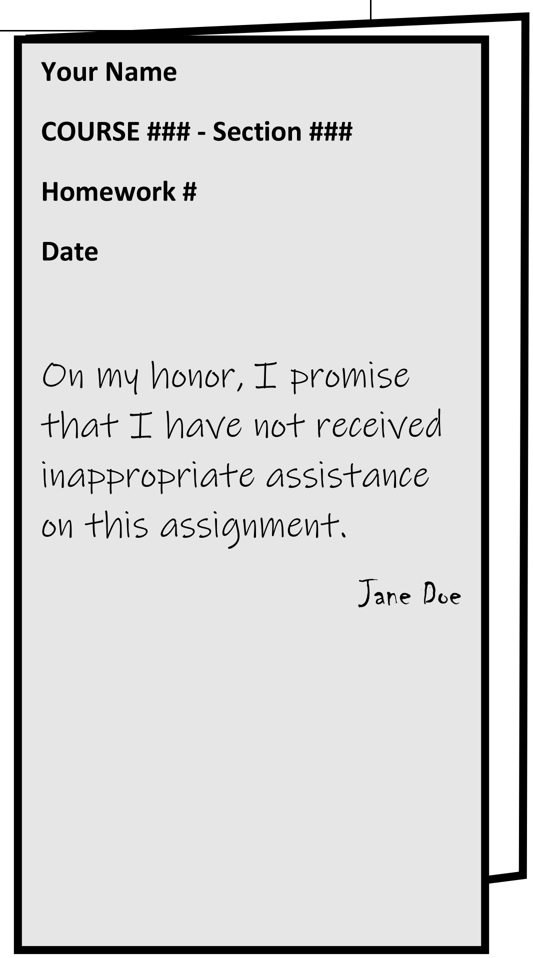
Engineering Format for Homework Solutions

Perhaps the most important thing you will learn as an engineering student is how to solve problems. Your solutions should contain each of the sections below (Given, Required, Solution, Discussion):

Given	• Rewrite the problem system on your paper and sketch the geometry or problem to be analyzed. • Clearly tabulate all the given information, such as current, voltage, dimensions, material properties, forces, etc.
Required	• Identify the unknown quantity (or quantities) to be determined.
Solution	• Draw additional sketches of the body to aid in your solution if needed. • Apply the appropriate principles and equations (IDENTIFY the principles and equations that you will employ) • Report the answer with the appropriate number of significant digits with the relevant units. • Place the final answer in a box, and underline critical intermediate results when applicable.
Discussion	• Study the answer to see if it is reasonable and give any limitations of the solution.

<u>**Other Requirements:**</u>

- Solutions should be NEAT.
- Solutions should be completed on engineering paper (yellow, green, or white) or white printer paper (with no lines).
- Put problems in the order they are assigned.
- Number all pages in the upper right-hand corner of the paper. For a 5-page assignment, the first page would be numbered 1/5, and the second page would be numbered 2/5, and so on.
- The use of Mathcad to complete all or part of a homework assignment is encouraged.
- The homework paper should be folded and labeled as shown in the figure.
- A properly formatted problem must include the proper units throughout the solution.
- Each problem should begin on a new page; there should never be more than one problem per page, although long problems may span multiple pages.



An example of a properly formatted problem solution is shown on the following pages. The example is annotated with red comments.

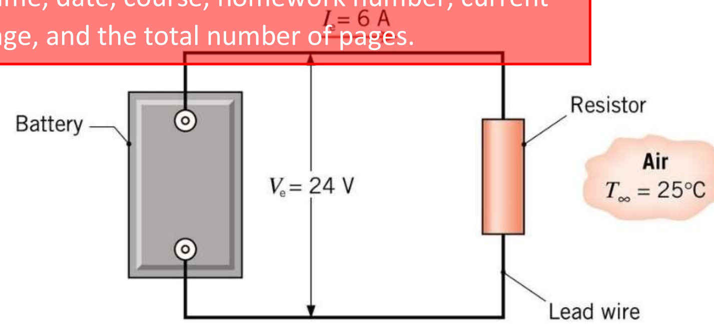
The header is included on each page and includes name, date, course, homework number, current page, and the total number of pages.

Problem 3

Problem number is clearly labeled.

Given:

An electrical resistor is connected to a 24 V battery. After a brief period, the resistor assumes a nearly uniform, steady-state temperature of 95 °C, while the battery and lead wires remain at the ambient temperature of 25 °C. At steady-state, the resistor draws 6 A of current. Neglect the electrical resistance of the lead wires.



(a) Consider the resistor as a system about which a control surface is placed, and the 1st Law of Thermodynamics equation is applied. Determine the corresponding values of the power entering ($\dot{E}_{in}$), the power generated ($\dot{E}_g$), the power leaving ($\dot{E}_{out}$), and the power stored ($\dot{E}_{st}$) all in W. If a control surface is placed about the entire system, what are the values of $\dot{E}_{in}$, $\dot{E}_g$, $\dot{E}_{out}$, and $\dot{E}_{st}$?

