

Code No.

**M – 2934**

## Ph.D. ENTRANCE EXAMINATION, DECEMBER 2021

Time : 3 Hours

Max. Marks : 100

### **Instructions :**

- 1) Answer **any ten** questions each from Part **A** and **B**.
- 2) Each question carries **five** marks.
- 3) Candidates should clearly indicate the **Part, Question Number** and **Question Booklet Code** in the answer booklet.
- 4) The candidates are **permitted** to answer questions **only** from the subject that comes under the **faculty** in which he/she seeks registration as indicated in the **application** form.

Name of candidate

Register Number

Answer Booklet Code

Signature of Candidate

Signature of Invigilator

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## FACULTY OF APPLIED SCIENCES AND TECHNOLOGY

1. Biotechnology
2. Computational Biology and Bioinformatics
3. Computer Science
4. Environmental Sciences
5. Futures Studies/Technology Management
6. Microbiology
7. Nanoscience and Nanotechnology
8. Optoelectronics

**1. Biotechnology**

**Part – A**

**Research Methodology**

I. Answer any **ten** questions :

1. Briefly discuss the Sanger's method of DNA sequencing.
2. What is Maxam and Gilbert method of DNA sequencing?
3. Explain Next Generation sequencing.
4. Explain ligase chain reaction briefly.
5. Discuss briefly the statistical methods involving response surface methodology in bioprocess research.
6. What is plagiarism? What is plagiarism by self?
7. Briefly explain the theory of constructing a dendrogram.
8. What is hypothesis for research? What are the essential features of a research article?
9. Distinguish standard deviation and standard error.
10. Explain the theory of NMR imaging.
11. Explain the technique of molecular structure determination using X-Rays.
12. What is metagenomics?
13. What is a test of significance?
14. What is meta data?
15. Briefly explain the important molecular affinities employed in chromatography.

**(10 × 5 = 50 Marks)**

**Part – B**  
**Biotechnology**

II. Answer any **ten** questions :

1. What are endophytic bacteria? How useful they are?
2. How come human antibodies from transgenic animals significant in COVID-19?
3. How could you make alcohol-free beer?
4. How is CRISPR CAS13 different from CRISPR CAS9?
5. What are transgenic animal models? State briefly an example.
6. How plants may become bioreactors of proteins important for humans?
7. That is the use of surfactants in bioprocess industry, compare with its application in human system?
8. Explain aerobic fermentation. Why it is called a 'fermentation'?
9. Compare regular and irregular structures of proteins.
10. What do you understand by protein engineering?
11. Briefly explain tissue engineering.
12. Why water is used as a universal solvent?
13. What is horizontal gene transfer?
14. What is apoptosis?
15. What are SNPs and what they may lead to?

**(10 × 5 = 50 Marks)**

## 2. Computational Biology and Bioinformatics

### Part – A

#### Research Methodology

I. Answer any **ten** questions :

1. What is an impact factor for journals and why is it important?
2. How can you avoid plagiarism in research?
3. Illustrate IMRAD format for writing research paper.
4. Discuss the difference between qualitative and quantitative research
5. Explain the difference between the null hypothesis and alternative hypothesis.
6. How to make use of reference management tools in your research? List any two.
7. Explain the steps involved in research design with their importance.
8. Illustrate different types of intellectual property rights in India.
9. Explain the process of filing a patent in India.
10. Explain the significance of the h-index in a research journal.
11. Discuss open access journals. List any two open-access journal.
12. Explain the importance of review of literature in research.
13. Explain different types of peer review processes in research paper publication.
14. Discuss sampling techniques in research methodology.
15. Illustrate steps involved in the identification and formulation of a research problem.

**(10 × 5 = 50 Marks)**

## Part – B

### Computational Biology and Bioinformatics

II. Answer any **ten** questions :

1. What is computer-aided drug discovery? How it helps scientists in minimizing the biological testing efforts?
2. Demonstrate with the help of a flow diagram the generation of protein using the transcription and translation process.
3. Find the sequence alignment between the following two sequences, Locally and Globally Sequence 1: GATTCTAACTA, Sequence 2: GTTCTTCTAAC.
4. Define motif in DNA. Mention its importance in finding a conserved sequence.
5. Discuss variants of BLAST with its input and output.
6. What is the use of scoring matrices? Differentiate between PAM and BLOSUM matrices and their usage in alignment of sequences.
7. Explain multiple sequence alignment. Mention any tool for it.
8. Explain how the protein structure is determined by using experimental techniques.
9. Discuss protein interaction. How it contributes to the complexity of an organism? Also, write a short note on the protein interaction database.
10. Discuss any two NGS (Next Generation Sequencing) techniques.
11. Explain the approach of systems biology in understanding complex biological systems.
12. Explain different methods for constructing a phylogenetic tree.
13. Illustrate the procedure of homology Modelling.
14. Discuss the hierarchical levels of protein structure.
15. Explain how is the primary transcript produced by a prokaryote different from that produced by a eukaryotic cell?

