Name:

Enrolment No:

UPES

End Semester Examination, May 2025

Course: Tissue Engineering **Semester: VIII**

Program: B.Tech Biotechnology **Time : 03 hrs.**

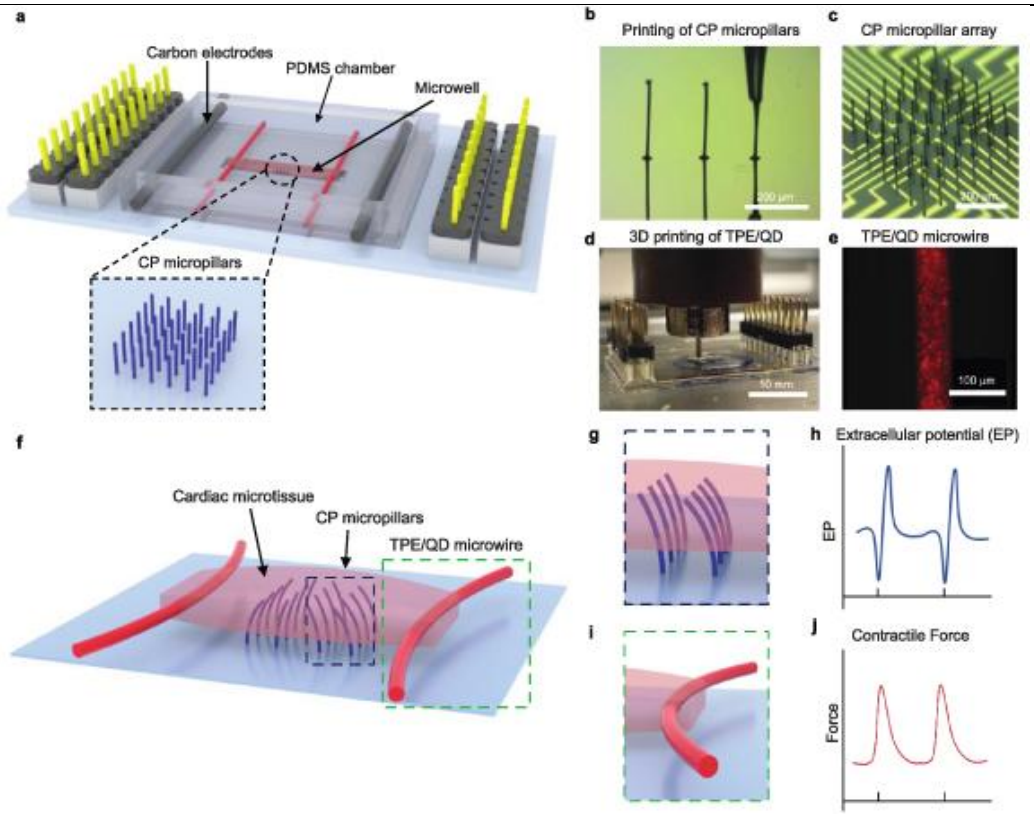
Course Code: HSBT4012 **Max. Marks: 100**

