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Printed Page:-4 **Subject Code:- BBT0602**

Roll. No:

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) How does isoenzyme regulation differ from other forms of enzyme regulation? (CO1, K2) 1

(a) Isoenzymes catalyze different reactions
(b) Isoenzymes have different kinetic properties but catalyze the same reaction
(c) Isoenzymes are regulated by temperature
(d) Isoenzymes are unaffected by substrate concentration

(1.2) Which of the following is an example of concerted feedback regulation? (CO1, K2) 1

(a) Multiple enzymes being inhibited by the same product
(b) Single enzyme inhibition by multiple products
(c) Product inhibition via multiple feedback loops
(d) Regulation by isoenzymes

(1.3) Which of the following is an example of an isotopic steady-state method? (CO2, K2) 1

(a) 13C labeling
(b) NMR spectroscopy
(c) Dynamic flux balance analysis
(d) Enzyme activity assays

(1.4) Which computational approach is often used in metabolic flux analysis? (CO2, K2) 1

(a) Graph-based methods
(b) Statistical inference
(c) Machine learning models
(d) Differential equations

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(1.5) Which of the following is a key challenge in 13C metabolic flux analysis? (CO3, K2) 1

(a) Finding suitable enzymes for labeling
(b) Accurately determining the steady-state condition
(c) Incorporating radioactive isotopes
(d) Detecting mutations in the metabolic pathways

(1.6) ROOM stands for.....(CO3, K2) 1

(a) Regulatory on/off minimization
(b) Regulation on/off minimization
(c) Revised on/off minimization
(d) Regulatory on/off maxmization

(1.7) Which of the following best describes the role of synthetic biology in metabolic engineering? (CO4, K2) 1

(a) It reduces the need for metabolic flux analysis
(b) It designs and builds new biological systems
(c) It increases the efficiency of fermentation
(d) It improves the accuracy of gene editing

(1.8) E represents (CO4, K1) 1

(a) Elemental matrix
(b) stoichiomatrix
(c) Both
(d) None

(1.9) What is a significant application of metabolic flux analysis in biotechnology? (CO5, K1) 1

(a) Studying protein interactions
(b) Optimizing microbial fermentation
(c) Sequencing genes
(d) Analyzing gene expression

(1.10) What is one of the challenges in metabolic engineering? (CO5, K1) 1

(a) Lack of suitable organisms
(b) Overproduction of metabolites
(c) Limited pathway reconstruction methods
(d) Difficulty in enzyme identification

2. Attempt all parts:-

(2.1) How can metabolic engineering be used to improve the yield of biofuels or amino acids?(CO1, K2) 2

(2.2) What are the different ways of labelling the metabolite with (CO2, K1) 2

(2.3) Explain the importance of dynamic flux balance analysis (DFBA) in microbial metabolism.(CO3, K2) 2

(2.4) What are degenerate solutions? (CO4, K2) 2

(2.5) Write bioconversion applications across different industrial sectors. (CO5, K2) 2

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SECTION-B 30

Answer any one of the following:-

(3.1) Investigate the interplay between enzyme regulation and metabolite transport in branched pathways. (CO1, K3) 6

(3.2) Explain the application of synthetic biology tools in modifying metabolic pathways for pharmaceutical compound production. (CO1, K2) 6

Answer any one of the following:-

(3.3) Explain the concept of dynamic metabolic flux analysis (13C MFA) and its applications in studying metabolism. (CO2, K2) 6

(3.4) What are the various attributes of stoichiometric matrix? (CO2, K2) 6

Answer any one of the following:-

(3.5) Discuss the steps involved in isotope labeling experiments for metabolic flux analysis. (CO3, K2) 6

(3.6) Write the commands utilized in MATLAB for drawing a helix. (CO3, K2) 6

Answer any one of the following:-

(3.7) Discuss the significance of metabolic flux analysis in identifying rate-limiting steps in metabolic networks and its impact on metabolic engineering.(CO4, K2) 6

(3.8) How is the partitioning of flux vectors be used to predict internal and external metabolic fluxes? (CO4, K2) 6

Answer any one of the following:-

(3.9) Explain the differences between biosynthetic and fueling reactions? (CO5, K2) 6

(3.10) What are polymerization and assembly reactions? (CO5, K2) 6

SECTION-C 50

4. Answer any one of the following:-

(4.1) Apply strategies to modify microbial strains for overproduction of taxol. (CO1, K3) 10

(4.2) How lignocelluclosic residues are promising substrates for biofuel production? Describe the conversion of lignocellulosic residues to biofuels.(CO5) (CO1, K2) 10

5. Answer any one of the following:-

(5.1) Discuss the concept of heat balance in metabolic reactions. Why is it important in biotechnological applications? (CO2, K2) 10

(5.2) How is data analysis performed in NMR spectroscopy? What are some common applications of NMR spectroscopy in chemistry and biochemistry? (CO2, K2) 10

6. Answer any one of the following:-

(6.1) Describe the process of building a stoichiometric matrix for metabolic flux analysis. How does it help in understanding the metabolic network? (CO3, K2) 10

(6.2) Explain how isotopic steady-state methods are used in metabolic flux analysis. Provide examples of their applications in metabolic engineering. (CO3, K2) 10

7. Answer any one of the following:-

(7.1) Explain how GC-MS and NMR can be integrated to provide complementary data for metabolic flux analysis. (CO4, K2) 10

(7.2) Discuss various attributes of Stoichiometric matrix. How can you formulate a 10

stoichiometric matrix utilizing internal and external reactions? (CO4, K2)

8. Answer any <u>one</u> of the following:-

(8.1) *Candida utilis* cells convert glucose to CO_2 and H_2O during growth. The cell composition is CH 1.84 O 0.55 N 0.2 plus 5% ash. Yield of biomass from substrate is 0.5 g^{-1}. Ammonia is used as nitrogen source. (a) What is the oxygen demand with growth compared to that without? (b) *C. utilis* is also able to grow with ethanol as substrate, producing cells of the same composition as above. On a mass basis, how does the maximum possible biomass yield from ethanol compare with the maximum possible yield from glucose?(CO5, K4) 10

(8.2) Explain with the help of application, the black box model. (CO5, K2) 10