Sanjay Ghodawat University Kolhapur



School of Engineering and Technology

Department of Artificial Intelligence and Machine Learning

B. Tech. Artificial Intelligence and Machine Learning

Curriculum Structure & Detail Syllabus (R23)

Semester: VII-VIII

Programme structure for B. Tech. Final Year Artificial Intelligence and Machine Learning
Semester VII: Teaching Scheme

Course code	Course name	Teaching scheme (Hrs/week)			Credits assigned			
		Th.	Pr	Tu.	Th.	Pr	Tu.	Total credits
U12PC701	Optimization Techniques	3	-	-	3	-	-	3
U12PC702	Computer Vision	3	-	-	3	-	-	3
U12PE7XX	Program Elective IV	3	-	-	3	-	-	3
U01RM701	Research Methodology	3	-	-	3	-	-	3
UXXMM0XX	Multidisciplinary Minor V	2	-	-	2	-	-	2
U12PC703	Optimization Techniques Lab	-	4	-	-	2	-	2
U12PC704	Computer Vision Lab	-	4	-	-	2	-	2
U12PE7XX	Program Elective IV Lab	-	4	-	-	2	-	2
U12PR701 OR U12EP701 OR U12RE701	Project Phase I (Industry Internship with Capstone Project Track) OR Entrepreneurship Project Phase I (Entrepreneurship Venture Track) OR Research Project Phase I (Higher Opportunity Track)	-	4	-	-	2	-	2
	Total	14	16		14	8		22

Th: Theory, Pr: practical, Tu: Tutorial

Program Elective IV			
Vertical I (Data Analytics)		**Vertical II (Data Management)**	
Code	**Course Name**	**Code**	**Course Name**
U12PE711	ARVR	U12PE721	Business Intelligence
Vertical III (Cloud Computing)			
Code	Course Name		
U12PE731	Devops & MLOPS		

Program Elective IV Lab			
Vertical I (Data Analytics)		**Vertical II (Data Management)**	
Code	**Course Name**	**Code**	**Course Name**
U12PE712	ARVR Lab	U12PE722	Intelligence System Lab
Vertical III (Cloud Computing)			
Code	**Course Name**		
U12PE732	Devops& MLOPS Lab		

Final Year Artificial Intelligence and Machine Learning Programs Semester VII: Evaluation Scheme

Course code	Course name	*Theory Marks*					Practical Marks		Total
		Evaluation(Theory)				SEE	Term work	Practical Oral/POE	
		T1	T2	FET	Total				
U12PC701	Optimization Techniques	10	10	5	25	50	-	-	75
U12PC702	Computer Vision	10	10	5	25	50	-	-	75
U12PE7XX	Program Elective IV	10	10	5	25	50	-	-	75
U01RM701	Research Methodology	10	10	5	25	50	-	-	75
U12MM0XX	Multidisciplinary Minor V	-	10	5	15	35	-	-	50
U12PC703	Optimization Techniques Lab	-	-	-	-	-	25	25	50
U12PC704	Computer Vision Lab	-	-	-	-		25	25	50
U12PE7XX	Program Elective IV Lab	-	-	-	-	-	25	25	50
U12PR701 OR U12EP701 OR U12RE701	Project Phase I (Industry Internship with Capstone Project) OR Entrepreneurship Project Phase I (Entrepreneurship Venture Track) OR Research Project Phase I (Higher Opportunity Track)	-	-	-	-	-	50	-	50
								Total	550

* Minimum passing is 40% for all courses and evaluation head mentioned above. FET – Faculty evaluation for Theory ,T1, T2, Continuous Assessment Test, FEP, Faculty Evaluation for Practical, ESE - End Semester Examination, P/F – Pass/ Fail Course, AU – Audit Course

Note: The Evaluation of Project Phase I is divided into two parts (Internal Assessment)

a) Preparation and presentation of the proposal of the Project (Motivation/ Relevance, Problem Statement, Literature Survey, Objectives, Methodology and design of the project) for 25marks.

b) Student shall present a seminar on the topic relevant to the Project work for 25 marks.

Programme structure for B. Tech. Final Year Artificial Intelligence and Machine Learning

Semester VIII: Teaching Scheme

Track I: Industry Internship with Capstone Project Track

Course code	Course name	Teaching scheme (Hrs./week)			Credits assigned			
		Th	Pr	Tu	Th	Pr	Tu	Total credits
U12PE8XX	Program Elective V	3	-	-	3	-	-	3
UXXMM0XX	Multidisciplinary Minor VI	2	-	-	2	-	-	2
U12PR801	Project Phase II	-	8	-	-	4	-	4
U12OT801	Internship/On job Training	-	24	-	-	12	-	12
	Total	**5**	32	-	5	16	-	**21**

Th: Theory, Pr: practical, Tu: Tutorial

Program Elective V			
Vertical I (Data Analytics)		**Vertical II (Data Management))**	
Code	**Course Name**	**Code**	**Course Name**
U12PE811	Recommendation System	U12PE821	Business Analytics
Vertical III (Cloud Computing)			
Code	**Course Name**		
U12PE831	Advanced Cloud Computing		

Note: The Program Elective V and Multidisciplinary Minor VI shall be conducted in online mode, by faculty of SGU or other institute/ University. Students can also opt a course from MOOCs platforms such as SWAYAM, NPTEL, Coursera etc. In case there is no assessment and examination conducted by the MOOCs platforms then the assessment and examination will be conducted by SGU.

