GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code:
Semester – VII
Subject Name: LASER and Fiber Optics in Medical Technology

Type of course: Professional Elective Course

Prerequisite: Basic Physics, Mathematics, Human Anatomy and Physiology, Basic Electronics

Rationale: Optics is a branch of science which deals with study of properties and characteristics of light. With advancement of science and technology light and its characteristics have been used in conventional medical diagnosis and treatment. In most of the medical devices like Endoscopes, Medical LASERs, LED based devices are being used in healthcare devices. It is the necessity to study optics and its application in medical field for understanding fundamentals of LASERs and Optical Fibers.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
	Unit-I [Fiber Optics]	
1	**Optical Fiber and light**: Light guiding, communication, Refraction, Units, Snell's Law, Critical Angle, Total internal reflection, Electromagnetic Waves-Spectrum **Propagation of light along the fiber:** Transmission of light through straight transparent slab and bend slab, Cone of acceptance, numerical aperture, the use of decibels in fiber optic circuits **Losses and dispersion in fiber optics:** Absorption, Rayleigh scatter, Fresnel Reflection, Bending losses, dispersion Graded Index fiber, Single mode fiber, cables for fiber optics, Problems occurring in connecting optical fibers, Cleaving Process, Connectors and couplers	**15**
	Unit-I [Fiber Optics]	
2	**Basics of Lasers and Optical and Thermal Response of Tissue to Laser Radiation:** Laser Principles, Laser Materials, Pump Sources, Resonators, Major Types of Lasers, Medical Lasers, Measuring Laser Power, Focusing Laser Energy, The Future of Medical Lasers, The Optical Response of Tissue, Thermal Response.	**8**

3	**Application of Lasers in therapy and diagnosis**: Introduction, laser assisted diagnosis and therapy fundamentals, Interaction of Laser beams and materials- Principles, Laser interaction with tissue, application of Lasers in Diagnosis and Imaging, Laser surgery and therapy, thermal interaction between laser and Tissue. Integrated laser-fiber systems and their applications, Complications in the use of Laser fiber optic system	**6**
4	**Endoscopy and Fiber Optic Medical Diagnosis :** Endoscopic imaging system fundamentals, Angioscope, Videoscopy, Fluorescence endoscopy, Endoscopic therapy, Endoscopic ultrasound imaging-principles, introduction, fundamentals, fiberoptic biomedical sensor-principles, Direct-indirect Sensor principles	**9**
5	**Clinical applications of fiber optic Laser systems**: Fiber optic Laser system in cardiovascular disease, Fiber optic Laser system in Gastroenterology, Fiber optic Laser system in general and thoracic surgery, Fiber optic Laser system in Neurosurgery, Fiber optic Laser system in Oncology, Fiber optic Laser system in Opthalmology, Fiber optic Laser system in Orthopedics, Fiber optic Laser system in Otolaryngology, Fiber optic Laser system in Urology, Flow chart diagrams for clinical applications of laser –fiber systems.	**7**
		45

Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
25	**25**	**20**	**10**	**10**	**10**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Abraham Katzir, "Lasers and Optical Fibers in Medicine", Academic press Inc.
2. John Crisp," Introduction to fiber optics", 2nd Edition, 2001, Newnes
3. Lasers in Medicine / edited by Ronald W. Waynant, ISBN 0-8493-1146-2, © 2002 by CRC Press LLC
4. Lasers in medicine: an introductory guide/ Gregory T. Absten, Stephen N. Joffe. - [2nd ed.], Springer-Science+Business Media, B.Y.

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Course Outcomes: After learning the course, the students should be able to:

Sr. No	CO Statement	% Marks weightage
CO-1	Learn the construction, working principle of fibers and Light propagation through fibers.	33%
CO-2	Understand the LASER physics, optical and thermal response of tissues to LASER radiation.	18%
CO-3	Learn biomedical sensor integration with optical fiber and thus its emerging various therapeutic, diagnostic as well as imaging application, its advantages and safety aspects.	13%
CO-4	Learn fiber optics in medical diagnosis and types of endoscopy.	20%
CO-5	Understand the various applications for curing different diseases accurately by fiber optic laser system in an easy, fast and safe method of operation.	16%

List of Experiments:

1. To study electromagnetic spectrum.
2. To study the structure of optical fiber and its working principle.
3. To study the propagation of light through straight and bend fiber.
4. To study the terminology related to fiber optic communication.
5. To study losses and dispersion in fiber optics.
6. To study the working principle of LASER.
7. To study various types of LASER used in biomedical engineering.
8. To study the application of LASER in Neurosurgery
9. To study the application of LASER in Gastroenterology
10. To study the application of LASER in Opthalmology
11. To study the application of LASER in Oncology
12. To study the application of LASER in Urology
13. To study the application of LASER in Orthopedics
14. To study the principle and construction of Endoscopy.
15. To study fiber optic biomedical sensors and its coupling with fibers.

List of Open Source Software/learning website: MATLAB, COMSOL, AUTOCAD, ANSIS.