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Your Name Goes On This Line

E98 Third 70 Minute Exam
5 May 1998

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 my homework solutions. All other references are forbidden. There are four problems worth 25 points each. The problems are of equal weight but *not* of equal difficulty. There is partial credit. Please write neatly and *on one side* of the paper only. If you use any additional paper, please attach it immediately following the sheet on which the problem statement appears.

1. A sample of polypropylene was measured and found to have the following molecular weight distribution:

Table 1: polypropylene molecular weight distribution

MW Range	x_i	w_i
50,000–70,000	0.125	0.081
70,000–90,000	0.250	0.216
90,000–110,000	0.500	0.541
110,000–130,000	0.125	0.162

a. Calculate the number-averaged molecular weight, $\overline{M}_n$.

b. Calculate the weight-averaged molecular weight, $\overline{M}_w$.

c. How many grams of H_2O_2 were added to 1000 g of propylene to create this polymer?

(additional space for Problem #1)

2. A carbon-fiber reinforced epoxy is desired with standard-modulus fibers (data in Table 17.7 on page 539). Parallel cylindrical fibers are to be laid in the longitudinal direction.
   a. What is the maximum volume fraction possible for the fibers?
   b. Estimate the longitudinal modulus for a fiber volume fraction of 80 percent of the maximum.
   c. Estimate the transverse modulus for a fiber volume fraction of 80 percent of the maximum.

(additional space for Problem #2)

3. An aramid-epoxy composite (properties in table 17.4 page 530) is used to make a 1.000 m long by 1.000 cm diameter cylindrical rod. The fibers are aligned axially. The base of the rod is attached to the ceiling. A 230 kg weight is hung from the opposite end of the rod.
   a. Limiting yourself to the two-dimensional case, determine the values in the stress tensor.
   b. Write the 2-D compliance matrix inserting numerical quantities where possible. Assume $n_{lt} = 0.4$.
   c. Determine n_{tl}.
   d. Determine the final dimensions of the rod.

(additional space for Problem #3)

4. A slightly deranged engineer wants to design a toaster with an intrinsic silicon heating element (Si data in Table 19.2 on page 603 and on page 747 in the third paragraph). The power draw at room temperature should be 115 W.
   a. What diameter should the heating element be if it has a total length of 1.000 m? (I didn't say it was a good idea).
   b. What would the approximate power draw be at the operating temperature of 500 °C?
   c. What would the heating-element length be at 500°C?
   d. What is your evaluation of the engineer's design idea?

(additional space for Problem #4)