Semester VIII: Evaluation Scheme

Track I: Industry Internship With Capstone Project Track

Course code	Course name	*Theory Marks*					Practical Marks		Total
		Evaluation (Theory)				SEE	Evaluation (Lab)		
		T1	T2	FET	Total		Term work	Practical Oral/POE	
U12PE8XX	Program Elective V	10	10	5	25	50	-	-	75
U12MM0XX	Multidisciplinary Minor VI	10	-	5	15	35	-	-	50
U12PR801	Project Phase -I	-	-	-	-	-	50	50	100
U12OT801	Internship/On job Training	-	-	-	-	-	200	100	300

* Minimum passing is 40% for all courses and evaluation head mentioned above. FET – Faculty evaluation for Theory ,T1, T2, Continuous Assessment Test, FEP, Faculty Evaluation for Practical, ESE - End Semester Examination, P/F – Pass/ Fail Course, AU – Audit Course

- Additional Credits for Bachelor's Degree- with Double Minor OR Honours: 12 Credits.

These are additional credits to be offered from the second year to the final year and will be offered as an option to students.

- Additional Credits for Bachelor's Degree- Honours with Research: Minimum 16- 20 Credits

These are additional credit from same domain to be offered from the second year to the final year and will br offered as an option to students

- Additional Credits for Bachelor's Degree-Honors with Research: Minimum 16-20 Credits. These are additional credits to be offered in the final year and will be offered as an option to students

Programme structure for B. Tech. Final YearArtificial Intelligence and Machine Learning

Semester VIII: Teaching Scheme

Track II: Entrepreneurship Venture Track

Course code	Course name	Teaching scheme			Credits assigned			
		Th	Pr	Tu	Th	Pr	Tu	Total credits
U12PE8XX	Program Elective V	3	-	-	3	-	-	3
UXXMM0XX	Multidisciplinary Minor VI	2	-	-	2	-	-	2
U12EP801	Online Course in Advanced Technology (domain area)	-	-	-	4	-	-	4
U12EP802	Entrepreneurship Project Phase -II	-	24	-	-	12	-	12
	Total	**5**	24	-	9	12	-	**21**

Th: Theory, Pr: practical, Tu: Tutorial

Program Elective V			
Vertical I (Data Analytics)		**Vertical II (Data Management))**	
Code	**Course Name**	**Code**	**Course Name**
U12PE811	Recommendation System	U12PE821	Business Analytics
Vertical III (Cloud Computing)			
Code	**Course Name**		
U12PE831	Advanced Cloud Computing		

Note: The Program Elective V and Multidisciplinary Minor VI shall be conducted in online mode, by faculty of SGU or other institute/ University. Students can also opt a course from MOOCs platforms such as SWAYAM, NPTEL, Coursera etc. In case there is no assessment and examination conducted by the MOOCs platforms then the assessment and examination will be conducted by SGU.

Semester VIII: Evaluation Scheme

Track II: Entrepreneurship Venture Track

Course code	Course name	*Theory Marks*					Practical Marks		Total
		Evaluation (Theory)				SEE	Evaluation (Lab)		
		T1	T2	FET	Total		Term work	Practical Oral/POE	
U12PE8XX	Program Elective V	10	10	5	25	50	-	-	75
UXXMM0XX	Multidisciplinary Minor VI	10	-	5	15	35	-	-	50
U12EP801	Online Course in Advanced Technology (domain area)	-	-	-	25	75	-	-	100
U12EP802	Entrepreneurship Project Phase -II	-	-	-	-	-	200	100	300

* Minimum passing is 40% for all courses and evaluation head mentioned above. FET – Faculty evaluation for Theory ,T1, T2, Continuous Assessment Test, FEP, Faculty Evaluation for Practical, ESE - End Semester Examination, P/F – Pass/ Fail Course, AU – Audit Course

- Additional Credits for Bachelor's Degree- with Double Minor OR Honours: 12 Credits.

These are additional credits to be offered from the second year to the final year and will be offered as an option to students.

