Vidyalankar Institute of Technology

An Autonomous Institute affiliated to University of Mumbai

Honours/Minor Degree Programme for

Bachelor of Technology

in

Biomedical Engineering

(R-2022 Curriculum)

(As per AICTE guidelines, with effect from the Academic Year 2024-25)

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated, and taken forward in a systematic manner. Therefore, autonomy for Vidyalankar Institute of Technology is not merely a transition from pre-cooked syllabi to self-designed curriculum. The autonomous curriculum of the Institute offers required academic flexibility with emphasis on industry requirements and market trends, employability and problem-solving approach which leads to improving competency level of learners with diverse strengths. In line with this, the curriculum framework designed is **Choice-Based Credit and Grading System (CBCGS)**. The number of credits for each category of courses learnt by learners, internships and projects is finalized considering the scope of study and the ability that a learner should gain through the programme. The overall credits and approach of curriculum proposed is in line with AICTE model curriculum.

The curriculum comprises courses from various categories like basic sciences, humanities and social sciences, engineering sciences, general education and branch specific courses including professional electives and open electives. The curriculum has core courses of branch of engineering positioned and sequenced to achieve sequential and integral learning of the entire breadth of the specific branch. These courses are completed by the third year of the engineering programme that enables learners to prepare for higher education during their final year. Professional elective courses, that begins from third year of programme, offer flexibility and diversity to learners to choose specialization from a basket of recent developments in their field of technology. The selection of unique professional elective courses based on industrial requirements and organizing them into tracks is a salient feature of this curricula ensuring employability. Open Elective courses cover multi-disciplinary, special skill development, project management and similar knowledge that make learners capable of working in an industrial environment.

For holistic development of learners, apart from technical courses, Humanities and Social Science courses develop the required soft-skills and attitude amongst learners. Our curriculum also introduces Social Service Internship and Internship with institutes abroad along with courses like Design Thinking, Wellness - Body, Mind & Spirit, Indian Traditional Knowledge System under General Education category. These general education courses aim to create balance in brain hemispheres and hence improve learners' clarity in thoughts and responses.

Additionally, curriculum provides add-on Honours/Minor degree that involves field/ domain study. Learner can avail themselves of this degree by completing requirement of additional 18 credits.

Thus, the academic plan of VIT envisages a shift from summative to formative and competency-based learning system which will enhance learner's ability towards higher education, employability and entrepreneurship.

Chairman, Board of Studies
Department of Biomedical Engineering
Vidyalankar Institute of Technology

Chairman, Academic Council
Vidyalankar Institute of Technology

[A] Guidelines for Award of Honours/ Minor Degree Programme

Honours and Minor Degree programme is introduced in order to facilitate learners to enhance the depth of knowledge, diversity, breadth and skills in emerging fields. An Honours or Minor Degree typically refers to a higher level of academic achievement either for research orientation or for improving employability. Learners can select any Honours or Minor Degree programme as per his/her choice.

In our curriculum, learners can choose to avail Honours/ Minor Degree programme by completing requirements of 18 credits, which will be over and above the minimum credits required for B.Tech. degree i.e. credit requirement for the award of degree programme and Honours/ Minor degree programme are required to be explicitly carried out. Learners shall opt for Honours or Minor specialisations during the break of Semester 5 and Semester 6. **Learners may complete the B.Tech. Degree programme without opting for Honours/Minor degree programme** i.e. opting for Honours/ Minor Degree programme is not mandatory as a part of B.Tech. Degree programme

For Honours/Minor Degree, the learner shall select an Honours/Minor programme offered by his/her own department.

Eligibility Criteria

- Basic eligibility for opting for Honours/Minor shall be minimum CGPA of 6.75 at the end of 4th semester and earned 81 credits from Sem 1 to Sem 4 (41 credits for DSY students).
- If student has already completed any course(s) that is listed in the chosen Honours/ Minor degree programme, as additional learning course(s), then the transfer credits for such course(s) can be carried out towards Honours/ Minor degree programme.
- For a student to get Honours/ Minor degree, it is mandatory that the student completes the relevant courses before graduating.

