VIT Vidyalankar Institute of Technology
Accredited A+ by NAAC

Vidyalankar Institute of Technology

An Autonomous Institute affiliated to University of Mumbai

Bachelor of Technology

in

Biomedical Engineering

Final Year Scheme & Syllabus

(As per AICTE guidelines, with effect from Academic Year 2025-26)

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

Final Year B. Tech. Biomedical Engineering **Semester: VII**

Course Structure and Assessment guidelines

Course		Head of Learning	Credits	Assessment guidelines (Marks)			Total marks (Passing@40% of total marks)
Code	Name			ISA	MSE	ESE	
BMXXT	Prof. Elective 4	Theory	2	15	20	40	075
BMXXP	Prof. Elective 4 Lab	Practical	1	25	-	25	050
BMXXT	Prof. Elective 5	Theory	2	15	20	40	075
BMXXP	Prof. Elective 5 Lab	Practical	1	25	-	25	050
BMXXT	Prof. Elective 6	Theory	2	15	20	40	075
BMXXP	Prof. Elective 6 Lab	Practical	1	25	-	25	050
OEXX*	Any 2 from the offered Open Elective courses	Theory	3	20	30	50	100
OEXX*		Theory	3	20	30	50	100
BM42	Project-1 Synopsis	Theory	3	50	-	50	100
		Total	**18**				
Course credits completed during the previous inter-semester break will appear in this semester marksheet							
BM41	Industry Internship	Practical	5	75	-	75	150

ISA=In Semester Assessment, MSE= Mid Semester Examination, ESA= End Semester Examination

*Selection based on the subset of OE courses made available by the Institute for the semester.

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.

Professional Elective -4 Courses (BMXX)

Specialization Track Name#	Course		Head of Learning	Credits	Assessment guidelines (Marks)			Total marks (Passing@40% of total marks)
	Code	Name			ISA	MSE	ESE	
Artificial Intelligence-Machine Learning (AIML)	BM30T	Deep learning	Theory	2	15	20	40	075
	BM30P	Deep learning Lab	Practical	1	25	-	25	050
Internet of Things (IoT)	BM31T	Internet of Things (IoT) and Edge Computing	Theory	2	15	20	40	075

Specialization Track Name#	Course		Head of Learning	Credits	Assessment guidelines (Marks)			Total marks (Passing@40% of total marks)
	Code	Name			ISA	MSE	ESE	
	BM31P	Internet of Things (IoT) and Edge Computing Lab	Practical	1	25	-	25	050
Biomedical Technology and Innovation (BTI)	BM32T	Biomedical Equipment Safety	Theory	2	15	20	40	075
	BM32P	Biomedical Equipment Safety Lab	Practical	1	25	-	25	050

#For details of Specialization Certificate, refer Appendix-A

Professional Elective -5 Courses (BMXX)

Specialization Track Name#	Course		Head of Learning	Credits	Assessment guidelines (Marks)			Total marks (Passing@40% of total marks)
	Code	Name			ISA	MSE	ESE	
Artificial Intelligence-Machine Learning (AIML)	BM33T	Data Analytics	Theory	2	15	20	40	075
	BM33P	Data Analytics Lab	Practical	1	25	-	25	050
Internet of Things (IoT)	BM34T	Internet of Things (IoT) Security and Trust	Theory	2	15	20	40	075
	BM34P	Internet of Things (IoT) Security and Trust Lab	Practical	1	25	-	25	050
Biomedical Technology and Innovation (BTI)	BM35T	Medical Device Regulation	Theory	2	15	20	40	075
	BM35P	Medical Device	Practical	1	25	-	25	050

		Regulation Lab						

#For details of Specialization Certificate, refer Appendix-A

Professional Elective -6 Courses (BMXX)

Specialization Track Name#	Course		Head of Learning	Credits	Assessment guidelines (Marks)			Total marks (Passing@40% of total marks)
	Code	Name			ISA	MSE	ESE	
Artificial Intelligence-Machine Learning (AIML)	BM36T	Basics of Natural Language Processing	Theory	2	15	20	40	075
	BM36P	Basics of Natural Language Processing Lab	Practical	1	25	-	25	050
Internet of Things (IoT)	BM37T	Industrial Internet of Things (IIoT)	Theory	2	15	20	40	075
	BM37P	Industrial Internet of Things (IIoT) Lab	Practical	1	25	-	25	050
Biomedical Technology and Innovation (BTI)	BM38T	Installation & Maintenance of Medical Equipment	Theory	2	15	20	40	075
	BM38P	Installation & Maintenance of Medical Equipment Lab	Practical	1	25	-	25	050

#For details of Specialization Certificate, refer Appendix-A

Final Year B. Tech. Biomedical Engineering **Semester: VIII**

Course Structure and Assessment guidelines

Course		Head of Learning	Credits	Assessment guidelines (Marks)			Total marks (Passing@40% of total marks)
Code	Name			ISA	MSE	ESE	
OEXX*	Any 3 Open Elective courses from the list offered.	Theory	3	20	30	50	100
OEXX*		Theory	3	20	30	50	100
OEXX*		Theory	3	20	30	50	100
BM43	Publication / Patent	Practical	2	25		50	075
BM44	Project 2 - Demonstration	Theory+ Practical	4	75	-	50	125
		Total	**15**				

ISA=In Semester Assessment, MSE= Mid Semester Examination, ESA= End Semester Examination
*Selection based on the subset of OE courses made available by the Institute for the semester.

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.

Open Elective Courses

Open Elective bucket offers number of courses at Institute level for all branches. The Learner is expected to complete requirement of 15 credits by taking 5 courses as suggested in their program structure.

The following is the list of the courses offered by Institute.

Sr. No.	Course Code	Course Title	Hours Per Week			Credits
			Theory	Practical	Tutorial	
1	OE01	Cyber Law	3	-	-	3
2	OE02	Project Management	3	-	-	3

Sr. No.	Course Code	Course Title	Hours Per Week			Credits
			Theory	Practical	Tutorial	
3	OE03	Product Lifecycle Management	3	-	-	3
4	OE04	Sustainability Management	3	-	-	3
5	OE05	Operation Research	3	-	-	3
6	OE06	IPR and Patenting	3	-	-	3
7	OE07	Research Methodology	3	-	-	3
8	OE08	Renewable Energy Management	3	-	-	3
9	OE09	Energy Audit and Management	3	-	-	3
10	OE11	Bioinformatics	3	-	-	3
11	OE12	Nanotechnology	3	-	-	3

Detailed Syllabus of Final Year Semester-VII

Course Name: Deep learning

Course Code: BM30T

Category: Professional Elective

Preamble: This course provides a practical and theoretical foundation in Deep Learning, focusing on the design, training, and application of deep neural networks. Students will explore advanced models such as CNNs, Autoencoders, RNNs, Transformers, and GANs, and apply them to real-world tasks in vision, language, and generative AI. Emphasizing implementation and concepts, the course prepares learners to build and optimize deep learning systems for research and industry use.

Pre-requisites:

1. Engineering Mathematics-I(BS02)
2. Engineering Mathematics-II(BS04)
3. Engineering Mathematics-III(BS06)
4. Engineering Mathematics-IV(BS08)
5. Python Programming (BM08T&P)
6. Machine Learning (BM27T&P)

Course Objectives:

- To introduce the foundational principles and architectures of deep neural networks, enabling students to understand their structure, activation behaviors, and the challenges involved in training deep models.
- To develop the ability to apply advanced training, optimization, and regularization techniques for effectively building and tuning deep learning models in real-world applications.
- To equip students with the skills to design and analyze specialized architectures, including Convolutional Neural Networks (CNNs), Autoencoders, and Recurrent Neural Networks (RNNs), for tasks involving images, sequences, and feature representation.
- To explore modern trends in deep learning through generative and attention-based models, such as GANs and Transformers, and understand their applications in vision, language, and synthetic data generation.

Course Outcomes:

Learner will be able to:

CO1: Explain the architecture, functioning, and training challenges of deep neural networks, including the role of activation functions and weight initialization.

CO2: Implement training strategies using optimization algorithms like Adam and SGD, and apply regularization methods to improve model generalization.

CO3: Construct CNN architectures and analyze their performance on image-based tasks using concepts like convolution, pooling, and transfer learning.

CO4: Compare different types of autoencoders and evaluate their effectiveness in tasks like data compression, feature learning, and anomaly detection.

CO5: Use RNNs, LSTMs, and GRUs to model temporal or sequential data and solve real-world problems in domains such as time series or natural language.

CO6: Design generative and attention-based models to perform tasks such as image generation or text modeling, and explore modern trends in deep learning.

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	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	Deep Learning Fundamentals & Network Architectures	• Recap: Need for Deep Learning beyond traditional ML • Deep Neural Networks: Depth vs width, representation power • Forward and Backward Propagation: Detailed explanation • Challenges in deep learning: Vanishing/exploding gradients • Activation functions in depth: ReLU, Leaky ReLU, Softmax, ELU • Weight initialization strategies (Xavier, He initialization)	5
2	Optimization and Regularization Technique	• Deep learning training pipelines • Optimization algorithms: SGD, Momentum, Nesterov, RMSProp, Adam, AdamW • Learning rate strategies: decay, warm-up, cyclic schedulers	5

		• Overfitting and generalization revisited • Regularization techniques: Dropout, Batch Normalization, L1/L2, Early stopping Data augmentation, label smoothing, CutMix, MixUp	
3	Convolutional Neural Networks (CNNs)	• Convolution operations, padding, stride, pooling • CNN architecture components: Conv layer, pooling, FC layers • Popular architectures: LeNet, AlexNet, VGG, ResNet (skip connections) MobileNet (depthwise separable conv) – for edge devices • Feature extraction and transfer learning basics	5
4	Autoencoders and Representation Learning	• Undercomplete vs Overcomplete Autoencoders • Sparse, Denoising, and Contractive Autoencoders • Variational Autoencoders (VAE) – Introduction and intuition • Applications: Anomaly detection, feature compression, denoising	4
5	Recurrent Neural Networks and Sequence Models	• Sequence modeling: applications and challenges • RNNs and Backpropagation Through Time (BPTT) • LSTM and GRU: gating mechanisms, comparison • Bidirectional RNNs and stacked RNNs • Attention mechanism – basic intuition and role in sequence modeling	5
6	Transformers and Generative Models	• Transformers: self-attention mechanism, encoder-decoder structure • Applications: NLP and Vision (ViT – overview) • Introduction to BERT and GPT (functional understanding) • GANs: architecture and training dynamics • DCGAN, Conditional GAN – overview • Applications: Image generation, deepfakes, augmentation	6
Total			30

Reference Books:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville. —Deep Learning||, MIT Press Ltd, 2016

2. Li Deng and Dong Yu, —Deep Learning Methods and Applications||, Publishers Inc.
3. Satish Kumar "Neural Networks A Classroom Approach" Tata McGraw-Hill.
4. JM Zurada —Introduction to Artificial Neural Systems||, Jaico Publishing House
5. M. J. Kochenderfer, Tim A. Wheeler. —Algorithms for Optimization||, MIt Press.
6. Buduma, N. and Locascio, N., —Fundamentals of deep learning: Designing next-generation
7. Machine intelligence algorithms" 2017. O'Reilly Media, Inc.".
8. François Chollet. —Deep learning with Python —(Vol. 361). 2018 New York: Manning.
9. Douwe Osinga. —Deep Learning Cookbook||, O'REILLY, SPD Publishers, Delhi.
10. Simon Haykin, Neural Network- A Comprehensive Foundation- Prentice Hall International, Inc

Useful Links:

1. https://nptel.ac. https://deeplearning.cs.cmu.edu/S21/index.html
2. http://www.cse.iitm.ac.in/~miteshk/CS6910.html
3. https://nptel.ac.in/courses/106/106/106106184/
4. https://www.deeplearningbook.org
5. https://huggingface.co/learn/nlp-course
6. https://jovian.ai/learn/deep-learning-with-pytorch-zero-to-gans
7. https://course.fast.ai
8. https://cs231n.stanford.edu/

Course Name: Deep learning Lab

Course Code: BM30P

Category: Professional Elective

Preamble: This course provides a practical and theoretical foundation in Deep Learning, focusing on the design, training, and application of deep neural networks. Students will explore advanced models such as CNNs, Autoencoders, RNNs, Transformers, and GANs, and apply them to real-world tasks in vision, language, and generative AI. Emphasizing implementation and concepts, the course prepares learners to build and optimize deep learning systems for research and industry use.

Pre-requisites:

1. Engineering Mathematics-I(BS02)
2. Engineering Mathematics-II(BS04)
3. Engineering Mathematics-III(BS06)
4. Engineering Mathematics-IV(BS08)
5. Python Programming (BM08T&P)
6. Machine Learning (BM27T&P)

Course Objectives:

- To introduce the foundational principles and architectures of deep neural networks, enabling students to understand their structure, activation behaviors, and the challenges involved in training deep models.
- To develop the ability to apply advanced training, optimization, and regularization techniques for effectively building and tuning deep learning models in real-world applications.
- To equip students with the skills to design and analyze specialized architectures, including Convolutional Neural Networks (CNNs), Autoencoders, and Recurrent Neural Networks (RNNs), for tasks involving images, sequences, and feature representation.
- To explore modern trends in deep learning through generative and attention-based models, such as GANs and Transformers, and understand their applications in vision, language, and synthetic data generation.

Course Outcomes:

Learner will be able to:

CO1: Explain the architecture, functioning, and training challenges of deep neural networks, including the role of activation functions and weight initialization.

CO2: Implement training strategies using optimization algorithms like Adam and SGD, and apply regularization methods to improve model generalization.

CO3: Construct CNN architectures and analyze their performance on image-based tasks using concepts like convolution, pooling, and transfer learning.

CO4: Compare different types of autoencoders and evaluate their effectiveness in tasks like data compression, feature learning, and anomaly detection.

CO5: Use RNNs, LSTMs, and GRUs to model temporal or sequential data and solve real-world problems in domains such as time series or natural language.

CO6: Design generative and attention-based models to perform tasks such as image generation or text modeling, and explore modern trends in deep learning.

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.

Guidelines to conduct practical sessions and Mini projects:

1. The Mini Project work should be carried out by a group of 2 to 3 students to promote collaborative learning and workload sharing.
2. To foster project-based learning, students are required to select a project topic from a suggested list or propose their own topic, which must be approved by the course instructor through a review process.
3. In addition to the mini project, each student must complete a minimum of 8 practical sessions during the course. These sessions will cover core deep learning implementations using frameworks like TensorFlow, Keras, or PyTorch.
4. Out of the 8 practicals, at least 3 sessions should involve the use of pretrained models or advanced techniques such as transfer learning, attention mechanisms, or generative models.
5. Practical assessments must be conducted weekly to evaluate student progress, while mini project assessments should be conducted at least twice during the semester – once mid-way and once before final submission.
6. It is recommended to certify the practical completion during the final lab session, so that no separate submission is required at the end of the semester.

Suggested List of Practicals:

1. Implement a basic Feedforward Neural Network (FNN)
   - Train on a small dataset (e.g., Iris or digits) using ReLU and Softmax activations.
2. Effect of activation functions and weight initialization
   - Compare Sigmoid, Tanh, ReLU, and Leaky ReLU with different initialization strategies.
3. Visualize loss surface and training curves
   - Plot training/validation loss for shallow vs deep networks.

