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NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA
(An Autonomous Institute Affiliated to AKTU, Lucknow)

B.Tech

SEM: VI - THEORY EXAMINATION (2025 - 2026)

Subject: Metabolic Engineering

Time: 3 Hours

Max. Marks: 100

General Instructions:

IMP: Verify that you have received the question paper with the correct course, code, branch etc.

1. This Question paper comprises of **three Sections -A, B, & C**. It consists of Multiple Choice Questions (MCQ's) & Subjective type questions.

2. Maximum marks for each question are indicated on right -hand side of each question.

3. Illustrate your answers with neat sketches wherever necessary.

4. Assume suitable data if necessary.

5. Preferably, write the answers in sequential order.

6. No sheet should be left blank. Any written material after a blank sheet will not be evaluated/checked.

SECTION-A

20

1. Attempt all parts:-

- (1.1) Which of the following techniques is commonly used in metabolic engineering to modify genetic material? (CO1, K2) 1
- (a) Polymerase chain reaction (PCR)
- (b) Western blotting
- (c) Enzyme-linked immunosorbent assay (ELISA)
- (d) Nuclear magnetic resonance (NMR)
- (1.2) Which of the following is NOT a potential application of metabolic engineering? (CO1, K2) 1
- (a) Designing microbial factories for sustainable chemical production
- (b) Developing new therapies for genetic diseases
- (c) Creating bioengineered materials
- (d) Enhancing food preservation techniques
- (1.3) Constraint based Reconstruction and Analysis involves ____ (CO2, K2) 1
- (a) Flux variability analysis
- (b) Linear programming
- (c) Quadratic programming
- (d) All of the above
- (1.4) At steady state (CO2, K2) 1
- (a) $S.v=0$
- (b) $S.v=b$
- (c) $S.v= v^2$
- (d) None of the above

- (1.5) _____ represents fluxes and metabolites in the form of matrix (CO3, K2) 1
- Stoichiometric matrix
 - Elemental matrix
 - Electron matrix
 - None of the above
- (1.6) Carbon tracking can be done using _____ (CO3, K2) 1
- NMR
 - GC-MS
 - Both
 - None
- (1.7) What is the symbol used to evaluate the transpose of a vector? (CO4, K2) 1
- “ ^ ”
 - “ * ”
 - “ ‘ ”
 - “ ~ ”
- (1.8) Write the output of OR gate if A and B are the inputs? (CO4, K2) 1
- AB
 - A+B
 - A'+B'
 - (A+B)'
- (1.9) The primary precursor molecule for amino acid biosynthesis is: (CO5, K2) 1
- Glucose
 - Acetyl CoA
 - Pyruvate
 - Ribose-6-phosphate
- (1.10) Which of the following is a potential benefit of pathway engineering? (CO5, K2) 1
- Increased cellular growth rate
 - Decreased production of waste product
 - Improved cell membrane stability
 - Increased tolerance to environmental stress

2. Attempt all parts:-

- (2.1) What is the role of enzymes in metabolism? (CO1, K2) 2
- (2.2) What do you understand by C13 MFA recursive function? (CO2, K2) 2
- (2.3) Differentiate between isotopomers and isotopologues. (CO3, K2) 2
- (2.4) Discuss at least three commands of MATLAB interface. (CO4, K1) 2
- (2.5) Name few metabolic engineering strategies employed in cell factories (CO5, K2) 2

SECTION-B

30

Answer any one of the following:-

- (3.1) How do phospholipids assemble to form a cell membrane, and why is this assembly crucial for cell survival? (CO1, K3) 6

- (3.2) How do phospholipids assemble to form a cell membrane, and why is this assembly crucial for cell survival? How are these reactions different from polymerization reactions (CO1, K3) 6

Answer any one of the following:-

- (3.3) Discuss the concept of reaction and compound maps and how are these different from one another? (CO2, K2) 6
- (3.4) How would you use the concept of metabolic boundaries to explain the importance of determination of metabolic fluxes? (CO2, K3) 6

Answer any one of the following:-

- (3.5) How is the balancing of chemical reactions is done using stoichiometric matrix? (CO3, K3) 6
- (3.6) What are some of the limitations of C13 MFA in analyzing complex metabolic networks? (CO3, K2) 6

Answer any one of the following:-

- (3.7) Describe the commands used for plotting a helix in 3D. (CO4, K3) 6
- (3.8) Describe with the help of commands, how MATLAB can be used as calculator? (CO4, K3) 6

Answer any one of the following:-

- (3.9) What are the few metabolic engineering applications? (CO5, K3) 6
- (3.10) Describe the process of strain selection and improvement in the context of biotechnology and industrial applications.(CO5, K3) 6

SECTION-C 50

4. Answer any one of the following:-

- (4.1) What do you understand by Jacob Monod model? How is it used for lactose metabolism? (CO1, K3) 10
- (4.2) Discuss in detail permeability and transport of metabolites? (CO1, K2) 10

5. Answer any one of the following:-

- (5.1) Discuss various characteristics of Stoichiometric matrix. How can you construct a stoichiometric matrix employing internal and external reactions? (CO2, K3) 10
- (5.2) What is flux balance analysis? How does FBA use flux variability to predict metabolic fluxes? (CO2, K3) 10

6. Answer any one of the following:-

- (6.1) Differentiate between Purge and trap GC-MS and analyze the detection of different elements in GC-MS is performed. (CO3, K4) 10
- (6.2) Discuss in detail about the instrumentation and principles of NMR spectroscopy. What are the various applications of NMR spectroscopy? (CO3, K3) 10

7. Answer any one of the following:-

- (7.1) Elaborate how MATLAB can be used as a calculator (CO4, K3) 10
- (7.2) Analyze how ROOM is different from MOMA? Elaborate the advantages and limitation sof both the algorithms (CO4, K3) 10

8. Answer any one of the following:-

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|-------|---|----|
| (8.1) | Apply pathway engineering strategies to increase the yield of recombinant insulin in <i>E. coli</i> . (CO5, K3) | 10 |
| (8.2) | Demonstrate the use of bioconversion in pharmaceutical compound synthesis. (CO5, K3) | 10 |

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