- Additional Credits for Bachelor's Degree- Honours with Research: Minimum 16- 20 Credits

These are additional credit from same domain to be offered from the second year to the final year and will be offered as an option to students

- Additional Credits for Bachelor's Degree-Honors with Research: Minimum 16-20 Credits. These are additional credits to be offered in the final year and will be offered as an option to students

Programme structure for B. Tech. Final Year Artificial Intelligence and Machine Learning

Semester VIII: Teaching Scheme

Track III: Higher Opportunity Track

Course code	Course name	Teaching scheme (Hrs./week)			Credits assigned			
		Th	Pr	Tu	Th	Pr	Tu	Total credits
U12PE8XX	Program Elective V	3	-	-	3	-	-	3
UXXMM0XX	Multidisciplinary Minor VI	2	-	-	2	-	-	2
U12RE801	Online Course in Advanced Technology (domain area)	-	-	-	4	-	-	4
U12RE802	Research Project Phase -II	-	24	-	-	12	-	12
	Total	**5**	24	-	9	12	-	**21**

Th: Theory, Pr: practical, Tu: Tutorial

Program Elective V			
Vertical I (Data Analytics)		**Vertical II (Data Management))**	
Code	**Course Name**	**Code**	**Course Name**
U12PE811	Recommendation System	U12PE821	Business Analytics
Vertical III (Cloud Computing)			
Code	**Course Name**		
U12PE831	Advanced Cloud Computing		

Note: The Program Elective V and Multidisciplinary Minor VI shall be conducted in online mode, by faculty of SGU or other institute/ University. Students can also opt a course from MOOCs platforms such as SWAYAM, NPTEL, Coursera etc. In case there is no assessment and examination conducted by the MOOCs platforms then the assessment and examination will be conducted by SGU.

Semester VIII: Evaluation Scheme
Track III: Higher Opportunity Track

Course code	Course name	*Theory Marks*					Practical Marks		Total
		Evaluation (Theory)				SEE	Evaluation (Lab)		
		T1	T2	FET	Total		Term work	Practical Oral/POE	
U12PE8XX	Program Elective V	10	10	5	25	50	-	-	75
UXXMM0XX	Multidisciplinary Minor VI	10	-	5	15	35	-	-	50
U12RE801	Online Course in Advanced Technology (domain area)	-	-	-	25	75	-	-	100
U12RE802	Research Project Phase -II	-	-	-	-	-	200	100	300

* Minimum passing is 40% for all courses and evaluation head mentioned above. FET – Faculty evaluation for Theory ,T1, T2, Continuous Assessment Test, FEP, Faculty Evaluation for Practical, ESE - End Semester Examination, P/F – Pass/ Fail Course, AU – Audit Course

- Additional Credits for Bachelor's Degree- with Double Minor OR Honours: 12 Credits.

These are additional credits to be offered from the second year to the final year and will be offered as an option to students.

- Additional Credits for Bachelor's Degree- Honours with Research: Minimum 16- 20 Credits

These are additional credit from same domain to be offered from the second year to the final year and will be offered as an option to students

- Additional Credits for Bachelor's Degree-Honors with Research: Minimum 16-20 Credits. These are additional credits to be offered in the final year and will be offered as an option to students

Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U12PC701	Optimization Techniques	3	-	-	3	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		Total (Marks)
		T1	T2	FET	Total	Min pass	Marks	Min pass	
U12PC701	Optimization Techniques	10	10	5	25	40%	50	40%	75

Course Description: This course provides an introduction to optimization techniques, covering fundamental principles, classical methods, and modern approaches used in engineering and technology. Students will learn how to formulate and solve optimization problems in areas such as engineering design, robotics, artificial intelligence, and machine learning. The course integrates statistical foundations to enhance problem-solving skills in uncertain environments. Practical applications and computational tools like Python will be emphasized to equip students with hands-on experience in optimization modelling and implementation.

Course Objectives:

- To **impart basic knowledge** of the fundamental concepts of optimization.
- To **develop skills** in applying linear programming techniques such as graphical method, simplex method, duality, and sensitivity analysis for solving optimization problems.
- To **enable students to comprehend** unconstrained and constrained nonlinear optimization problems.

Course Outcomes: After the successful completion of the course students will able to:

CO1 **Explain**[2] basic concepts of optimization: decision variable, objective function and constraints

CO2 **Apply**[5] various method to obtain optimum solution of LPP, IPP and QPP

CO3 **Solve**[3] linear and nonlinear programming problems using appropriate mathematical models and algorithms

CO4 **Analyze**[4] the impact of uncertainty in optimization problems and apply stochastic optimization techniques to develop effective solutions

CO5 **Design**[6] optimization models for practical applications in engineering computer science, finance, and logistics, utilizing appropriate algorithms and computational tools.

Course Contents

Module	Unit	Description	Hours
1.0		**Introduction to Optimization**	
1	1.1	Overview of Optimization: Definition, importance, Decision variables, objective functions, Constraints, Objective function surfaces, Constraints surface. Engineering applications of Optimization	9
	1.2	Single variable Optimization, Multi-Variable Optimization with no constraints, Multi variable Optimization with Equality constraints	
2.0		**Linear Programming Problem**	
2	2.1	Linear programming, standard form of linear programming, geometry of linear programming problems, solution of a system of linear simultaneous equations, pivotal production of general systems of equations, simplex algorithms, revised simpler methods, duality in linear programming	9
3.0		**Nonlinear Programming**	
3	3.1	Unconstrained Optimization: Gradient descent, Newton's method, conjugate gradient method	9
	3.2	Constrained Optimization: Lagrange multipliers, Karush-Kuhn-Tucker (KKT) conditions	
	3.3	Quadratic Programming: Problem formulation and solution techniques	
4.0		**Discrete Optimization**	
4	4.1	Integer Programming: Formulation, branch and bound method, cutting plane method.	9
	4.2	Dynamic Programming: Principle of optimality, recursive equations, and applications.	
	4.3	Combinatorial Optimization: Traveling salesman problem, knapsack problem, graph algorithms.	
5.0		**Stochastic Optimization**	
5	5.1	Introduction to Stochastic Optimization: Concepts, importance, and challenges of handling uncertainty in optimization problems.	9
	5.2	Stochastic Programming: Formulation and solution techniques for problems with probabilistic constraints and objectives.	