4. Train a DNN using different optimizers
   - SGD, Adam, RMSProp on MNIST; compare convergence behavior.
5. Regularization techniques: Dropout and Batch Normalization
   - Apply and analyze their effect on overfitting.
6. Data Augmentation in image datasets
   - Use techniques like flipping, rotation, zooming with Keras ImageDataGenerator.
7. Build a basic CNN for handwritten digit recognition (MNIST)
   - Use Conv2D, MaxPooling, Flatten, and Dense layers.
8. Train and evaluate deeper CNN models (e.g., VGG-like)
   - Compare accuracy and training time with basic CNN.
9. Transfer learning with a pre-trained model (e.g., MobileNet or VGG16)
   - Fine-tune last few layers for a custom image classification task.
10. Build an undercomplete autoencoder
    - Train it for image reconstruction using MNIST or Fashion-MNIST.
11. Implement a denoising autoencoder
    - Add noise to input images and compare reconstructed output.
12. Explore latent space with Variational Autoencoder (VAE) (optional/advanced)
    - Visualize learned embeddings and reconstruction accuracy.
13. Build and train a simple RNN for character-level text generation
    - Use a small text corpus and predict next characters.
14. Sentiment classification using LSTM
    - Apply LSTM to IMDB dataset or any custom text dataset.
15. Use a pre-trained Transformer model for text classification or question answering
    - Example: Use BERT via Hugging Face's Transformers library on a text dataset.

Reference Books:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville. —Deep Learning||, MIT Press Ltd, 2016
2. Li Deng and Dong Yu, —Deep Learning Methods and Applications||, Publishers Inc.
3. Satish Kumar "Neural Networks A Classroom Approach" Tata McGraw-Hill.
4. JM Zurada —Introduction to Artificial Neural Systems||, Jaico Publishing House
5. M. J. Kochenderfer, Tim A. Wheeler. —Algorithms for Optimization||, MIt Press.
6. Buduma, N. and Locascio, N., —Fundamentals of deep learning: Designing next-generation
7. Machine intelligence algorithms" 2017. O'Reilly Media, Inc.".
8. François Chollet. —Deep learning with Python —(Vol. 361). 2018 New York: Manning.
9. Douwe Osinga. —Deep Learning Cookbook||, O'REILLY, SPD Publishers, Delhi.
10. Simon Haykin, Neural Network- A Comprehensive Foundation- Prentice Hall International, Inc

Useful Links:

1. https://nptel.ac. https://deeplearning.cs.cmu.edu/S21/index.html
2. http://www.cse.iitm.ac.in/~miteshk/CS6910.html
3. https://nptel.ac.in/courses/106/106/106106184/

4. https://www.deeplearningbook.org
5. https://huggingface.co/learn/nlp-course
6. https://jovian.ai/learn/deep-learning-with-pytorch-zero-to-gans
7. https://course.fast.ai
8. https://cs231n.stanford.edu/

Course Name: Internet of Things and Edge Computing

Course Code: BM31T

Category: Professional elective - 4 (IoT Track)

Preamble:

This course explores the convergence of Internet of Things (IoT) and Edge Computing, delving into the technologies and applications that are transforming our world. This course delves into the rapidly evolving landscape where everyday objects are becoming intelligent and interconnected. Students will explore how sensors, actuators, and embedded systems are weaving a web of data, transforming how we live, work, and interact with the environment.

The course will equip students with a foundational understanding of IoT, its core technologies, and communication protocols. Students will delve into the power of Edge Computing, a paradigm shift that brings processing capabilities closer to the data source, enabling real-time analytics, faster decision-making, and improved efficiency.

Pre-requisites:

Structured Programming(ES 04T&P)
Microprocessors and Microcontrollers(bm10T&P)
Modern Sensors for Internet of Things (IoT)(BM22T&P)

Course Objectives:

- To understand the core concepts of the Internet of Things (IoT) and its key components & Levels.
- Analyze the role of Edge Computing in distributed processing and data analysis within the IoT ecosystem**.**
- Evaluate the security challenges and potential vulnerabilities within IoT deployments.
- Understand the fundamental concepts of IoT, CPS, and their convergence.

Course Outcomes:

Student will be able to:

CO1: Understand the interaction between IoT devices, cloud platforms, and physical systems in CPS.

CO2: Apply principles of Edge Computing to analyze data at the network edge.

CO3: Analyze the role of Edge Computing in distributed processing and data analysis within the IoT ecosystem.

CO4: Identify and discuss security best practices for secure IoT deployments.

CO5: Analyze the role of cloud computing in managing and processing data from IoT device

CO6: Develop creative applications of IoT technology in chosen fields.

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	75

The assessment guidelines for the courses of different credits are mentioned in the above table. 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	Introduction to IoT and CPS	1.1 Introduction to Cyber-Physical Systems (CPS) 1.2 Characteristics and applications of CPS 1.3 Convergence of IoT and CPS: creating intelligent systems	5
2	Introduction to Edge Computing	2.1 What is Edge Computing? 2.2 Benefits of Edge Computing in the IoT ecosystem (e.g., reduced latency, improved efficiency) 2.3 Edge Computing architectures (e.g., edge nodes, fog computing) Resource constraints and limitations of edge devices	5

3	Edge Computing Applications and Programming	3.1 Case studies of Edge Computing applications in IoT (e.g., predictive maintenance, autonomous vehicles) 3.2 Introduction to Edge Computing development tools and frameworks 3.3 Programming for edge devices (e.g., embedded systems programming)	5
4	Security Considerations in IoT	4.1 Security vulnerabilities in IoT deployments 4.2 Authentication and authorization mechanisms 4.3 Data encryption and privacy concerns 4.4 Secure coding practices for IoT devices	5
5	Cloud Computing for IoT	5.1 Cloud service models for IoT (IaaS, PaaS, SaaS) 5.2 Benefits of cloud computing in managing and processing IoT data (scalability, security, etc.) 5.3 Cloud platforms for IoT (e.g., AWS IoT, Azure IoT) 5.4 Data pipelines for transferring and processing sensor data in the cloud	5
6	Future Trends in IoT CPS and Edge Computing	6.1 Emerging technologies (e.g., Artificial Intelligence, Block chain) in IoT 6.2 Impact of 5G on IoT and Edge Computing 6.3 Ethical considerations and responsible development of CPS solutions	5
Total			**30**

Text Books:

1. "Cyber-Physical Systems: Design and Analysis" by Lee E. Miller (2013)
2. "Cloud Computing for Cyber Physical Systems: Enabling Technologies and Applications" by Vijayakumar Gayathri, et al. (2019)
3. "Hands-On Internet of Things with Arduino and Raspberry Pi: Building Practical Applications" by Dr. Srinivas Upputuri (2020)
4. "Building IoT Projects with ESP8266 and ESP32" by Pradeeka Kumar (2020)
5. "Edge Computing for the Internet of Things: Secure and Scalable Distributed Intelligence" by Michael Dieterich (2020)
6. "Cyber-Physical Systems Prototyping with Lego Mindstorms" by Wesley Plugge et al. (2014)

Reference Books:

1. "Designing the Internet of Things" by Adrian McEwen and Hakim Cassimally (2014)
2. "Edge Computing: Networking and Security for the Internet of Things" by Yuhui Xu, et al. (2018)
3. "Fog Computing: Theory, Practice, and Applications" by Tom Pfeifer and Dominic Grulich (2019)

Course Name: Internet of Things and Edge Computing Laboratory

Course Code: BM31P

Category: Professional elective - 4 (IoT track)

Preamble:

This laboratory course delves into the practical applications of the Internet of Things (IoT), Edge Computing, Cloud Computing, and Cyber-Physical Systems (CPS). Students will gain hands-on experience by working with real-world scenarios and exploring the interaction between these technologies
The lab will equip students with the skills to:

- Design and implement basic IoT systems
- Utilize Edge Computing platforms for data processing closer to the source
- Leverage cloud services for data storage, analysis, and visualization
- Integrate IoT devices with Cyber-Physical Systems for real-world applications

Pre-requisites:

- Structured Programming(ES 04T&P)
- Microprocessors and Microcontrollers(bm10T&P)
- Modern Sensors for Internet of Things (IoT)(BM22T&P)

Course Objectives:

- Gain practical experience in setting up and configuring IoT devices.
- Understand and implement data collection and processing techniques on edge devices.
- Analyze and visualize data generated by IoT devices using cloud platforms.
- Design and implement basic Cyber-Physical Systems using IoT and cloud integration.
- Apply security best practices in developing and deploying IoT solutions.

Course Outcomes:

Student will be able to:
CO1: Successfully configure and program various IoT devices (sensors, actuators).
CO2: Utilize Edge Computing platforms for data processing tasks on edge nodes.
CO3: Develop data pipelines to transfer data from IoT devices to the cloud.
CO4: Analyze and visualize sensor data using cloud-based tools and services.
CO5: Design and prototype a basic Cyber-Physical System with IoT and cloud integration.
CO6: Implement secure communication protocols for data transmission in an IoT system.

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 in the above table. 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.

List of Practical's:

Experiment 1: Setting Up an IoT Development Environment

Familiarize with development boards (e.g., Arduino, Raspberry Pi

Install necessary software and libraries

Experiment 2: Sensor Interfacing and Data Acquisition

- Interface various sensors (e.g., temperature, humidity) with the development board
- Write code to collect and record sensor data

Experiment 3: Communication Protocols for IoT

- Experiment with different communication protocols (e.g., Wi-Fi, Bluetooth)
- Develop code to send and receive data between devices

Experiment 4: Introduction to Edge Computing Platforms

- Explore popular Edge Computing platforms (e.g., AWS Greengrass, Azure IoT Edge)
- Deploy simple applications for data processing on edge devices

Experiment 5: Cloud Integration for IoT Data

- Connect IoT devices to a cloud platform (e.g., AWS IoT, Azure IoT Hub)
- Develop code to send sensor data to the cloud

Experiment 6: Data Visualization with Cloud Services

- Utilize cloud platform tools to visualize sensor data in real-time (e.g., dashboards, charts)

Experiment 7: Introduction to Cyber-Physical Systems (CPS)

- Simulate a basic CPS scenario (e.g., smart home, industrial automation)
- Integrate IoT devices with actuators to control physical processes

Experiment 8: Security Considerations in IoT Systems

- Implement secure communication protocols (e.g., encryption)
- Understand best practices for securing data transmission and storage in IoT

Mini Projects / Case Study:

Design and develop a complete IoT-based system with Edge Computing and Cloud integration

Text Books:

1. "Cyber-Physical Systems: Design and Analysis" by Lee E. Miller (2013)
2. "Cloud Computing for Cyber Physical Systems: Enabling Technologies and Applications" by Vijayakumar Gayathri, et al. (2019)
3. "Hands-On Internet of Things with Arduino and Raspberry Pi: Building Practical Applications" by Dr. Srinivas Upputuri (2020)
4. "Building IoT Projects with ESP8266 and ESP32" by Pradeeka Kumar (2020)
5. "Edge Computing for the Internet of Things: Secure and Scalable Distributed Intelligence" by Michael Dieterich (2020)
6. "Cyber-Physical Systems Prototyping with Lego Mindstorms" by Wesley Plugge et al. (2014)

Reference Books:

1. "Designing the Internet of Things" by Adrian McEwen and Hakim Cassimally (2014)
2. "Edge Computing: Networking and Security for the Internet of Things" by Yuhui Xu, et al. (2018)
3. "Fog Computing: Theory, Practice, and Applications" by Tom Pfeifer and Dominic Grulich (2019)

Course Name: Biomedical Equipment Safety

Course Code: BM32T

Category: Professional Elective

Preamble:
Biomedical Equipment Safety is a critical area in healthcare technology management. This course provides engineering students with the knowledge and tools to ensure that biomedical devices function safely and effectively in clinical environments. With the increasing use of sophisticated medical devices in diagnostics, therapy, and monitoring, understanding and implementing equipment safety is crucial for patient safety and healthcare outcomes.

Pre-requisites:

- Critical Care Equipment (BM13T&P)
- Diagnostic and Monitoring Equipment (BM09T&P)
- Human Physiology & Anatomy(BS18T&P)

Course Objectives:

- To enable learners to understand the roles of engineers and hospital staff in ensuring safety.
- To enable learners to explore electrical hazards associated with biomedical equipment.
- To enable learners to study radiation hazards (ionizing and non-ionizing) and control methods.
- To enable learners to understand infection control and sterilization practices in equipment use.
- To enable learners to understand safety testing and calibration tools and techniques.
- To enable learners to analyze real-world incidents and evaluate system failures.

Course Outcomes:

Learner will be able to:
CO1: Identify categories of medical equipment risks.
CO2: Differentiate between macro and micro shock and their physiological effects.
CO3: Understand radiation protection principles and regulatory norm.
CO4: Understand basic calibration and safety checks.
CO5: Perform basic safety tests using appropriate analyzers (ECG, defib, etc.).
CO6: Develop recommendations from case study analysis.

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	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	Introduction to Biomedical Equipment Safety	Overview of biomedical equipment safety, Types of hazards (electrical, mechanical, biological), Accident case studies, Safety standards: IEC 60601, BIS, Indian regulatory bodies: CDSCO, NABH	5
2	Electrical Safety in Medical Equipment	Electrical hazards and shock types, Earth grounding and insulation, 8. Leakage current and test methods, Isolation techniques in equipment, Safety analyzers: usage and interpretation, Case studies of electrical safety failures	6
3	Mechanical and Radiation Safety	Mechanical hazards and safeguards, Pressure-related injuries in suction, ventilators, Radiation types, risks, ALARA principle, Radiology equipment shielding and signage.	4
4	Safety Testing, Calibration, and Maintenance	Preventive and predictive maintenance, Functional testing and performance verification, Safety testing tools (ESU analyzer, Defib analyzer), Calibration of sensors and transducers, Documentation and equipment history log, Biomedical maintenance SOPs	6
5	Testing, Calibration & Quality Assurance	Overview of quality assurance in biomedical equipment, Equipment acceptance testing vs routine testing, Calibration protocols and traceability, ISO standards for quality management in healthcare (e.g., ISO 13485), Biomedical QA documentation and audit trails, Role of Biomedical Engineers in hospital quality committees	5
6	Safety Standards, Regulations, and Case Studies	Deep dive into: IEC 60601 compliance process, CDSCO approval for new equipment, National regulations on medical device safety, Comparing global vs Indian safety regulations (FDA vs CDSCO), Case studies:	4
Total			**30**

Suggested list of Assignments:

1. Classification of pacemakers and their applications.
2. Defibrillators need and types.
3. Role of Anesthesia machine and parts.
4. Different output waveforms of Surgical Equipment.
5. Functional block diagram of HLM
6. Dialysis principle and working of blocks.

Suggested List of Value-Added Home Assignments:

1. Reviewing Literature in the form of a technical paper based on specialized equipment.
2. Novel technical paper writing based on recent advancements.
3. Problem Based Learning on Equipment

Suggested Online Courses:

1. Introduction to Biomedical Engineering
   https://www.coursera.org/learn/bioengineering
2. Foundations of Healthcare Systems Engineering
   https://www.coursera.org/learn/foundations-of-healthcare-systems-engineering

Reference Books:

1. R S. Khandpur, "Handbook of Biomedical Instrumentation", PH Publication, Third edition, 2014.
2. J G. Webster, "Medical Instrumentation, Application and Design", John Wiley Publication, 2012
3. Leislie Cromwell, Fred J. Weibell, Enrich A. Pfeiffer, "Biomedical Instrumentation and measurements". PHI Publication, 1990.