(b) If electrical power is dissipated uniformly within the resistor, which is a cylinder of a diameter of 60 mm and length of 250 mm, what is the volumetric heat generation rate in W/m^3?

Section headers are clearly defined.

$V_e = 24\ V$
$T_s = 95\ °C$
$T_\infty = 25\ °C$
$I_e = 6\ A$

Variables given in the problem statement are clearly defined. A table format is often appropriate.

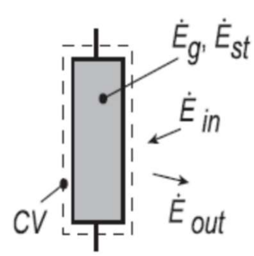
Required:

(a) The power entering, generated, leaving, and stored in the system where the system contains just the resistor and where the system includes both the battery and resistor
$\dot{E}_{in}$, $\dot{E}_g$,$\dot{E}_{out}$, and $\dot{E}_{in}$

(b) The volumetric heat rate generated by the resistor
$\dot{q}$

Solution:

A sketch of the system containing just the resistor is shown below.



A resistor does not store or generate power so $\dot{E}_{st} = 0\ W$ and $\dot{E}_g = 0\ W$.

The page header is repeated on each new page.

Problem 3 (contd.)

Solution (contd.):

Problem and section header is repeated on each new page.

The 1st Law of Thermodynamics for the system shown above is

$$\frac{d\,E_{sys}}{dt} = \sum \dot{E}_{in} - \sum \dot{E}_{out}$$

$$0 = \dot{E}_{in} - \dot{E}_{out}$$

$$0 = P_s - \dot{E}_{out}$$

Where P_s is the power supplied by the battery to the resistor. The power provided by the battery is given by

Units are included on all intermediate steps.

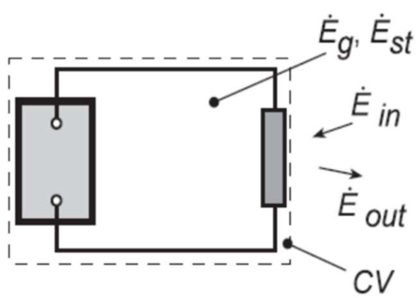
$$P_s = V_e I_e = \boxed{(24\,V)(6\,A)} = 144.0\,W$$

Thus, the power entering and leaving the resistor is $144.0\,W$.

Final answers are aligned to the right margin, boxed, and clearly labeled.

$$\boxed{\begin{aligned} \dot{E}_{in} &= 144.0\,W \\ \dot{E}_g &= 0\,W \\ \dot{E}_{out} &= 144.0\,W \\ \dot{E}_{st} &= 0\,W \end{aligned}} \quad \text{(a)(1)}$$

A sketch of the system containing the battery and resistor is shown below.



There is no power entering the system so $\dot{E}_{in} = 0\,W$. There is no power being stored in the system so $\dot{E}_{st} = 0\,W$.

The 1st Law of Thermodynamics for the system shown above is

$$\frac{d\,E_{sys}}{dt} = \sum \dot{E}_{in} - \sum \dot{E}_{out}$$

$$0 = \dot{E}_{in} - \dot{E}_{out}$$

$$0 = P_g - \dot{E}_{out}$$

where P_g is the power generated by the battery through its chemical reaction. The power generated by the battery is given by

$$P_g = V_e I_e = (24\,V)(6\,A) = 144.0\,W$$

Problem 3 (contd.)

Solution (contd.):

Thus, the power generated in the system is $144.0\ W$ and the power leaving the system must be $144.0\ W$.

$$\boxed{\begin{aligned}\dot{E}_{in} &= 0\ W\\ \dot{E}_{g} &= 144.0\ W\\ \dot{E}_{out} &= 144.0\ W\\ \dot{E}_{st} &= 0\ W\end{aligned}} \quad \text{(a)(2)}$$

The volume of the resistor is given by

$$V_r = \frac{\pi}{4}D^2L = \frac{\pi}{4}(60\ mm)^2(250\ mm) = 706.9\ cm^3$$

The volumetric heat rate generated by the resistor is given by

An appropriate number of digits is used in final answers.

$$\boxed{\dot{q} = \frac{\dot{E}_{out}}{V_r} = \frac{144.0\ W}{706.9\ cm^3} = \boxed{2.037\times10^5}\ {}^{W}\!/_{m^3}} \quad \text{(b)}$$

Discussion:

The answers are reasonable. This solution assumes there are no losses in the leads connecting the battery and resistor. For a simple system like this, the assumption is valid.

The discussion section should not only say "The answers are reasonable" or a similar statement. The section should include any underlying assumptions and why in this particular case, those assumptions are valid.