Text Books

1. A. Ravindran, “Engineering Optimization: Methods and Applications”, Wiley, 2nd Edition, 2006.
2. S. S. Rao, “Engineering Optimization: Theory and Practice”, Wiley, 4th Edition, 2009

References

1. A. Konkalmatt, A. K. Nagar and D. P. Mohapatra, “Optimization Techniques in Engineering: Advances and Applications”, CRC Press, 2023.

Internal Assessment (T1, T2 and FET)

1. T1 should be based on first two modules and T2 should be based on next two modules, for 10 marks each.

2. Fifth module will be assessed for 5 marks separately.

Semester End Exam

1. Question paper will comprise of 5 questions, each carrying 10 marks.
2. The duration of semester end examination shall be 2 hours.
3. The students need to solve all 5 questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
U12PC702	Computer Vision.	Theory	Practical	Tutorial	Theory	Practical	Tutorial
		03	-	-	03	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		Total (Marks)
U12PC702	Computer Vision.	T1	T2	FET	Total	Min pass	Marks	Min pass	75
		10	10	5	25	40%	50	40%	

Course Description: This course provides a foundation in computer vision and image processing, covering image formation, processing techniques, feature detection, and shape analysis. It explores advanced methods like Hough Transform and feature matching for object detection and recognition. The course also highlights real-world applications such as face recognition, surveillance systems, and intelligent image analysis.

Pre-requisites: Python Programming

Course Objectives:

- To **review** image processing techniques used in Computer Vision.
- To **develop understanding** of shape and region analysis techniques.
- To **enable students to comprehend** three-dimensional image analysis techniques.

Course Outcomes: after the end of this course students will be able to

CO1 **Implement**[3] fundamental image processing techniques required for computer vision.

CO2 **Apply**[3] feature extraction techniques.

CO3 **Apply**[3] Hough Transform for line, circle, and ellipse detections

CO4 **Implement**[3] three-dimensional analysis techniques.

CO5 **Develop**[4] skills to implement diverse computer vision applications.

Course Contents			
Module	**Unit**	**Description**	**Hours**
1.0		**Introduction to Computer Vision and Image Processing**	9
	1.1	Introduction to Computer Vision, Fundamentals Of Image Formation, Review of Digital image processing: Introduction, Origin, Applications and Examples of Digital Image Processing, Fundamental steps in Digital Image Processing, Components of Digital Image Processing, Elements of Visual Perception, Image Sensing and Acquisition, Image Sampling and Quantization, Basic Relationship between pixels,	
	1.2	Image processing techniques: classical filtering operations, Thresholding techniques, edge detection techniques, corner and interest point detection, texture Analysis	
2.0		**Shapes And Regions**	9
	2.1	Binary shape analysis, Connectedness, object labelling and counting, size filtering, distance functions and their uses, skeletons and thinning, Other Measures for Shape Recognition	
	2.2	Boundary pattern analysis: Boundary Tracking Procedures, Centroidal Profiles, Tackling the Problems of Occlusion, Accuracy of Boundary Length Measures, Object segmentation and shape models, Active Contours, Shape Models	
3.0		**Feature Detection and Matching**	9
	3.1	Points and patches: Feature detectors, Feature descriptors, Feature matching, Feature tracking Application: Performance-driven animation, Edges: Edge detection, Edge linking, Application: Edge editing and enhancement, Vanishing points, Application: Rectangle detection	
	3.2	**Deep Learning for Computer Vision**: CNNs, transfer learning, object detection like YOLO, segmentation like U-Net	
4.0		**Hough Transform**	9
	4.1	Line detection – Hough Transform (HT) for line detection, the foot-of-normal method, Using RANSAC for Straight Line Detection, Hough-Based Schemes for Circular Object Detection, The Problem of Unknown Circle Radius, Overcoming the Speed Problem, Ellipse Detection Case study: Human Iris Location, The Generalized Hough Transform (GHT), Use of the GHT for Ellipse Detection, A Graph-Theoretic Approach to Object	

		Location, Possibilities for Saving Computation, Using the GHT for Feature Collation	
5.0		**Computer Vision Applications**	9
	5.1	Application: 1.Photo album – Object detection, Face detection, Pedestrian detection, Face recognition: Eigen faces, Active appearance and 3D shape models, 2.Surveillance – The basic geometry, foreground-background separation, particle filters, Chamfer Matching, Tracking, and Occlusion, combining views from multiple cameras 3.In-vehicle vision system: Locating the Roadway, Location of Road Markings, Location of Road Signs, Location of Vehicles, Locating Pedestrians	

Textbooks:

1. Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", Pearson Education, 4th Edition, 2018.
2. Richard Szeliski, *"Computer Vision: Algorithms and Applications"*, Springer, 2nd Edition, 2022.

