



UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 6 Examination in Engineering: December 2015

Module Number: ME 6303

Module Name: Computer Aided Manufacturing

[Three Hours]

[Answer all questions, each question carries ten marks]

-
- Q1. a) Discuss the necessity of Robots for manufacturing systems. [2 Marks]
- b) i) Describe the capabilities of 5-axis machining over 3-axis machining.
ii) With aid of a suitable sketch illustrate the motion and coordinate system of a five axis milling machine. Clearly label the axes and indicate the positive and negative directions of motion. [4 Marks]
- c) A die and mold manufacturing firm is planning to purchase a suitable CAM software package for their company. Suppose you are the manufacturing engineer who is responsible for the selection.
i) What are the factors that you would consider?
ii) What would be the CAM software package that you recommend? Compare the capabilities and limitations of your selection with other CAM packages. [4 Marks]
- Q2. a) i) Why adaptive controlling is important for machining operations?
ii) What are the three basic functions of a typical Adaptive Control System? [2 Marks]
- b) i) List down the basic hardware components of an adaptive control system.
ii) With aid of a block diagram explain the general configuration and the operation of an adaptive control machining system. [4 Marks]
- c) i) Differentiate the Variant approach and Generative approach used in Computer Aided Process Planning (CAPP)?
ii) What would be the future trends in CAPP and how those developments will advance the manufacturing engineering? [4 Marks]
- Q3. a) Briefly explain the concept of grouping parts in to families based on the design attributes and manufacturing attributes. [2 Marks]
- b) As it is show in *Table Q3. (a)*, thirteen different parts are processed in eleven machine stations. Find out the best possible machine arrangement for the parts, by rearranging and rebuilding the matrix. Clearly mention the assumptions that you have made. [4 Marks]
- c) As it is shown in *Table Q3. (b)*, five hundred different parts are processed in a GT machine cell which contains eight dissimilar machines. Find an effective logical machine arrangement and draw the flow diagram. [4 Marks]

- Q4. a) Briefly explain the significance of tool path generation available in commercial CAM packages. [2 Marks]
- b) i) You are required to machine a rectangular pocket on a 30mm thick steel plate. The length, width and depth of the pocket are 150mm, 100mm and 15mm respectively. The all four corners of the pocket must be filleted to 20mm radius. Write the part program for the milling operation to machine the pocket to the given dimensions. You may refer to *Table Q4* for relevant G codes and M codes. [5 Marks]
- ii) State the type of tool that you would use to perform the operation. Sketch the geometry of the selected tool and show the dimensions. [3 Marks]
- c) Explain how you would adopt the above part program to machine three more similar pockets unevenly located on the same steel plate. [3 Marks]
- Q5. a) i) Why automated inspection systems are important for manufacturing? [3 Marks]
- ii) Differentiate the capabilities and limitations of Contact Inspection Techniques Vs Non-Contact Inspection Techniques. [4 Marks]
- b) i) Briefly explain the techniques used for additive manufacturing. [3 Marks]
- ii) By considering the future trends of manufacturing compare the 3D printing technology with other CAM technologies. [4 Marks]
- c) Illustrate the steps that should be followed to produce a part by 3D printing. Point out the factors to be considered during the design stage. [3 Marks]

Table Q3. (a)

| | <i>Part Number</i> | | | | | | | | | | | | |
|---------------------|--------------------|---|---|---|---|---|---|---|---|----|----|----|----|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| <i>Machine Code</i> | A | 1 | | | 1 | | 1 | | | | | | |
| B | | 1 | 1 | | | | | 1 | | 1 | | | |
| C | | | | | | | | | | | 1 | | 1 |
| D | | | 1 | | | | 1 | | | 1 | | 1 | |
| E | 1 | 1 | 1 | 1 | | 1 | | 1 | | 1 | | | |
| F | | | | | | | 1 | | | | | 1 | |
| G | 1 | | | | | 1 | | | | | | | |
| H | | 1 | 1 | | | | | | | 1 | | | |
| I | | | | | | | | | | | 1 | | 1 |
| J | | | 1 | | | | | 1 | | 1 | | | |
| K | | | | | 1 | | 1 | | 1 | | | 1 | |

Table Q3. (b)

| <i>From:</i> | <i>To:</i> | | | | | | | |
|--------------|------------|----|----|----|----|----|----|----|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1 | | 10 | | 20 | 10 | 15 | | |
| 2 | | | | | | | | 30 |
| 3 | 50 | | | | 20 | 20 | 10 | |
| 4 | | 50 | | | | | | 35 |
| 5 | 40 | | | | | | 30 | |
| 6 | | 20 | 35 | | 45 | | | |
| 7 | 20 | | | 10 | | | | |
| 8 | | 20 | | | 10 | | | |

Table Q4. G - Codes and M – Codes

| G - Codes | | G90 | Absolute Positioning |
|-----------|---|-----|---------------------------------------|
| G00 | Positioning in Rapid | G91 | Incremental Positioning |
| G01 | Linear Interpolation | G92 | Reposition Origin Point |
| G02 | Circular Interpolation (CW) | G93 | Inverse time feed |
| G03 | Circular Interpolation (CCW) | G94 | Per minute feed |
| G04 | Dwell | G95 | Per revolution feed |
| G07 | Imaginary axis designation | G96 | Constant surface speed control |
| G09 | Exact stop check | G97 | Constant surface speed control cancel |
| G10 | Program parameter input | G98 | Set Initial Plane default |
| G11 | Program parameter input cancel | G99 | Return to Retract (Rapid) Plane |
| G12 | Circle Cutting CW | | |
| G13 | Circle Cutting CCW | | M - Codes |
| G17 | XY Plane | M00 | Program Stop |
| G18 | XZ Plane | M01 | Optional Program Stop |
| G19 | YZ Plane | M02 | Program End |
| G22 | Stored stroke limit ON | M03 | Spindle On Clockwise |
| G23 | Stored stroke limit OFF | M04 | Spindle On Counterclockwise |
| G28 | Automatic return to reference point | M05 | Spindle Stop |
| G29 | Automatic return from reference point | M06 | Tool Change |
| G30 | Return to 2nd, 3rd, 4th reference point | M08 | Coolant On |
| G31 | Skip function | M09 | Coolant Off |
| G52 | Local coordinate system setting | M10 | Clamps On |
| G53 | Machine coordinate system selection | M11 | Clamps Off |
| G54 | Work piece Coordinate System | M30 | End of Program, Reset to Start |
| G55 | Work piece Coordinate System 2 | M98 | Call subroutine command |
| G56 | Work piece Coordinate System 3 | M99 | Return from subroutine command |
| G57 | Work piece Coordinate System 4 | | |
| G58 | Work piece Coordinate System 5 | | |
| G59 | Work piece Coordinate System 6 | | |
| G70 | Inch Units | | |
| G71 | Metric Units | | |