EGR 125   Due date: _____
Introduction to Engineering Methods (C++)
File: N125P1A
Programming Assignment #1
Calculation of Electric Power Bill

Background:
Monthly Dominion Virginia Power billing amounts can be calculated using various quantities and rates which are available on the billing statement or online. First a few terms should be defined:

Distribution Service Charge – consists of three parts:
1) Basic Charge: $7.00 - this fee is charged regardless of the energy usage
2) Distribution kWh Charge:
    $0.02269/kWh for the first 800 kWh
    $0.01296/kWh for the portion over 800 kWh
3) Riders:
    Rider C1A: $0.00010/kWh
    Rider C2A: $0.00024/kWh

Electricity Supply Service (ESS) Charge – consists of three parts:
1) Generation – consists of three parts
    a) For June – September ("Summer" rates are higher)
        $0.03795/kWh for the first 800 kWh
        $0.05773/kWh for the portion over 800 kWh
      For October - May
        $0.03795/kWh for the first 800 kWh
        $0.02927/kWh for the portion over 800 kWh
    b) Rider S: 0.00474/kWh
        Rider B: 0.00012/kWh
        Rider W: 0.00066/kWh
        Rider R: 0.00142/kWh
2) Transmission – consists of two parts:
    a)   Transmission kW Charge: $0.0097/kWh
    b)   Rider T1: *Subtract* $0.00267
3) Fuel Charge (Rider A) - $0.02706/kWh

Sales and Use Surcharge - $0.00061/kWh

State/Local Consumption Tax
    a) 0 to 2500 kWh:
        State Consumption: $0.00102/kWh
        Special Regulatory: $0.00012/kWh
        Local Consumption: $0.00038/kWh
    b) 2501 to 50,000 kWh:
        State Consumption: $0.00065/kWh
        Special Regulatory: $0.00008/kWh
        Local Consumption: $0.00024/kWh
    c) Over 50,000 kWh:

State Consumption: $0.00050/kWh
Special Regulatory: $0.00006/kWh
Local Consumption: $0.00018/kWh

Virginia Beach Utility Tax - $3.00
Late Penalty: 1.5% of the amount before taxes

Energy Used　　= Final meter reading - Initial meter reading (add 100000 if negative) - see note below

$$\text{Average Daily Cost} = \frac{\text{Bill Amount before taxes and not including late penalties}}{\text{Number of days in the billing period}}$$

Number of days in billing period – Varies from 26 to 35.

Rounding – Assume that all monetary values on power bills are ***rounded to the nearest cent***.

Note: the reading on the meter displays 5 digits, so the meter reads counts 99998, 99999, 00000, etc. So if the final meter reading is less than the initial reading (or if the Energy Used is negative), 100000 must be added.

Example: (See attached Dominion Virginia Power bill)

Month Number: 12 (i.e., December, so "Winter rates")
Number of days in billing period: 30
Previous month's Bill: $52.35 (paid on time)
Initial meter reading = 98830 kWh
Final meter reading = 99882 kWh
Energy Used = Final meter reading - Initial meter reading = 99882 –98830 = 1052 kWh

Cost summary:

Balance Forward:	$46.65

Distribution Service Charge:
　　$7.00 + ($0.02269/kWh)(800 kWh) + ($0.01296/kWh)(1052-800 kWh)

+ ($0.00010/kWh)(1052) + ($0.00024/kWh)(1052) :	$28.78

Electricity Supply Service:
* Generation:
　　　　($0.03795/kWh)(800 kWh) + ($0.02927/kWh)(1052-800 kWh)
　　　　+ ($0.00474/kWh)(1052 kWh) + ($0.00012/kWh)(1052 kWh)

+ ($0.00066/kWh)(1052 kWh) + ($0.00142/kWh)(1052 kWh):	$45.04

* Transmission:

($0.0097/kWh)(1052 kWh) - ($0.00267/kWh)(1052 kWh):	$7.40

* Fuel Charge (Rider A):

($0.02607/kWh)(1052 kWh):	$28.47
Sales and Use Surcharge: ($0.00061/kWh)(1052 kWh):	$0.64

State/Local Consumption Tax:
　　($0.00102/kWh)(1052 kWh) + ($0.00012/kWh)(1052 kWh)

+ ($0.00038/kWh)(1052 kWh) :	$1.60
Virginia Beach Utility Tax:	$3.00
Late Payment Charge *: = ($46.65)(0): (not paid late)	$0.00
Total Current Charges:	$114.93
Total Account Balance: ($114.93 - $46.65)	$68.28
Average Daily Cost = ($114.93 – $1.60 – $3.00 – $0.00)/30	$3.68

<u>Note</u>: An actual Dominion Virginia Power bill is attached. For some unknown reason, all values on the bill match the calculations above except the Generation charge ($43.11 vs $45.04) and the Sales and Use Surcharge ($0.54 vs $0.64). However, Dominion has a spreadsheet that can be used to calculate bills and it agrees with the calculations above (also attached).

