( ) Biology for Engineers

Teaching Scheme: **Examination Scheme:**

Lectures: 3 hrs/week T1 and T2: 20 Marks each

End-Sem Exam: 60 marks

Course Outcomes:

Students will be able to,

CO-1 Understand basic biological principles and organizational structure of living systems at molecular level.

CO-2 Comprehend basic biological principles and organizational structure of living systems at cellular level.

CO-3 Know Energy transformations and information processing in biological systems.

CO-4 Appreciate biological process with engineering perspective.

CO-5 Impart knowledge about the common corridors of biology and engineering and biologically inspired technologies.

CO-PO Mapping for Biology for Engineers

CO	PO1	PO2	PO3	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
CO-1	2	1	1	0	0	3	2	2	1	1	0	2	2	0	0	0
CO-2	2	1	1	0	0	3	1	2	1	1	0	2	2	0	0	0
CO-3	2	1	3	0	0	2	1	1	2	2	1	1	2	0	0	0
CO-4	2	0	1	1	2	2	2	1	1	1	0	2	2	0	0	0
CO-5	2	1	2	0	1	2	2	1	1	1	0	2	2	0	0	0

Unit 1:

Biomolecules and Biopolymers: Structure and Function

Organic and inorganic molecules; Unique Properties of water, Vitamins and Minerals, Carbohydrates, Lipids, Amino Acids and proteins, Nucleic Acids (DNA and RNA). **[06 Hrs]**

Unit 2:

Levels of Organization of Life: Cell as a basic unit of life, prokaryotic and eukaryotic cells, microbes, plant and animal cells; Cell organelles – structure and function; Cell membrane

Levels of organization: cells, tissues, organs, systems & organism. **[06 Hrs]**

Unit 3:

Energy Transformations in Chloroplast: Photosynthesis (photochemical & biochemical phase) and ATP generation, Aerobic and anaerobic systems.

Energy Transformations in Mitochondria: Cellular respiration (glycolysis and Kreb cycle) and ATP generation.

Bioenergetics: Thermodynamic principles applied to biology, negative entropy changes in biological systems, Free Energy, Chemical Equilibrium. **[06 Hrs]**

Unit 4:

Expression and Transmission of Genetic Information: DNA replication, Enzyme driven process of DNA cloning, Protein synthesis- Transcription & translation.

Techniques for optimization:

At molecular level: Recombinant DNA Technology, DNA hybridization, PCR, DNA microarray.

Unit 5:

Transport Phenomena in Biological Systems: Membrane channels and ion channels; Fluid flow and mass transfer (nutrients & ions); In plants: Xylem and Phloem; In animals: Blood and Lymph Transport of gases: Oxygen and Carbon dioxide

Heat Transport - Body temperature regulation.

Communication: Cell junctions, Cell-cell communications – cell signaling, Hormones, Pheromones and cell behaviour

Defense mechanisms:

In plants: Herbivory, secondary metabolites,

In animals: Innate and Adaptive immune systems **[06 Hrs]**

Unit 6:

Engineering perspectives of Biological Sciences:

Biology and engineering crosstalk – At cell level: Hybridoma technology, At tissue level: Plant Tissue Culture, Animal Tissue Culture; Tissue Engineering: Principles, methods and applications Introduction to Biomimetics and Biomimicry, nanobiotechnology **[06 Hrs]**

References:

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- Lehninger, A. L., Nelson, D. L., & Cox, M. M. (2000). Lehninger principles of biochemistry. New York: Worth Publishers.
- Rao CNR, et.al. Chemistry of Nanomaterials: Synthesis, Properties and Applications.
- Eggins BR. (1006) Biosensors: An Introduction. John Wiley & Sons Publishers.
- Palsson B.O. and Bhatia S.N. (2009) Tissue Engineering. Pearson.
- Yoseph Bar-Cohen (2005). Biomimetics- Biologically Inspired Technologies
- Joseph D. Bronzino, John Enderle, Susan M. Blanchard (1999) Introduction to Biomedical Engineering.
- Routledge Taylor and Francis group (2012). Introduction to Bio-medical Engineering technologies

Table 1.1: For Teachers: Additional topics to be discussed with students in accordance with relevant biological topics (in branch-wise manner)

Disease/ Disorder	Physiology	Diagnosis	Therapeutics		Medical procedure
			Biomaterials	Instrumentation	
Cardiovascular disease	Heart – electrical stimulation and mechanical pumping	ECG, Angiography	Stents for angioplasty	Heart lung machines	Angioplasty, By-pass surgery
Bone/skull injuries	Biomechanics of musculo-skeletal system	Medical imaging technologies Arthroscopy	Prosthetics	Arthroscope Biomechanics Prosthetics	Joint replacement Total hip Replacement reh abilitation engg
Kidney disorders	Functioning of Kidney	Medical imaging technologies	Filtration membranes	Dialyser	Dialysis

Program Outcomes (POs):

Engineering Graduate will be able to:

1. **Engineering Knowledge:** Apply the knowledge of mathematics , science , engineering fundamentals , and an engineering specialization to the solution of complex engineering problem

2. **Problem Analysis:** Identify , Formulate , review research literature , and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics , natural science, and engineering sciences

3. **Design/Development solution:** Design solution for complex engineering problems & design system component or process that meet the specified needs with appropriate consideration for the public health & safety , and the cultural , social & environmental conditions

4. **Conduct investigation of complex problem:** Use research based knowledge & research methods including design of experiments , analysis and interpretation of data and synthesis **of** the information to provide valid conclusion

5. **Method tool usage:** create , select and apply appropriately technique, resources , and modern engineering and IT tools including prediction and modelling to complex engineering activities with understanding the limitation

6. **The engineer & society:** Apply reasoning informed by the contextual knowledge to access societal , health , safety , legal & cultural and consequent responsibility relevant to the professional engineering practice

7. **Environment & sustainability:** understand the impact of the professional engineering solution in societal & environmental context , and demonstrate the knowledge of , and need for sustainable development

8. **Ethics:** Apply ethical principle and commitment to professional ethics and responsibilities and norms of the engineering practices

9. **Individual & team work:** Function effectively as an individual , and as the member or leader in diverse team and multidisciplinary setting

10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large , such as , and being able to comprehend and write effective reports & design documentation & effective presentation and give & receive clear instructions

11. **Project management & Finance:** Demonstrate knowledge & understanding of the engineering and management principles & apply these to ones work , as the member & the leader in a team to manage projects and in multidisciplinary environment

12. **Life Long Learning:** Recognize the need for , and have the preparation and ability to engage in independent and life long learning in broadest context of technological change

PSO for undergraduate

13. To design and develop power electronics hardware and its control to cater the needs of industry

Such as electric vehicles, renewable interconnections, smart grid and micro-grid

14. To analyse and solve the problems related to smart grid using modern techniques and tools

15. To design, simulate, and make prototype of special purpose machines for enhancing the Performance.