Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

IV SEM B. Tech. (BME) DEGREE END-SEMESTER EXAMINATIONS APRIL 2018

SUBJECT: ELEMENTS OF BIO-INSTRUMENTATION (BME 2201)

(REVISED CREDIT SYSTEM)

Friday, 27th April 2018: 2 PM to 5 PM

TIME: 3 HOURS **MAX. MARKS: 100**

Instructions to Candidates:

Answer ALL questions

1. (a) A 0.1m long by 0.005m diameter elastic resistive transducer has a resistance of 1KΩ. (i) Calculate the resistivity of the elastically conductive material inside the transducer. (ii) Calculate the resistance of the transducer after it has been wrapped around a patient's chest having a circumference of 1.2m. Assume that the cross sectional area of the transducer remains unchanged. (3)

(b) (i) With a neat figure, explain two configurations of measuring the pulse of a subject using a photo transducer. (4)

(ii) Figure 1 shows a Wheatstone bridge with strain gauge elements for each of the four bridge arms. In the null condition, each element has a resistance of 200Ω. When a force is applied, each resistance changes by 10Ω (resistors R1 and R4 will be in compression, while R2 and R3 are in tension). Find the output voltage if a 10V excitation potential is applied to the bridge. (4)

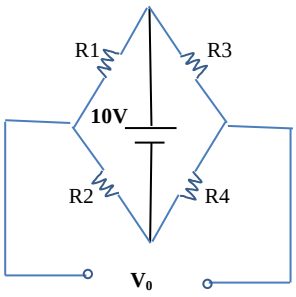

Figure 1

(iii) Differentiate thermistors from resistance temperature detectors. Which of the above mentioned temperature transducers would be preferred when a higher sensitivity is required for a measurement. (3+1)

(c) (i) Explain in detail, a type of active pressure transducer that can be used to measure dynamic pressures, and mention two specific medical applications of this transducer. (3)

(ii) Explain the working principle of a condenser microphone. (2)

2. (a) (i) With suitable reasons, explain which type of surface electrode would be ideal for recording ECG of mobile subjects. Also give the construction of that specific electrode. (3)

(ii) A blood vessel having a radius of 0.4cms has a blood velocity of 10cm/sec. A magnetic flow probe with a magnetic field of $1x10^{-5}$ weber/ m^2 surrounds the blood vessel. Calculate the voltage induced in the probe. (3)

(b) (i) What is a microelectrode? Draw and explain the equivalent circuit of a microelectrode. (1+4)

(ii) Find the capacitance of a microelectrode if the pipette radius is 0.2μm and the inner tip radius is 0.15μm [Assume Ɛ to be the dielectric constant of glass]. How does the value of capacitance and resistance affect the performance of the microelectrode. (2+1)

(c) (i) What is meant by 'driven right leg lead'? What is the purpose of this connection in the ECG machine? (2)

(ii) Explain the origin, frequency and duration of different heart sounds. (4)

3. (a) (i) Draw the energy-level diagram and explain the laser set-up of a molecular gas laser. Give two medical applications of this laser. (2+4+2)

(ii) In a certain defibrillator, a constant voltage of 1800V is observed across the electrodes for 5msec, and then the voltage drops to 0V. The delivered energy is 200J. Compute the energy delivered when the constant voltage (4)

(i) Drops to 900V and the duration of the pulse remains 5msec.

(ii)Drops to 900V and the duration of the pulse is 10msec.

(b) (i) What is 'Doppler effect'? Explain in detail, the non-invasive technique of measuring blood flow velocity. (1+4)

(ii) Determine the angle θ, between the direction of ultrasound propagation and that of the measured blood flow, if the ratio between the Doppler frequency and the transmission frequency is 10^{-5} and the velocity of blood cells is 0.15m/sec. In general, which angle θ would provide the largest Doppler frequency? Assume that the velocity of sound in blood is equal to 1500m/s. (3)

4. (a) (i) Compare 'ink-jet' with 'pen-and-ink' writing systems, and describe the optical PMMC writing systems in detail. (3+5)

(ii) An ECG recorder is calibrated so that the vertical deflection factor is 1V/cm, and an external pre-amplifier has a gain of 1000. How much deflection would occur if a 4mV signal is applied to the input. (2)

(b) (i) Describe the key factors to be considered in the design of a defibrillator electrode. (2)

(ii) Calculate the energy stored in a 16μF capacitor that is charged to a potential of 5000V dc. (2)

(iii) Which type of defibrillator would be ideal to treat the condition of tachycardia. Justify your answer and explain the specific type of defibrillator in detail. (1+1+4)

5. (a) (i) What is meant by 'let-go' current? What is the magnitude of this current? (2)

(ii) What are the precautions required to minimize electric-shock hazards? Explain any two methods of electrical accident prevention. (4+4)

(b) (i) Compute the energy per pulse, when the pacemaker pulse width is 0.5msec, the circuit current drain is 1 μA, the heart-electrode resistance is 200Ω and the peak voltage is 1.8V. (Given: heart rate is 70bpm). Also, compute the battery life time (in years), when the battery energy is 6480J. (4)

(ii) Differentiate 'VVI' from 'VVIR' pacemakers. Explain the 'VVI' pacemaker in detail. (1+5)