping a proper cutter radius compensation. You may or may not use macro-programming. (Hint : for circular movement it is always better to divide into two half-circles).

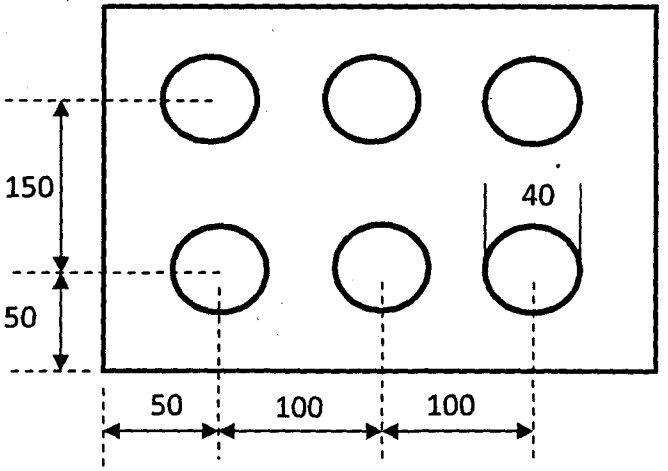


**Fig.A (All dimensions are in mm)**

[3+8]

10 a) Explain how a stepper motor works and how exactly its speed can be controlled.

b) Write the signal pattern to rotate a $30^0$ stepper motor as following :

$180^\circ$ clockwise then $90^\circ$ anti-clockwise

c) What should be the pulse rate to run the above stepper motor at the speed of 300 RPM?

[4+4+3]