Open Elective Courses for PG

Open Elective Courses

S. No.	Course code	Course Title	Course Coordinator
1.	26PHTXXX	Introduction to Machine Learning in Physics and Applications	Dr. Kavita Lalwani
2.	26PHTXXX	Nature Inspired Materials and Innovations	Dr. Kamlendra Awasthi

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

DEPARTMENT OF PHYSICS

Program: M.Sc. (Physics)

DETAILS OF THE COURSE

Course Code	Course Title	Credits	Lecture	Tutorial	Practical	Studio
26PHTXX	**Introduction to The Machine Learning in Physics and Applications**	**3**	**3**	**0**	**0**	**0**

PREREQUISITE – None

COURSE OBJECTIVE(s)

This course aims to provide students with programming knowledge from basics of Python to the advanced level of Machine Learning using Python.

COURSE ASSESSMENT

The Course Assessment (culminating to the final grade), will be made up of the following three components;

S. No.	Component	Weightage
a)	Internal assessment (based upon assignments, quizzes and attendance)	20%
b)	Mid-term examination	30%
c)	End Semester Examination	50%

COURSE CONTENTS

Module I: Introduction to Python and ML

Machine learning software packages (open sources, e.g., python) and their installation, Basics of Python and ML, Classifications of ML, Supervised and Unsupervised learning.

(No. of lectures: 11)

Module II: Mathematical Treatment and Machine Learning Techniques in Physics

Mathematical Treatment of Machine Learning Algorithms : Regression, Classification, Principal component analysis, Singular value decomposition, Support vector machines, Clustering, K-Nearest Neighbors, Decision trees, Neural Networks, overview of Deep learning.

(No. of lectures: 19)

Module III: Physics Applications of ML

Applications of machine learning in physics, & Preparation of mini projects in the interdisciplinary field of physics such as Statistical Physics, Electromagnetism, Nuclear Physics, Device Physics etc.

(No. of lectures: 09)

Books and References

1. Introduction to Machine Learning, 3rd ed., E. Alpaydin, MIT Press (2014)
2. Introduction to Machine Learning with Python, Andreas C. Müller & Sarah Guido
3. Python Machine Learning - Second Edition, Sebastian Raschka , Vahid Mirjalili
4. Statistics: R J Barlow (John Wiley and Sons)
5. A Practical Guide to Data Analysis for Physical Science Students –L. Lyons (Cambridge University Press)
6. Data analysis techniques for HEP, Fruhwirth et al (Cambridge University Press)
7. The Elements of Statistical Learning, 2nd ed., T. Hastie, R. Tibshirani, & J. Friedman, Springer (2016)
8. Handbook of Radiotherapy Physics, Theory and Practice: P Mayles, A Nahum, J.C Rosenwald (Taylor & Francis)
9. Hands-On Machine Learning: Concepts, Tools, and Techniques to Build Intelligent Systems 2nd Edition, Aurélien Géron

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DEPARTMENT OF PHYSICS

Program: M.Sc. (Physics)

DETAILS OF THE COURSE

Course Code	Course Title	Credits	Lecture	Tutorial	Practical	Studio
26PHTXXX	**Nature Inspired Materials and Innovations**	**3**	**2**	**1**	**0**	**0**

PREREQUISITE – Basic knowledge of material science

COURSE OBJECTIVE(s)

The course Nature Inspired Materials and Innovations aim to understand the structure, composition, and physical or chemical mechanisms of biological materials at multiple length scales. It covers synthesis and process of nature-inspired architected materials, surfaces, and smart polymers. The intent is to cultivate a holistic design process that incorporates the basic elements of nature's design process, embedded with multifunctionality, sustainability, and recyclability

COURSE ASSESSMENT

The Course Assessment (culminating to the final grade), will be made up of the following three components;

S. No.	Component	Weightage
a)	Internal assessment (based upon assignments, quizzes and attendance)	20%
b)	Mid-term examination	30%
c)	End Semester Examination	50%

COURSE CONTENTS

Unit I:

Nature as mentor, source of inspiration, Stealing ideas from nature, biomimetics, bio-inspired designs, gecko inspired adhesion, lotus surface, Spider silk, butterfly wings inspired colour-changing materials, Birds and flight, shark skin, Biological sensors, bio-inspired nanostructures. Copy Nature? Design Constraints in Organisms.

(No. of lectures: 08)

Unit II:
Bio-inspired nanomaterials, Methods of self-assembly, Structural photonics: Bio inspired Optics, Hierarchical structures: Scale dependent properties, Systems Organization: Bees as a model, Locomotion: Control, balance, gait: Bio-inspired robotics, Biological sensors: Bio-inspired sensors, Bio-inspired surfaces and structures

(No. of lectures: 09)

Unit III:
Bio-inspired optical systems, Design of muscle-like actuators, self-cleaning facade paint, Tissues inspired bioelectronics, Bullet-proof protecto-flexible material, Implantable foams, films, and scaffolds for surgical closures as well as regenerative medicine applications, Humanoid Robotics, Solar decathlon: Green building, Sustainability: Natural Capitalism

(No. of lectures: 09)

TEXTBOOKS:

1. Biomimicry: Innovation Inspired by Nature. Janine Benyus, HarperCollins
2. Biomimetics: Nature-Inspired Design and Innovation. Yoseph Bar-Cohen, Wiley
3. Design Like Nature: Biomimicry for a Healthy Planet. Meg Lowman and Julia Zumpano, Nomad Press

REFERENCE BOOKS:

1. Design In Nature: How the Constructal Law Governs Evolution In Biology, Physics, Technology, & Social Organization. Adrian Bejan and J. Peder Zane, New York : Doubleday
2. The Nature of Design: Ecology, Culture, and Human Intention. David W. Orr, Oxford
3. Comparative Biomechanics: Life's Physical World. Steven Vogel, Princeton