References:

1. Pancham Shukla, Rajanikanth Aluvalu, Shilpa Gite, Uma Maheswari, *"Computer Vision"*, De Gruyter, 2023.

Internal Assessment (T1, T2 and FET)

1.T1 should be based on first two modules and T2 should be based on next two modules, for 10 marks each.

2. Fifth module will be assessed for 5 marks separately.

Semester End Exam

1.Question paper will comprise of 5 questions, each carrying 10 marks.

2.The duration of semester end examination shall be 2 hours.

3.The students need to solve all 5 questions.

4.Question No.1 will be compulsory and based on entire syllabus.

5.Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U12PE711	ARVR	3	-	-	3	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		Total (Marks)
		T1	T2	FET	Total	Min pass	Marks	Min pass	
U12PE711	ARVR	10	10	5	25	40%	50	40%	75

Course Description: This is an intermediate course on Augmented Reality and Virtual Reality that focuses on understanding the principles, techniques, and applications of immersive technologies. The course covers AR/VR systems, interaction methods, tracking techniques, and emerging applications.

Course Objectives:

- To **introduce** the fundamentals of immersive technologies such as Augmented Reality, Virtual Reality, and Mixed Reality.
- To **enable students to comprehend** system architectures and interaction techniques in AR/VR environments.
- To **develop skills** in tracking, rendering, and performance optimization aspects of immersive systems.
- To **familiarize students with** real-world applications and emerging trends in AR/VR .

Course Outcomes:
After the successful completion of the course students will able to:

CO1 **Explain**[2] core concepts and evolution of AR, VR, and MR technologies.

CO2 **Analyze**[4]immersive system components and architectures used in AR/VR systems.

CO3 **Apply**[3] interaction and tracking techniques in AR/VR systems.

CO4 **Evaluate**[5] performance, usability, and challenges of AR/VR applications.

CO5 **Analyze**[4] emerging trends and applications of immersive technologies.

Course Contents

Module	Unit	Description	Hours
1.0		**Introduction to Immersive Technologies**	
1	1.1	Introduction to Immersive Technologies, Reality–Virtuality Continuum (AR, VR, MR, XR), Historical evolution of AR and VR, Difference between AR, VR, and MR	9
	1.2	Components of immersive systems, Applications of AR/VR in industry, healthcare, education, defense, Online and offline AR/VR tools overview, Social, ethical, and psychological impacts of AR/VR, Health, safety, and consequences of excessive immersive usage	
2.0		**Virtual Reality Systems and Technologies**	
2	2.1	Fundamentals of Virtual Reality, Types of VR systems, VR hardware, VR input devices, VR output devices	9
	2.2	VR system architecture and components, Human perception in VR, VR applications and use cases	
3.0		**Virtual Reality Application Development**	
3	3.1	VR application development lifecycle, Comparison of VR lifecycle with SDLC, Introduction to Unity for VR development, Basics of Unreal Engine and Blueprints	9
	3.2	Scene creation, lighting, and camera setup, Interaction techniques in VR environments, Web VR and Mobile VR development, Case studies of VR applications	
4.0		**Augmented Reality Concepts and Techniques**	
4	4.1	Introduction to Augmented Reality, Types of AR: Marker-based, Marker-less, Location-based, Mobile AR, Web AR, and Headset AR, Working principle of AR systems, Image processing fundamentals for AR.	9
	4.2	Feature detection and key-point extraction, AR tracking and registration techniques, Challenges and limitations of AR systems, Evaluation and performance metrics of AR applications.	
5.0		**Augmented and Mixed Reality Applications**	
5	5.1	AR development tools and frameworks, Vuforia engine architecture and features, Unity with Vuforia integration, AR application design workflow, Challenges in AR deployment	9
	5.2	Introduction to Mixed Reality, MR hardware and software requirements, Security, privacy, and ethical issues in AR/MR, Real-world applications and case studies of AR/MR.	

Text Books

1. Tony Parisi , “Learning Virtual Reality”, O’Reilly Media, 1st Edition, 2015
2. Dieter Schmalstieg & Tobias Höllerer, “Augmented Reality: Principles and Practice” , Pearson / Addison-Wesley, 1st Edition , 2016

References

1. Oliver Bimber and Ramesh Raskar, "Spatial Augmented Reality: Merging Real and Virtual Worlds", First Edition, A K Peters / CRC Press, Natick, Massachusetts, 1st Edition ,2005.

Internal Assessment (T1, T2 and FET)

1.T1 should be based on first two modules and T2 should be based on next two modules, for 10 marks each.

2.Fifth module will be assessed for 5 marks separately.

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Semester End Exam

1.Question paper will comprise of 5 questions, each carrying 10 marks.

2.The duration of semester end examination shall be 2 hours.

3.The students need to solve all 5 questions.

4.Question No.1 will be compulsory and based on entire syllabus.