Syllabus Scheme Template

Course		Head of Learning	Preferred Semester	Credits	Assessment Guidelines (Marks)			Total marks (Passing@40% of total marks)
Code	Name				ISA	MSE	ESE	
HM01	Industry Interaction	Theory	Break of Sem5 and Sem6	1	25	-	-	025
HMXX	Honours / Minor Degree Course 1	Theory	6	2	15	20	40	075
HMXX	Honours / Minor Degree Course 1 Lab	Practical	6	1	25	-	25	050
HM02	Survey Report/ Paper	Theory	Break of Sem6 and Sem7	2	25	-	25	050
HMXX	Honours / Minor Degree Course 2	Theory	7	2	15	20	40	075
HMXX	Honours / Minor Degree Course 2 Lab	Practical	7	1	25	-	25	050
HM03	Seminar	Theory	Break of Sem7 and Sem8	2	25	-	25	050
HMXX	Honours / Minor Degree Course 3	Theory	8	2	15	20	40	075
HMXX	Honours / Minor Degree Course 3 Lab	Practical	8	1	25	-	25	050
HM04	Capstone Project	Practical	8	4	75	-	50	125
			Total	**18**				

[B] Honours/ Minor Degree Programmes offered for B.Tech. Biomedical Engineering

The Institute offers the listed Honours/Minor Degree Programme for learners of Biomedical Engineering.

Honours/ Minor Degree Programmes Offered

Sr.No.	Honours/Minor Degree Programme	Department offering Honours	Honours applicable for	Minors applicable for
1	AI in Healthcare	Biomedical Engineering	B.Tech. Biomedical Engineering students who have opted for AIML specialization track.	None
2	Medical Imaging Technology	Biomedical Engineering	B.Tech. Biomedical Engineering students who have opted for Biomedical Technology and Innovation specialization track.	None
3	Next-Gen Internet of Things	Electronics and Telecommunication Engineering	None	As stated in Honours/ Minor Degree document of Electronics and Telecommunication department.
4	Blockchain	Information Technology	None	As stated in Honours/ Minor Degree document of Information Technology department.
5	User Interface and User Experience (UI/ UX)	Information Technology	None	As stated in Honours/ Minor document of Information Technology department.

List of courses under each Honours/ Minor Programme:

1. AI in Healthcare

Semester	Course Code	Course Name
VI	HMBM01T	Ethics, Privacy, & Security in AI Driven Healthcare
VI	HMBM01P	Ethics, Privacy, & Security in AI Driven Healthcare Lab
VII	HMBM02T	Applied Machine Learning for Biomedical Signals
VII	HMBM02P	Applied Machine Learning for Biomedical Signals Lab
VIII	HMBM03T	Application of ML in Healthcare
VIII	HMBM03P	Application of ML in Healthcare Lab

2. Medical Imaging Technology

Semester	Course Code	Course Name
VI	HMBM04T	Structural Imaging Technology
VI	HMBM04P	Structural Imaging Technology Lab
VII	HMBM05T	Functional Imaging Technology
VII	HMBM05P	Functional Imaging Technology Lab
VIII	HMBM06T	Nuclear Imaging Techniques
VIII	HMBM06P	Nuclear Imaging Techniques Lab

3. Next-Gen Internet of Things

Semester	Course Code*	Course Name
VI	HMET01T	Embedded Linux System
VI	HMET01P	Embedded Linux System Lab
VII	HMET02T	IoT and Data Analytics
VII	HMET02P	IoT and Data Analytics Lab
VIII	HMET03T	IoT Applications and Web Development
VIII	HMET03P	IoT Applications and Web Development Lab

* Detailed Syllabus of these courses can be obtained from the Honours/ Minor document of Electronics and Telecommunication department

4. User Interface and User Experience (UI/UX)

Semester	Course Code*	Course Name
VI	HMIT01T	Foundation of UI/UX
VI	HMIT01P	Foundation of UI/UX Lab
VII	HMIT02T	UX Design, Evaluation and ARVR
VII	HMIT02P	UX Design, Evaluation and ARVR Lab
VIII	HMIT03T	Use cases in UI/UX
VIII	HMIT03P	Use cases in UI/UX Lab

