**Assignment 2 – Structures and Functions**

**1.** A hospital supply company wants to market a program to assist with the calculation of intravenous rates. Design and implement a program that interacts with the user as follows. Samples have been provided (in green) to demonstrate possible user input with expected results for all questions.

*Intravenous Rate Assistant*

*Given a medical order in: Calculate Rate in:*

*(1) ml/hr & tubing drop factor drops / min*

*(2) 1 L for n hr ml / hr*

*(3) mg/kg/hr & concentration in mg/ml ml / hr*

*(4) units/hr & concentration in units/ml ml/hr*

*(5) Exit*

*Enter the number of the programme you wish to solve: 1*

*Enter rate in ml/hr: 150*

*Enter tubing’s drop factor (drops/ml): 15*

*The drop rate per minute is 38.*

*Given a medical order in: Calculate Rate in:*

*(1) ml/hr & tubing drop factor drops / min*

*(2) 1 L for n hr ml / hr*

*(3) mg/kg/hr & concentration in mg/ml ml / hr*

*(4) units/hr & concentration in units/ml ml/hr*

*(5) Exit*

*Enter the number of the programme you wish to solve: 2*

*Enter number of hours: 8*

*The rate in millilitres per hour is: 125.*

*Given a medical order in: Calculate Rate in:*

*(1) ml/hr & tubing drop factor drops / min*

*(2) 1 L for n hr ml / hr*

*(3) mg/kg/hr & concentration in mg/ml ml / hr*

*(4) units/hr & concentration in units/ml ml/hr*

*(5) Exit*

*Enter the number of the programme you wish to solve: 3*

*Enter rate in mg/kg/hr: 0.6*

*Enter patient weight in kg: 70*

*Enter concentration in mg/ml: 1*

*The rate in millilitres per hour is: 42.*

*Given a medical order in: Calculate Rate in:*

*(1) ml/hr & tubing drop factor drops / min*

*(2) 1 L for n hr ml / hr*

*(3) mg/kg/hr & concentration in mg/ml ml / hr*

*(4) units/hr & concentration in units/ml ml/hr*

*(5) Exit*

*Enter the number of the programme you wish to solve: 4*

*Enter rate in units/hr: 1000*

*Enter concentration in units/ml: 25*

*The rate in millilitres per hour is: 40.*

*Given a medical order in: Calculate Rate in:*

*(1) ml/hr & tubing drop factor drops / min*

*(2) 1 L for n hr ml / hr*

*(3) mg/kg/hr & concentration in mg/ml ml / hr*

*(4) units/hr & concentration in units/ml ml/hr*

*(5) Exit*

*Enter the number of the programme you wish to solve: 5*

*(Application exits otherwise it will continue to loop as seen above)*

Implement the following functions to complete the above:

1. get\_problem – Displays the user menu, then inputs and returns as the function value the problem number selected.
2. get\_rate\_drop\_factor – Prompts the user to enter the data required for problem 1, and sends this data back to the calling module vai output parameters
3. get\_kg\_rate\_conc – Prompts the user to enter the data required for problem 3, and sends this data back to the calling module via output parameters
4. get\_units\_conc – Prompts the user to enter the data required for problem 4, and sends this data back to calling module via output parameters
5. fig\_drops\_min – Takes rate and drop factor as input parameters and returns drops/min (rounded to nearest whole drop) as a function value
6. fig\_ml\_hr – Takes as an input parameter the number of hours over which 1 L is to be delivered and returns ml/hr (rounded) as a function value
7. by\_weight – Takes as input parameters rate in mg/kg/hr, patient weight in kg, and concentration of drug in mg/ml and returns ml/hr (rounded) as function value
8. by\_units – Takes as input parameters rate in units/hr and concentration in units/ml, and returns ml/hr (rounded) as function value

Save the source for number 1 as “Assn2-Hospital-YourName”

**2.** Create a structure type, *battery\_t*, to represent a battery with members consisting of the voltage, how much energy the battery is capable of storing, and how much energy it is currently storing (in Joules).

Define functions for input and output of batteries.

Create a function called *power\_device* that:

a. takes the current of an electrical device (Amps) and the time the device is to be powered

by the battery (seconds) as input parameters

b. takes the battery as an input/output parameter

The function first determines whether the battery’s energy reserve is adequate to power the device for the prescribed time, if so:

a.i. the function updates the battery’s energy reserve by subtracting the energy

consumed and then returns the value true (1).

a.ii. Otherwise it returns the value false (0) and leaves the energy reserve unchanged.