Instructions: Attempt all questions

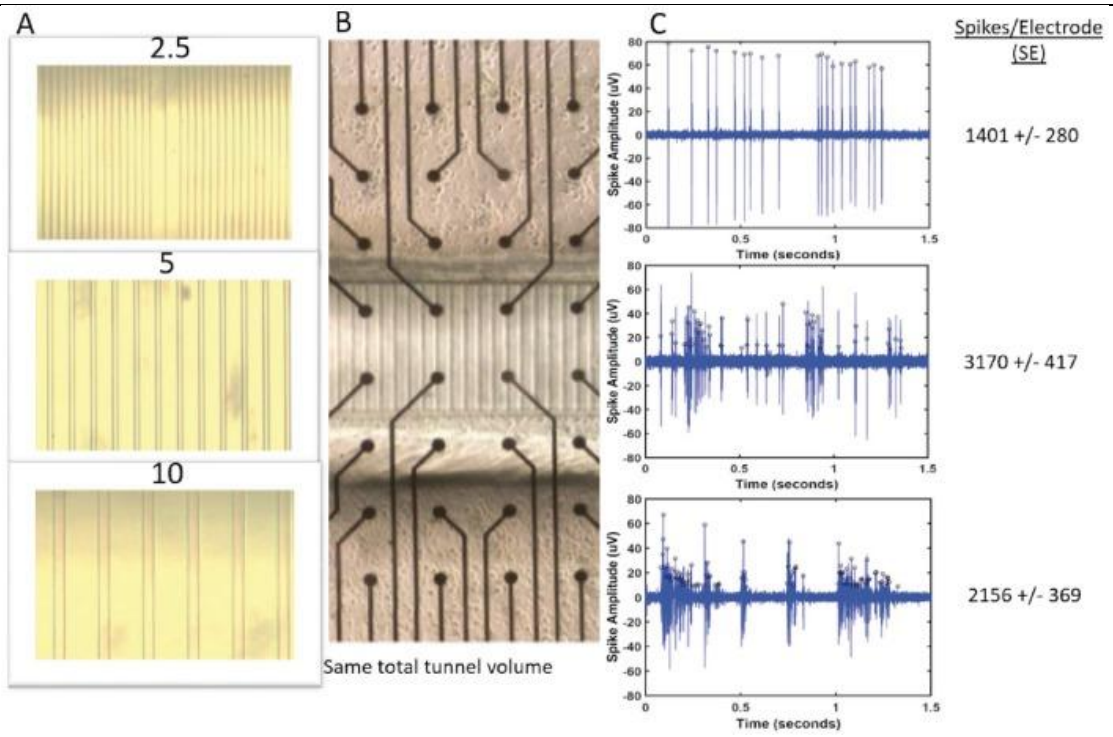
S. No.	Section A **Short answer questions/ MCQ/T&F (20Qx1.5M= 30 Marks)**	Marks	COs
Q 1	Which of the following processes primarily governs the movement of cells during embryonic development and tissue repair? A) Apoptosis B) Cell migration C) Cell adhesion D) Differentiation	**1.5**	**CO1**
Q 2	Which type of cell fate decision leads to a daughter cell with a distinct identity from its parent cell? A) Proliferation B) Transdifferentiation C) Self-renewal D) Differentiation	**1.5**	**CO1**
Q 3	In tissue engineering, mesenchymal stem cells (MSCs) are primarily used for regenerating which of the following? A) Nervous tissue B) Connective tissue C) Epithelial tissue D) Cardiac tissue	**1.5**	**CO1**
Q 4	Which of the following is NOT a key component of tissue architecture? A) Extracellular matrix B) Functional subunits C) Genetic code D) Vascularity	**1.5**	**CO1**
Q 5	Which type of cells can differentiate into multiple lineages?	**1.5**	**CO1**
Q 6	Which cell type lines the blood vessels?	**1.5**	**CO2**
Q 7	Which type of tissue is characterized by low vascularity and high extracellular matrix content? A) Neural	**1.5**	**CO2**

	B) Connective C) Epithelial D) Muscle		
Q 8	Homeostasis in highly proliferative tissues is tightly regulated through: A) Random cell division B) Controlled apoptosis and cell renewal C) Angiogenesis only D) Inflammatory cytokines	**1.5**	**CO2**
Q 9	Which tissue type is avascular and rich in ECM?	**1.5**	**CO2**
Q 10	Which of the following best represents the order of tissue repair? A) Inflammation → Angiogenesis → Remodeling → Proliferation B) Inflammation → Proliferation → Angiogenesis → Remodeling C) Inflammation → Proliferation → Remodeling D) Proliferation → Inflammation → Remodeling	**1.5**	**CO2**
Q 11	Write the full form of MEA.	**1.5**	**CO3**
Q 12	1 m = _____ μm.	**1.5**	**CO3**
Q 13	Name the first multichambered micro-tunnel device used for cell culture.	**1.5**	**CO3**
Q 14	Name any one component of skeletal muscle extracellular matrix.	**1.5**	**CO3**
Q 15	Name the longest process of a neuron.	**1.5**	**CO3**
Q 16	What is the use of poly D lysine cell culture.	**1.5**	**CO4**
Q 17	Describe the function of papain.	**1.5**	**CO4**
Q 18	Contact angle of oil on a glass will be a. 0˚ b. <90˚ c. >90˚ d. Cannot be predicted	**1.5**	**CO4**
Q 19	Differentiate between cardiac and neuronal cells based on their function.	**1.5**	**CO4**
Q 20	Describe the use of Calcein-AM in cell culture.	**1.5**	**CO4**
Section B **(4Qx5M=20 Marks)**			
Q 1	List the current and potential therapeutic applications of tissue engineering.	**5**	**CO1**
Q 2	Discuss the concept of "tissue homeostasis" in highly proliferative tissues. How is this balance maintained?	**5**	**CO2**
Q 3	The table shows the fatigue index values for the primary skeletal muscle myotubes grown on DETA-Elastin-Collagen substrate. a. Define fatigue index (1 mark)	**5**	**CO3**