* Detailed Syllabus of these courses can be obtained from the Honours/ Minor document of Information and Technology department

5. Blockchain

Semester	Course Code*	Course Name
VI	HMIT04T	Blockchain Technology
VI	HMIT04P	Blockchain Technology Lab
VII	HMIT05T	Smart Contract and Crypto Currencies
VII	HMIT05P	Smart Contract and Crypto Currencies Lab
VIII	HMIT06T	Decentralize and Blockchain Technologies
VIII	HMIT06P	Decentralize and Blockchain Technologies Lab

* Detailed Syllabus of these courses can be obtained from the Honours/ Minor document of Information and Technology department

Learners of Biomedical Engineering Department who wish to opt for Minor Degree Programme offered by other department can obtain details of the same from Section-B and Section C of the Honour/ Minor Degree Programme document of respective department.

[C] Honours/ Minor Degree Programmes Course Syllabus

Course Name: Ethics, Privacy, & Security in AI Driven Healthcare

Course Code: HMBM01T

Category: Honours in AI in Healthcare

Preamble:
This course, "Ethics, Privacy, & Security in AI-Driven Healthcare," is conceived with the vision of empowering healthcare professionals, AI developers, policymakers, and researchers with the knowledge and tools necessary to responsibly harness the power of AI. It provides a comprehensive framework to understand and address the ethical dilemmas, privacy concerns, and security risks associated with AI in healthcare.

Pre-requisites:
AI and ML

Course Objectives:
- To develop a Comprehensive Understanding of AI Technologies in Healthcare
- To analyze and Address Ethical, Privacy, and Security Challenges
- To integrate Ethical, Legal, and Social Considerations into AI Development

Course Outcomes:
Learner will be able to:
CO1: Demonstrate a comprehensive understanding of the basic principles of AI, including machine learning and deep learning, and their specific applications in healthcare.
CO2: Articulate the foundational ethical principles relevant to AI in healthcare, including beneficence, non-maleficence, autonomy, and justice.
CO3: Identify privacy risks and concerns associated with AI-driven healthcare, including common breaches and vulnerabilities.
CO4: Identify specific vulnerabilities and threats to AI systems in healthcare, including adversarial attacks.
CO5: Evaluate the impact of AI on the healthcare workforce and societal and cultural considerations.
CO6: Integrate ethical, privacy, and security considerations into the development and deployment of AI technologies in healthcare.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No of Hours
1	Introduction	Foundational Ethical Principles, Beneficence, non-maleficence, autonomy, and justice, Applying these principles to AI Ethical Challenges in AI	4
2	Ethics in AI-Driven Healthcare	Bias and fairness in AI algorithms Transparency and explainability, Accountability and responsibility, Case Studies and Ethical Dilemmas, Real-world scenarios, Group analysis and discussion, Regulations and Guidelines	4
3	Privacy Concerns in AI-Driven Healthcare	Understanding Healthcare Data, Types of data used in AI Data lifecycle in healthcare, Privacy Risks and Concerns, Identifying and assessing privacy risks, Common privacy breaches in healthcare, Data Anonymization and De-identification, Techniques for protecting patient privacy Balancing data utility and privacy Regulatory Frameworks, HIPAA, GDPR, and other relevant regulations, Compliance requirements and best practices, Case Studies and Best Practices, Analyzing privacy breaches, Developing privacy-preserving strategies	6
4	Security in AI-Driven Healthcare	Cybersecurity Basics in Healthcare, Key security concepts and threats, Importance of cybersecurity in healthcare Threats to AI Systems, Specific vulnerabilities of AI systems Adversarial attacks on AI models Security Measures and Protocols, Encryption, access controls, and monitoring Implementing robust security frameworks Incident Response and Management, Developing an incident response plan, Case studies of security breaches	6
5	Ethical, Legal, and Social Implications (ELSI) of AI in Healthcare	Introduction to ELSI, Framework for understanding ELSI, Importance of ELSI in AI development, Legal Issues and Intellectual Property, Understanding legal challenges Intellectual property rights in AI, Social Implications, Impact on healthcare workforce, Societal and cultural considerations Patient Consent and Autonomy, Informed consent in AI applications, Respecting patient autonomy, Policy and Advocacy, Role of policy in shaping AI ethics, Advocacy for ethical AI practices	6
6	Practical Applications and Future Directions	Integrating Ethics, Privacy, and Security into AI Development, Best practices for developers, Interdisciplinary approaches Building Ethical AI Models, Techniques for bias mitigation Ensuring fairness and transparency, Privacy-Preserving AI Techniques, Differential privacy, federated learning, Emerging privacy-preserving technologies, Interactive Workshop:	4