**(10 × 5 = 50 Marks)**

### 3. Computer Science

#### Part – A

#### Research Methodology

- I. Answer any **ten** questions :
1. What is ethical research? Justify your answer.
  2. Explain the criteria of a good research.
  3. Research is much concerned with proper fact finding, analysis and evaluation. Do you agree with this statement? Give reasons in support of your answers.
  4. Distinguish between probability and non-probability sampling.
  5. As a researcher, what are the precautions to be taken to publish a plagiarism free report?
  6. Prepare a research plan for a topic “Health care of Diabetic Persons with Covid19”.
  7. Briefly explain the following :
    - (a) Scopus Indexed Journals
    - (b) Science Citation Index
    - (c) Journal Impact Factor
    - (d) h-Index.
  8. Differentiate between descriptive and analytical research giving examples.
  9. Explain five of the principles of research ethics.
  10. Define the appropriate target population and the sampling frame in each of following situations :
    - (a) The manufacturer of a new cereal brand wants to conduct product usage test in India.
    - (b) A local TV station wants to determine households’ viewing habits and programming preferences.
  11. “Data interpretation is an art of drawing inferences, depending upon the skills of the researcher.” Elucidate the given statement explaining the technique of interpretation.

12. Differentiate Copyright, Patent and Trademark.
13. What is Hypothesis? What is the significance of formulating the hypothesis in research work?
14. Give a note on Citation and Acknowledgement in research article.
15. Differentiate Type-I and Type-II error in statistics with example.

**(10 × 5 = 50 Marks)**

**Part – B**  
**Computer Science**

- II. Answer any **ten** questions :
1. Find out which algorithm among FCFS, SJF and Round Robin with quantum 10, would give the minimum average time for a given workload.
  2. Discuss about cache coherence and cache miss.
  3. Write a program in C/C++/Java/Python to implement quick sort and explain the steps with an example.
  4. What are the differences between Data Mining approaches and DBMS approaches in decision-making process. Substantiate.
  5. Explain various issues in the design of the code generation.
  6. In an RSA cryptosystem, if  $p = 7$ ,  $q = 11$  and  $e = 13$ , then what will be the value of  $d$ ?
  7. Discuss the procedure for handling scheduling in any operating system.
  8. What are the differences between Alpha testing and Beta testing?
  9. Explain spatial filtering in image enhancement.
  10. Explain different types of services provided by the cloud service providers.
  11. How is Amazon able to recommend other things to buy? How does the recommendation engine work?
  12. Explain different centrality measures in Social Network Analysis.
  13. Sketch the emergence of bitcoin.
  14. Compare and contrast analysis and reporting in data analytics with suitable example.
  15. Using second order derivative, develop a Laplacian mask.

**(10 × 5 = 50 Marks)**

#### 4. Environmental Sciences

##### Part – A

##### Research Methodology

I. Answer any **ten** questions :

1. Explain the methods of toxicity testing.
2. Explain how climate change threatens food security.
3. Write a note on disaster management cycle.
4. Explain the steps involved in EIA.
5. Explain the importance of ethics in research.
6. How does plagiarism affect research?
7. Explain the methods of water sampling analysis.
8. Write the working principle of spectrophotometer.
9. Write in detail about *In Situ* remediation techniques.
10. Explain the advanced tools in GIS.
11. Explain the importance of chromatographic techniques.
12. Explain the construction of sanitary landfill.
13. Explain the applications of Gaussian plume model.
14. Explain the importance of EPR in waste management.
15. Explain the various Engineering control in OSHA.

**(10 × 5 = 50 Marks)**



**Part – B**  
**Environmental Sciences**

II. Answer any **ten** questions :

1. Explain the importance of mangrove ecosystem.
2. Write short note on formation and composition of acid rain.
3. Write a note on the various SD Goals.
4. Explain the causes and prevention of landslides.
5. Explain the effects of Global warming.
6. Explain the sources, causes, effects and control of thermal pollution.
7. Explain the concepts and principle of Ecotourism.
8. Explain the sources, disposal and management of bio medical waste.
9. Write a note on incineration.
10. Write a note on oxidation pond.
11. Explain the role of media in disaster preparedness.
12. Write a note on carbon sequestration.
13. Explain the importance of renewable energy resources.
14. Explain the laws of thermodynamics with examples.
15. Explain the importance of ecological restoration.

