Math-in-CTE Lesson Plan Template

Lesson Title:		Lesson #
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Occupational Area: Welding		
CTE Concept(s): Duty Cycle		
Math Concepts: percentages, rounding, order of operation		
Lesson Objective:	To understand the length of time a welding machine may be operated in a given time	
Supplies Needed:	Calculator, handouts, textbook (Welding – Principles and Applications)	

THE "7 ELEMENTS"	TEACHER NOTES (and answer key)
1. Introduce the CTE lesson. One of the most important aspects of using SMAW equipment is knowing and understanding duty cycle. The duty cycle of a piece of equipment is one of the considerations that I consider when I purchase a new piece of equipment for the shop. As you know most 1/8 inch electrodes operate at lower amperage than this. What amperage does an 1/8 inch electrode (e7018) normally run at? Because of a lower amperage rate setting this would increase the duty cycle. The more expensive a piece of equipment is the longer the duty cycle. What I would like you to do now is read page 58-59 in your textbook (Welding principles and applications).	Definition: Duty cycle is the number of minutes out a 10 minute period a welder can operate a piece of equipment at rated amperage. An example would be if a machine is rated at 60% duty cycle at 150 amps would mean the if you were welding at 150 amps you could weld 6 minutes out of 10. 60% of 10 is 6. 110-120 amps Students have seen duty cycle in a vocabulary sheet.

2. Assess students' math awareness as it relates to the CTE lesson. Now that you have read this lets take a look at figure 3-31. Do you understand how to read it? Ask questions about table to see if they can answer the questions.	Dependent variable/Independent variable Left is amps and bottom is % duty cycle.
How many of you understand %.	Most calculators do not have a **%** sign so you need to know how to make it calculator ready. 50 % means 50/100 or 50÷100. In math class you might have learned about **ratio**. It looks just like a fraction (20/50). When you call it a ratio it would be read as 20 to 50. Some teachers may say 20 out of 50. After practicing a few of these you start to see a pattern. 43%=43/100=.43 80%=80/100=.80 60%=60/100=.60
Try these: 15%, 41%, 87%	Answers: .15,.41,.87
What does 60% of 300 mean and how do you work it out?	What is the **pattern**? (move the decimal 2 places to the right) First change 60% to a decimal (.60) The word **of** in math means **multiply**. To show multiplication you use either a dot · or parenthesis() So now you have .60·300=180 or .60(300)=180

3. Work through the math example *embedded* in the CTE lesson.

My brother bought a fish finder at LL Bean that was on sale for 90% off. And because his wife is a manager she got an additional 25% off. How much did the fish finder cost if the original price was $300.

By breaking this down into 3- $100 bills I then subtract $90. (90%) from 100 and get $10. Because I did this 3 time I end up with $30. I now try to figure out how much 25% off of this amount is. I take the $30 and break it down into 3- $10 bills. Then I subtract $2.50 (25%) from $10 get $7.50. Because I do this 3 times I end up with $22.50. On top of this I have to add tax which is 6%. I would add $.60 to each $10. I would do this twice for a total of $1.20, leaving $2.50 to deal with. Then I would break it down into 2 $1.00 and the last $0.50 would be ½ of that for a total of $.15. I would then add the $22.50 plus $1.20 and $0.15 and get $23.85.

Instructor should do more mental math examples.

With duty cycle it is a really easy process because every machine is based on 10 minutes. The tag on the front of the machine will tell you the duty cycle. For example; if it says 60% duty cycle at 125amps you only have to figure out what 60% duty cycle is.

.6(10min) =6min. That 6 minutes is the operating time (arc time) for this machine.
This only works if running at 125 amps. High amperage = less duty cycle, lower amperage= more duty cycle.

.20(10MIN)=2 minutes work time per 10 minutes

If the machine has a duty cycle of 20% at 100 amps, what is the work time?

There are 6 10 minute periods in 1 hour.

Job efficiency. Do you really want to be able to work on something only 2 minutes out of every 10 minutes?

How long would you work in an hour?

6(2 min)=12 min work time in 1 hours

Talk about efficiency of equipment.

5. Work through *traditional math* examples.

What happens if you want to work at 180 amps on a machine rated at 60% at 120 amps? How many minutes could you run the machine without burning out the transformer? The formula is:	Where have you seen this before?
	Talk about what they know about formulas.
	How would you find the required duty cycle?
$$D_{needed} = D_{rated}\left[\frac{I_{rated}}{I_{needed}}\right]^2$$	Talk about order of operations. Parentheses, exponents, multiple/divide left to right and then add and subtract left to right. "**P**lease **E**xcuse **M**y **D**ear **A**unt **S**ally"
D_{needed} is the required duty cycle	Use the problem at left:
D_{rated} is the rated duty cycle	In the engineering world
I_{needed} is the required current (amps)	D is the Duty cycle
I_{rated} is the rated current (amps)$_d$ is the required duty cycle	I is amperage
	D needed = unknown or x
	D rated = 60%
	I rated = 120 amps
In our language	I needed = 180amps
$X = 60\%(have/want)^2 =$ new work time	
	X= 60%(120/180)²= 26.7 minutes rounded of to 27% or 2.7 minutes out of 10 minutes
	X = 2.7minutes
	X = 3 minutes

For the purpose of this class we will round of to nearest whole number	In math **rounding** to the nearest whole number means:
	
	If the number after the decimal point 0-4, round down.
	
	If the number is 5-9, round up
	
	   2.3 rounds to 2
	
	   2.7 rounds to 3
	
	Make up more examples, then hand out worksheet

4. Work through *related, contextual* math-in-CTE examples. Make up more examples, and then hand out worksheet. If your % comes out to over 100 it means you may work your machine the full 10 minutes or for that matter the full day. Would this be an expensive or inexpensive machine?	Duty Cycle – Worksheet 1 Answer sheet: 1. 109 % 10 minutes 2. 55 % 6 minutes 3. 29 % 3 minutes 4. 28 % 3 minutes 5. 115 % 10 minutes 6. 44 % 4 minutes

6. Students demonstrate their understanding.	
In your shop you have two welding machine to choose from. One has a rated duty cycle of 60% at 140 amperage and the other welding machine is rated at 90% duty cycle at 100 amps. If you were required to do a project that needed to be done ASAP and you are required to use FCAW .045 wire which will need to operate at 170 amps, which welding machine would be the best choice for the job?	**FCAW** means **F**lux **C**ored **A**rc **W**elding $60\%(100/140)^2 = 30.61$ ANSWER = 31% Which is 3.1 minute, rounded to 3 minutes per 10 minutes $60\%(100/170)^2 = 20.76$ Answer = 21 % Which is 2.1 minutes, rounded to 2 minutes per 10 minutes
7. Formal assessment. Students are to go into the welding lab and identify what the duty cycle is on the machine that they are going to be using. Then workout how long that particular machine can operate at these amps: 1. 100 amps 2. 147 amps 3. 250 amps	Students are assigned a welding machine at the beginning of the school year. Answers will vary

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