5.Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U12PE721	Business Intelligence	3	-	-	3	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		Total (Marks)
		T1	T2	FET	Total	Min pass	Marks	Min pass	
U12PE721	Business Intelligence	10	10	5	25	40%	50	40%	75

Course Description

This course introduces the fundamental concepts, architectures, tools, and techniques of Business Intelligence (BI). It focuses on transforming raw data into meaningful insights for effective decision-making using reporting, OLAP, dashboards, data warehousing, and emerging BI technologies.

Course Objectives

- To **introduce** the fundamentals and importance of Business Intelligence in organizations.
- To **develop skills** in BI architectures, tools, and data management techniques.
- To **enhance** analytical thinking using BI reporting and visualization methods.
- To **enable students to comprehend** the BI implementation lifecycle and strategic applications in organizations.
- To **familiarize students with** modern BI trends and industry practic

Course Outcomes: After the successful completion of the course students will able to:

CO1	**Explain**[2]the concepts, evolution, and role of Business Intelligence
CO2	**Apply**[3] data warehousing and dimensional modeling concepts to design BI data architectures and ETL workflows.
CO3	**Apply**[3]reporting, dashboards, and visualization techniques for decision-making
CO4	**Examine**[4] BI lifecycle, strategy, and implementation challenges
CO5	**Evaluate**[5] emerging BI tools, technologies, and industry applications

Course Contents

Module	Unit	Description	Hours
1.0		**Introduction to Business Intelligence**	
1	1.1	Decision-making and role of information, Definition and scope of Business Intelligence, BI value proposition, History and evolution of BI.	9
	1.2	BI components and architecture overview, BI vs. traditional reporting systems, Strategic vs. tactical BI, Applications of BI in business domains.	
2.0		**BI Data Architecture and Warehousing**	
2	2.1	Data sources and data integration, Data warehouse concepts and characteristics, ETL process (Extract, Transform, Load), Data marts and operational data stores.	9
	2.2	Dimensional data modeling, Star and snowflake schemas, OLTP vs OLAP systems, BI data quality and governance.	
3.0		**BI Reporting and Analytical Processing**	
3	3.1	Reporting fundamentals and query processing, Ad-hoc reporting and managed reporting, Self-service BI	9
	3.2	OLAP concepts and multidimensional analysis, OLAP cube operations: drill-down, roll-up, slice, dice, MOLAP, ROLAP, HOLAP architectures	
4.0		**Dashboards, Visualization, and Advanced BI**	
4	4.1	Key Performance Indicators (KPIs), BI dashboards and scorecards, Dashboard design principles	9
	4.2	Data visualization techniques, Guided analytics and predictive analytics, Introduction to data mining and advanced BI tools	
5.0		**BI Lifecycle, Strategy, and Trends**	
5	5.1	BI lifecycle and implementation methodology, BI project planning and requirement analysis, Human and organizational factors in BI	9
	5.2	BI strategy and roadmap, BI tools and vendors overview, Emerging trends: real-time BI, self-service BI, AI-enabled BI	

Text Books

1. Ramesh Sharda, Dursun Delen and Efraim Turban, “Business Intelligence, Analytics, and Data Science: A Managerial Perspective”, Pearson Education, 4th Edition, 2021.
2. Nitin Seth, “Mastering the Data Paradox”, Penguin Random House India, 2024.

References

1. Cindi Howson, “Successful Business Intelligence: Unlock the Value of BI and Big Data”, McGraw-Hill Osborne Media, 2nd Edition, 2014.

Internal Assessment (T1, T2 and FET)

1.T1 should be based on first two modules and T2 should be based on next two modules, for 10 marks each.

2.Fifth module will be assessed for 5 marks separately.

Semester End Exam

1.Question paper will comprise of 5 questions, each carrying 10 marks.

2.The duration of semester end examination shall be 2 hours.

3.The students need to solve all 5 questions.

4.Question No.1 will be compulsory and based on entire syllabus.

5.Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U12PE731	DevOps & MLOPS	3	-	-	3	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		Total (Marks)
		T1	T2	FET	Total	Min pass	Marks	Min pass	
U12PE731	DevOps& MLOPS	10	10	5	25	40%	50	40%	75

Course Description: This course integrates DevOps and MLOps concepts to bridge modern software engineering and data science. It covers DevOps principles, cloud computing, version control, CI/CD pipelines, containerization with Docker and Kubernetes, and MLOps practices such as data versioning, experiment tracking, model deployment, monitoring, and governance for scalable and reliable machine learning systems.

Pre-requisites: Python Programming, Machine Learning

Course Objectives:

- To **develop** a strong DevOps mindset for rapid and reliable software delivery.
- To **develop skills** in automating infrastructure and deployment using IaC and CI/CD pipelines.
- To **build competency** in developing and managing scalable containerized applications.
- To **enable students to comprehend** end-to-end MLOps practices for the machine learning lifecycle.
- To **enhance** the ability to monitor and optimize systems for performance, reliability, and compliance.

Course Outcomes: after the end of this course students will be able to

CO1 **Explain**[2]DevOps culture, cloud service models, and version control strategies that support effective software delivery.

CO2 **Apply**[3]containerization and orchestration concepts using Docker and Kubernetes for deploying scalable applications.