**(10 × 5 = 50 Marks)**

## 5. Futures Studies/Technology Management

### Part – A

#### Research Methodology

- I. Answer any **ten** questions :
  1. What is ontology? What is the relation between ontology and metaphysics?
  2. What are the main differences between inductive and deductive reasoning? List the main advantages of deductive reasoning.
  3. What are the main perspective differences between realism and anti-realism?
  4. How does a mathematical model act as a decision-making tool? Discuss the difference between deterministic and probabilistic models.
  5. Describe some of the popular techniques for turning research ideas into empirically testable research questions and use those techniques to generate questions.
  6. What is the major difference between deterministic and stochastic models? Give one example each.
  7. What is paradigm shift in science according to Thomas Kuhn?
  8. What are the significant differences between the analysis of quantitative and qualitative data?
  9. Discuss the role of research and development in the economic growth of a society.
  10. Discuss the basic differences between mathematical and scientific induction methods with examples.
  11. What are the major guidelines for writing a thesis or dissertation? What are the major sections? What is the order of the sections?

12. What is the major difference between rationalism and empiricism in the process of gaining knowledge?
13. What is a hypothesis? What is hypothesis testing? What is the main purpose of statistics to test a hypothesis? Explain the general process of testing a hypothesis.
14. What is dimensionality reduction? What are the main advantages of reducing the dimension of a given data set? Discuss two methods of dimensionality reduction.
15. What is regression analysis? What is the main objective of regression analysis? What is meant by dependent and independent variables? What is the difference between simple linear and multiple linear regressions?

**(10 × 5 = 50 Marks)**

## **Part – B**

### **Futures Studies/Technology Management**

- II. Answer any **ten** questions :
1. What is technology management? What are its components? Discuss the role of technology management in an organization for creating value and competitive advantage.
  2. What is technology assessment? Discuss the steps involved in conducting technology assessment for an organization.
  3. What is environmental monitoring and scanning? Discuss the significance of environmental scanning in futures studies.

4. Discuss the role scenario Planning in carrying out flexible long-term planning for an organization.
5. Discuss the role of artificial intelligence methods in foresight studies for generating actionable scenarios.
6. What are Intellectual Property Rights (IPR)? What is the purpose of Intellectual Property Rights?
7. What is innovation diffusion? Write the main features of the innovation diffusion model.
8. What are growth curves? How do they help in forecasting technology?
9. What are the leading technologies which will have a significant future impact? Justify your answer.
10. What is the role of computer modelling and simulation in research and development? Explain with examples.
11. Explain the techno-economic dimension of technology forecasting using the method of analogy. Give an example case where this dimension is significant.
12. How do you identify and formulate a research problem? Justify your answer.
13. What are econometric models? Write their role in guiding and formulating economic policy.
14. Describe the six basic concepts and six basic pillars of futures studies.
15. Discuss the methods to validate the computer model simulation results.

**(10 × 5 = 50 Marks)**

## 6. Microbiology

### Part – A

#### Research Methodology

I. Answer any **ten** questions :

1. What do you mean by hypothesis? How it differs from theory? How do you frame a hypothesis?
2. Describe various types of research with appropriate examples.
3. What do you mean by review of literature? How it helps to formulate the objectives?
4. What is the significance of regression and correlation analysis?
5. What do you mean by multivariate analysis? How it helps in research?
6. What is the structural component of a research report?
7. How do you frame specific objectives for a research question? What are the parameters required for this?
8. What do you mean by descriptive statistics? What is the significance?
9. What are replicates of an experiment? How do you test the significance of the replicates?
10. What is the need of probability analysis for statistical testing?
11. Differentiate between one way and two-way ANOVA. Give the rationale of the selection of appropriate ANOVA for research questions.
12. What do you mean by plagiarism? Describe two tools used to determine the plagiarisms?
13. What is scientific evidence? Describe its importance?
14. What is bibliography? What are the various formats of bibliography?
15. Write briefly about types of research methods.

**(10 × 5 = 50 Marks)**

**Part – B**  
**Microbiology**

II. Answer any **ten** questions :

1. Differentiate respiration and fermentation. What is the total ATP yield when one molecule of glucose metabolised through aerobic respiration?
2. What are secondary infections? What are the major secondary infections reported post COVID?
3. What is epitope? Where it is present? How it is different from paratope?
4. Illustrate the file format of GenBank.
5. What are the major types of structural databases available for computational biology?
6. Differentiate commensalism and ammensalism with suitable examples.
7. What are auxotrophic mutants? What are the major methods for the identification of auxotrophic mutants?
8. What are the major types of nitrogen fixation? What is the structural component of nitrogenase enzyme?
9. What are indicator microorganisms? What are the characteristic features of indicator microorganisms? Give examples.
10. What do you mean by strain improvement? What are the methods used for the improvement of strain for industrially important microorganisms?
11. Differentiate between cloning and expression vectors. What are the salient features of PVC vectors?
12. What do you mean by hybridoma technology? What are the applications of this techniques?
13. What are the major mechanisms for the acquired resistance by bacteria towards antibiotics?
14. What are the various types of post translational modifications occurring in prokaryotic polypeptide chain?
15. What is biolistic? How it is useful in gene transfer techniques?