Program Requirements:

1. The program should display a descriptive program title initially and then request the following information from the user:
    - The user's full name (read as a string)
    - Month Number (1 - 12)
    - Initial meter reading (an Integer)
    - Final meter reading (an Integer)
    - Number of days in the billing period (26 to 35)
    - Was last month's bill paid late? If so, enter the balance from the previous month.
    - Include clear variable names and plenty of comments.
2. Check for improper inputs. If an improper input is entered, display an error message and terminate the program (**return 1** in the main program). Failure paths should include:
    - a valid month number must be entered
    - a valid number of days in the billing period must be entered (26 to 35)
    - initial and final meter readings must be between 00000 and 99999
    - if the user enters the amount for the last month's bill, it must be positive
3. Other notes:
    - Use descriptive variables for all charges, rates, amounts, etc.
    - Assign rates to variables rather than using numerical values for the rates in formulas. This makes for more readable code and allows for easy changes to rates in the future.
    - For example, instead of using: Fuel Charge Rider A = (0.02607)(1052)
              you might use: Fuel Charge Rider A = (RiderA_Rate)*(Energy_Used)
    - Do not simplify the problem by combining rates (such as Riders S, B, W, and R), but use descriptive variables for each of the rates.
4. The output should display the following information (nicely formatted):
    User's full name
    Month (name, not number)
    Previous Balance
    Initial meter reading (show all 5 digits, including leading 0s)
    Final meter reading (show all 5 digits, including leading 0s)
    Energy Used (total kWh)
    Distribution Service Charge
    Electricity Supply Service:
          Generation
          Transmission
          Fuel
    Sales and Use Surcharge
    State/Local Consumption Tax
    Virginia Beach Utility Tax
    Late Charge
    Total Current Charge
    Total Account Balance
    Average Daily Cost

Note: Meter readings and energy used should be expressed in kWh and all monetary values should be expressed in dollars and cents using the $ symbol. Additionally, all monetary values should use 2 digits after the decimal point. Round off (do not truncate) all monetary values.

5. Run your program for at least the following cases and include printed results for each case in your report.

Initial meter reading (kW ·h)	Final meter reading (kW ·h)	Month	Number of Days in Billing Cycle	Last month's bill late?	If late, amount was
98830	99882	December	30	No	
28420	29844	August	29	Yes	$132.61
99856	00631	September	32	No	
98212	00000	January	27	No	
76892	79599	February	33	Yes	$293.25
10000	13000	May	35	Yes	
10000	70000	June	26	No	

Note: Case 1 above is the same example above. Your results should match.

Report
Follow the guidelines in the handout Format for Programming Projects (available on the instructor's web page).

Extra Credit Suggestions:
You can earn up to 10 additional points on this program's grade. The number of points awarded depends on the complexity or creativity of the feature. You do not need to do all items listed below to receive 10 points. In general you should include extra text cases to illustrate your new features if appropriate. Here are a few ideas:

1. Rather than terminate the program for invalid inputs, display an error message for invalid inputs and allow the user to correct the inputs. This can be done fairly easily using a **do while loop** (covered in Ch. 6).
2. Rather than requiring the user to enter the number of days in the billing period, require the user to enter the starting date and ending date (month and day only) for the period and let the program calculate the number of days. Check to be sure the number of days is from 26 to 35. Assume that February has 28 days. Use the ending date to determine whether summer rates or winter rates apply.
3. Use strings to read the month (i.e., user enters February instead of 2), but check for reasonable combinations of upper- and lower-case letters.
4. Use a loop to allow the user to re-run the program.
5. Use your imagination!

Submitting your Project
See the document "Submitting Projects Using Blackboard" on the course website and follow the guidelines for submitting projects.

Billing and Payment Summary

Account #	**Due Date: Jan 21, 2013**
Total Budget Due:	**$ 99.00**

To avoid a Late Payment Charge of 1.5% please pay **by Jan 21, 2013.**

Previous Amount Due:	$	99.00
Payments as of Dec 27:	$	99.00CR

For service emergencies and power outages please call
***1-866-DOM-HELP** (1-866-366-4357). Visit us at www.dom.com.*

Meter and Usage

Current Billing Days: 30

Billable Usage
Schedule 1   11/21-12/21
Total kWh   1052

Measured Usage
Meter: 0069508286   11/21-12/21
Current Reading   99882
Previous Reading   98830
Total kWh   1052

Usage History

Mo	Yr	kWh
Dec	11	937
Jan	12	1290
Feb	12	972
Mar	12	853
Apr	12	731
May	12	671
Jun	12	789
Jul	12	1264
Aug	12	962
Sep	12	810
Oct	12	682
Nov	12	802
Dec	12	1052

Explanation of Bill Detail

Customer Service   1-866-DOM-HELP *(1-866-366-4357)*

Previous Balance	52.35	
Payment Received	99.00CR	
Balance Forward		**46.65CR**
Residential Service (Schedule 1)	*11/21-12/21*	
Distribution Service		28.78
Electricity Supply Svc (ESS)		
Generation		43.11
Transmission		7.40
Fuel		28.47
Sales and Use Surcharge		0.53
State/Local Consumption Tax		1.60
VIRGINIA BEACH Utility Tax		3.00
Total Current Charges		**112.89**
Total Account Balance		**66.24**

View payment options, request service changes and enroll in eBill at www.dom.com, search: Manage Your Account

Schedule 1 - Virginia Residential Service Rate Worksheet
Refer to effective dates listed in left hand column.