Course Name: Biomedical Equipment Safety Lab

Course Code: BM32 P

Category: Professional Elective

Preamble:

This course introduces students to different critical care equipment which are life-saving equipment. The course covers working principle and development in this category of the equipment.

Pre-requisites:

- Critical Care Equipment (BM13T&P)
- Diagnostic and Monitoring Equipment (BM09T&P)
- Human Physiology & Anatomy(BS18T&P)

Course Objectives:

- To enable learners to understand the basic blocks of Pacemakers.
- To enable learners to understand the working of Defibrillators.
- To enable learners to understand the different blocks of instrumentation involved in Anesthesia machine and Capnograph.
- To enable learners to learn fundamentals of surgical equipment.
- To enable learners to understand the working of heart-lung machine.
- To enable learners to understand the functions of different blocks of Dialysis machine**.**

Course Outcomes:

Learner will be able to:
CO1: Understand the working principle and recent developments in Cardiac Pacemakers.
CO2: Demonstrate performance of Defibrillators.
CO3: Express the importance of use of Anesthesia machine and Capnograph during Surgery.
CO4: Explain the basic principle, working and applications of surgical equipment with safety aspects.
CO5: Describe the importance and application of heart lung machine during surgery.
CO6: Summarize the basic principle of Dialysis and compare its types.

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. Implementation and testing of basic circuit of pacemaker.
2. Implementation of NAND Gate Oscillator in Surgical Diathermy.
3. Implementation of RLC Over damped system.
4. Demonstration of Defibrillator.
5. Demonstration of Pacemaker.
6. Demonstration of Surgical Diathermy.
7. Industry / Hospital visits.

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:

Introduction to Biomedical Engineering
https://www.coursera.org/learn/bioengineering
Foundations of Healthcare Systems Engineering
https://www.coursera.org/learn/foundations-of-healthcare-systems-engineering

Reference Books:

1. R S. Khandpur, "Handbook of Biomedical Instrumentation", PH Publication, Third edition, 2014.
2. J G. Webster, "Medical Instrumentation, Application and Design", John Wiley Publication, 2012

3. Leislie Cromwell, Fred J. Weibell, Enrich A. Pfeiffer, "Biomedical Instrumentation and measurements". PHI Publication, 1990.

Course Name: Data Analytics

Course Code: BM33T

Category: Professional Elective

Preamble:

This course introduces students to essential data analytics techniques, focusing on data preparation, visualization, statistical analysis, and interpretation. With prior knowledge of Machine Learning, students will focus on the foundational analytics workflow to make datasets analysis-ready and insights-driven using Python or Excel.

Pre-requisites:

Python Programming (BM08 T&P)
Integrated Database Management (BM21 T&P)
Artificial Intelligence (BM24 T&P)
Machine Learning (BM27T&P)

Course Objectives:

- Understand data analytics concepts and real-world applications.
- Collect, clean, and preprocess data using Python or Excel
- Explore datasets using visualization and summary statistics.
- Apply statistical tests and basic regression.
- Interpret and communicate analytical findings through projects.

Course Outcomes:

CO1: Learners will explain the fundamental concepts, types, and applications of data analytics across various domains. *(Bloom's Level: Understand)*
CO2: Learners will perform data collection, cleaning, and preprocessing techniques to prepare raw data for analysis. *(Bloom's Level: Apply)*
CO3: Learners will analyze datasets using descriptive statistics and create visualizations to explore and summarize data. *(Bloom's Level: Analyze)*
CO4: Learners will apply basic statistical methods such as regression and hypothesis testing to derive insights from data. *(Bloom's Level: Apply)*
CO5: Learners will develop practical skills in data wrangling and visualization using Python (pandas, matplotlib) or Excel to analyze and present insights from real-world datasets. (Bloom's Level: Apply**)**
CO6: Learners will develop a mini data analytics project using Python or Excel, demonstrating the application of techniques to a real-world dataset. *(Bloom's Level: Create)*

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	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	Module Contents	No. of Hours
1	Introduction to Data Analytics	Definition and scope, types of analytics (descriptive, diagnostic, predictive, prescriptive), applications in healthcare, business, social media.	4
2	Data Collection and Preprocessing	Data types and sources, data acquisition, handling missing values and duplicates, normalization, encoding, introduction to Python (pandas, numpy) or Excel.	6
3	Exploratory Data Analysis (EDA).	Descriptive statistics (mean, median, mode, variance, std deviation), data visualization (histograms, scatter plots, box plots), correlation, covariance.	6
4	Statistical Methods for Data Analysis	Probability distributions, hypothesis testing (t-test, chi-square, ANOVA), simple linear regression and interpretation	6
5	Data Analytics Tools and Techniques	Hands-on data wrangling, visualization with Python (pandas, matplotlib) or Excel, practical case studies.	5
6	Ethics, Privacy, and Project	Data ethics, privacy and anonymization, mini project involving cleaning, analysis, reporting and presentation using real data.	3
Total			**30**

Recommended Online Courses:

1. Introduction to Data Analytics https://cognitiveclass.ai/courses/introduction-to-data-analytics
2. Data Visualization with Pythonhttps://cognitiveclass.ai/courses/data-visualization-with-python
3. Data Analysis with Pythonhttps://www.freecodecamp.org/learn/data-analysis-with-python/

4. Introduction to Data Analysis using Excel (Free on edX)https://www.edx.org/course/introduction-to-data-analysis-using-excel
5. Data Analysis with Python https://www.freecodecamp.org/learn/data-analysis-with-python/
6. Data Science: R Basics https://www.edx.org/course/data-science-r-basics
7. Data Visualization with Tableau Public https://www.udemy.com/course/tableau-public/

Reference Books / Articles

1. Hands-on Data Preprocessing in Python by Roy Jafari
2. Machine Learning with Python: Theory and Implementation by Amin Zollanvari
3. Practical Statistics for Data Scientists by Peter Bruce & Andrew Bruce
4. Practical Machine Learning with Python by Dipanjan Sarkar, Raghav Bali
5. Python for Data Analysis by Fabio Nelli
6. Introduction to Python for Computer Science and Data Science by Paul Deitel & Harvey Deitel

Course Name: Data Analytics Lab

Course Code: BM33P

Category: Professional elective

Preamble:

This course introduces students to essential data analytics techniques, focusing on data preparation, visualization, statistical analysis, and interpretation. With prior knowledge of Machine Learning, students will focus on the foundational analytics workflow to make datasets analysis-ready and insights-driven using Python or Excel.

Course Objectives:

- Understand key concepts and types of data analytics and their applications across various domains.
- Develop skills to collect, preprocess, and analyze data using Python or Excel tools.
- Apply statistical and visualization techniques to interpret data and communicate meaningful insights effectively.

Pre-requisites:

Python Programming(BM08 T&P)
Integrated Database Management(BM21 T&P)
Artificial Intelligence (BM24 T&P)
Machine Learning (BM27T&P)

Course Outcomes:

CO1: Learners will explain the fundamental concepts, types, and applications of data analytics across various domains. *(Bloom's Level: Understand)*
CO2: Learners will perform data collection, cleaning, and preprocessing techniques to prepare raw data for analysis. *(Bloom's Level: Apply)*
CO3: Learners will analyze datasets using descriptive statistics and create visualizations to explore and summarize data. *(Bloom's Level: Analyze)*
CO4: Learners will apply basic statistical methods such as regression and hypothesis testing to derive insights from data. *(Bloom's Level: Apply)*
CO5: Learners will develop practical skills in data wrangling and visualization using Python (pandas, matplotlib) or Excel to analyze and present insights from real-world datasets. (Bloom's Level: Apply**)**
CO6: Learners will develop a mini data analytics project using Python or Excel, demonstrating the application of techniques to a real-world dataset. *(Bloom's Level: Create)*

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/evaluation guidelines for the courses of different credits are mentioned in the above table. Not withstanding 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 a 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 Experiments

1. Introduction to types of analytics: Analyze examples from healthcare, business, and social media to classify descriptive, diagnostic, predictive, and prescriptive analytics.
2. Data acquisition and cleaning: Import datasets using Python (pandas) or Excel; handle missing values and duplicates to prepare clean data.
3. Data normalization and encoding: Apply Min-Max scaling and Z-score normalization; perform one-hot and label encoding on categorical data.
4. Descriptive statistics calculation: Compute mean, median, mode, variance, and standard deviation for a given dataset.
5. Data visualization: Create histograms, scatter plots, and box plots using matplotlib in Python or Excel charts.
6. Correlation and covariance analysis: Calculate correlation coefficients and covariance matrices to understand variable relationships.
7. Hypothesis testing: Conduct t-tests, chi-square tests, and ANOVA to determine statistical significance.
8. Simple linear regression: Build and interpret a simple linear regression model to predict outcomes based on independent variables.
9. Data wrangling: Perform data filtering, aggregation, merging, and reshaping to prepare datasets for analysis.
10. Case study analysis: Perform end-to-end exploration data analysis and basic modeling on a real-world dataset and present insights.

Guidelines to conduct practical sessions:

1. Group Work: Laboratory sessions will be carried out by groups of three to five students.

2. Project-Based Learning: Students are encouraged to select a case study topic of their choice, subject to review and approval by the course faculty, fostering a project-based learning approach.
3. Case Study Identification: In collaboration with the subject faculty, each group will identify a relevant area for the case study, upon which their research and analysis will be focused.
4. Presentation Preparation: Students will prepare presentations (e.g., PowerPoint slides) and posters to showcase their findings on the selected case study.
5. Virtual Labs: Students will have access to virtual labs to conduct experiments, simulations, and analysis related to their case study. These virtual labs will support learning in areas like medical equipment installation, maintenance, and calibration.
6. End-of-Semester Assessment: Evaluation of the students' work will take place at the end of the semester, based on their case study projects, virtual lab activities, and presentations.

Recommended Online Courses:

1. Introduction to Data Analytics https://cognitiveclass.ai/courses/introduction-to-data-analytics
2. Data Visualization with Python https://cognitiveclass.ai/courses/data-visualization-with-python
3. Data Analysis with Python https://www.freecodecamp.org/learn/data-analysis-with-python/
4. Introduction to Data Analysis using Excel (Free on edX) https://www.edx.org/course/introduction-to-data-analysis-using-excel
5. Data Analysis with Python https://www.freecodecamp.org/learn/data-analysis-with-python/
6. Data Science: R Basics https://www.edx.org/course/data-science-r-basics
7. Data Visualization with Tableau Public https://www.udemy.com/course/tableau-public/

Reference Books / Articles

1. Hands-on Data Preprocessing in Python by Roy Jafari
2. Machine Learning with Python: Theory and Implementation by Amin Zollanvari
3. Practical Statistics for Data Scientists by Peter Bruce & Andrew Bruce
4. Practical Machine Learning with Python by Dipanjan Sarkar, Raghav Bali
5. Python for Data Analysis by Fabio Nelli
6. Introduction to Python for Computer Science and Data Science by Paul Deitel & Harvey Deitel

Course Name: Internet of Things Security and Trust

Course Code: BM34T

Category: Professional elective - 5 (IoT Track)

Preamble:

The modern world is becoming increasingly interconnected through a technology called Internet of Things (IoT). IoT is rapidly evolving field that is transforming the way we live, work, and interact with the real world. This course is useful for learning security aspects of IoT applications. Security is a major requirement for IoT applications since variety of devices and networks are involved in IoT application. This course teaches fundamental aspects of security and different techniques for providing security to IoT application.

Pre-requisites:

Structured Programming (ES04T&P)
Object Oriented Programming (ES 05T&P)
Microprocessor and Microcontroller (BM10 T&P)

Course Objectives:

- To understand the core concepts of the IoT security.
- To explore different types of vulnerabilities and threats.
- To gain a foundational knowledge of testing.
- To gain foundation knowledge of tools and framework.
- To get understanding of firmware security aspects.
- To gain knowledge of common attack vectors.

Course Outcomes:

Student will be able to:
CO1: Understand the concepts of security in IoT system.
CO2: Implement mechanism to handle IoT Vulnerabilities and Threats.
CO3: Perform testing of IoT systems.
CO4: Use monitoring tools for providing IoT security.
CO5: Use techniques for efficient firmware design of IoT application.
CO6: Identify different attacks.

Course Scheme:

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

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 in the above table. 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	Introduction	Overview of industrial control systems (ICS), ICS operation & components, Perdue model, SCADA systems, Cyber-physical systems (CPS) & IoT	4
2	IoT Vulnerabilities and Threats	STRIDE methodology, OWASP Iot vulnerabilities, Privacy & trust, Insufficient authentication/authorization, Insufficient access control, Attacks on IoT data, Attacks on IoT layered architecture, Security concerns in IoT applications, Security concerns in SCADA	6
3	IoT Pen Testing	Active vulnerability analysis tools, Port scanning, Operating system fingerprinting and version scanning, Penetration testing, Attack surface mapping	6
4	Monitoring Tools	Exploitation using I2C & SPI, JTAG debugging and exploitation, Boundary scan, Test access ports	6
5	Firmware Implementation	Understanding firmware, Extracting firmware, Manual firmware extraction, Automated file system extraction, Firmware internals, Backdooring a firmware, Static & dynamic analysis	4

6	Attack Surfaces	Software defined radio, Exploiting ZIGBEE & BLE, Power analysis attack, Invasive attack, Perturbation - attacks, Electromagnetic side channel attack, fault injection attack, timing attack, covert channel attacks	4
Total			**30**

Text Books:

1. "Securing the Internet of Things", Shancang Li, Li Da Xu, Syngress, Elsevier, 2017.
2. "Security and Privacy in Internet of Things (IoTs) Models, Algorithms, and Implementations", Edited by Fei Hu, CRC Press, 2016.
3. "IoT Security Guide", DSCI, August 2022.

Reference Books:

1. "Practical Internet of Things Security", Brian Russell Drew Van Duren, Packt Publishing, 2016

Course Name: Internet of Things (IoT) Security and Trust Laboratory

Course Code: BM34P

Category: Professional Elective- 5 (IoT Track)

Preamble:

The modern world is becoming increasingly interconnected through a technology called Internet of Things (IoT). IoT is rapidly evolving field that is transforming the way we live, work, and interact with the real world. This course is useful for learning security aspects of IoT applications. Security is a major requirement for IoT applications since variety of devices and networks are involved in IoT application. This course teaches implementation of different security techniques for IoT application. It also enables learner to use standard tools and frameworks for developing efficient security solutions.

Pre-requisites:

Structured Programming (ES04T&P)
Object Oriented Programming (ES 05T&P)
Microprocessor and Microcontroller (BM10 T&P)

Course Objectives:

- To understand the core concepts of the IoT security.
- To explore different types of vulnerabilities and threats.
- To gain a foundational knowledge of testing.
- To gain foundation knowledge of tools and framework.
- To get understanding of firmware security aspects.
- To gain knowledge of common attack vectors.

