Indian Institute of Technology, Kanpur

Proposal for a New Course

1. Course No: DES6XX

2. Course Title: Nature-Inspired Design

3. Per Week Lectures:2(L), Tutorial: 0(T), Laboratory: 0(P), Additional Hours[0-2]: 0(A),

   Credits (3*L+2*T+P+A): 6 Duration of Course: ~~Full Semester~~ / Modular

4. Proposing Department/IDP : Department of Design

   Other Departments/IDPs which may be interested in the proposed course: BSBE, CHE, CHM, ME, MSE, SEE

   Other faculty members interested in teaching the proposed course: N/A

5. Proposing Instructor(s): Dr. Himanshi Jangir

6. Course Description:

   Nature has been tinkering for billions of years to design innumerable products (organisms), processes, forms, and systems. It is both perfectionist and childlike in its design approach, often repeating itself until perfection, while some of its designs are among the most rudimentary and playful. The natural process of evolution mirrors the iterative genius of nature as a designer, where diverse solutions to similar design problems co-exist in harmony. This fundamental understanding underpins nature-inspired design: deriving inspiration from and using natural systems and processes to solve our simplest to most complex problems. The philosophy of nature-inspired design is essential for designers as we move towards circular systemic solutions, since nature designs solutions that are multifunctional, sustainable, and recyclable, whereas human-designed solutions focus on efficiency, manufacturability, and durability. The idea is to introduce a comparative understanding of these design processes that exist around us and have stood the test of time, and to question, “What will futuristic design solutions look like?”
   This course offers an opportunity to appreciate nature's simple yet complex designs, which harmonise needs with ecological resilience and can inspire futuristic and sustainable design solutions.

   A) Objectives:

   1. Discuss the guiding principles of natural designs

   2. Compare nature’s design process with human-made design innovations

   3. Apply nature’s design principles to develop futuristic, sustainable solutions.

B) Contents (*preferably in the form of 5 to 10 broad titles)*:

S. No	Broad Title	Topics	No. of Lectures
1.	Energy systems design	a. Solar cells (Chloroplast and photosynthesis) b. Power generator (Mitochondria and respiration) c. Dye-sensitised solar cells (Flower pigments) d. Chemical energy generators (Life in hydrothermal vents)	5
2.	Housing systems design	a. Thermoregulation (Termite nest, hornet nest, honeycomb, silk cocoon, wasp nest) b. Ventilation (Termite nest, hornet nest, honeycomb, silk cocoon, wasp nest) c. Structural resilience (Termite nest, hornet nest, honeycomb, silk cocoon, wasp nest)	5
3.	Material transport and filtration systems design	a. Pumping systems (Heart) b. Filtration systems (Kidneys) c. Material transport (Xylem-phloem vessels)	4
4.	Sensing systems design	a. Camera (Human eye, insect eye, and fish eye) b. Piezoelectric devices (Hair cells)	4
5.	Material systems design	a. Semiconductors (Silk and human hair) b. Springs (Resilin, elastin, spider silk)	2

C) Pre-requisites, if any (*examples: a- PSO201A,or b- PSO201A or equivalent*): N/A

D) Short summary for including in the Courses of Study Booklet: The course 'Nature-Inspired Design' attempts to immerse students in the wondrous world of the oldest designer, 'Nature.' 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.

7. Recommended books:

Textbooks:

1. Biomimicry: Innovation Inspired by Nature. Janine Benyus, HarperCollins, 1997.
2. Animal Behavior: An Evolutionary Approach. John Alcock, Sinauer, 10th ed., 2013.
3. Comparative Biomechanics: Life's Physical World. Steven Vogel, 2nd ed., Princeton UP, 2013.

Reference Books:

1. Biomimetics: Nature-Inspired Design and Innovation. Yoseph Bar-Cohen, Wiley, 2022

2. How Insects Work: An Illustrated Guide to the Wonders of Form and Function—from Antennae to Wings. Marianne Taylor, The Experiment, 2020
3. Biomimicry Resource Handbook. Dayna Baumeister, Biomimicry 3.8, 2014.
4. Bio Design: Nature · Science · Creativity. William Myers, Thames & Hudson, Revised and expanded edition, 2018.
5. The Shark's Paintbrush: Biomimicry and How Nature Is Inspiring Innovation. Jay Harman, White Cloud Press, 2013.
6. Design Like Nature: Biomimicry for a Healthy Planet. Meg Lowman and Julia Zumpano, Nomad Press, 2021.
7. Design In Nature: How The Constructal Law Governs Evolution In Biology, Physics, Technology, And Social Organization. Adrian Bejan and J. Peder Zane, New York : Doubleday, 2012.
8. The Nature of Design: Ecology, Culture, and Human Intention. David W. Orr, Oxford University Press, New York, 2002.

8. Any other remarks:

Dated:13.2.2026 Proposer: Dr. Himanshi Jangir

Dated:_____ DUGC/DPGC Convener:_____

The course is approved / not approved

Chairman, SUGC/SPGC

Dated:_____