	Please study the table carefully and comment on the change in the fatigue index over time. (4 marks) <table><tr><td></td><td colspan="4">Fatigue index</td></tr><tr><td>Stimulation Frequency</td><td>Day 14</td><td>Day 17</td><td>Day 21</td><td>Day 28</td></tr><tr><td>1Hz</td><td>0.314 ± 0.045</td><td>0.284 ± 0.040</td><td>0.272 ± 0.045</td><td>0.229 ± 0.080</td></tr><tr><td>2 Hz</td><td>0.259 ± 0.048</td><td>0.190 ± 0.016</td><td>0.168 ± 0.041</td><td>0.140 ± 0.022</td></tr></table>		
Q 4	Please study the table carefully and answer the following questions <table><tr><th>Surface</th><th>DETA</th><th>DETA-Elastin-HSPG (DEH)</th></tr><tr><td>Contact angle (average ± standard error) in degrees</td><td>41.70 ± 0.84</td><td>33.80 ± 2.08</td></tr><tr><td>Advancing angle (average ± standard error) in degrees</td><td>56.77 ± 1.03</td><td>41.97 ± 0.85</td></tr><tr><td>Receding angle (average ± standard error) in degrees</td><td>29.97 ± 0.83</td><td>21.25 ± 0.76</td></tr><tr><td>Hysteresis (average ± standard error)</td><td>0.32 ± 0.011</td><td>0.19 ± 0.006</td></tr></table> a. Comment on the hydrophilicity or hydrophobicity of DETA and DETA-Elastin-HSPG surfaces. (3 marks) b. Which of these two surfaces will you choose for cell culture. Explain why (2 marks)	**5**	**CO4**
	Section C **(2Qx15M=30 Marks)**		
Q 1	**Case study:** A 55-year-old diabetic patient presents with a chronic, non-healing wound on the lower leg. The wound has poor vascularization and delayed epithelialization. Physicians are exploring tissue-engineered therapies involving skin substitutes, growth factors, and cellular scaffolds. Based on the case study, answer the following questions:	**15**	**CO3**

	1. Explain why diabetic patients typically experience delayed wound healing. (4 marks) 2. Discuss the role of angiogenesis in wound healing and why it is impaired in this case. (4 marks) 3. Suggest a tissue-engineered approach to accelerate healing in this case. Include the type of cells and materials that could be used. (5 marks) 4. How can growth factors like VEGF be utilized in this situation to promote recovery? (2 marks)		
Q 2	 A heart-on-a-chip platform integrating stimulating and recording electrodes with force sensors. (a) Schematic illustration of the device consisting of a soft conductive polymer (CP) micropillar array (blue) for extracellular potential recording, TPE/QD nanocomposite microwire (red) for force sensing, a microwell for seeding cardiac tissue and carbon electrodes (dark grey) for electrical stimulation of cardiac tissue. (b) An optical image showing direct writing of a CP micropillar (scale bar, 100 μm). (c) A microscopy image of the CP micropillar array (scale bar, 200 μm). (d) An optical image illustrating 3D printing of TPE/QD nanocomposites on both sides of the microwell (scale bar, 10 mm). (e) A representative fluorescent image of the nanocomposite microwire (scale bar, 100 μm). (f) Schematic illustration of the cardiac microtissue generated from the device, showing the CP micropillars embedded in the tissue and the TPE/QD microwires deflected by the cardiac microtissue. (g) Schematic illustration of the 3D CP micropillars in the device and (h) schematic illustration of the extracellular	**15**	**CO4**

	potential detected by the CP micropillars. (i) Schematic illustration of the TPE/QD microwire used as a force sensor. Microwire bending due to pre-tension of the cardiac microtissue. (j) Schematic illustration of the contractile force measured by fluorescent tracing of the microwires. Based on the above figure answer the following questions: a. Describe the device design shown in figure A. (5 marks) b. Describe the function of micropillar in the cardiac function assessment. Justify how the integration of micropillars enhances signal acquisition as compared to contemporary devices for cardiac systems. (2+2 marks) c. Explain the use of quantum dots in this system. (2 marks) d. Explain how the displacement sensor measures the contraction forces. (4 marks)		
Section D **(2Qx10M=20 Marks)**			
Q 1	A) Explain the organization and dynamics of tissues with reference to their components and types. (5 marks) **B)** Provide a detailed account of epithelial and connective tissues, their structural features, and functional importance in tissue engineering. (5 marks)	**10**	**CO3**
Q 2	Micro-tunnel and MEA assembly with burst examples. (A) Tunnel widths of either 2.5, 5 or 10 μm were created in PDMS devices separating two chambers. The number of tunnels was adjusted for equal volume. (B) The devices were aligned over the 2 middle rows of an MEA (inter-electrode spacing 200 μm). (C) Bursts in different tunnel widths 2.5, 5 and 10 μm, with spike peaks represented by black circles. Mean and S.E. of spikes per electrode are shown. Note more uniform heights of higher amplitude in the 2.5 μm wide tunnels.	**10**	**CO4**



Based on the above figure, answer the following questions:

a. Justify why more uniform heights of higher amplitude are observed in the 2.5 µm wide tunnels. (3 marks)
b. "To keep the tunnel volume constant, the 51 tunnels of 10 µm was doubled and quadrupled for the 5 and 2.5 µm wide tunnels." Why tunnel volume needs to be kept constant? How was tunnel volume maintained constant here. (2 + 2 = 4 marks)
c. Describe how the setup in figure B can be used to study the direction of movement of signal between neurons in two chambers (3 marks)