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|  |  | Full mark is 50 marks |
| Mansoura University Biomedical Engineering Department (BME) | Faculty of Engineering | Time allowed: 120 Min |
| | | Sunday 17/01/2016 |
| | | Exam is two sheets front and back (four pages) |
| | | Assume any missing data |
| | | Include and name all steps |
| | | Start each question at a new page |

Question # 1: (20 marks) Choose the correct choice and fill it on a table on your answer sheet

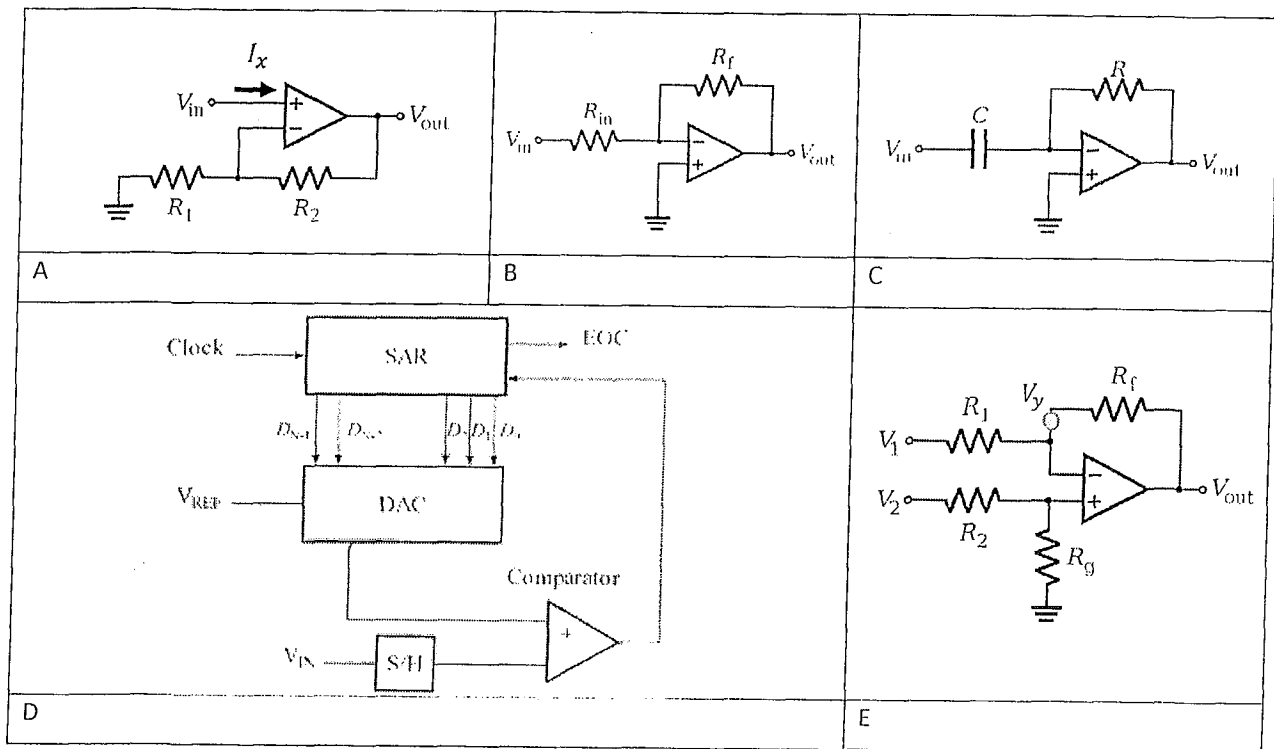
- If an excitable cell at reset state, then the cell interior (داخل الخلية) is with respect to the exterior (خارج الخلية)
 - negatively polarized
 - zero polarized
 - positively polarized
 - hyperpolarized
- If an excitable cell at its absolute refractory state is stimulated with a stimulus significantly larger than its standard excitation threshold, then....
 - an action potential is produced
 - first, the cell will be polarized
 - an action potential may be produced
 - an action potential will not be produced
- In electrocardiogram (ECG), ventricular expansion is associated with a....
 - P-wave
 - T-wave
 - QRS-wave
 - all of choices
- If the pulse rate is 80 beats per minute, then the interval between two peaks in the ECG (RR interval) issecond
 - 1.33
 - 1/80
 - 0.8
 - 0.75
- A dichroic mirror in the fluorescent microscope is used to...
 - pass the emitted photons of the desired frequencies and reflect the excited photons
 - pass both the emitted and excited photons
 - reflect the emitted photons and pass the excited photons of the desired frequencies
 - reflect both the emitted and excited photons
- In a fluorescence process, the emitted photons are of the excited photons
 - longer wavelength than
 - shorter wavelength than
 - the same wavelength as
 - the same number as
- If the quantum efficiency is 75%, and the number of excited photons is 100, then the number of emitted photons is
 - 75
 - 125
 - 100
 - 400/3
- In a fluorescence process, the difference ($E_{EX} - E_{EM}$) between the energy E_{EX} of the excited photons and the energy E_{EM} of the emitted photons is
 - positive
 - the stoke shift
 - lost as a heat signal
 - all of the given answers
- If the measurement involves tools that break the skin or physically enter the body, it is called measurement
 - in-vivo
 - in-vitro
 - invasive
 - non-invasive