Course Outcomes:

Student will be able to:
CO1: Identify metrics for providing security in IoT system.
CO2: Implement techniques for handling IoT Vulnerabilities and Threats.
CO3: Perform testing of IoT systems.
CO4: Use tools and frameworks for providing security to IoT applications.
CO5: Design efficient secure firmware for IoT applications.
CO6: Implement mechanism to handle different types of attacks in IoT application.

Course Scheme:

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

Assessment Scheme:

Head	ISA	MSA	ESA	Total
Practical	25	-	25	25

Suggested List of Practical:

All practical will be project based with focus on following concepts

1. Identification and implementation of standard metrics for providing security.
2. Handle different types of threats and vulnerabilities in IoT application.
3. Perform security testing of IoT application.
4. Identify and explore different tools for monitoring and providing security to IoT applications.
5. Design secure firmware for IoT application.
6. Handle different types of attacks in IoT application.

Text Books:

1. "Securing the Internet of Things", Shancang Li, Li Da Xu, Syngress, Elsevier, 2017.
2. "Security and Privacy in Internet of Things (IoTs) Models, Algorithms, and Implementations", Edited by Fei Hu, CRC Press, 2016.
3. "IoT Security Guide", DSCI, August 2022.

Reference Books:

1. "Practical Internet of Things Security", Brian Russell Drew Van Duren, Packt Publishing, 2016

Assessment: In-Semester-Assessment (25 Marks)

1. All the students are required (mandatory) to be present in person during the laboratory conduction session**.** The ISA will consist of awarding marks for the complete, successful and in time submission of minimum 10 dually graded experiments (project based).
2. Project prototype to be developed and demonstrated.
3. Graded marks for 10 experiments will be converted to ISA marks of 25. Only one repeat session is allowed to cover up the missed lab session.
4. Students will be awarded grade / or marks on each experiment based on his / her own contribution, showcasing the knowledge application skills, demonstrating measurement work,

developing code / solution to the given problem and peer interaction. Student will lose the marks if he or she remains absent for the Laboratory Practical Session.

Course Name: Medical Device Regulation

Course Code: BM35T

Category: Professional Elective

Preamble:

The course will include all elements of the device product lifecycle from idea to initial market entry, sustaining activities, post-market activities and the subsequent obsolescence of the device. Special focus will be placed upon the Medical Device Regulatory landscapes.

Course Objectives:

- To demonstrate an understanding of ethical considerations and regulatory classifications in the development and evaluation of biomedical devices.
- To explain and compare the regulatory frameworks and quality management systems governing medical devices of various countries.
- To apply principles of risk management, compliance auditing, and post-market surveillance of medical devices

Pre-requisites:

1. Physics for Biomedical Engineering (BS20T)
2. Analytical and Clinical Equipment (BM05T)
3. Diagnostic and Monitoring Equipment (BM09T)
4. Critical Care Equipment (BM13T)

Course Outcome:

Learner will be able to:

CO1: Recall the regulatory framework, life cycle of medical devices, and risk-based classification and control mechanisms.

CO2: Explain the principles of safety, effectiveness, and bioethics, and the role of QMS, standards, and cybersecurity in compliance.

CO3: Apply international regulatory requirements and ISO standards to determine appropriate device pathways for global markets.

CO4: Analyze the structure and components of technical documentation and regulatory submissions across jurisdictions.

CO5: Evaluate premarket design controls, R&D traceability, and risk management through case-based scenarios.

CO6: Assess post-market surveillance strategies, audit practices, and compliance systems for sustained regulatory approval.

Course Scheme:

Contact Hours		Credits Assigned
Theory	Practical	Total
02	--	02

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory+ Tutorial	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 a 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	Module Contents	No. of Hours
01	Overview of regulatory framework for medical devices:	Credibility and authority of approvals, medical devices life cycle, risk-based classification, risk based approach for regulatory controls. Introduction to International Regulatory Requirements & Device Pathways.	06
02	Safety & Effectiveness:	Principles of safety and effectiveness, Quality management system, Standards, Risk management, Cybersecurity, Clinical evaluation. Classification of Biomedical Instruments, based on safety standards, Approach to Bioethics	06
03	Technical Documentation:	Technical documentation required by regulators, Essential requirements checklist, Risk management summary report, Manufacturing information, Regulated product submissions, Regulatory submission repository	06
04	Premarket phase:	Design controls, Information management during premarket phase, R&D planning stage, Design & development process stage, product identification & traceability, Case study	04
05	Regulatory submissions, approvals and registration:	Administrative provisions, regulatory submission and approval, international scenario	04
06	Post market phase	Product launch, continued regulatory compliance, Post market surveillance, Product obsolescence, Quality management	04

Module No.	Module Name	Module Contents	No. of Hours
		system, Regulatory system, and processes. Types of medical device audits. Medical device Compliance Audit	
Total			**30**

Suggested List of Value-Added Home Assignments:

1. Prepare Case Study on Regulatory approach for US FDA / Vital Monitoring Device
2. Prepare Case Study on Regulatory approach for US FDA / Defibrillator with Vital Monitoring Device
3. Prepare Case Study on Regulatory approach for the following Device: US / Class I - 510(k)
4. Prepare Case Study on Regulatory approach for the following Device: India / Class C
5. Prepare Case Study on Regulatory approach for the following Device: EU / Class III
6. ISO 13485 Gap Analysis

Recommended Online Courses:

1. ISO 14971 Medical Device Development & Risk Management https://www.udemy.com/course/master-medical-device-development-risk-management-course/?couponCode=CP130525
2. Mastering Medical Device Regulatory Affairs https://www.udemy.com/course/mastering-medical-device-regulatory-affairs/?couponCode=CP130525
3. Medical Device Regulation 2017/745 EU regulatory affairs. https://www.udemy.com/course/medical-device-regulation-2017745-explained-in-simple-terms/?srsltid=AfmBOoqd0GsyxC_X4ihuOoYfpaXmSv3kzpRlmiRLbjaiXTugYF4T0_YQ&couponCode=CP130525
4. Medical Device Regulations. https://www.udemy.com/course/medical-devices/?kw=Medical+Device+Regulations&src=sac&couponCode=CP130525

Reference Books / Articles

1. Medical device regulatory practices, Val Theisz, PAN Satnford Publishing
2. Handbook of Medical Device regulatory affairs in Asia, edited by Jack Wong and Raymond KY Tong
3. Medical Device Regulations: Global Overview and Guiding Principles, Michael Cheng, World Health Organization.
4. Daniel A. Vallero - Biomedical Ethics for Engineers_ Ethics and Decision Making in Biomedical and Biosystem Engineering (Biomedical Engineering Series)-Academic Press
5. Encyclopedia of Medical Devices and Instrumentation: John G. Webster. Vol. I, II, III, IV (Marcel Dekkar Pub).
6. Ethics for Biomedical Engineers, Jong Yong Abdiel Foo, Stephen J. Wilson, Andrew P. Bradley, Winston Gwee, Dennis Kwok-Wing Tam (auth.) , Springer-Verlag New York
7. Michael Cheng - Medical Device Regulations_ Global Overview and Guiding Principles (2003)

8. David A. Vogel - Medical Device Software Verification, Validation and Compliance- Artech House (2010)
9. Daniel A. Vallero - Biomedical Ethics for Engineers_ Ethics and Decision Making in Biomedical and Biosystem Engineering (Biomedical Engineering Series)-Academic Press (2007)
10. Jong Yong Abdiel Foo, Stephen J. Wilson, Andrew P. Bradley, Winston Gwee, Dennis Kwok-Wing Tam (auth.) - Ethics for Biomedical Engineers-Springer-Verlag New York (2013)
11. DeMarco, Carl T. - Medical Device Design and Regulation-American Society for Quality (ASQ) (2011)
12. G.R Higson - Medical Device Safety_ The Regulation of Medical Devices for Public Health and Safety (2002)

Course Name Medical Device Regulation Lab

Course Code: BM35 P **Category:**

Professional Elective **Preamble:**

The course will include all elements of the device product lifecycle from idea to initial market entry, sustaining activities, post-market activities and the subsequent obsolescence of the device. Special focus will be placed upon the Medical Device Regulatory landscapes.

Course Objectives:

- To demonstrate an understanding of ethical considerations and regulatory classifications in the development and evaluation of biomedical devices.
- To explain and compare the regulatory frameworks and quality management systems governing medical devices of various countries.
- To apply principles of risk management, compliance auditing, and post-market surveillance of medical devices

Pre-requisites:

Physics for Biomedical Engineering Lab (BS20P) Analytical and Clinical Equipment Lab (BM05P) Diagnostic and Monitoring Equipment Lab (BM09P) Critical Care Equipment Lab (BM13P)

Course Outcome:

Learner will be able to:

CO1: Recall the regulatory framework, life cycle of medical devices, and risk-based classification and control mechanisms.
CO2: Explain the principles of safety, effectiveness, and bioethics, and the role of QMS, standards, and cybersecurity in compliance.
CO3: Apply international regulatory requirements and ISO standards to determine appropriate device pathways for global markets.
CO4: Analyze the structure and components of technical documentation and regulatory submissions across jurisdictions.
CO5: Evaluate premarket design controls, R&D traceability, and risk management through case-based scenarios.
CO6: Assess post-market surveillance strategies, audit practices, and compliance systems for sustained regulatory approval.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
--	02	--	01

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory+ Tutorial	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 a 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 Experiments

1. Analyze the ethical lapses in the design and failure of the medical devices like Therac-25 Radiation Therapy Machine/ Medtronic Sprint Fidelis Defibrillator Leads/ Infusion Pumps etc.Discuss responsibility distribution among engineers, regulators, and manufacturers.
2. Evaluate ethical considerations in approving and recalling implantable medical devices like Implantable Cardioverter-Defibrillators (ICDs)
3. Compare 510(k) Clearance vs. PMA Approval for medical device like Power Morcellators (Used in Laparoscopic Surgery)/ Metal-on-Metal Hip Implants/ Pelvic Mesh Implants/ Essure (Bayer) – Permanent Birth Control Device
4. Analyze the FDA's recall classification and enforcement process for Class I/Class II/Class II recalls with example Medtronic Mini Med Insulin Pumps, Philips Respironics CPAP, BiPAP, and Ventilators, Abbott Free Style Libre Glucose Monitoring System, Ethicon Surgical Staplers etc.
5. Track the steps for obtaining CE marking for a Class IIa diagnostic device under EU MDR.
6. Compare with Health Canada's approval process.
7. Assess the integration of ISO 13485 QMS in a small MedTech company. Identify gaps and suggest compliance strategies.
8. Perform a basic FMEA (Failure Modes and Effects Analysis) on a smartwatch-based health monitor. Identify potential hazards and propose control measures.
9. Examine software-related risks in infusion pumps.Map the failure to risk management steps under ISO 14971.

10. Review and critique a sample Audit Report of a Medical Device Manufacturer. Identify non-conformities and propose corrective actions. Take example of Class III implantable Devices Orthopedic Implants/ Surgical Mesh Devices.
11. Develop a basic PMS plan for a surgical tool used in orthopedic procedures. Include reporting methods, vigilance, and trend analysis.
12. Review a sample CER and assess its adequacy for regulatory submission. Identify deficiencies and suggest areas of improvement.
13. Analyze a failed notified body audit for non-compliance with MDR Annex I. Recommend improvements for passing future audits.

Suggested List of Project:

1. Comparative Analysis of US FDA 510(k) and EU MDR CE Marking Process.Study the submission requirements, timelines, clinical data expectations, and costs.Deliverable: Report or presentation comparing regulatory pathways for Class II devices.
2. Design a Risk Management File for a Hypothetical Medical Device (ISO 14971).Create risk analysis, risk evaluation, and risk control documentation.Device example: Insulin pump, ECG machine, or smart inhaler.
3. Post-Market Surveillance Plan Development.Create a PMS plan for a selected Class II or III device.Include vigilance reporting, trend analysis, and post-market clinical follow-up (PMCF).
4. Gap Analysis of a Legacy Device under EU MDR Compliance.Pick a real-world legacy device and evaluate it against MDR Annex I & II.Identify required updates in CER, labeling, UDI, and PMS.
5. Build a Quality Management System (QMS) Model Based on ISO 13485.Develop a mini-QMS model covering design control, CAPA, document control, internal audits, and supplier management.
6. Mock Regulatory Submission Dossier (US FDA 510(k) or De Novo Pathway).Choose an innovative device and prepare a mock premarket submission with device description, substantial equivalence chart, labeling, and bench testing summary.
7. Ethical and Legal Analysis of a Device Recall (Case Study). Choose a past FDA Class I recall (e.g., Therac-25, Philips CPAP). Evaluate ethical issues, regulatory gaps, and manufacturer response.
8. Evaluate the Implementation of UDI (Unique Device Identification) System. Study how UDI is structured, implemented, and affects traceability. Propose a UDI system for a sample product line.
9. Audit Simulation for a Medical Device Company. Create an internal audit checklist. Conduct a simulated audit for areas such as design control, production, complaint handling, or CAPA.
10. Country-Specific Medical Device Regulatory Landscape. Pick a non-US/EU country (e.g., India, Japan, Brazil, Canada). Analyze the medical device classification, approval process, QMS expectations, and import/export rules.

Reference Books / Articles

1. Michael Cheng - Medical Device Regulations_ Global Overview and Guiding Principles (2003)
2. David A. Vogel - Medical Device Software Verification, Validation and Compliance- Artech House (2010)

3. Daniel A. Vallero - Biomedical Ethics for Engineers_ Ethics and Decision Making in Biomedical and Biosystem Engineering (Biomedical Engineering Series)-Academic Press (2007)
4. Jong Yong Abdiel Foo, Stephen J. Wilson, Andrew P. Bradley, Winston Gwee, Dennis Kwok-Wing Tam (auth.) - Ethics for Biomedical Engineers-Springer-Verlag New York (2013)
5. DeMarco, Carl T. - Medical Device Design and Regulation-American Society for Quality (ASQ) (2011)
6. G.R Higson - Medical Device Safety_ The Regulation of Medical Devices for Public Health and Safety (2002)

Course Name: Basics of Natural Language Processing

Course Code: BM36T

Category: Professional Elective(AI-ML Track)

Preamble:

This course introduces students to the foundational concepts of Natural Language Processing (NLP), covering the processing, analysis, and understanding of human language by computer. It emphasizes linguistic structure, syntax, semantics, and the application of algorithms for tasks such as text classification, sentiment analysis, and language modeling. The course is structured to benefit students in biomedical applications and AI integration.

Pre-requisites:

Python Programming (BM08T &P)
Machine Learning (BM27T&P)

Course Objectives:

- To introduce students to the core concepts, models, and algorithms in NLP.
- To develop the ability to apply linguistic knowledge and computational models in real-world applications.
- To provide exposure to practical NLP systems and tools.
- To build foundational understanding required for advanced NLP research and applications.

