4-LEVEL DEPARTMENT ELECTIVE

Course Number & Title: BT4422 CRISPR-based Genome Editing	
L-T-P-C: 3-0-0-6	
Type of Letter Grading (Regular Letter Grades / PP or NP Letter Grades): Regular Letter Grades	
Kind of Proposal (New Course / Revision of Existing Course): New Course	
Offered as (Compulsory / Elective): Elective	
Offered to: B Tech (7^{th} semester and 8^{th} semester)	
Offered in (Odd/ Even / Any): Any	
Offered by (Name of Department/ Center): Biosciences and Bioengineering	
Pre-Requisite: Cell and Molecular Biology, and Genetic Engineering	
Preamble / Objectives (Optional)**:** Genome editing has revolutionized biology, biotechnology, agriculture, and medicine by enabling precise and programmable modification of genetic material. This course introduces the principles, tools, and applications of genome editing, with emphasis on CRISPR-Cas systems, base editing, prime editing, and RNA-guided nucleases. Students will gain a comprehensive understanding of DNA repair pathways, editing mechanisms, delivery strategies, validation methods, and ethical/regulatory frameworks. By integrating foundational molecular biology with cutting-edge technologies, the course prepares learners for research and industry applications in functional genomics, disease modeling, gene therapy, crop improvement, and diagnostics.	
Genome editing: origins, evolution and scope**; DNA damage and repair pathways:** double-strand breaks, NHEJ, HDR, MMEJ; **Early genome editing tools:** FokI, ZFNs, TALENs**,** limitations of pre-CRISPR technologies; **CRISPR systems:** discovery, bacterial adaptive immunity, classification (Class I and Class II), Cas protein structures and functions; **CRISPR-Cas9 mechanism:** guide RNA design, PAM recognition, DNA cleavage, repair outcomes (knockout and knock-in), specificity, off-target effects; **Advanced genome editing technologies:** Cas12, Cas13, RNA editing, base editing, prime editing, multiplex genome editing, epigenome editing (CRISPRi, CRISPRa); **Delivery systems:** physical (electroporation, microinjection), viral (lentivirus, AAV), non-viral (lipid nanoparticles, RNP complexes), in vivo and ex vivo strategies; **Screening and validation:** PCR assays, sequencing, T7 endonuclease assay, next-generation sequencing, genome-wide CRISPR screens; **Applications in:** functional genomics, disease modeling, gene therapy, cancer research, agricultural biotechnology, industrial biotechnology; **diagnostics:** nucleic acid detection platforms (SHERLOCK, DETECTR); Ethical, biosafety, and regulatory considerations in genome editing.	
Text books and **References:**	
1.	Doudna, J.A. & Sternberg, S.H. (2017). A Crack in Creation: *Gene Editing and the Unthinkable Power to Control Evolution*. Houghton Mifflin Harcourt, Boston, USA. (ISBN: 978054416940)
2.	Gaj, T., Gersbach, C.A., & Barbas, C.F. (2013). *Zinc-Finger Nucleases and Transcription Activator-Like Effector Nucleases*. Cold Spring Harbor Protocols (Collection Edition). Cold Spring Harbor Laboratory Press.
3.	Maloy, S.R., Hughes, K., & Cronan, J.E. (1994). *Microbial Genetics* (2nd Edition). Jones & Bartlett Learning. (ISBN: 978-0763784089).
4.	Lanza, R., Atala, A., & others (Editors) (2014). *Handbook of Stem Cells* (2nd Edition). Academic Press.
5.	National Academies of Sciences, Engineering, and Medicine (2017). Human Genome Editing: Science, Ethics, and Governance. National Academies Press. (ISBN: 978-0309452880).