Total	**30**

Textbooks:

1. "Data Structures and Algorithms Made Easy" by Narasimha Karumanchi, CareerMonk Publications, 2016.
2. "Artificial Intelligence in Healthcare", by Adam Bohr and Kaveh Memarzadeh, Edition 1st , Academic Press.
3. "Ethics of Artificial Intelligence and Robotics", by Vincent C. Müller, Edition 1st, Publisher: Springer.
4. "Healthcare Privacy and Security: Regulatory Compliance and Data Security in the Age of Electronic Health Records", by Bernard Peter Robichau, Edition 1st, Auerbach Publications

Reference books:

1. "Machine Learning and AI for Healthcare: Big Data for Improved Health Outcomes", by Arjun Panesar, Edition 1st, Apress.
2. "AI in Healthcare: Ethical and Legal Challenges", by Stefan Felder and Claus Wendt, Edition: 1st, Springer.
3. "Security and Privacy in Cyber-Physical Systems: Foundations, Principles, and Applications", by Houbing Song, Glenn A. Fink, and Sabina Jeschke, Edition 1st, Wiley-IEEE Press

Course Name: Ethics, Privacy, & Security in AI Driven Healthcare Lab

Course Code: HMBM01P

Category: Honours in AI in Healthcare

Preamble:
"Hands-On Practice in Ethics, Privacy, & Security for AI-Driven Healthcare," is designed to provide participants with practical experience and technical expertise in addressing these critical issues. Through a series of hands-on lab sessions, participants will gain proficiency in implementing ethical, privacy-preserving, and secure AI solutions in healthcare settings.

Pre-requisites:
AI-ML

Course Objectives:

- To introduce AI Tools in Healthcare
- To study risks associated with AI-driven healthcare systems, apply data anonymization and de-identification techniques,
- To understand relevant legal and regulatory frameworks (HIPAA, GDPR), conduct compliance assessments for AI systems in healthcare

Course Outcomes:
Learner will be able:
CO1: Setup AI development environments and using fundamental AI tools (TensorFlow, PyTorch) to build and run basic AI models on healthcare datasets.
CO2: Understand basic machine learning algorithms, evaluate model performance, and perform feature selection and data preprocessing in the context of healthcare.
CO3: identify ethical issues in AI applications through case study analysis, engage in meaningful discussions on ethical principles, and develop ethical guidelines for AI systems in healthcare.
CO4: Understand risks in healthcare datasets, apply data anonymization and de-identification techniques, and utilize tools for privacy risk assessment and mitigation.
CO5: Implement advanced data privacy techniques like differential privacy and federated learning and evaluate the balance between data utility and privacy in AI healthcare applications.
CO6: Identify and mitigate cybersecurity threats, apply encryption and access control mechanisms, and develop and test incident response plans to protect AI systems in healthcare.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	050

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Practicals:

Sr No.	Title of Practicals
1	Familiarize participants with AI tools and platforms commonly used in healthcare.
2	Implement basic machine learning algorithms in a healthcare context.
3	Analyze ethical challenges in AI systems through real-world scenarios (case study)
4	Identifying privacy risks in sample healthcare datasets.
5	Applying differential privacy techniques to healthcare datasets.
6	Identifying and mitigating common cybersecurity threats in AI systems.
7	Implementing techniques to reduce bias in AI models.
8	Reviewing HIPAA, GDPR, and other relevant regulations.
9	Building AI models with fairness and transparency in mind.

Course Name: Structural Imaging Technology

Course Code: HMBM04T

Category: Honours Course in Medical Imaging Technology

Preamble:

This course will lay a foundation knowledge for students to understand concepts of structural imaging technology. Structural imaging focusses on techniques used to create detailed images of the human anatomy and structure.