Course Outcomes:

CO1: Learners will describe the fundamentals of NLP, its evolution, core tasks, and real-world applications such as sentiment analysis, resume parsing, and machine translation.
CO2: Learners will perform text preprocessing techniques including tokenization, stop word removal, stemming, and lemmatization using NLP tools like NLTK and SpaCy.
CO3: Learners will convert text data into numerical representations using Bag-of-Words, TF-IDF, and word embeddings, and compare different representation methods.
CO4: Learners will explain and apply POS tagging and parsing techniques including rule based, HMM, CRF models, and syntactic parsing to analyze sentence structure.
CO5: Learners will build, evaluate, and interpret text classification models such as Naive Bayes, Logistic Regression, and SVM for tasks like spam detection and sentiment analysis using relevant metrics.
CO6: Learners will develop, deploy, and demonstrate end-to-end NLP applications such as chatbots, resume classifiers, or fake news detectors using advanced tools and frameworks.

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	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	Module Contents	No. of Hours
1	Introduction to NLP and Applications	Fundamentals of NLP, historical evolution from rule-based to neural approaches; overview of core NLP tasks; real-world applications including sentiment analysis, resume parsing, fake news detection, chatbots, and machine translation.	4
2	Text Preprocessing	Hands-on techniques for preparing raw text: cleaning, tokenization, lowercasing, stopword removal, stemming (Porter, Snowball), lemmatization using NLTK and SpaCy. Importance of preprocessing in improving model accuracy.	5
3	Text Representation	Techniques to convert text into numerical form: Bag-of-Words (BoW), TF-IDF, and Word Embeddings (Word2Vec, GloVe); brief intro to contextual embeddings like BERT; comparison of sparse vs dense representations.	5
4	POS Tagging & Parsing	Part-of-Speech (POS) tagging using rule-based, HMM, and CRF models; parsing techniques: chunking, constituency and dependency parsing, shallow parsing, grammar trees; real-time demos using SpaCy and NLTK.	5
5	Text Classification	Building binary classifiers for NLP tasks like spam detection and sentiment analysis using Naive Bayes, Logistic Regression, and SVM; performance metrics: accuracy, precision, recall, F1-score; hands-on model evaluation and interpretation.	6
6	Case Studies	End-to-end implementation of real-world NLP applications such as a chatbot, resume classifier, or fake news detector using tools like scikit-learn, transformers, or Streamlit. Includes discussion of model deployment and demo	5

Module No.	Module Name	Module Contents	No. of Hours
		presentations.	
		Total	**30**

Recommended Online Courses:

1. Natural Language Processing Specialization – DeepLearning.AI
   https://www.coursera.org/specializations/natural-language-processing
2. Natural Language Processing with Python – University of Michigan (via Coursera)
   https://www.coursera.org/learn/python-text-mining
3. Introduction to Natural Language Processing – Microsoft (via edX)
   https://www.edx.org/course/introduction-to-natural-language-processing-nlp
4. NLP Projects – Great Learning

   https://www.mygreatlearning.com/academy/learn-for-free/courses/natural-language-processing-

Reference Books / Articles

1. Speech and Language Processing, Daniel Jurafsky, James H. Martin, Prentice Hal
2. Foundations of Statistical Natural Language Processing, Christopher D. Manning and Hinrich Schütze
3. Natural Language Processing with Python, Steven Bird, Ewan Klein, and Edward Loper (O'Reilly)
4. Research articles from ACL, NAACL, and EMNLP conferences.

Course Name: Basics of Natural Language Processing Lab

Course Code: BM36P

Category: Professional Elective(AI-ML Track)

Preamble:

This lab introduces students to core Natural Language Processing (NLP) techniques through hands- on experiments using Python and open-source NLP libraries like NLTK, SpaCy, Scikit-learn, and Hugging Face Transformers. Students will implement tasks such as text preprocessing, classification, and mini projects based on real-world applications like sentiment analysis, resume classification, and fake news detection.

Course Objectives:

- To provide hands-on experience in implementing foundational NLP techniques.
- To enable students to process, classify, and analyze textual data using Python.
- To develop NLP applications relevant to healthcare and biomedical domains.

Pre-requisites:

Python Programming (BM08T &P)
Machine Learning (BM27T&P)

Course Outcome:

The students will be able to:

CO1: Learners will **describe** the fundamentals of NLP, its evolution, core tasks, and real-world applications such as sentiment analysis, resume parsing, and machine translation.
CO2: Learners will **perform** text preprocessing techniques including tokenization, stop word removal, stemming, and lemmatization using NLP tools like NLTK and SpaCy.
CO3: Learners will **convert** text data into numerical representations using Bag-of-Words, TF-IDF, and word embeddings, and **compare** different representation methods.
CO4: Learners will **explain** and **apply** POS tagging and parsing techniques including rule based, HMM, CRF models, and syntactic parsing to analyze sentence structure.
CO5: Learners will **build**, **evaluate**, and **interpret** text classification models such as Naive Bayes, Logistic Regression, and SVM for tasks like spam detection and sentiment analysis using relevant metrics.
CO6: Learners will **develop**, **deploy**, and **demonstrate** end-to-end NLP applications such as chatbots, resume classifiers, or fake news detectors using advanced tools and frameworks.

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/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 a 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 Experiments

1. Text Cleaning and Tokenization using NLTK/SpaCy
2. Stopword Removal, Stemming and Lemmatization
3. Convert text into BoW and TF-IDF using Scikit-learn
4. Perform POS Tagging and Named Entity Recognition using SpaCy
5. Train a Naive Bayes model for Email Spam Detection
6. Perform Sentiment Analysis using Logistic Regression on customer reviews
7. Use pre-trained BERT model from Hugging Face for text classification (demo)
8. Parsing: Chunking and Dependency Tree Visualizations
9. Resume Classifier: Build a multi-class classifier based on job descriptions
10. Mini Project: Chatbot / Fake News Detector (Evaluation + Deployment Plan)

Guidelines to conduct practical sessions:

1. **Group Work**: Laboratory sessions will be carried out by groups of three to five students.
2. **Project-Based Learning**: Students are encouraged to select a case study topic of their choice, subject to review and approval by the course faculty, fostering a project-based learning approach.
3. **Case Study Identification**: In collaboration with the subject faculty, each group will identify a relevant area for the case study, upon which their research and analysis will be focused.
4. **Presentation Preparation**: Students will prepare presentations (e.g., PowerPoint slides) and posters to showcase their findings on the selected case study.
5. **Virtual Labs**: Students will have access to virtual labs to conduct experiments, simulations, and analysis related to their case study. These virtual labs will support learning in areas like medical equipment installation, maintenance, and calibration.
6. **End-of-Semester Assessment**: Evaluation of the students' work will take place at the end of the semester, based on their case study projects, virtual lab activities, and presentations.

Recommended Online Courses:

1. Natural Language Processing Specialization – DeepLearning.AI https://www.coursera.org/specializations/natural-language-processing
2. Natural Language Processing with Python – University of Michigan https://www.coursera.org/learn/python-text-mining
3. NLP with Transformers – Hugging Face https://huggingface.co/learn/nlp-course
4. Applied Text Mining in Python – University of Michigan https://www.coursera.org/learn/python-text-mining
5. Kaggle NLP Micro-Course https://www.kaggle.com/learn/natural-language-processingHealthcare Technology Management

Reference Books / Articles

1. Speech and Language Processing – Daniel Jurafsky and James H. Martin
2. Natural Language Processing with Python – Steven Bird, Ewan Klein, and Edward Loper
3. Practical Natural Language Processing – Sowmya Vajjala et al.
4. Hugging Face Documentation – https://huggingface.co/docs
5. NLTK Book – http://www.nltk.org/book/

Course Name: Industrial Internet of Things (IIoT)

Course Code: BM37T

Category: Professional elective – 6 (IoT Track)

Preamble:
This course introduces students to IIoT complexity on a scale previously unseen in the software industry. Software architecture must accommodate these heterogeneous domains and competencies and handle the increasing levels of complexity. The IIoT generates large amounts of data that is subsequently stored, analysed, archived and eventually fed back into the product life cycle.

Pre-requisites:

- Modern Sensor Technology for IoT(BM22T&P)
- Principles of IoT(BM25T&P)

Course Objectives:

- To understand the concepts of Industry 4.0 and IIoT.
- To learn the reference architecture of IIoT
- To learn industrial data acquisition and transmission
- To learn the IIoT key technologies.
- To learn securities in IIoT.
- To learn application areas in IIoT.

Course Outcomes:

Student will be able to:

CO1: Understand the fundamentals of Industry 4.0 and IIoT.
CO2: Understand different types of architectures required in the IIoT applications.
CO3: Apply knowledge of data acquisition and transmission techniques required in IIoT.
CO4: Understand Key technologies required in the implementation of IIoT model.
CO5: Create a security system for IIoT application.
CO6: Design prototype model of IIoT system.

Course Scheme:

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

Assessment Guidelines:

Contact Hours	**Credits Assigned**

Theory	Practical	Theory	Practical
2	2	2	1

The assessment guidelines for the courses of different credits are mentioned in the above table. 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	Introduction	Overview of Industry 4.0 and Industrial Internet of Things, Industrial Internet, Design requirements of Industry 4.0, Drivers of Industry 4.0, Sustainability Assessment of Industries, Smart Business Perspective, Basics, IIOT and Industry 4.0, Industrial Internet Systems, Industrial Sensing, Industrial Processes, IIOT Challenges – Identifying Things within the internet, Discovering Things and the Data they possess, Managing massive amount of data, Navigating Connectivity Outages, IIOT Edge - Leveraging the Power of Cloud Computing, Communicating with Devices on the Edge, Determining a Request/Response Model	4
2	IIOT Reference Architecture	The IIC Industrial Internet Reference Architecture - Industrial Internet Architecture Framework (IIAF), Industrial Internet Viewpoints. The Three-Tier Topology, Key Functional Characteristics of Connectivity. Software Architectural Style for the Industrial Internet of Things. Challenges of Software Engineering in IIoT, Principles for Software Architecture design in IIoT, The Principled Decomposition, and The Architectural Style.	5
3	IIoT data acquisition and transmission	Introduction, Features and Components of - Foundation Fieldbus, Profibus, HART, Interbus, Bitbus, CC-Link, Modbus, Batibus, DigitalSTROM, Controller Area Network, DeviceNet, LonWorks, ISA 100.11a, Wireless HART, LoRa and LoRaWAN) NB-IoT, IEEE 802.11AH, Distributed Control System, PLC, SCADA	6
4	Key Technologies in IIoT	Off-Site Technologies: Cloud Computing in IIOT Fog Computing: Principles, Architectures, and	5

		Applications. On-Site Technologies: Big Data and Advanced Analytics	
5	IIoT securities	Securing the Industrial Internet- Security in Manufacturing, PLCs and DCS, Securing the OT (Operation Technology), Network, System Level: Potential Security Issues, Identity Access Management. Internet of Things (IoT) Cyber security Improvement Act of 2017, Other governmental bodies, IoT security best practices, Holistic security. The IoT Security Lifecycle	6
6	IIoT Applications	Develop New Business Models : Adopt Smart Architectures and Technologies, Sensor-Driven Computing, Industrial Analytics, Intelligent Machine Applications, Transform the Workforce. Inventory Management and Quality Control: Introduction, Inventory Management and IIOT, Quality Control Case Studies: Manufacturing Industry, Automotive Industry and Mining Industry, Healthcare Applications in Industries, Challenges associated with Healthcare	4
Total			**30**

Textbooks:

1. "Industry 4.0: The Industrial Internet of Things", by Alasdair Gilchrist (Apress)
2. "Introduction to Industrial Internet of Things and Industry 4.0",by Sudip Misra, Chandana Roy And Anandarup Mukherjee, CRC Press (Taylor & Francis Group)
3. "Internet of Things Principles and Paradigms", by Rajkumar Buyya, Amir Vahid Dastjerdi, ELSEVIER Inc.
4. Internet of things For Architects, Perry Lea Packt Publication,2018

Reference Books:

1. "Practical Internet of Things Security", by Brian Russell, Drew Van Duren (Packt Publishing)
2. "Industrial Internet of Things and Communications at the Edge", by Tony Paine, CEO, Kepware Technologies
3. "Architectural Design Principles For Industrial Internet of Things", Hasan Derhamy, Luleå University of Technology, Graphic Production

Course Name: Industrial Internet of Things (IIoT) Laboratory

Course Code: BM37P

Category: Professional elective – 6 (IoT Track)

Preamble:

The IIoT Lab is a hands-on learning environment where you will gain practical experience in designing, developing, and deploying IIoT solutions. By the end of this lab, students will have a strong foundation in IIoT concepts and be prepared to apply your knowledge to real-world industrial applications.

Pre-requisites:

- Modern Sensor Technology for IoT(BM22T&P)
- Principles of IoT(BM25T&P)

Course Objectives:

- Familiarize students with the fundamentals of Industrial IoT (IIoT)
- Understand the core concepts of IIoT, including sensors, actuators, communication protocols, and data analytics
- Gain insights into the applications of IIoT in various industries
- Develop the skills necessary to design and implement IIoT solutions

Course Outcomes:

Student will be able to:

CO1: Learn IIoT and its key components

CO2: Study and interface the different types of sensors and actuators used in IIoT applications

CO3: Analyze the various communication protocols used in IIoT

CO4: Analyze and interpret data collected from IIoT devices

CO5: Design and implement simple IIoT solutions

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical

-	2	-	1

Assessment Scheme:

Head	ISA	MSA	ESA	Total
Practical	25	-	25	050

Suggested List of Practical:

1. Familiarization with Development Boards: This experiment will get students familiar with popular development boards like Arduino Uno or Raspberry Pi. Students will learn how to set up the board, install the necessary software, and write simple programs to control LEDs, read sensor data, and control actuators.
2. Sensor Interfacing: This experiment will introduce students to various sensors used in IIoT applications, such as temperature sensors, humidity sensors, light sensors, and pressure sensors. Students will learn how to interface these sensors with the development board and read the sensor data.
3. Actuator Control: This experiment will introduce students to actuators used in IIoT applications, such as relays, motors, and solenoids. Students will learn how to control these actuators using the development board based on sensor readings or user input.
4. Data Visualization: This experiment will teach students how to visualize the data collected from sensors. Students will use software tools to plot the data on graphs and charts, allowing for easier monitoring and analysis.
5. Communication Protocols: This experiment will cover various communication protocols used in IIoT, such as Modbus, Profibus, and MQTT. Students will learn how to configure these protocols for communication between devices and the cloud platform.
6. Cloud Integration: This experiment will introduce students to cloud platforms for IIoT applications. Students will learn how to connect their IIoT devices to the cloud platform, send sensor data to the cloud, and receive commands from the cloud.
7. Remote Monitoring and Control: This experiment will build on the previous experiments by creating a system where students can remotely monitor sensor data and control actuators over the internet.
8. Data Analytics: This experiment will introduce students to basic data analytics techniques used in IIoT applications. Students will learn how to analyze sensor data to identify trends, patterns, and anomalies.
9. Robotics arms and Industry 4.0 Setup

Textbooks:

1. **Industrial Automation with the Internet of Things** by Andreas Georgakopoulos and Peter Slyepen
2. **Designing the Industrial Internet of Things** by Adrian McEwen and Hakim El-Darwich

Reference Books:

1. **Internet of Things (IoT) Prototyping with Arduino and Raspberry Pi**by Colin Wong
2. Hands-On Industrial Internet of Things by Richard Radoczki

Course Name: Installation & Maintenance of Medical Equipment

Course Code: BM38T

Category: Professional Elective

Preamble:

This course introduces students to understand the basic precautions to be taken while installing medical equipment. This course will also provide a practical knowledge of maintenance and servicing of key medical equipment. Courses will improve their skills to serve in the health care industry.

