Bengal Engineering and Science University, Shibpur
B.E. 7th Semester Examination, 2013
Subject: NC/CNC Machine Tools (ME 705/10)

Duration: 3 hours **Full Marks: 70**

FIRST HALF

Answer **question No. 1** and **any two** from the rest of this half

1. (a) Give a plausible definition of *numerical control.*
   (b) What do you mean by the term BLU?
   (c) Mention **five** productive features of CNC machine tools.
   (d) Discuss the major sources of inaccuracies in conventional machine tools and how these are remedied in CNC machine tools.

   [2+1+5+5=13]

2. (a) Show that the path error in linear interpolation is given by

$$E \approx \frac{f_x f_y}{fK}|d|,$$

   where f is feed-rate along the path, f_x and f_y are the axial components of feed-rate, and d is the percentage difference of the loop gains in the two axes. K is the nominal loop gain
   (b) Calculate the maximum allowable feed-rate in linear interpolation for a CNC system with nominal loop gain of 1000/s and maximum 5% gain difference between the two axes such that the maximum path error is within 0.001 mm.

   [6+5=11]

3. Design the CLU of a NC lathe with 10mm. lead-screw pitch, maximum feed-rate 1000 mm/min, 0.01 mm. BLU and load torque 250 N-m (max). The feed-drive is a DC servomotor with the following specifications: Nominal Torque =1500 N-m, Nominal speed = 1400 RPM, Torque Constant = 5 N-m/A, Motor constant = 2 rad/s-V, Time constant = 30 ms, Armature resistance = 2Ω, Speed variation allowed = ±20 rpm at full load.

   [11]

4. Develop the algorithm of stair approximation circular interpolator (clockwise in first quadrant) for reference pulse system and show sample calculations for 5 BLU radius.

   [11]

5. (a) Discuss the working of a sample data CNC system.
   (b) Develop the interpolation and error estimation algorithms for a sample data CNC system.

   [5+6=11]

SECOND HALF

(Answer any THREE questions)

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

b) Now write a MATLAB program to calculate feedback voltage, error voltage, the speed and position after each time interval of 0.1 second for a CNC work-table which is fitted with a positional servo-system. Assume the following data : Command: X= 22.5 (in mm), the gain of the amplifier = 20 v output / volt input; gain of the motor = 2 rev. per second per volt; gain of the lead-screw= 0.5 mm per rev. Maximum travel limit of the machine work-table = 300 mm and corresponding voltage reading is from 0 volt to 30 volt for the limits.

[4+7]

7 a) Explain how speed control is achieved for a particular speed, say 2000 rpm, by the DC servomotor of a CNC machine. Why its time response characteristic is important?
b) The voltage and torque constant of a permanent magnet servomotor are :
K_v=0.70 V.s/rad and K_t= 0.85 N.m/A respectively.
The armature resistance is 0.4 ohm and armature inertia is 0.026 Kg.m^2.
Find the time constant for the motor. Also calculate the steady-state speed (in rpm) at no-load and full-load condition if the input voltage = 80 V and static torque = 15 N.m

c) Write a MATLAB program to plot the values at t=0,10,20,30,40,50 millisecond for no-load condition only.

[4+3+4]

8 a) Explain how power of a DC servo-motor is controlled by PWM-chip?

b) Explain any braking mechanism of a DC servo-motor.

c) Suppose a lead-screw is fitted to a 60^0-stepper motor. It is required to turn the lead-screw by 2½ revolution clockwise then 1½ revolution anti-clockwise. Write the code pattern required to rotate the motor as stated.

[4+3+4]

9 a) Explain the working principle of an incremental encoder.

b) Suppose a CNC Lathe tool is fitted with an incremental encoder having disc of 36 holes. Pitch of the connecting lead-screw= 1 mm. Calculate the least count in linear scale

c) With an actual example show the usefulness of CAD/CAM software.

[4+2+5]

10 a) Write the complete canned cycle program for the product as shown below, which is to be machined with a CNC Lathe. Assume necessary data and explain the program

[11]

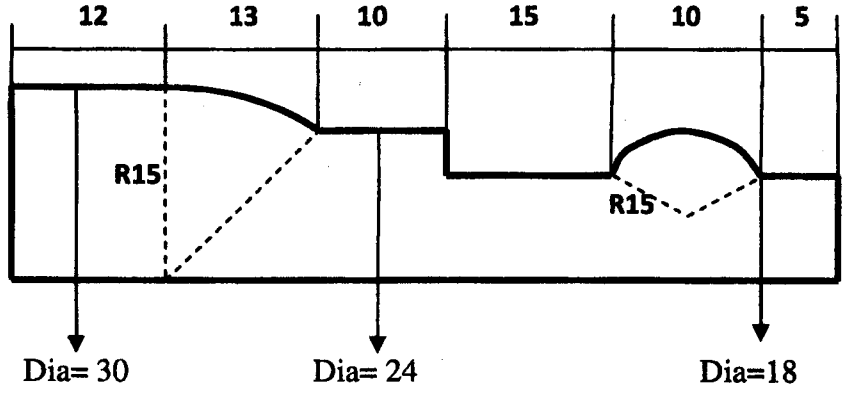

Fig.A : Half section of a CNC Lathe product (dimensions are in mm).

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