Pre-requisites:

- Physics for Biomedical Engineering (BS20T)
- Human Anatomy and Physiology (BS18T)
- Electronic Devices and Circuits (BM03T)

Course Objectives:

- Understand the principles of X-ray production, interaction with matter, and attenuation, and apply them to operate a total radiographic system effectively.
- Master techniques in advanced imaging modalities such as fluoroscopy, digital subtraction angiography, computed radiography, digital radiography, and mammography.
- Gain proficiency in utilizing CT technology, including scanner configurations, reconstruction techniques, and applications in clinical settings, as well as understanding the production and clinical applications of RF waves and linear accelerators.

Course Outcomes:

Learner will be able to:

CO1: Understand the basics of X-ray technology.

CO2: Explain the working principles of radiographic procedures.

CO3: Understand the working principles of different digital imaging technologies like computed radiography (CR) and digital radiography (DR).

CO4: Understand the working CT imaging technique.

CO5: Illustrate advanced applications of CT imaging.

CO6: Understand the components of linear accelerators.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2+1 (O)	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	X-ray Imaging	Properties of X rays, production of X rays, X ray interaction with matter, Attenuation Total radiographic System: X –ray tubes, Rating of X ray tubes, X –ray generators, Filters, Grids, Beam Restrictors, Control Panel, X ray Film	7
2	Fluoroscopic Imaging	Fluoroscopic Imaging and X ray Image Intensifier, Digital subtraction Angiography	4
3	Computed Radiography and Digital Radiography	Computed Radiography and Digital Radiography Mammography	4
4	Principle of Computed tomography	Scanner configurations/generations, CT system: Scanning unit(gantry), detectors, CT Number, Data Acquisition System, Spiral CT: technology and applications, Reconstruction Techniques: - Radon Transform, Iterative, Filtered back projection, Fourier reconstruction, CT artifacts, Clinical applications of CT	7
5	Advancements in CT	Multi-detector computed tomography (MDCT), Flat panel detectors CT-Angiography, Contrast agents in CT	4
6	Linear Accelerators	Production and transport of the RF wave, Major components of linear accelerator, Clinical Applications	4
Total			**30**

Suggested list of Assignments:

1. Compare and contrast the characteristics of different types of X-ray tubes.
2. Investigate the principles of X-ray generator operation and assess the factors affecting X-ray tube ratings.
3. Research and compile a comprehensive guide on the use of filters, grids, and beam restrictors in radiographic imaging.
4. Write a critical review paper on the evolution of fluoroscopic imaging technology, focusing on advancements in image intensifiers, digital fluoroscopy systems, and their impact on clinical practice.
5. Present a case study showcasing the application of digital subtraction angiography (DSA) in diagnosing vascular conditions.
6. Conduct a comparative analysis of computed radiography (CR) and digital radiography (DR) systems, evaluating their image quality, workflow efficiency, and cost-effectiveness in clinical settings.
7. Explore the technological advancements in mammography systems, including digital mammography, breast tomosynthesis, and contrast-enhanced mammography. Assess their roles in breast cancer screening and diagnosis.
8. Prepare a presentation outlining the various configurations and generations of CT scanners, discussing their design features, advantages, and limitations. Include examples of clinical applications for each configuration.
9. Research and compare different reconstruction techniques used in CT imaging, such as Radon Transform, iterative reconstruction, and filtered back projection. Evaluate their impact on image quality and diagnostic accuracy.
10. Write a comprehensive report on the clinical applications of multi-detector computed tomography (MDCT) and CT angiography (CTA).

Suggested List of Value-Added Home Assignments:

1. Design of Instructional Videos.
2. Design of Demographics and uploading on Social Media Platform.
3. Creation of a Wikipedia page.
4. Problem Based Assignment.

