NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY
DEPARTMENT OF INDUSTRIAL AND MANUFACTURING ENGINEERING

Bachelor of Engineering Honours Degree Industrial and Manufacturing Engineering

<u>2nd Semester Main Examination</u>

COURSE	**: ADVANCED MANUFACTURING TECHNOLOGY**
CODE	**: TIE 5216**
DATE	**: APRIL/MAY 2014**
DURATION	**: 3 HOURS**

INSTRUCTIONS AND INFORMATION TO CANDIDATE

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1. Answer ANY five questions.
2. All questions carry **20 marks** each.
3. This paper contains seven **(7)** questions.
4. There are four **(4)** printed pages.

QUESTION 1

Stereolithography is to be used to build the part in Figure Q1 below. Dimensions of the part are: height 125 mm, outside diameter 75 mm, inside diameter 65 mm, handle diameter 12 mm, handle distance from cup 70 mm measured from center (axis) of the cup to the center of the handle. The handle bars connecting the cup and handle at the top and bottom of the part have a rectangular cross section and are 10 mm thick and 12 mm wide. The thickness at the base of the cup is 10 mm. The laser beam diameter is 0.25 mm, and the beam can be moved across the surface of the photopolymer at 500 mm/s. Layer thickness is 0.20 mm. Calculate an estimate of the time required to build the part, if 10 seconds are lost each layer to lower the height of the platform that holds the part. Neglect post-curing time. [20]

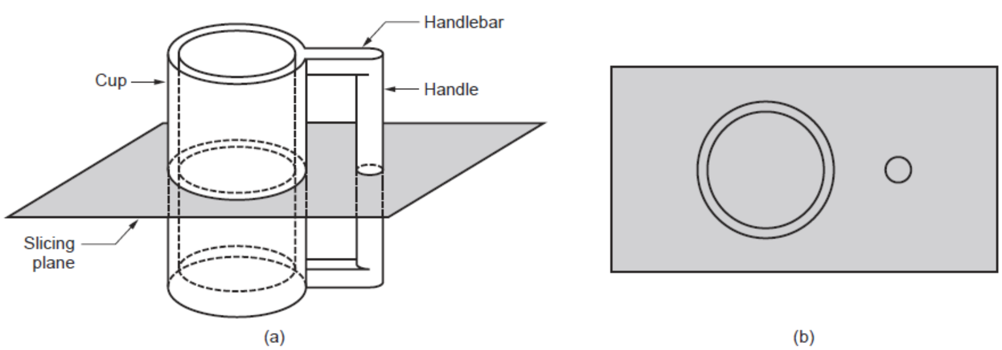

Figure Q1

QUESTION 2

(a) In an electrochemical machining operation, the frontal working area of the electrode is $2.5mm^2$. The applied current is 1500 amps, and the voltage is 12 volts. The material being cut is pure aluminum, whose specific removal rate is 3.44×10^{-2} mm^3/amp-sec. [10]

(b) If the ECM process is 90% efficient, determine the rate of metal removal in 3hr. [5]

(c) If the resistivity of the electrolyte is 6.2 ohm-mm, determine the working gap. [5]

QUESTION 3

A single crystal boule of silicon is grown by the Czochralski process to an average diameter of 320 mm with length 1500 mm. The seed and tang ends are removed, which reduces the length to 1150 mm. The diameter is ground to 300 mm. A 90mm wide flat is ground on the surface that extends from one end to the other. The ingot is then sliced into wafers of thickness 0.50 mm, using an abrasive saw blade whose thickness 0.33 mm. Assuming that the seed and tang portions cut off the ends of the starting boule were conical in shape, determine

(a) the original volume of the boule [6]

(b) how many wafers are cut from it, assuming the entire 1150 mm length can be sliced; [6]

(c) the volumetric proportion of silicon in the starting boule that is wasted during processing. [8]

QUESTION 4

(a) Microsytems devices can be classified either by type of device or by application. Describe three micro systems devices you know. [10]

(b) Use well labelled sketches to describe the LIGA process in Micro-systems fabrication.[10]

QUESTION 5

Fig Q5 below shows different structures of carbon nanotube of as low diameter dimensions as 1nm. Discuss how the different structures of carbon nanotubes in a) b) and c) below are **applied** especially with regards to heat emission during conduction. [20]

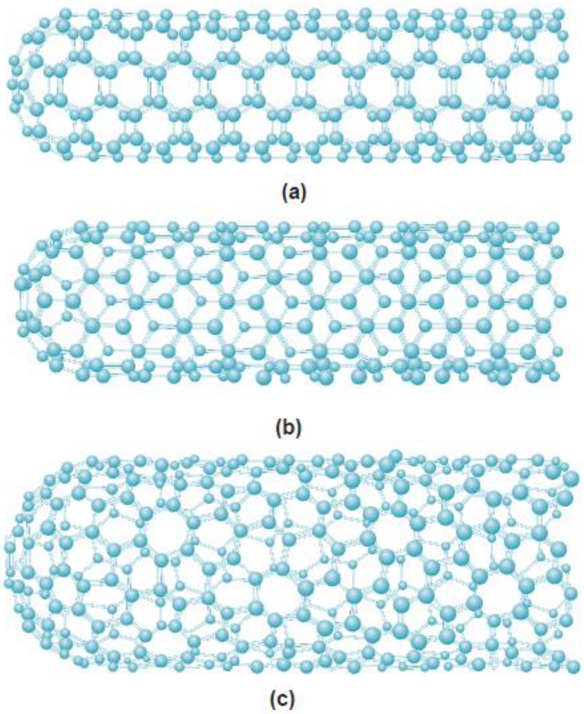

Figure Q5: Carbon monotube structures

QUESTION 6

(a) Describe the important features of clean rooms and how they are maintained. Why do you think clean rooms are important in micro-systems fabrication? [10]

(b) Use a clearly labelled sketch to illustrate Laminated Object Manufacturing as used in Rapid Prototyping [10]

QUESTION 7

Using appropriate sketches, how would you use bottom up and top-down approaches in nano fabrication. Clearly outline the differences between the two manufacturing methods stating the advantages of using one over the other. [20]

END OF EXAMINATION