10. In a biomedical instrumentation, a stimulus is ...
(a) a flash of light (b) a tone (c) an electrical signal (d) may be any of the given answers
- 11- If a given measurement is 10 volt with an accuracy of -25%, then its true value is.....
(a) -2.5 volt (b) 12.5 volt (c) 8 volt (d) 7.5 volt
- 12- If a digital thermometer has two decimal places, then its is 0.01 degree
(a) range (b) resolution (c) sensitivity (d) hysteresis
- 13- The following image modality is safe (its radiation is not harmful):
(a) X-ray (b) MRI (c) Computed Tomography (d) Nuclear imaging
- 14- Gas filled and bony structures cannot be imaged using ultrasound imaging because they ultrasound waves
(a) absorb (b) reflect (c) attenuate (d) amplify
- 15- If someone has a tumor in his/her lung, what will be the best modality to scan it
(a) X-ray (b) MRI (c) Ultrasound (d) Computed Tomography
- 16- If someone wants to image fetal (الجنين), what will be the best modality to scan it
(a) X-ray (b) MRI (c) Ultrasound (d) Nuclear imaging
- 17- The half-cell potential of an electrode is measure with respect to
(a) H_2 at $0^\circ C$ (b) H_2 at $25^\circ C$ (c) Hg at $0^\circ C$ (d) Hg at $25^\circ C$
- 18- The frequencies in the EEG (electroencephalogram) signals are the frequency of the ECG (electrocardiogram) signal
(a) lower than (b) the same as (c) larger than (d) twice as
- 19-electrodes are used to measure potential difference across cell membrane
(a) Internal micro-fabricated (b) Suction (c) Surface (d) Foam-pad
- 20- Electrogustogram (EGG) signals can be used to diagnose disorders of
(a) brain (b) heart (c) bowl (d) feet muscle

Question #2: [12 marks]

- (a) Sketch a block diagram of the basic fluorescence microscope [3 marks]
- (b) Sketch a general block diagram of a biomedical instrumentation system [3 marks]
- (c) What are the types of substances that can be circulate in the blood? What are the places to exchange these substances? [3 marks]
- (d) Draw a circuit diagram for the electrode-electrolyte interface electrical model. What is the effect of increasing the signal frequency on the circuit impedance? [3 marks]

Question # 3-a: [6 marks] In a TABLE, complete the following:



(1) In Figure A, $I_x = \dots$

(2) In Figure E, the relation between V_y and V_2 is $V_y = \dots$

(3) In Figure C, if $R=1\text{ M}\Omega$ and $C=2\text{ microF}$, then the relation between V_{out} and V_{in} is $V_{out}=\dots$

(4) In Figure B, if the circuit is operated with a power supply of ± 1 volt, and $R_{in}=0.5 R_f$, then the relation between V_{out} and V_{in} is $V_{out}=\dots$

(5) In Figure B, if the circuit is operated with a power supply of ± 1 volt, and $R_{in}=0.5 R_f$, then, the range of the V_{in} for proper operation (amplification) is

(6) As a block diagram, show an example of how the amplifier in Fig E is connected (e.g., showing the elements used as interface between human body and the amplifier) to measure the biological signal of the heart (ECG)

Question # 3-b: [6 marks] For Figure D, using 2 bit DAC and $V_{ref}=2V$. In a TABLE, complete the following:

(7) The number of clock cycles needed to convert the analog input to digital one is

(8) The resolution of the DAC isvolt

(9) To sample an electroencephalogram signal with a maximum frequency of 10 Hz, then the sampling interval of the sample and hold device is second to satisfy sampling theory (i.e., such that the signal can be recovered)

(10) If the input is 1.6 volt, then the SAR bit values after the first sample and hold clock cycle are.....

(11) If the input is 1.6 volt, then the final SAR bit values are.....

(12) If the digital output is "11" then the analog input signal range is

Question # 4 [6 marks] A medical record for 12 patients includes the data [1 2 1 3; 2 2 1 0; 1 2 0 2]. (Each patient is rated with a score from 0 to 3). The data is classified based on the score to a normal class (class_1, first class), and abnormal class (class_2, second class) using the given Matlab© code shown below:

MATLAB CODE

```

clc
close all
clear all
Input_Data=[1 2 1 3;2 2 1 0;1 2 0 2]; % The data contains 4 scores
[h w] = size(Input_Data);
p_1=[0.5 0.2 0.2 0.1];
    % probability distribution of the scores of the first class
p_2=[0.1 0.2 0.3 0.4];
    % probability distribution of the scores of the second class
class_1 = zeros(h,w); % Initialization of first class
class_2 = zeros(h,w); % Initialization of second class
for k1 = 1:1:h
    for k2 = 1:1:w
        q = Input_Data(k1,k2); % q represent the score value
        if (p_1(q+1)>=p_2(q+1))
            class_1(k1,k2) = q;
        else
            class_2(k1,k2)= q;
        end
    end
end
end

```

After the code is run, answer the following:

- (1) The variable h=
- (2) The variable w=
- (3) Based on the given values in the code of p_1 and p_2, the normal class (first class) score values are
- (4) The variable class_1=....
- (5) The variable class_2=....
- (6) In the code line: "if (p_1(q+1)>=p_2(q+1))", what is the need for increasing the score q by 1? Is it OK if we just replaced the line by "if (p_1(q)>=p_2(q))"?