Suggested Online Courses:

1. Introduction to Biomedical Imaging
   https://www.edx.org/course/introduction-to-biomedical-imaging
2. Fundamentals of Biomedical Imaging: Ultrasounds, X-ray, positron emission tomography (PET) and applications

https://www.edx.org/course/fundamentals-of-biomedical-imaging-ultrasounds-x-r

Reference Books:

1. Thomas S. Curry, James E. Dowdey, Robert C. Murry, "Christensen's Physics of Diagnostic Radiology", Lippincott Williams & Wilkins, 1990.
2. William R. Hendee, E. Russell Ritenour, "Medical Imaging Physics", Wiley-Liss, 2002.
3. Angela M. Duxbury, Pam Cherry, "Practical Radiotherapy: Physics and Equipment ", Wiley-Blackwell, 2009.
4. James Moore, George Zouridakis, "Biomedical Technology and Devices", CRC Press, 2013.
5. David Dowsett, Patrick A Kenny, R Eugene Johnston, "The Physics of Diagnostic Imaging", CRC Press, 2006.

Course Name: Structural Imaging Technology Lab

Course Code: HMBM04P

Category: Honours Course in Medical Imaging Technology

Preamble:

This course will lay a foundation knowledge for students to understand concepts of structural imaging technology. Structural imaging focusses on techniques used to create detailed images of the human anatomy and structure.

Pre-requisites:

- Physics for Biomedical Engineering (BS20T)
- Human Anatomy and Physiology (BS18T)
- Electronic Devices and Circuits (BM03T)

Course Objectives:

- Understand the principles of X-ray production, interaction with matter, and attenuation, and apply them to operate a total radiographic system effectively.
- Master techniques in advanced imaging modalities such as fluoroscopy, digital subtraction angiography, computed radiography, digital radiography, and mammography.
- Gain proficiency in utilizing CT technology, including scanner configurations, reconstruction techniques, and applications in clinical settings, as well as understanding the production and clinical applications of RF waves and linear accelerators.

Course Outcomes:

Learner will be able to:

CO1: Understand the basics of X-ray technology.

CO2: Explain the working principles of radiographic procedures.

CO3: Understand the working principles of different digital imaging technologies like computed radiography (CR) and digital radiography (DR).

CO4: Understand the working CT imaging technique.

CO5: Illustrate advanced applications of CT imaging.

CO6: Understand the components of linear accelerators.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Suggested list of Practicals:

1. Design and Implementation of X-Ray System Component-Timing Circuit.
2. Design and Implementation of X-Ray System Component-Exposure Circuit.
3. Design and Implementation of Digital Subtraction in sample X-Ray Images.
4. Generate Sinogram of Image.
5. Perform CT Windowing on an Image.
6. Design and Implementation of Back Projection Algorithm for CT Images.
7. Problem Based Activity on assigned topic

Guidelines to conduct practical sessions:

1. The Laboratory work is to be conducted by a group of three-five students.
2. To encourage project-based learning in the curriculum students may either select one of the commercial biosensors for a review.
3. Each group along with subject faculty shall identify a potential biosensor, on which the study can be conducted. They can perform real or virtual experiments related to the topic selected in the laboratory along with regular experiments.
4. Students should prepare working models, power point presentation, posters etc. on the selected topics.
5. The assessment will be done at the end of the semester.

Suggested Online Courses:

1. Introduction to Biomedical Imaging
   https://www.edx.org/course/introduction-to-biomedical-imaging
2. Fundamentals of Biomedical Imaging: Ultrasounds, X-ray, positron emission tomography (PET) and applications
   https://www.edx.org/course/fundamentals-of-biomedical-imaging-ultrasounds-x-r

Reference Books:

1. Thomas S. Curry, James E. Dowdey, Robert C. Murry, "Christensen's Physics of Diagnostic Radiology", Lippincott Williams & Wilkins, 1990.
2. William R. Hendee, E. Russell Ritenour, "Medical Imaging Physics", Wiley-Liss, 2002.
3. Angela M. Duxbury, Pam Cherry, "Practical Radiotherapy: Physics and Equipment ", Wiley-Blackwell, 2009.
4. James Moore, George Zouridakis, "Biomedical Technology and Devices", CRC Press, 2013.
5. David Dowsett, Patrick A Kenny, R Eugene Johnston, "The Physics of Diagnostic Imaging", CRC Press, 2006.