**(10 × 5 = 50 Marks)**

## 7. Nanoscience and Nanotechnology

### Part – A

#### Research Methodology

I. Answer any **ten** questions :

1. Briefly explain the significance of research in modern times.
2. Distinguish between quantitative research and qualitative research.
3. How do you define a research problem? Give one example to illustrate your answer.
4. Give a brief account on primary and secondary sources for literature review.
5. Briefly explain the importance of citation index.
6. What are the important concepts of research design?
7. Write a perspective on interdisciplinary and multidisciplinary research.
8. With one example each briefly explain
  - (a) Laws
  - (b) Theories.
9. Briefly explain variables in research with a suitable example.
10. Write short notes on data analysis in research with an example.
11. What are the roles of ethical committees in research?
12. Write a note on the intellectual property rights.
13. What are the steps involved for acquiring a patent?
14. Write a note on different types of errors involved in research.
15. Briefly explain the potential of software for arriving result in theoretical research.

**(10 × 5 = 50 Marks)**

## **Part – B**

### **Nanoscience and Nanotechnology**

II. Answer any **ten** questions :

1. Distinguish between the density of states of electron in a quantum well and quantum dot structures.
2. Write a short note on photonic crystals.
3. Distinguish between Top-down and Bottom-up approaches used for synthesis of nano materials.
4. Explain Surface Plasmon Resonance in metallic nano structures.
5. What are super lattices?
6. Explain the working of TEM.
7. What are nanocomposites? Give any two examples
8. Write a note on nanolithography.
9. What are Miller indices?
10. Give the postulates of wave mechanics
11. Explain the significance of wavefunction in quantum mechanics.
12. Distinguish between Type I and Type II superconductors.
13. What is meant by SQUID? List any two applications of SQUID.
14. List any four nanoscale electronic interaction that produce enhanced optical properties of materials.
15. Compare the properties of electron and photons.

**(10 × 5 = 50 Marks)**



<b>8. Optoelectronics</b>
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**Part – A**

**Research Methodology**

I. Answer any **ten** questions :

1. How do you define a research problem and what is its necessity?
2. Give a brief account of different types of research.
3. Define the term generalization and interpretation.
4. Differentiate between copyright and royalty.
5. What are the different methods of collecting data?
6. What is hypothesis? What are the different types of hypothesis? Describe the procedure for developing a good hypothesis.
7. Explain the term “plagiarism”. Explain in brief some methods to find it.
8. Describe how one can commercialize the results of research work.
9. Explain the various steps involved in assisting a research report.
10. Describe the role of Internet resources for research in optoelectronics.
11. List out and briefly explain some emerging research areas in optoelectronics.
12. Distinguish between patent and intellectual property.
13. Discuss on positive and negative correlation.
14. Explain the terms citation and bibliography.
15. Describe the various ethical issues involved in research.

**(10 × 5 = 50 Marks)**

**Part – B**  
**Optoelectronics**

II. Answer any **ten** questions :

1. Distinguish between TE, TM and TEM modes. Explain the reason for the non-existence of TEM waves in a hollow wave guide.
2. Explain the construction and working of a laser diode.
3. Explain the working of a laser resonator and show how modes are obtained.
4. Explain the condition for stimulated emission in a laser.
5. What are single mode fibres. Explain the characteristic parameters of single mode fibres.
6. Discuss the working of a Ruby laser.
7. Discuss the threshold condition for the laser action.
8. Discuss multiple beam interference and its applications.
9. Distinguish between electrooptic and acoustoptic modulator and its applications.
10. Distinguish between direct and indirect band gap semiconductors with simple equations.
11. State the Fermi-Dirac distribution functions. Plot it as a function of energy.
12. What is holography? Explain the principle and method of recording an image in a hologram.
13. Discuss the salient features of free electron theory of metals.
14. Derive an expression for numerical aperture. What is its importance.
15. Discuss the photoconductor detector with a typical biasing circuit.

**(10 × 5 = 50 Marks)**

## **ROUGH WORK**

## **ROUGH WORK**