Pre-requisites:

Analytical and Clinical Equipment (BM05T&P)
Diagnostic and Monitoring Equipment (BM09T&P)
Critical Care Equipment (BM13T&P)

Course Objectives:

- To provide participants with the necessary skills to install, maintain, and calibrate a wide range of medical equipment across various healthcare departments, ensuring optimal functionality and safety.
- To equip learners with the knowledge of preventive maintenance, troubleshooting, and servicing techniques for both analytical and critical care equipment, ensuring reliable performance and patient safety.
- To familiarize participants with industry standards, regulatory requirements, and best practices in the installation, maintenance, and calibration of medical devices, preparing them for ISO and NABH compliance.

Course Outcomes:

CO1: Learners will apply pre-installation checks, assemble and test medical equipment, ensuring compliance with safety and regulatory standards before handover.
CO2: Participants will **demonstrate** the ability to **install** medical equipment correctly in various departments, ensuring optimal functionality based on departmental needs.
CO3: Learners will **analyze** and **implement** preventive maintenance, **manage** contracts, **apply** safety protocols, and ensure compliance with ISO and NABH standards.
CO4: Learners will **maintain**, **troubleshoot**, and **calibrate** analytical instruments like colorimeters, spectrophotometers, and auto analyzers to ensure accuracy.
CO5: Learners will **service** and **maintain** critical care equipment, including defibrillators, ventilators, ECG machines, and infusion pumps, ensuring patient safety.
CO6: Participants will **use** calibration tools to **ensure** the accuracy and reliability of medical equipment post-repair.

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	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	Module Contents	No. of Hours
1	Installation techniques	Pre-installation techniques, Precautions to be taken. Assembly of instrument / system Testing of instrument before final handover	2
2	Installation procedure of medical equipment in various department.	Installation of medical equipment in various departments such as Cardiology, Radiology, Pathology, ICUs, Medical Gas department, Pediatric, Ophthalmology, Neurology, Emergency/ Casualty.	2
3	Principles of Maintenance and servicing.	Preventive maintenance and calibration checks, maintenance tools, Types of maintenance contracts- AMC and CMC, safety precautions while servicing of Medical and Non-Medical equipment, Insurance of Medical Equipment, Introduction to System operating protocol (SOP) for ISO certification and NABH certification	4
4	Maintenance of Analytical Equipment	Maintenance of Colorimeter, Spectrophotometer, Electrophoresis apparatus, Auto Analyser	8
5	Maintenance of Critical care equipment	Maintenance of Surgical diathermy, ECG, Patient monitors, Defibrillator, Ventilator, Physiotherapy equipment, X ray, Incubators, Infusion Pumps	10

Module No.	Module Name	Module Contents	No. of Hours
6	Calibration of Medical Equipment	Use of calibrating equipment after repairs such as, Defib Tester, Infusion Device Analyser, X ray machines Analyser, Ventilator testers	4
Total			**30**

Recommended Online Courses:

1. Defibrillator Testing https://www.flukebiomedical.com
2. Electrical Safety Testing https://www.flukebiomedical.com
3. Infusion Pump Testing https://www.flukebiomedical.com
4. Gas Flow/Ventilator Testing https://www.flukebiomedical.com
5. Patient Monitor Testing https://www.flukebiomedical.com
6. X-Ray Beam & Dose Quality Testing https://www.flukebiomedical.com
7. Healthcare Technology Management https://www.coursera.org/learn/healthcare-technology-management
8. Medical Device Regulatory Affairs https://www.coursera.org/learn/medical-device-regulatory-affairs

Reference Books / Articles

1. Maintenance manuals of various equipment.
2. Medical equipment Maintenance (Management and Oversight) Binseng Wang
3. Troubleshooting Electronic Equipment R.S. Khandpur, Second Edition
4. Medical Equipment Management Keith Wilson, KeithIson, Slavik Tabakov
5. Various standards (ISO, NABH)

Course Name: Installation & Maintenance of Medical Equipment Lab

Course Code: BM38P

Category: Professional Elective

Preamble:

This course introduces students to understand the basic precautions to be taken while installing medical equipment. This course will also provide a practical knowledge of maintenance and servicing of key medical equipment. Courses will improve their skills to serve in the health care industry.

Course Objectives:

- To provide participants with the necessary skills to install, maintain, and calibrate a wide range of medical equipment across various healthcare departments, ensuring optimal functionality and safety.
- To equip learners with the knowledge of preventive maintenance, troubleshooting, and servicing techniques for both analytical and critical care equipment, ensuring reliable performance and patient safety.
- To familiarize participants with industry standards, regulatory requirements, and best practices in the installation, maintenance, and calibration of medical devices, preparing them for ISO and NABH compliance.

Pre-requisites:

Analytical and Clinical Equipment (BM05T&P)
Diagnostic and Monitoring Equipment (BM09T&P)
Critical Care Equipment (BM13T&P)

Course Outcome:

The students will be able to:

CO1: Learners will apply pre-installation checks, assemble and test medical equipment, ensuring compliance with safety and regulatory standards before handover.
CO2: Participants will **demonstrate** the ability to **install** medical equipment correctly in various departments, ensuring optimal functionality based on departmental needs.
CO3: Learners will **analyze** and **implement** preventive maintenance, **manage** contracts, **apply** safety protocols, and ensure compliance with ISO and NABH standards.
CO4: Learners will **maintain**, **troubleshoot**, and **calibrate** analytical instruments like colorimeters, spectrophotometers, and auto analyzers to ensure accuracy.
CO5: Learners will **service** and **maintain** critical care equipment, including defibrillators, ventilators, ECG machines, and infusion pumps, ensuring patient safety.

CO6: Participants will **use** calibration tools to **ensure** the accuracy and reliability of medical equipment post-repair.

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/evaluation guidelines for the courses of different credits are mentioned in the above table. Not withstanding 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 a 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 Experiments

1. Pre-installation site assessment: Evaluate and prepare the installation site for medical equipment by checking space, electrical, and environmental conditions according to specific requirements.
2. Assembly and functional testing of ECG machine: Assemble a virtual ECG machine and perform functional testing to verify accurate heart rate signal detection and display.
3. Installation and testing of a defibrillator: Install a defibrillator, test its shock delivery, and ensure correct energy levels and battery functionality.
4. Preventive maintenance of a spectrophotometer: Perform preventive maintenance tasks on a spectrophotometer, including calibration and ensuring accurate light absorption measurements.
5. Calibration of a colorimeter: Calibrate a virtual colorimeter using standard solutions to ensure precise measurement of color and absorbance.
6. Troubleshooting and maintenance of an infusion pump: Diagnose and troubleshoot an infusion pump, ensuring proper flow rate and dosage delivery by recalibrating the device.
7. Calibration of an X-ray machine: Calibrate an X-ray machine for optimal radiation exposure and verify its accuracy using a virtual analyzer.
8. Preventive maintenance of a patient monitoring system: Inspect, clean, and calibrate a virtual patient monitoring system to ensure accurate data collection and alarm functionality.
9. Functional testing of a ventilator: Test a ventilator's ability to maintain proper airflow, pressure, and oxygen levels, ensuring its reliability for patient care.
10. Calibration of a defibrillator: Calibrate a defibrillator to ensure it delivers the correct shock energy levels and performs accurately during emergency scenarios

Guidelines to conduct practical sessions:

1. **Group Work**: Laboratory sessions will be carried out by groups of three to five students.

2. **Project-Based Learning**: Students are encouraged to select a case study topic of their choice, subject to review and approval by the course faculty, fostering a project-based learning approach.

3. **Case Study Identification**: In collaboration with the subject faculty, each group will identify a relevant area for the case study, upon which their research and analysis will be focused.

4. **Presentation Preparation**: Students will prepare presentations (e.g., PowerPoint slides) and posters to showcase their findings on the selected case study.

5. **Virtual Labs**: Students will have access to virtual labs to conduct experiments, simulations, and analysis related to their case study. These virtual labs will support learning in areas like medical equipment installation, maintenance, and calibration.

6. **End-of-Semester Assessment**: Evaluation of the students' work will take place at the end of the semester, based on their case study projects, virtual lab activities, and presentations.

Recommended Online Courses:

1. Defibrillator Testing https://www.flukebiomedical.com
2. Electrical Safety Testinghttps://www.flukebiomedical.com
3. Infusion Pump Testinghttps://www.flukebiomedical.com
4. Gas Flow/Ventilator Testinghttps://www.flukebiomedical.com
5. Patient Monitor Testinghttps://www.flukebiomedical.com
6. X-Ray Beam & Dose Quality Testinghttps://www.flukebiomedical.com
7. Healthcare Technology Management https://www.coursera.org/learn/healthcare-technology-management
8. Medical Device Regulatory Affairshttps://www.coursera.org/learn/medical-device-regulatory-affairs

Course Name: Project-1 Synopsis

Course Code: BM42

Category: Project and Internship

Preamble:

The "Project–1 Synopsis" course is designed to initiate undergraduate students into the process of structured problem-solving through research and design in the field of Biomedical Engineering. This course provides a platform for students to identify real-world healthcare challenges, review relevant literature, and formulate a viable project proposal under faculty guidance. It emphasizes interdisciplinary thinking, innovation, and planning, laying the groundwork for the major project in the final semester. By focusing on ethical, technical, and societal aspects, the course prepares students to undertake meaningful biomedical research or product development.

Pre-requisites:
Basic background of programming courses, fundamental of electronic devices and transducers, circuit design and analysis.

Course Objectives:

- To enable students to identify and define a significant biomedical engineering problem through critical analysis and literature review.
- To develop the ability to formulate a research or development plan, including defining objectives, scope, methodology, and anticipated outcomes.
- To enhance students' skills in technical writing and oral presentation by preparing a comprehensive synopsis and communicating the project proposal effectively to a technical audience.

Course Outcomes:
Student will be able to:
CO1: Design a programme (Plan) to conduct project on a chosen topic.
CO2: Define the problem statement & objectives for the Project.
CO3: Construct literature review and theoretical study required for the project.
CO4: Determine the most suitable methodology for data collection and experimental study.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical

-	6	0	3

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	50	-	50	100

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 of Semester VIII Courses

Open Elective Courses

Open Elective bucket offers number of courses at Institute level for all branches. The Learner is expected to complete requirement of 15 credits by taking 5 courses as suggested in their program structure.

The following is the list of the courses offered by Institute.

Sr. No.	Course Code	Course Title	Hours Per Week			Credits
			Theory	Practical	Tutorial	
1	OE21	Cyber Law	3	-	-	3
2	OE22	Project Management	3	-	-	3
3	OE23	Product Lifecycle Management	3	-	-	3
4	OE24	Sustainability Management	3	-	-	3
5	OE25	Operation Research	3	-	-	3
6	OE26	IPR and Patenting	3	-	-	3
7	OE27	Research Methodology	3	-	-	3
8	OE28	Renewable Energy Management	3	-	-	3
9	OE29	Energy Audit and Management	3	-	-	3
10	OE30	Bioinformatics	3	-	-	3
11	OE31	Nanotechnology	3	-	-	3

Course Name: Cyber Law

Course Code: OE21

Category: Open Elective

Preamble:

This course explores the evolving landscape of cyber law and security, equipping students with legal frameworks and technology insights necessary to navigate the challenges posed by digital crimes. It emphasizes both technical and legal aspects of cybersecurity, with a focus on Information Technology Act, 2000 (ITA 2000) and the amendments in the Information Technology Amendment Act, 2008 (ITAA 2008).

Pre-requisites: Nil

Course Objectives:

- To introduce students to the legal framework governing cyber activities, with a focus on ITA 2000 and ITAA 2008.
- To understand the technical foundations of cybersecurity and the role of various security mechanisms in preventing cyber threats.
- To explore different types of cybercrimes and the processes involved in investigating and addressing them.
- To examine the legal aspects of e-commerce, e-governance, and the use of electronic signatures in Indian law.
- To analyse the importance of privacy, data protection, and how international laws influence Indian regulations.
- To provide a global perspective on cyber law and international conventions, addressing challenges like intellectual property and cyber warfare.

Course Outcomes:

Learners will be able to:

CO1: Explain the key provisions of ITA 2000 and ITAA 2008 and their impact on various legal domains.
CO2: Gain practical knowledge of cybersecurity tools and techniques such as encryption, firewalls, and digital signatures.
CO3: Identify different types of cybercrimes and apply forensic techniques to investigate digital crimes.
CO4: Assess the legal implications of e-commerce, e-governance, and electronic contracts in India.
CO5: Analyze privacy and data protection laws in India and evaluate them from an international perspective.

CO6: Understand global cyber law frameworks and how international treaties impact the regulation of cyberspace in India.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	-	3	-

Assessment Guidelines:

Head	ISA	MSA	ESA	Total
Theory	20	30	50	100

The assessment guidelines for the courses of different credits are mentioned in the above table. 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	Introduction to Cyber Law and IT Act	Evolution and necessity of ITA 2000 Overview of ITA 2000 and ITAA 2008: Key provisions, authorities, and penalties Amendments to Indian Penal Code, Evidence Act, and other laws Case studies on jurisdiction under cyber law	6
2	Cyber Security Framework	Definition and importance of cybersecurity Overview of threats: hacking, malware, phishing, and cyberterrorism Basic security mechanisms: firewalls, encryption, PKI, and digital signatures Role of CERT-IN and other agencies in India	7
3	Cyber Crimes and Investigation	Types of cybercrimes: data theft, identity theft, cyberstalking, cyberbullying, and online fraud Investigation procedures for cybercrimes Seizure of digital evidence and forensic procedures Digital forensics: tools and anti-forensics measures	8
4	E-Commerce, E-Governance, and Cyber Law	E-commerce regulations under ITA 2000 and ITAA 2008 Validity of electronic signatures and contracts in Indian law	8

		E-Governance and issues in e-taxation Cyber Tribunal and appellate processes	
5	Privacy, Data Protection, and Emerging Trends	Sensitive Personal Data or Information (SPDI) under Indian law International perspectives on data protection and privacy (GDPR, HIPAA) Impact of cloud computing and data localization Case studies on privacy violations and legal recourse	8
6	International Cyber Law and Legal Framework	UNCITRAL model law and international conventions on cybercrime Intellectual property rights in cyberspace: trademarks, patents, and copyright Cyber warfare, digital sovereignty, and human rights Cyber law practices in other jurisdictions (US, EU, China)	8
Total			**45**

Textbooks:

1. "Cyber Law & Cyber Crimes" by Advocate Prashant Mali, Snow White Publications, Mumbai.
2. "Information Technology Law and Practice" by Vakul Sharma, Universal Law Publishing Co. Pvt. Ltd.
3. "The Indian Cyber Law" by Suresh T. Vishwanathan, Bharat Law House, New Delhi.

Reference Books:

1. "Digital Evidence and Computer Crime" by Eoghan Casey, Academic Press.
2. "Cyber Law in India" by Farooq Ahmad, Pioneer Books.
3. "Computer Forensics: Principles and Practices" by Linda Volonino et al., Pearson Prentice-Hall, 2007.