Also define a function named *max\_time* that takes a battery and the current of an electrical device as input parameters and returns the number of seconds the battery can operate the device before it is fully discharged (assume ideal battery). This function does not change any of the battery’s component values.

Write a function *recharge* that sets to the maximum capacity the battery’s component representing present energy reserve. Use the following equations in your design:

**P = I\*V** P = Power in watts (W) V = Voltage in Volts (V)

**W = P\*t**  I = Current in Amps (A) W = Energy in Joules (J)

t = Time in seconds (s) (re-arrange the equations as required)

For this simulation, neglect any loss of energy in the transfer form battery to device.

Create a main function that declares and initialises a variable to model a 12-V automotive battery with a maximum energy storage of 5 x 10^6 J.

Use this battery to:

* 1. Power a 4 Amp light for 15 minutes
  2. Then find out how long the battery’s remaining energy could power an 8 Amp device.
  3. Recharge the battery
  4. Recalculate how long it could operate an 8 Amp device once fully charged

Save the source for number 2 as “Assn2-Battery-YourName”

**3.** For this question you are going to write a basic calculator for complex numbers. Create a structure called ComplexNumber with 2 members of type double being real and imag (for imaginary).

The following will be a sample input for your programme:

*Enter the First Complex Number: A = -23+j34*

*Enter the Second Complex Number: B = 42-i44*

*Available Operations:*

*(1). C = A+B*

*(2). C = A-B*

*(3). C = A\*B*

*(4). C = A/B*

*(5). Exit*

*What operation would you like to perform? 2*

*C = (-23+j34) + (42-i44) = 19-i10*

(The application will continue to loop allowing for the other outputs)

Note that the input sequences allow for either a j or i as a separator and that this term separates the real and imaginary components. Thus in the sample application the real components are -23 and 42 and the imaginary components are 34 and -44 for A and B respectively. Because multiplication is commutative you can also write 42-44i and stipulate your user to use one format or the other if you desire. Ideally, the advanced solution would confirm what is real and what is imaginary based on the + or – and the position of the i (in case someone wrote -44i+42 which is the same as 42-44i).

Use the following functions in your code: *Complex\_Addition, Complex\_Subtraction, Complex\_Division, Complex\_Multiplication* and pass the Complex Numbers (structures) to the functions to perform the desired operation.

Assuming that, A = Areal + i\*Aimag and B = Breal + i\*Bimag the following equations model the 4 required operations where for these examples A = (-23+j34) and B = (42-i44).

C = A**+**B = (Areal **+** Breal) + j\*(Aimag **+** Bimag) = (-23 **+** 42) + j\*(34 **+** -44) = *19-i10*

C = A**-**B = (Areal **-** Breal) + j\*(Aimag **-** Bimag) = (-23 **-** 42) + j\*(34 **-** -44) = -*65+i78*

C = A\*B = ((Areal \* Breal) - (Aimag \* Bimag)) + j\*((Areal \* Bimag) + (Aimag \* Breal))

= ((-23 \* 42)-(34 \* -44)) + j\*((-23 \* -44)+(34 \* 42))

= ((-966))-(-1496)) + j\*((1012)+(1428))

= ((-966))-(-1496)) + j\*((1012)+(1428))

= (-966+1496) + j\*(1012**+**1428)

= 530 **+** j\*2440

C = A/B = ((Areal \* Breal) + (Aimag \* Bimag)) + j \* ((Aimag\* Breal) - (Areal \* Bimag))

(Bimag\* Bimag) + (Breal\* Breal) (Bimag\* Bimag) + (Breal\* Breal)

= ((-23\*42) + (34 \* -44)) + j \* ((34 \* 42) – (-23 \* -44))

(-44 \* -44) + (42\*42) (-44 \* -44) + (42\*42)

= ((-966)+(-1496) + j \* ((1428) – (1012))

(1936) + (1764) (1936) + (1764)

= (-966 - 1496) + j \* (1428 – 1012)

(1936 + 1764) (1936 + 1764)

= -2462 + j \* 416

3700 3700

= -0.665405405 + j \* 0.1124323432

// a good error checking position is in division the bottom of the fraction can never be negative

//you do not need to show all of your work in the solutions (but it is great if you do, and helpful for error checking).

While the above example provided 2 values of A and B (a full value being considered a real and imaginary) there are infinite solutions. Note that if there is no particular entry it is set to 0 in the equation thus 0-j\*3 is a valid complex number as is 33+j\*0. An online calculator can be used to verify all work or Octave. In particular you can use simpler numbers to verify rather than the given case.

For example: <https://www.mathsisfun.com/numbers/complex-calculator-flash.html>

Save the source for number 3 as “Assn2-ComplexCalc-YourName”