284 Principles of Neuroimaging

Pop Quiz – 20 minutes

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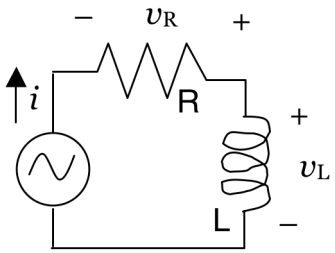
READ CAREFULLY – Some questions have multiple parts. Please circle the correct answer or answers in the column to the left.

1. The typical resting membrane potential of a neuron, referred to the extracellular fluid, is about:

A. 40 mV
B. 40 μV
C. 2 μA
D. −70 mV
E. −70 mA
F. 100 mM

The membrane potential is the difference in electrical potential energy (Voltage) between the extracellular and intracellular fluid of a cell. It is largely the consequence of the different concentrations of Sodium (Na^+) and Potassium (K^+) inside and outside of the cell. This concentration gradient is created and maintained by the "sodium/potassium pump", which consumes much cellular energy.

2. Which formulas describe the relationship between current and voltage in this circuit?



A. $v_L = L\, di/dt$
B. $i = C\, dv_L/dt$
C. $v_R = -iR$
D. $v_L(t) = e^{-t/RL} + v_0$

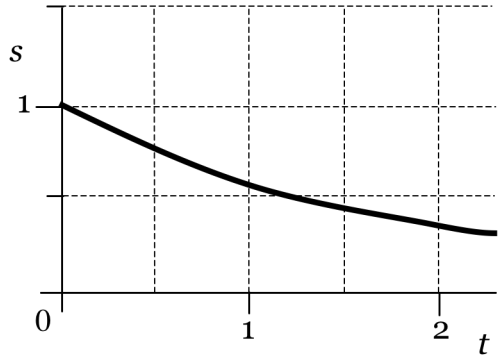
Answer A more or less defines the property of inductance, answer C is Ohm's law – the minus sign is a result of the indicated direction of current flow. B refers to capacitors (not in this circuit). Item D would describe the change in Voltage if the voltage source were changed suddenly to a new DC value.

3. If $y=3x^2 + 6x + 2$, find dy/dx.

A. $x^3 + x^2/3 + 2x + C$
B. $6x + 6$
C. *Indeterminate – cannot be solved in closed form*
D. $-3 \pm (24)^{0.5}/6$
E. None of the above

Item A is the *integral* of this equation. Item D is the quadratic formula solution to the roots of the equation.

4. Sketch the relationship between s and t where $s = \exp(-t/2)$:



5. What is the inverse of this matrix:

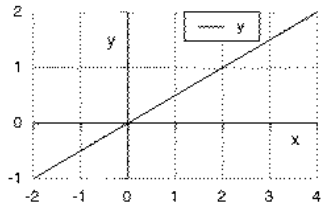
$$\begin{bmatrix} 1 & 4 \\ -1 & 2 \end{bmatrix}?$$

$$\begin{bmatrix} 1/3 & -2/3 \\ 1/6 & 1/6 \end{bmatrix}$$

6. Integrate to solve for y:

$y = \int_{x=-1}^{3} \frac{x}{2} dx$, where $\int y dx = 0$ when x=0.

$y =$ 2



$$y = \left[\frac{x}{4}^2\right]_{x=-1}^{x=3} + C$$

$$= \frac{9-1}{4} + C$$

$$= 2 + C.$$

C is equal to zero $\int y dx = 0$ when x=0.

7. In a random sample of the height of UCLA students, the following data were obtained:

Height (in.)	74	71	67	69	71	70	65	67	71	68	69	66	62	66	68	62	65	62	63	64
Gender	M	M	M	M	M	M	M	M	M	M	M	M	F	F	F	F	F	F	F	F

7.1 What is the modal height of the males in this sample? 71

The mode is the most frequently occurring value.

7.2 What is the difference in mean height between males and females? 5

The mean (average) height of the males is the sum of all of their heights (828), divided by the number of males (12) =69

For the females the sum of the heights is 512 and number is 8, so the mean is 64. The difference in means is 5.

7.3 Which of the following should be used to test if the average height of UCLA males and females are significantly different (at p < 0.01)? *circle all that are correct*

A. Increase the number of females in the sample by eight, then perform a t-test on the means.

B. Continue collecting data at UCLA until the probability of a two-tailed t-statistic comparing the heights of males and females is less than 0.01.

C. Collect the height data from all males and females at UCLA, then use a t-test to determine if the heights differ at the assigned probability level.