Course Name: Project Management

Course Code: OE22

Category: Open Elective

Preamble:

This course discusses tools that any organization can use to improve its ability to plan, implement, and control its activities as well as the ways in which it utilizes its people and resources.

Pre-requisites: Nil

Course Objectives:

- To familiarize the students with the use of a structured methodology/approach for each and
- every unique project undertaken, including utilizing project management concepts, tools and
- techniques.
- To appraise the students with the project management life cycle and make them knowledgeable.
- about the various phases from project initiation through closure.

Course Outcomes:

Learners will be able to:

CO1. Apply selection criteria and select an appropriate project from different options.
CO2. Write work break down structure for a project and develop a schedule based on it.
CO3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
CO4. Use Earned value technique, determine & predict status of the project.
CO5. Capture lessons learned during project phases and document them for future reference

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	-	3	-

Assessment Guidelines:

Head	ISA	MSA	ESA	Total
Theory	20	30	50	100

The assessment guidelines for the courses of different credits are mentioned in the above table. 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	Project Management Foundation	Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	6
2	Initiating Projects	How to get a project started, selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter, Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	8
3	Project Planning and Scheduling	Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS)	8
4	Planning Projects	Crashing project time, Resource loading and levelling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	8
5	Executing Projects, Monitoring and Controlling Projects and Project Contracting	Executing Projects: Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings. Monitoring and Controlling Projects: Earned Value Management	8

		techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. Project Contracting: Project procurement management, contracting and outsourcing	
6	Project Leadership and Ethics Closing the Project	Project Leadership and Ethics: Introduction to project leadership, ethics in projects. Multicultural and virtual projects. Closing the Project: Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lesson learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study	7
Total			**45**

Reference Books:

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7 th Ed.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

Course Name: Product Life Cycle Management

Course Code: OE23

Category: Open Elective

Preamble:

This course aims to give students an overview of the product Life Cycle Management (PLM), which is a strategic approach to managing the entire lifecycle of a product, from its inception through design, manufacturing, deployment, and disposal. This course gives student insights on various aspects such as PLM Strategies, Product design, Product Data Management, Virtual Product Development Tools, Integration of Environmental Aspects in Product Design, Life Cycle Assessment and Life Cycle Cost Analysis

Pre-requisites: Nil

Course Objective:

- To familiarize the students with the need, benefits and components of PLM
- To acquaint students with Product Data Management & PLM strategies
- To give insights into new product development program and guidelines for designing and developing a product
- To familiarize the students with Virtual Product Development

Course Outcomes:

Learners will be able to:

CO1: Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.

CO2: Illustrate various approaches and techniques for designing and developing products.

CO3: Apply product engineering guidelines / thumb rules in designing products for molding, machining, sheet metal working etc.

CO4: Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
3	-	3	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	20	30	50	100

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 a 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 to Product Lifecycle Management and PLM Strategies	**Introduction to Product Lifecycle Management (PLM):** Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy, Change management for PLM	10
2	Product Design	**Product Design:** Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering. and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	10

3	Product Data Management (PDM)	**Product Data Management (PDM):** Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	06
4	Virtual Product Development Tools	**Virtual Product Development Tools:** For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case Studies	07
5	Integration of Environmental Aspects in Product Design	**Integration of Environmental Aspects in Product Design:** Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	06
6	Life Cycle Assessment and Life Cycle Cost Analysis	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	06
Total			**45**

Textbooks:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229

Reference Books:

1. Saaksvuori Antti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
2. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Course Name: Sustainability Management
Course Code: OE24
Category: Open Elective
Preamble:
To provide learners with a comprehensive understanding of sustainability principles, strategies, and management practices that enable organizations to operate responsibly while achieving long-term success.
Pre-requisites: NIL
Course Objectives:

- To provide a comprehensive understanding of sustainability concepts and their importance in global and organizational contexts.
- To equip participants with the tools and frameworks to develop and implement effective sustainability strategies.
- To foster the ability to analyze environmental, social, and economic impacts and propose practical solutions.
- To empower learners to lead and manage sustainable practices through innovation, technology, and ethical decision-making.

Course Outcomes:

Learners will be able to:

CO1: Understand the Core Principles of Sustainability: Comprehend the key environmental, social, and economic dimensions of sustainability
CO2: Analyze Environmental Impacts: Evaluate organizational and societal environmental footprints and recommend sustainable practices.
CO3: Develop Strategies for Social and Economic Sustainability: Formulate strategies that address social equity, community engagement, and economic resilience.
CO4: Implement Sustainability Practices: Design and implement sustainability strategies within an organizational context, including reporting and stakeholder management.
CO5: Leverage Technology and Innovation: Utilize emerging technologies to enhance sustainability outcomes.
CO6: Lead and Manage Change: Apply leadership and change management principles to foster a sustainability-focused culture.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	-	3	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	20	30	50	100

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 to Sustainability	Overview of Sustainability: Definition, history, and importance. Sustainable Development Goals (SDGs): UN's 2030 Agenda and its impact on global development. Three Pillars of Sustainability: Environmental, social, and economic dimensions. Current Challenges: Climate change, resource depletion, inequality, and global initiatives.	5
2	Environmental Sustainability	Understanding Environmental Impact: Carbon footprint, waste management, and biodiversity. Energy Management: Renewable energy sources, energy efficiency, and innovations in energy systems. Circular Economy: Concepts, examples, and transitioning to closed-loop systems. Sustainable Resource Management: Water, minerals, and sustainable agriculture.	8
3	Social Sustainability	Social Equity and Inclusion: Addressing diversity, equity, and inclusion in organizations. Community Engagement: Building partnerships and contributing to societal development. Labor Practices: Ethical employment practices, health, and safety. Corporate Social Responsibility (CSR): Importance, frameworks, and success stories.	7
4	Economic Sustainability	Sustainable Business Practices: Triple bottom line approach. Green Finance: ESG investing, green bonds, and carbon pricing. Sustainable Innovation: Developing products and	5

		services that align with sustainability goals. Regulatory Frameworks: Policies and standards for sustainable business operations.	
5	Sustainability Strategy & Implementation	Developing a Sustainability Strategy: Key steps and tools. Stakeholder Engagement: Identifying and collaborating with key stakeholders. Sustainability Reporting: Standards (GRI, SASB), metrics, and case studies. Measuring Impact: Life cycle assessment (LCA), carbon accounting, and sustainability indicators.	8
6	Technology and Innovation for Sustainability	Digital Transformation: Role of AI, IoT, and big data in achieving sustainability. Green Technologies: Innovations in clean energy, transportation, and waste management. Smart Cities: Integration of sustainable technologies in urban planning. Role of Blockchain: Transparency and traceability in sustainability practices.	6
7	Leadership and Change Management in Sustainability	Sustainability Leadership: Characteristics and examples of successful leaders. Driving Organizational Change: Overcoming resistance and fostering a sustainability culture. Ethical Decision Making: Frameworks for responsible leadership. Global Case Studies: Examining successful implementations of sustainability initiatives.	6
		Total	**45**

Textbooks:

1. "Sustainability Principles and Practice" by Margaret Robertson.
2. "The Triple Bottom Line" by Andrew Savitz.
3. "The Business Guide to Sustainability" by Darcy Hitchcock and Marsha Willard.

Reference Books:

1. "Cradle to Cradle: Remaking the Way We Make Things" by William McDonough and Michael Braungart.
2. "Sustainability: A Systems Approach" by Tony Clayton and Nicholas Radcliffe.

Course Name: Operations Research

Course Code: OE25

Category: Open Elective

Preamble:
This course discusses various tools in scientific management.

Course Objectives:

- Formulate a real-world problem as a mathematical programming model.
- Understand the mathematical tools that are needed to solve optimization problems.
- Use mathematical software to solve the proposed models.

Course Outcomes:
Learners will be able to…
CO1: Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
CO2: Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
CO3: Solve specialized linear programming problems like transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
CO4: Understand the applications of integer programming and a queuing model and compute important performance measures

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	-	3	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	20	30	50	100

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 to Operations Research	**Introduction to Operations Research**: Introduction, Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, Duality, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem:** Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the steppingstone method and MODI method. **Assignment Problem:** Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem:** Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	15
2	Queuing models	Queuing models: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	6
3	Simulation	Simulation: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	6

4	Dynamic programming	Dynamic programming. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stagecoach/Shortest Path, cargo loading and Reliability problems.	6
5	Game Theory	Game Theory. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	6
6	Inventory Models	Inventory Models: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	6
Total			**45**

Reference Books:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice",
3. John Willey and Sons, 2nd Edition, 2009.
4. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill,
5. 2002.
6. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
7. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Course Name: IPR and Patenting

Course Code: OE26

Category: Open Elective

Preamble:

This course discusses legal rights that can be registered with a legal authority in some presentable or tangible form which can be sold or bought or licensed, like physical property given to creator or innovator to harvest the economic benefits on their invention or creation.

Course Objectives:

- To understand the intellectual property rights protection system
- To promote the knowledge of Intellectual Property Laws of India as well as international treaty procedures
- To get acquaintance with Patent search and patent filing procedure and applications

Course Outcomes:

Learner will be able to

CO1: Understand Intellectual Property assets.
CO2: Assist individuals and organizations in capacity building
CO3: Work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	-	3	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	20	30	50	100

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 a 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 to Intellectual Property Rights (IPR):	Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. Importance of IPR in Modern Global Economic Environment: Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	6
2	Enforcement of Intellectual Property Rights:	Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, international agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement Indian Scenario of IPR: Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	8
3	Emerging Issues in IPR:	Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc	6
4	Basics of Patents:	Definition of Patents, Conditions of patentability, Patentable and nonpatentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	8
5	Patent Rules:	Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	9
6	Procedure for Filing a Patent (National and International):	Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication etc, Time frame and cost, Patent Licensing, Patent Infringement Patent databases: Important websites, Searching international databases	8
Total			**45**

Reference Books:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi, IPR: Drafting, Interpretation of Patent Specifications and Claims, New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers, IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Course Name: Research Methodology

Course Code: OE27

Category: Oen Elective

Preamble:

This course offers "An overview of research methodology including basic concepts employed in quantitative and qualitative research methods. Includes computer applications for research.

Pre-requisites: Nil

Course Objectives:

- To understand Research and Research Process
- To acquaint students with identifying problems for research and develop research strategies
- To familiarize students with the techniques of data collection, analysis of data and interpretation

Course Outcomes:

learners will be able to:

CO1: Prepare a preliminary research design for projects in their subject matter areas

CO2: Accurately collect, analyze and report data

CO3: Present complex data or situations clearly

CO4: Review and analyze research findings

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	-	3	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	20	30	50	100

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 and Basic Research Concepts	Introduction and Basic Research Concepts 1.1 Research – Definition: Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology 1.2 Need of Research in Business and Social Sciences 1.3 Objectives of Research 1.4 Issues and Problems in Research 1.5 Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	10
2	Types of Research	Types of Research 2.1. Basic Research 2.2. Applied Research 2.3. Descriptive Research 2.4. Analytical Research 2.5. Empirical Research 2.6 Qualitative and Quantitative Approaches	8
3	Research Design and Sample Design	Research Design and Sample Design 3.1 Research Design – Meaning, Types and Significance 3.2 Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	9
4	Research Methodology	Research Methodology 4.1 Meaning of Research Methodology 4.2. Stages in Scientific Research Process: a. Identification and Selection of Research Problem b. Formulation of Research Problem c. Review of Literature d. Formulation of Hypothesis e. Formulation of research Design f. Sample Design g. Data Collection h. Data Analysis i. Hypothesis testing and Interpretation of Data j. Preparation of Research Report	8
5	Ethics in Research	Ethics in Research Plagiarism - Definition, different forms, consequences, unintentional plagiarism, copyright infringement, collaborative work. Qualities of good Researcher.	5
6	ICT Tools for	ICT Tools for Research:	5

	Research	Role of computers in research, maintenance of data using software such as Mendeley, Endnote, Tabulation and graphical presentation of research data and software tools. Web search: Introduction to Internet, use of Internet and www, using search engines and advanced search tools.	
Total			**45**

Textbooks:

1. Donald Cooper and PS Schindler (2009) Business Research Methods, 9th edition, Tata McGraw Hill.
2. Kothari C. R Research Methodology
3. Uma Sekaran (2010) Research Methods for Business, 4th edition, Wiley.
4. Ranjit Kumar (2009) Research Methodology, 2nd edition, Pearson Education
5. Naresh Malhotra and S Dash (2009) Marketing Research, 5th edition, Pearson Prentice Hall.
6. Michael V. P Research Methodology.
7. Fred N. Kerlinger: Foundations of Behavioral Research.

Reference books

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nded), Singapore, Pearson Education.

Course: Renewable Energy Management
Category: Open Elective
Course Code: OE28
Preamble:
Renewable Energy Management focuses on the development, implementation, and management of renewable energy projects. This course aims to equip students with the knowledge and skills required to effectively manage renewable energy resources, assess their impact, and implement sustainable energy solutions. The curriculum covers various renewable energy technologies, their applications, and the economic, environmental, and policy aspects of renewable energy systems.

Pre-requisites: Nil

Course Outcomes:

CO1: Understand the principles and technologies of various renewable energy sources.

CO2: Analyse the economic, environmental, and social impacts of renewable energy projects.

CO3: Evaluate and design renewable energy systems for specific applications.

CO4: Develop strategies for the integration and management of renewable energy in the energy mix.

CO5: Understand the policies, regulations, and incentives related to renewable energy.

CO6: Gain practical skills in renewable energy project planning, implementation, and management.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	-	3	-

Assessment Guidelines:

Head of Learning	ISA	MSE	Project	Total
Theory	20	30	50	100

The assessment guidelines for the courses of different credits are mentioned in the above table. 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 hrs.
1	Introduction to Renewable Energy	• Overview of global and national energy scenarios • Importance and benefits of renewable energy • Types of renewable energy sources: solar, wind, biomass, hydro, and geothermal • Comparison between renewable and non-renewable energy • Current trends and future prospects in renewable energy	7
2	Solar Thermal Energy	• Principles of solar thermal energy conversion • Solar collectors: flat plate, evacuated tube, and concentrating collectors • Solar thermal applications: water heating, space heating, and industrial processes • Solar thermal power plants: parabolic troughs, solar towers, and dish Stirling systems • Economic and environmental aspects of solar thermal energy	6
3	Solar Photovoltaics	• Principles of photovoltaic energy conversion • Types of photovoltaic cells: monocrystalline, polycrystalline, and thin film • Design and components of photovoltaic systems: modules, inverters, and batteries • Performance analysis of PV systems: efficiency, shading, and temperature effects • Grid integration and energy storage for PV systems	6
4	Wind Energy	• Fundamentals of wind energy conversion • Wind turbine types, components, and operation • Wind farm design and site selection • Environmental and social impacts of wind energy projects • Economic analysis and policy considerations for wind energy	6
5	Biomass, Hydro and Geothermal Energy	• Biomass & Bio Energy • Biomass resources and conversion technologies • Bioenergy production: biogas, biofuels, and biomass power generation • Waste-to-energy systems • Environmental and economic aspects of bioenergy • Policies and incentives for bioenergy development • Hydro Energy • Principles of hydro power generation	9

		• Small-scale and large-scale hydro power plants • Geothermal Energy • Geothermal energy resources and extraction methods • Applications and challenges of geothermal energy • Environmental and economic considerations for hydro and geothermal energy	
6	Renewable Energy and Management Policy	• Energy management principles and practices • Renewable energy project planning and management • Integration of renewable energy into the grid • Policies, regulations, and incentives for renewable energy • Case studies of successful renewable energy projects	11
Total			**45**

Textbooks:

1. "Renewable Energy: Power for a Sustainable Future" by Godfrey Boyle
2. "Renewable Energy Systems: The Earthscan Expert Guide to Renewable Energy Technologies for Home and Business" by David Thorpe
3. "Energy Management Handbook" by Wayne C. Turner and Steve Doty

Reference Books:

1. "Solar Engineering of Thermal Processes" by John A. Duffie and William A. Beckman
2. "Wind Energy Explained: Theory, Design and Application" by James F. Manwell, Jon G. McGowan, and Anthony L. Rogers
3. "Biomass to Renewable Energy Processes" by Jay Cheng
4. "Hydropower: Renewable Energy for a Sustainable Future" by Dirk Aschenbach
5. "Geothermal Energy: Renewable Energy and the Environment" by William E. Glassley
6. "Renewable Energy Policy and Politics: A Handbook for Decision-Making" by Volker M. Quaschning

Course Name: Energy Audit and Management

Course Code: OE029

Category: Open Elective

Preamble:
Energy Audit is a systematic approach for decision-making in energy management to balance the total energy inputs with its use. The objective of Energy Management is to achieve and maintain optimum energy procurement and utilization to minimize energy costs/waste without affecting production & quality with minimum environmental effects.

