

**SOFT METHODS IN MICROSTRUCTURE FABRICATION  
(CHEN 4127)**

**Time Allotted : 3 hrs**

**Full Marks : 70**

*Figures out of the right margin indicate full marks.*

*Candidates are required to answer Group A and  
any 5 (five) from Group B to E, taking at least one from each group.*

*Candidates are required to give answer in their own words as far as practicable.*

**Group - A  
(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) The first commercial example of a microfluidic device  
(a) Lab on chip device (b) inkjet printer  
(c) injection syringe (d) none of above
- (ii) One component of a microfluidic device is  
(a) syringe pump (b) droplet  
(c) fluidic interconnect (d) microreservoir
- (iii) The material most commonly used for soft lithography can be classified as \_\_\_\_\_  
(a) a thermoplast (b) an elastomer  
(c) a photopolymer (d) a metal
- (iv) Which of the following statement is true \_\_\_\_\_  
(a) SU8 is an elastomer (b) PDMS is a thermoplast  
(c) SU8 is light sensitive (d) PDMS is light sensitive
- (v) The technique most commonly used in paper microfluidic device \_\_\_\_\_  
(a) patterning to create water resistant channels  
(b) creating 3d channels for fluidic interconnects  
(c) building 2d structures with paper as substrate  
(d) using it as an absorber to store fluids
- (vi) CMC value decrease with \_\_\_\_\_ during polypropylene oxide-polyethylene oxide block polymerization.  
(a) an increase in the polyethylene oxide chain length  
(b) a decrease in the polyethylene oxide chain length  
(c) an increase in the polypropylene oxide chain length  
(d) a decrease in the polypropylene oxide chain length



- (c) What properties of PDMS make it the preferred polymer in soft lithography?  
[[CO2](Remember/LOCQ)]  
**3 + 6 + 3 = 12**
5. (a) What is dry etching? Draw a schematic of the equipment explaining the process by which dry etching is performed. [[CO2] (Understand/LOCQ)]
- (b) With relevant diagrams, explain the difference between positive and negative tone photoresist. Give examples of each. [[CO2] (Apply/LOCQ)]  
**6 + 6 = 12**

### Group - D

6. (a) In a core-shell hydrogel preparation what is the purpose of entrapping "bait" within the core of the hydrogel? If a small protein (pI=6) needs to be concentrated from a solution with pH=4 using core-shell hydrogel, what will be the nature of the "bait" one must consider? For the same protein if the recovery will be made from a solution with pH=9, what will be nature of the "bait"?  
[[CO3] (Understanding/LOCQ)]
- (b) Drug for cancer treatment is entrapped within a hydrogel made up of 'A' (pKa~6) as one of the hydrogel components. *In-vitro* study shows that drug is more prone to be released at pH=2 compared to pH=9. What can we conclude about the surface charge of the hydrogel? If the intracellular matrix shows alkaline nature, what do you feel about the efficacy of the drug on tumor cell? Provide proper justification on your conclusion. [[CO3] (Evaluate/HOCQ)]
- (c) Develop a surfactant system (HLB 10) after combining two surfactants A (HLB 17) and B (HLB 3) to use it for the hydrogel preparation using emulsion polymerization. [[CO3](Analyze/IOCQ)]  
**(2 + 2 + 2) + (2 + 2) + 2 = 12**
7. (a) During hydrogel preparation using block copolymerization unimers  $A_n$  and  $B_m$  are there in the system at a constant mass ratio 2:1, when  $n=50$  and  $m=100$ . The aggregation or CMC value is 1 mM. What happens to the CMC (more or less than 1 mM), when  $n=100$  and  $m=50$ ? Justify your answer with appropriate reasoning. Given: Mass ratio=2:1,  $A_n$  is hydrophilic and  $B_m$  is hydrophobic.  
[[CO3] (Analyze/IOCQ)]
- (b) During the preparation of hydrogel using 0.17g of alginate and 2 g of PAAM, it was seen that the final percentage of alginate is 6.5% (w/w) based on the total amount of alginate, PAMM, Potassium persulfate and bisacrylamide in the product sample. Two types of samples were prepared, where sample A was prepared in 0.2 ml of water and sample B was prepared in 7 ml of water. Which of the sample will appear as hydrogel and elaborate the reason for your decision? Density of water = 1 g/ml. [[CO3] (Evaluate/HOCQ)]

- (c) “Precipitation polymerization process for hydrogel preparation increases the purity of the hydrogel compared to emulsion polymerization” – Justify the appropriateness of the statement. [(CO3) (Analyze/IOCQ)]  
**(2 + 4) + (3 + 1) + 2 = 12**

**Group - E**

8. (a) Describe the process of gelation with a sketch. [(CO4) (Remember/LOCQ)]  
 (b) What are the types of bonds present in a gel matrix? What types of structures that have been developed with a gel matrix? [(CO4) (Understand/LOCQ)]  
**6 + 6 = 12**
9. (a) Explain the fundamental principle of LbL assemblies. [(CO4)(Remember/LOCQ)]  
 (b) How is LbL assemblies different from films draw with LB process?  
 [(CO4) (Understand/LOCQ)]  
**6 + 6 = 12**

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	70.84%	20.83%	8.33%

**Course Outcome (CO):**

After the completion of the course students will be able to:

1. Demonstrate the concept of microscopic system.
2. Identify various applications and fabrication methods of microfluidics.
3. Illustrate the basics of hydrogels and its fabrication technologies.
4. Summarise the concept of organometallic structure and compare various methods of self-assembly of organic molecules in nanostructures.

\*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question;  
 HOCQ: Higher Order Cognitive Question

Department & Section	Submission Link
BT	<a href="https://classroom.google.com/c/NDA1MzEwNzgxNjU4/a/NDU0OTIzMk3MzM2/details">https://classroom.google.com/c/NDA1MzEwNzgxNjU4/a/NDU0OTIzMk3MzM2/details</a>