CO3 **Apply**[3]automated CI/CD workflows using industry-standard tools for build, test, and deployment automation.

CO4 **Analyze**[4] MLOps workflows incorporating data versioning, experiment tracking, and model management practices**.**

CO5 **Evaluate**[5] deployed ML systems for performance, drift, and governance requirements.

Course Contents			
Module	**Unit**	**Description**	**Hours**
1.0		**Introduction To Devops & Cloud Fundamentals**	
	1.1	DevOps Essentials: Core philosophy, evolution from Agile, and cross-functional team roles. SDLC in DevOps Context: The lifecycle from planning to monitoring and feedback loops.	9
	1.2	Cloud Computing Fundamentals, Version Control Systems: Git fundamentals, workflows, and collaborative development.	
2.0		**Containerization & Orchestration**	
	2.1	Container Technology (Docker): Architecture, image creation, and multi-container applications. Kubernetes (K8s) Orchestration: Architecture, core objects, networking, and resource management.	9
	2.2	Registry and Image Management: Public/private registries, versioning, and security scanning.	
3.0		**Continuous Integration & Continuous Deployment (CI/CD)**	
	3.1	Continuous Integration (CI) Principles: Automation of builds, testing, and artifact management. CI/CD Platforms & Tools: Overview of Jenkins, GitHub Actions, GitLab CI/CD, and cloud-native options. Continuous Deployment (CD) Strategies: Blue-Green, Canary releases, and Feature Flags.	9
	3.2	Testing in CI/CD: Integration of unit, load, and performance testing within pipelines.	
4.0		**Machine Learning Operations (MLOPS) Foundations**	
	4.1	The MLOps Lifecycle: Differences from traditional DevOps and workflow orchestration. Data Management & Versioning: Data Version Control (DVC), validation,	9
	4.2	Experiment Tracking & Model Management: Tools for logging metrics, hyperparameters, and model registries (MLflow, Weights & Biases).	
5.0		**Ml Model Deployment, Monitoring & Governance**	
	5.1	Model Packaging & Serving: Batch vs. Real-time inference and serving frameworks. Monitoring & Observability in MLOps: Detection of Data Drift and	9

		Concept Drift; performance metrics.	
	5.2	Cloud MLOps Platforms: Managed services on AWS, Google Cloud, and Azure.	

Textbooks:

1. Noah Gift and Alfredo Deza, "Practical MLOps: Operationalizing Machine Learning Models", O'Reilly Media, 1st Edition, 2021
2. Mark Treveil, Nicolas Omont and Clément Stenac, "Introducing MLOps: How to Scale Machine Learning in the Enterprise", O'Reilly Media, 1st Edition, 2021.

References:

1. Sanjeev Sharma and Bernie Coyne, "DevOps For Dummies", Wiley, 3rd Edition, 2017.

- Internal Assessment (T1, T2 and FET):

1.T1 (Test 1) should be based on first two modules and T2 (Test 2) should be based on next two modules, for 10 marks each.

2.Fifth module will be assessed for 5 marks separately.

- End Semester Examination:
    1. Question paper will comprise of 5 questions, each carrying 10 marks.
    2. The duration of end semester examination shall be 2 hours.
    3. The students need to solve all 5 questions.
    4. Question No.1 will be compulsory and based on entire syllabus.
    5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U01RM701	Research Methodology	3	-	-	3	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		Total (Marks)
		T1	T2	FET	Total	Min pass	Marks	Min pass	
U01RM701	Research Methodology	10	10	5	25	40%	50	40%	75

Course Description

This course equips students with essential research skills including problem identification, research design, sampling, data collection, statistical analysis, hypothesis testing, and research report writing. The course emphasizes practical application and preparation for project work and higher studies.

Course Objectives:

- To **understand** the fundamentals of Research Methodology.
- To **develop skills** in designing research studies independently.
- To **develop competency** in using statistical tools for data analysis.
- To **interpret** research results and draw meaningful conclusions.
- To **prepare** structured project reports in an ethical manner.

Course Outcomes: After the successful completion of the course students will able to:

CO1 **Explain**[2] research concepts and processes.

CO2 **Formulate**[3]research problems and hypotheses.

CO3 **Design**[4] sampling and data collection strategies.

CO4 **Apply**[3]statistical techniques for analysis and hypothesis testing.

CO5 **Prepare**[5] research reports following academic standards.