Pre-requisites: Nil

Course Objectives:
- To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
- To introduce performance evaluation criteria of various electrical and thermal installations to facilitate energy management
- To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Course Outcomes:

Learners will be able to:

CO1: To identify and describe the present state of energy security and its importance.
CO2: To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
CO3: To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
CO4: To describe the energy performance evaluation of some common thermal installations and identify energy saving opportunities
CO5: To analyze the data collected during performance evaluation and recommend energy saving measures

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
3	-	3	-

Assessment Guidelines:

Head	**ISA**	**MSA**	**ESA**	**Total**

Theory	20	30	50	100

The assessment guidelines for the courses of different credits are mentioned in the above table. 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	Energy Scenario	Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	5
2	Energy Audit Principles	Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	10
3	Energy Management and Energy Conservation in Electrical System	Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipment and appliances, star ratings. Energy efficiency measures in lighting system, Lighting control: Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	10
4	Energy Management and Energy Conservation in Thermal Systems	Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy	10

		measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	
5	Energy Performance Assessment	On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis	5
6	Energy conservation in Buildings:	Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	5
Total			**45**

Reference Books:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.
9. http://www.bee-india.nic.in

Course Name: Bioinformatics

Course Code: OE30

Category: Open elective

Preamble:

This course is designed with the objective of equipping students with a robust understanding of the integration between biology and computational science, key bioinformatics concepts, methodologies, and applications. Through a combination of theoretical knowledge and practical applications, students will develop a holistic understanding of how computational methods can enhance the comprehension of biological processes. It also emphasizes real-world biological questions and research challenges, empowering them to make meaningful contributions to the rapidly evolving field of bioinformatics.

Pre-requisites: Nil

Course Objectives:

- To enable learners to understand the basic principles of bioinformatics.
- To provide a foundational understanding of key bioinformatics concepts, including biological data types and analysis methods.
- To develop the skills necessary for analyzing and interpreting genomic and proteomic datasets using computational techniques.
- To familiarize students with essential bioinformatics tools and databases, enabling effective selection and application in research.
- To encourage the integration of bioinformatics approaches into biological research, fostering the ability to formulate and test hypotheses.

Course Outcomes:

Learners will be able to:
CO1: Understanding of foundational bioinformatics concepts.
CO2: Comprehending and applying knowledge of basic principles of mathematics and statistics.
CO3: Implementing efficient and reliable bioinformatics solutions by optimizing the usage of existing tools. CO4: Apply problem-solving skills to multivariate methods in bioinformatics.
CO5: Search and apply bioinformatics tools to analyze and interpret biological data

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	-	3	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	20	30	50	100

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	Introduction to Bioinformatics	Basics of Biology: Characteristics and Principles of cells, DNA and chromosome, genes and the genomes. Types of biological data, Sequencing Methods: DNA & Protein, Genomic Sequencing, and Human Genome Project Overview and scope of Bioinformatics, Computers in biology, medicine & different problems in biology, Applications of Bioinformatics	9
2	Biological databases and their classification	Based on storage techniques (Flat, Relational, Object Oriented). Based on data (Primary, Secondary, Specialized and Composite). Search engines: Entrez& SRS Sequence databases: NCBI, EMBL, DDBJ Structural Databases: PDB Protein Databases: PIR, SWISS PROT Other Databases: Chemical and Drug Molecule Databases	9
3	Algorithms in Bioinformatics	Sequence Alignment: Heuristic Method (BLAST, FASTA) Pairwise Sequence Alignment: Local and Global Alignment (Dynamic programming Methods: Needleman Wunch Algorithm, Smith Waterman Algorithm.), Multiple Sequence Alignment: CLUSTAL W, Phylogenetic Analysis.	9
4	Introduction to drug designing	History of drug design, Stages of drug discovery and development; Drug properties, likeness. Preparation of Protein Structure: In silico Structure Prediction - Homology Modeling; Threading; Fold Recognition. Ab initio modeling; Model refinement and validation	10

		Molecular Visualization Software: Methods for representing biological data, 3D Structure Viewers Concept of pharmacophore mapping and pharmacophore based Screening	
5	Computer aided drug designing	High throughput Virtual Screening and Molecular Docking: Rigid and Flexible Docking Analysis of Protein-Ligand interactions Quantitative Structure Activity Relationship (QSAR) (3D-QSAR approaches like COMFA and COMSIA.) Molecular Mechanics and Molecular Dynamics Simulations: Understanding the structural stability of protein and protein-ligand complex ADMET analysis	8
Total			**45**

Suggested list of Assignments:

1. Retrieving sequences, it's structural and functional data from the set of databases.
2. Analysing sequences through alignment tools - BLAST, FASTA and CLUSTAL s.
3. 3D Protein modelling, validation and visualization
4. Protein ligand interaction by docking techniques
5. Designing a potential drug candidate.

Suggested List of Value-Added Home Assignments:

1. Mapping genes to biological pathways and analyze their interactions.
2. Construct and interpret a phylogenetic tree.

Suggested Online Courses:

1. Bioinformatics: Algorithms and Applications, offered by NPTEL Swayam, https://onlinecourses.nptel.ac.in/noc21_bt06/preview
2. Bioinformatics: Introduction and Methods, offered by Peking University through Coursera, https://coursesity.com/r/site/bioinformatics-introduction-and-methods-

Reference Books:

1. Bioinformatics and Functional genomics, Jonathan Pevsner, Wiley Blackwell, 2015, Third edition.
2. Bioinformatics: Sequence and genome analysis, David mount, Cold Spring Harbor, N.Y press, 2004, Second edition.
3. Strategies for Organic Drug Discovery Synthesis and Design, Daniel Lednicer, Wiley International Publishers, 1998, Second Edition.
4. Essential Bioinformatics, Jin Xiong, Cambridge University Press, 2006, First Edition.

Course Name: Nanotechnology
Course Code: OE31
Category: Open elective
Preamble:

The course aims to provide a comprehensive understanding of nanotechnology fundamentals, its scientific principles, fabrication techniques, applications in engineering, and the ethical considerations associated with its usage. Students will explore how nanotechnology can be applied to different fields of engineering, including electronics, materials science, biomedical applications, and energy.

Pre-requisites:
Nil
Course Objectives:

- To enable learners to understand the basic principles and concepts of nanotechnology.
- To enable learners to explain the properties and behavior of materials at the nanoscale.
- To enable learners to describe the fabrication and characterization techniques used in nanotechnology.
- To enable learners to explore the applications of nanotechnology in various engineering fields.
- To enable learners to analyze the societal and ethical implications of nanotechnology advancements.

Course Outcomes:

Learners will be able to:

CO1: Understand nanotechnology fundamentals.
CO2: Analyze nanoscale phenomena
CO3: Understand and apply key nanofabrication methods for creating nanoscale structures and devices.
CO4: Understand the principles behind various characterization techniques for nanoscale materials.
CO5: Explore engineering applications of nanotechnology.
CO6: Evaluate ethical, environmental, and societal Impacts.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	-	3	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	20	30	50	100

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	Introduction to Nanotechnology	Definition, scope, and multidisciplinary nature of nanotechnology. Historical development of nanotechnology and key breakthroughs. Types of nanomaterials: nanoparticles, nanotubes, nanowires, quantum dots, and nanocomposites. Nanoscale dimensions: importance of size, surface area, and quantum effects. Exploration of nanotechnology's role in various industries (electronics, medicine, energy, etc.).	9
2	Properties of Nanomaterials	In-depth study of the physical, chemical, electrical, optical, and mechanical properties of nanomaterials. Surface energy, surface-to-volume ratio, and its impact on material properties. Detailed study of quantum confinement and its influence on electrical and optical properties. Toxicity and environmental concerns of nanomaterials: impact on living organisms and ecosystems.	9
3	Nanofabrication Techniques	Comprehensive overview of top-down and bottom-up nanofabrication methods. In-depth study of lithographic techniques: photolithography, electron-beam lithography. Advanced deposition techniques: Chemical Vapor Deposition (CVD), Atomic Layer Deposition (ALD), Physical Vapor Deposition (PVD). Molecular self-assembly, nanoimprint lithography, and soft lithography techniques.	9
4	Characterization of Nanomaterials	Detailed study of key characterization tools: Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM). Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy (STM), X-ray diffraction (XRD). Optical spectroscopy and Raman spectroscopy techniques.	6

		Importance of precision and resolution in nanomaterial characterization.	
5	Applications of Nanotechnology in Engineering	Nanotechnology in Electronics: nanoscale transistors, quantum dots, and nanomaterials for next-gen electronics. Energy Applications: nanomaterials for solar cells, energy storage, supercapacitors, and batteries. Biomedical Applications: drug delivery, diagnostic tools, nanomedicine, and tissue engineering. Environmental Applications: nanotechnology in water purification, air filtration, and pollution control. Mechanical and Civil Engineering: nanocomposites, self-cleaning surfaces, and smart materials.	8
6	Societal, Ethical, and Environmental Implications	Ethical issues related to nanotechnology: privacy concerns, nanotoxicology, and regulation. Environmental impacts of nanomaterials: nanowaste management and recycling. Public perception of nanotechnology and its societal impacts. Responsible innovation and future directions for ethical development of nanotechnology. Regulatory frameworks for nanomaterials in India and worldwide.	4
Total			**45**

Suggested list of Assignments:

1. Explore one specific application of nanotechnology in any engineering field (e.g., electronics, medicine, or energy).
2. Comparative Analysis of Nanoscale vs. Bulk Properties.
3. Design of a Nanofabrication Process for a device.
4. Nanomaterials Characterization Report interpretation.
5. Propose a simple nanotechnology-based solution for an engineering challenge in your chosen field.
6. Ethical and Environmental Implications of Nanotechnology.

Suggested List of Value-Added Home Assignments:

1. Reviewing Nano products and new technologies.
2. Novel technical paper writing based on recent advancements.
3. Problem Based Learning on Nano sensor development.

Suggested Online Courses:

1. Nanotechnology : Introduction, Essentials, and Opportunities
   https://www.udemy.com/course/nanotechnology/?couponCode=IND21PM

2. Nanotechnology: A Maker's Course
   https://www.coursera.org/learn/nanotechnology

Reference Books:

1. Marc Madou, "Fundamentals of Microfabrication", CRC Press, 1997.
2. Charles P. Poole and Frank J. Owens, "Introduction to Nanotechnology", Wiley-Interscience, 2003.
3. Sulabha Kulkarni, "Nanotechnology: Principles and Practices", Springer, 2015.
4. R.S. Tiwari and A. Gosh, "Nanomaterials and Nanotechnology", S. Chand & Company, 2017.
5. Patricia I. Dolez, "Nanoengineering: Global Approaches to Health and Safety Issues", Elsevier, 2015.

Course Name: Publication / Patent

Course Code: BM43

Category: Project and Internship

Preamble:

In the rapidly evolving landscape of biomedical engineering, the ability to effectively communicate research findings and protect intellectual property is essential. This course equips students with the skills and knowledge needed to write and publish scientific papers in reputed journals and to understand the legal, technical, and strategic aspects of patenting biomedical innovations. It aims to foster innovation, academic integrity, and awareness of global standards in research dissemination and intellectual property rights.

Pre-requisites:
Basic background of programming courses, fundamental of electronic devices and transducers, circuit design and analysis.

Course Objectives:

- To understand the structure, process, and ethics of scientific publication in biomedical engineering, including peer review, impact factor, plagiarism, and authorship norms.
- To analyze and draft technical manuscripts, research articles, and conference papers suitable for national and international biomedical engineering platforms.
- To understand the fundamentals of intellectual property rights (IPR), including types of patents, patentability criteria, and the process for filing and protecting patents in India and internationally.

Course Outcomes:
Student will be able to:
CO1: Describe the structure and components of scientific research papers, patents, and technical reports relevant to biomedical engineering.
CO2: Explain the ethical guidelines, peer-review process, plagiarism norms, and authorship criteria in scientific publishing.
CO3: Analyze published biomedical research articles to evaluate technical content, clarity, and impact.
CO4: Demonstrate the ability to write a structured draft of a scientific article, conference abstract, or technical report in a given biomedical domain.

CO5: Identify types of intellectual property rights (IPR), and outline the procedures and criteria for filing patents, with examples from biomedical innovations.
Course Scheme:

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

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25		50	075

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.

Course Name: Project-2 Demonstration

Course Code: BM44

Category: Project and Internship

Preamble:

"Project–2 Demonstration" serves as a continuation and implementation phase of the work proposed in Project–1. It provides Biomedical Engineering undergraduates the opportunity to translate their proposed ideas into functional systems, devices, or research outcomes. The course emphasizes practical application, innovation, problem-solving, and critical thinking. Students are expected to demonstrate their ability to apply biomedical engineering principles to address real-world healthcare problems, while also considering ethical, regulatory, and user-centric design aspects. The culmination of this course is a working prototype or research output and its effective communication through demonstration and documentation.

Pre-requisites:
Basic background of programming courses, fundamental of electronic devices and transducers, circuit design and analysis.

Course Objectives:

- To apply engineering principles and project management strategies to implement the proposed biomedical project solution effectively.
- To develop, test, and validate biomedical devices, systems, or methodologies in line with the defined project scope and objectives.
- To strengthen communication, documentation, and teamwork skills through regular progress reporting, demonstrations, and technical presentations.

Course Outcomes:
Student will be able to:
CO1: Demonstrates effective use of written, verbal, and non-verbal communication, uses industry terminology.
CO2: Demonstrate an understanding of professional engineering regulations, legislation and standards
CO3: Understand the relationship between the technical, socio-economic and environmental dimensions of sustainability
CO4: Implement the selected methodology and evaluate the findings of the project.
CO5: Demonstrate an ability to plan/manage an engineering activity within time and budget constraints

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
1	6	1	3

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	75	-	50	125

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.