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Your Name Goes On This Line

E98 Fourth Examination
3 May 2000
Suggested Exam Time: 75 minutes.
Due in Prof. Spjut's office 24 hours after:

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In this examination you may use the class texts and *any notes* that you have taken in class or made in preparation for the exam. You may also use your homework and quizzes, and my homework solutions. *All other references are forbidden*. There are two sections to the exam. The first section consists of four short problems, each worth 12 points. They are designed to be answered quickly, without a great deal of derivation or calculation. To pass the class you must get three of the four essentially correct. The second section consists of two problems, each worth 25 points. The total possible for the exam is 98 points. Within each section, the problems are of equal weight but *not* of equal difficulty. There is partial credit. Please write neatly and *on one side* of your paper only. You may work on your problems in any order, but please assemble your completed exam with the problems in the correct order and in the correct section. For safety, you may want to write your name on every page.

Section I – Skills Questions (12 Points Each)

1. A 10Ω copper ($\rho = 1.72\times10^{-8}$¾m) wire-wound resistor has a total wire length of 100 m. Calculate the wire diameter.

2. Germanium ($A_{Ge} = 72.59$ g/mol , $\rho = 5.32$ g/cm^3 , $\mu_e = 0.38$ m^2/V-s , $\mu_h = 0.18$ m^2/V-s) is doped with 0.12×10^{-6} atomic fraction gallium. Calculate the conductivity of the doped germanium.

3. A flat-plate capacitor with dimensions $2\text{ m} \times 0.5\text{ m}$ has a plate separation of 1 mm and a capacitiance of 0.0425 μF. Calculate the dielectric constant of the dielectric in the capacitor.

4. The performance index for a material exposed to fluctuating temperatures is the thermal shock resistance.

   $$P = TSR = \frac{k\sigma_f}{E\alpha_l} \quad ,$$

   where k is the thermal conductivity, σ_f is the failure strength, E is Young's modulus, and α_l is the linear coefficient of thermal expansion. Determine which material: A36 Steel, Soda-Lime Glass, Sintered Silicon Nitride, or Dry Nylon 6,6, is best for fluctuating-temperature applications. The properties can all be found in Appendix B of Callister. If a range of properties is given for a material, use the most favorable value.

Section II – Long Questions (25 Points Each)

1. 37.5 kg of nylon 6,6 is produced by reacting adipic acid and hexamethylenediamine. Data are in supplementary problem 76.
   a. What masses of adipic acid and hexamethylenediamine were required?

   b. What other byproduct was produced? What was its mass?

2. A sheet of continuous and aligned fiber-reinforced aramid-fiber polycarbonate-matrix composite consists of 70 vol% fibers and 30 vol% matrix (data are in Problem 17.11 on page 557 of Callister. Note: Your problem has exactly reversed vol% from Problem 17.11). The fibers are aligned in the x-direction and the y-direction is transverse to the fibers. Assume $\nu_{lt} = 0.3$.
   a. Calculate E_{cl} and E_{ct} for the composite.

   b. Calculate ε_x, ε_y, and γ_{xy} for applied tensile stresses of 50 MPa in the x-direction and 5 MPa in the y-direction.