Dominion Virginia Power is providing this Rate Worksheet to its Virginia residential customers as a tool to help in better understanding their Schedule 1 – Residential Service electric bill. This Rate Worksheet is only a guide, and Dominion Virginia Power is not responsible for any errors resulting from its use. For example, rounding differences may occur between the charges listed on your electric bill itself and this worksheet. If there is a discrepancy, the Customer Bill governs. Please refer to the Customer Bill for the actual charges.

NOTE: The basic customer charge and kWh tiers are prorated when the number of billing days is < 26 or > 40 days. The rates per kWh are prorated when the measured usage period spans over two rate filing dates. If one or more of these conditions exist, this worksheet may not accurately calculate the charges on your bill. In certain instances, when your bill date falls on the last few business days of either May or September or the first few business days of either June or October, the current reading date may be used to determine the billing month.

Required fields.

1	Billing Month:	October - May
2	Current Billing Days:	30
3	Total kWh:	1,052

Using your bill, complete all of the required fields on the left; then scroll down to view the calculations.

	kWh	@ !ate per kWh			Subtotal	Charges
A. Distribution Service Charges						
1. Basic Customer Charge	n/a	@ flat charge	=	$	7.00	
2. Distribution kWh Charge						
First 800 kWh	800	@ $ 0.02269	=	$	18.15	
Over 800 kWh	252	@ $ 0.01296	=	$	3.27	
3. Applicable Rider(s)						
Rider C1A	1,052	@ $ 0.00010		$	0.11	
Rider C2A	1,052	@ $ 0.00024		$	0.25	
				Distribution Service		**$ 28.78**

	kWh	@ !ate per kWh			Subtotal	Charges
B. Electricity Supply Service Charges						
1. Generation						
First 800 kWh	800	@ $ 0.03795	=	$	30.36	
Over 800 kWh	252	@ $ 0.02927	=	$	7.38	
2. Applicable Rider(s)						
Rider S (Virginia City Hybrid Energy Center)	1,052	@ $ 0.00474	=	$	4.99	
Rider B (Biomass Conversions)	1,052	@ $ 0.00012		$	0.13	
Rider W (Warren County Power Station)	1,052	@ $ 0.00066		$	0.69	
Rider R (Bear Garden Generating Station)	1,052	@ $ 0.00142	=	$	1.49	
				Generation		**$ 45.04**

	kWh	@ !ate per kWh			Subtotal		Charges
Transmission							
Transmission kWh Chg	1,052	@	$ 0.00970	=	$	10.20	
Rider T1	1,052	@	$(0.00267)		$	(2.81)	
					Transmission	**$**	**7.40**

	kWh	@ !ate per kWh			Subtotal		Charges
Fuel							
Rider A (Fuel Charge Rider)	1,052	@	$ 0.02706	=	$	28.47	
					Fuel	**$**	**28.47**

	kWh	@ !ate per kWh			Subtotal		Charges
Sales and Use Surcharge	1,052	@	$ 0.00061	=	$	0.64	
					Sales and Use Surcharge	**$**	**0.64**

	kWh	@ !ate per kWh			Subtotal		Charges
Consumption Tax							
0 to 2,500 kWh							
State Consumption	1,052	@	$ 0.00102	=	$	1.07	
Special Regulatory	1,052	@	$ 0.00012	=	$	0.13	
Local Consumption	1,052	@	$ 0.00038	=	$	0.40	
					$	1.60	
2,501 to 50,000 kWh							
State Consumption	0	@	$ 0.00065	=	$	-	
Special Regulatory	0	@	$ 0.00008	=	$	-	
Local Consumption	0	@	$ 0.00024	=	$	-	
					$	-	
Over 50,000 kWh							
State Consumption	0	@	$ 0.00050	=	$	-	
Special Regulatory	0	@	$ 0.00006	=	$	-	
Local Consumption	0	@	$ 0.00018	=	$	-	
					$	-	
					State/Local Consumption Tax	**$**	**1.60**
					SUBTOTAL	**$**	**111.92**

Spreadsheet for estimating Dominion Virginia Bills can be downloaded at:
https://www.dom.com/dominion-virginia-power/customer-service/your-bill/understanding-your-bill.jsp