D. Collect height data from an age matched population from the surrounding community.

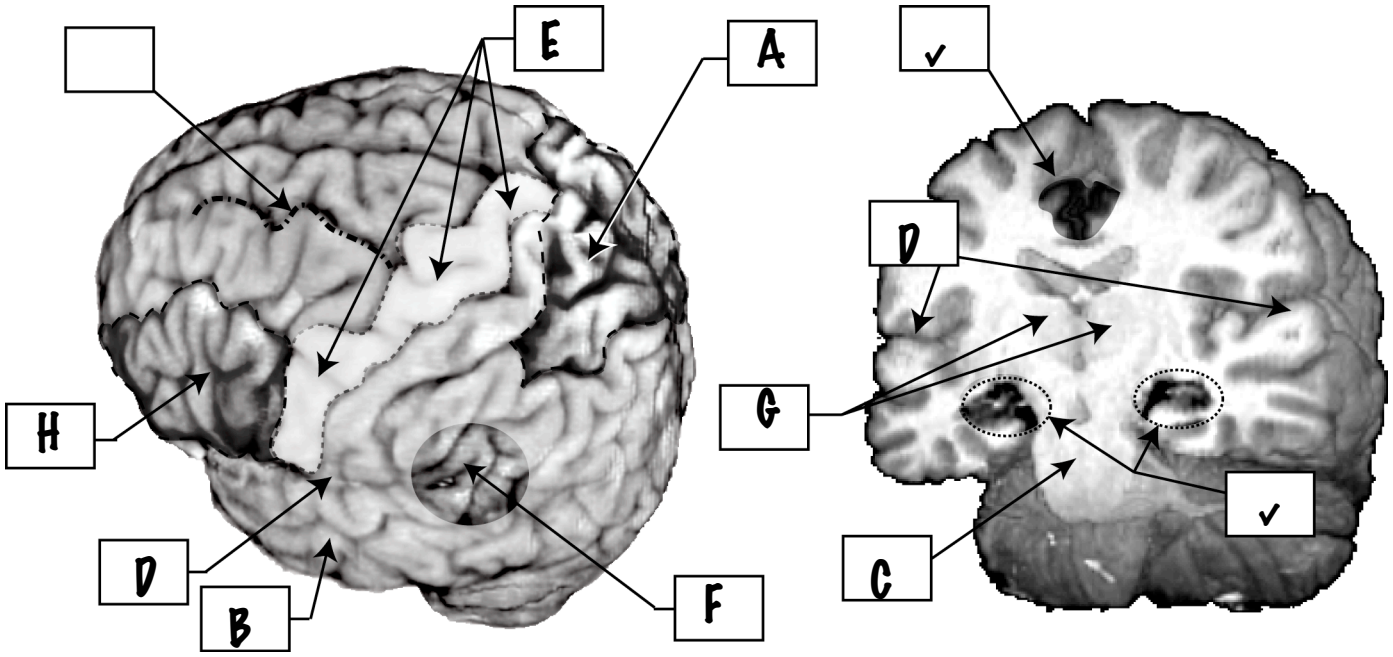
E. Add to the sample until there are exactly 100 males and 100 females, and determine if the average heights differ by more than 1 inch.

F. None of the above.

This is probably the most subtle question of the quiz. To do a test on the difference in mean it is NOT necessary to have an equal number of males and females (A). Solution B is a surprisingly common fallacy. It can be shown that if N (the number of samples) is made large enough, and there is variation in the sample value (height), it is possible to find "significant" difference at any value of probability. We will see that this is a problem in functional imaging of the brain. I would accept item C as a correct answer, but it is not efficient. It is possible to estimate the sample size needed to test at a particular significance level using a "power analysis". The concept is to assess the variability in a small sample, such as this one, and to use it to estimate the number of additional samples needed to test at the hypothesis. Item D refers to the generalizability of the data. To make inferences about UCLA students, you should test UCLA students. To make inferences about e.g., all people in Westwood, your sample population should include a random group of people in that community. We will see much more of this. Finally, item E is simply a red herring.

8. A.) Match the anatomical terms to the indicated brain regions; place the letter in the corresponding box. *N.B.*, not all boxes are named, and some names match multiple boxes.
B.) Place a check mark √ in the boxes of regions that are part of the limbic system.

A. Superior Parietal Lobule
B. Middle temporal gyrus
C. Pons
D. A1 – primary auditory cortex
E. M1 – primary motor cortex
F. Wernicke's area
G. Thalamus
H. Inferior Frontal Gyrus



The checked regions are the cingulate gyrus (top) and hippocampus (bottom).

9. Write a short program (in any computer language) in the space below that will print the letters of a word in reverse order. For example, a sample run, with computer output shown `in this font` and user input shown ***like this*** might read:

```
Enter your word: Palindrome
Your word in reverse: emordnilaP
```

There are an infinite number of possible answers here. I program in an ancient language called, C. A good program would have error checking, etc..., but this works.

```
#include <stdio.h>
#include <string.h>
int main( void )
{
      char inString[512];
      int i;
      printf( "Enter your word: " );
      scanf( "%s", inString );
      i = strlen( inString );
      printf( "Your word in reverse: " );
      while( i>0 ) {
            printf( "%c", inString[--i] );
      }
      printf( "\n" );
      return 0;
}
```