Metallurgical

COLLEGE OF ENGINEERING, PUNE – 5
(An Autonomous Institute of Government of Maharashtra)
Autumn Semester
End Semester Examination
(MT401) Design and Selection of Materials

Programme: **Final Year B.Tech. (Metallurgical Engineering)** Year: **2012-13**
Duration: **3 Hours** Max. Marks: **50** Date: **23 November 2012**
Instructions:

1) Answer ***any five*** questions.
2) Draw neat figures wherever required.
3) Figures to the right indicate full marks.
4) Assume suitable data if required.
5) Use of non-programmable calculators is allowed.
6) Write clearly question numbers. In case a question is solved on different pages, indicate the page number clearly where the remaining part of answer is continued.

Q.1 (a) What do you mean by fixed costs and variable cost? With the help of a graph explain the 'break even point'. 3

(b) State the four rules the designer should bear in mind for minimizing the process cost. 4

(c) What are the different 'Eco properties' of materials? What are their units? 3

Q.2 (a) 'Structure-sensitive properties' appear as elongated bubbles within the envelopes on the material property-charts. State three ways of achieving such wide variation of the properties in materials. 5

(b) Using the following data, draw the material property-chart of thermal expansion, α *versus* thermal conductivity, λ.

Material	α (10^{-6}/C)	λ (W/m.K)
Ferrous Metals and alloys	10-20	11-55
Non ferrous Metals and alloys	8-28	2-390
Glasses	0.55-9.5	0.7-2.5
Technical Ceramics	2.2-10.9	22-200
Metal composites	15-23	160-180
Polymer Composites	1-33	0.4-2.6
Elastomers	120-610	0.08-0.4
Thermoplastics	72-306	0.11-0.44
Thermosetting polymers	58-180	0.14-.03
Polymer foams	20-220	0.04-0.08

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Q.3 (a) Drive the material index for 'light stiff beam' with the following design requirements. Which material property-chart is required for the material selection purpose?

Function: Beam
Constraints : Length L is specified
Beam must support a bending load F with minimum deflection δ, (bending stiffness S is specified)
Objective: Minimize the mass of the beam, m

Free variables: Cross-section area, A
Choice of material

Given:

$$S = \frac{F}{\delta} \geq \frac{C_1 EI}{L^3} \qquad \text{and} \qquad I = \frac{b^4}{12} = \frac{A^2}{12}$$

where E is Young's modulus, C_1 is a constant and I is the second moment of the area of the section. 4

(b) What do you mean by 'structural index' in material selection? In what way is it used? 3

(c) Explain with a schematic figure, metal turning process. What are the process parameters involved? 3

Q.4 (a) State the design requirements of a flywheel for a child's toy.
The flywheel has thickness t, outside radius R, mass m, volume V, density ρ, and angular velocity ω.
Derive the material index with following given data.
The energy U stored in the flywheel is

$$U = \frac{1}{2} J\omega^2$$

where 'polar moment of inertia' of the disk $J=(\pi/2)\rho R^4 t$.
The maximum principal stress in a spinning disk of uniform thickness is

$$\sigma_{max} \approx \frac{1}{2} \rho R^2 \omega^2$$

Which material property-chart is required for the material selection? Suggest suitable material(s) for the toy flywheel. 8

(b) Which materials can be selected for the following?
i. Heat sink
ii. Oars for boating 2

Q.5 (a) State the design requirements in terms of *function, objectives, constraints and free variables* for ***any two*** of the following applications:
i. Structural materials for buildings,
ii. Efficient small springs,
iii. Safe pressure vessels 5

(b) There are three design requirements for deflection limited structures - load specified, energy specified or deflection specified. What are their respective material indices and material families selected? 5

Q.6 (a) Classify the different processes used for engineering production. State the different attributes used in their selection. 5

(b) A muffle furnace is to be constructed for hardening of a small batch of 10 drills. Write the desired specification for the same. 3

(c) List different rapid prototyping systems used in industry. 2

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