Course Contents (Common to all Branches)

Module	Unit	Description	Hours
1.0		**Introduction to Research Methodology**	
	1.1	Meaning, objectives, and characteristics of research, Types of research (basic, applied, exploratory, descriptive, analytical), Research process, Criteria of good research.	9
	1.2	Research problem formulation, Literature review, Research gap identification, Research objectives and hypotheses formulation.	
2.0		**Research Design and Sampling**	
	2.1	Research design: Meaning and types (exploratory, descriptive, causal, experimental), Variables and measurement scales (nominal, ordinal, interval, ratio).	9
	2.2	Sampling design: Census vs sampling, Probability and non-probability sampling methods, Sample size determination, Sampling errors.	
3.0		**Data Collection and Processing**	
	3.1	Primary and secondary data, Methods of data collection: observation, interview, questionnaire, schedule, case study method.	9
	3.2	Data preparation: Editing, coding, classification, tabulation, Data presentation techniques (tables, charts, diagrams).	
4.0		**Statistical Analysis and Hypothesis Testing**	
	4.1	Measures of central tendency, Measures of Variation, Measures of skewness, Correlation and regression analysis.	9
	4.2	Hypothesis testing: Null and alternative hypotheses, Type I & Type II errors, t-test, z-test, chi-square test, ANOVA (conceptual understanding).	
5.0		**Research Report Writing and Ethics**	
	5.1	Structure of research report: Title page, abstract, introduction, literature review, methodology, analysis, findings, conclusion and references.	9
	5.2	Citation styles (APA/IEEE), Plagiarism and research ethics, Intellectual property rights, Use of software tools (SPSS/Excel/LaTeX basics for report preparation).	

Text Books

1. C. R. Kothari and Gaurav Garg, “Research Methodology: Methods and Techniques”, New Age International Publishers, 4th Edition, 2019.
2. John W. Creswell and J. David Creswell, “Research Design: Qualitative, Quantitative, and Mixed Methods Approaches”, Sage Publications, 5th Edition, 2018.

References

1. Donald R. Cooper and Pamela S. Schindler, “Business Research Methods”, McGraw-Hill Education, 13th Edition, 2019.

Internal Assessment (T1, T2 and FET)

1.T1 should be based on first two modules and T2 should be based on next two modules, for 10 marks each.

2.Fifth module will be assessed for 5 marks separately.

Semester End Exam

1.Question paper will comprise of 5 questions, each carrying 10 marks.

2.The duration of semester end examination shall be 2 hours.

3.The students need to solve all 5 questions.

4.Question No.1 will be compulsory and based on entire syllabus.

5.Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
U12PC703	Optimization Techniques Lab	Theory	Practical	Tutorial	Theory	Practical	Tutorial
		-	4	-	-	2	-

Evaluation Scheme

Course Code	Course Name	In Semester Evaluation		Semester End Exam (OE/POE)		Total (Marks)
U12PC703	Optimization Techniques Lab	Term work	Min pass	Marks	Min pass	50
		25	40%	25	40%	

Course Description: The Optimization Techniques Lab provides practical exposure to applying optimization methods for solving real-world engineering problems. It complements theoretical concepts by enabling students to implement algorithms such as linear, nonlinear, and heuristic optimization using computational tools. The course focuses on problem modeling, analysis of results under different conditions, and developing decision-making skills through hands-on experiments and continuous assessment**.**

Course Objective:

- To **study** the application of optimization methods for solving engineering problems.
- To **develop skills** in implementing linear, nonlinear, and heuristic optimization algorithms using computational tools.
- To **enable students to comprehend** problem modeling and formulation in optimization.

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Apply**[3] optimization algorithms to solve engineering problems.
- **CO2** **Analyze**[4]optimization results under deterministic and stochastic conditions for decision-making in real-world applications.

List of Experiments:

All the experiments will be based on the course content Optimization Techniques with Course code U12PC701

References:

1. A. Ravindran, “Engineering Optimization: Methods and Applications”, Wiley, 2nd Edition, 2006

2. A. Konkalmatt, A. K. Nagar and D. P. Mohapatra, “Optimization Techniques in Engineering: Advances and Applications”, CRC Press, 2023

Evaluation Scheme:

1. TERM WORK assessment must be based on the overall performance of the student with every assignment graded from time to time.
2. The grades will be converted to marks as per ‘credit and grading system’ manual and should be added and averaged.
3. Based on above scheme grading and TERM WORK assessment should be done

Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U12PC704	Computer Vision Lab	-	4	-	-	2	-

Evaluation Scheme

Course Code	Course Name	In Semester Evaluation		Semester End Exam (OE/POE)		Total (Marks)
		Term work	Min pass	Marks	Min pass	
U12PC704	Computer Vision Lab	25	40%	25	40%	50

Course Description: The Computer Vision Lab provides hands-on experience in applying image processing and computer vision techniques using tools like OpenCV and deep learning frameworks. The course focuses on implementing and evaluating methods such as feature extraction, object detection, and deep learning models for real-world visual intelligence applications. Through practical experiments based on the core course content, students develop skills in analyzing visual data, building intelligent systems, and making performance-based evaluations.

Course Objectives:

- To study image processing and computer vision techniques using tools such as OpenCV and deep learning frameworks.
- To learn feature extraction and object detection methods for visual data analysis.
- To understand the implementation of deep learning models in computer vision applications.
- To study performance evaluation of computer vision techniques for real-world problems.

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Apply**[3]image processing and computer vision techniques using tools such as OpenCV and deep learning frameworks for solving real-world problems
- **CO2** **Evaluate**[5] feature extraction, object detection, and deep learning models for visual intelligence applications.

List of Experiments:

All the experiments will be based on the course content Computer Vision with course code U12PC702

References:

1. Benjamin Planche and Eliot Andres, "Hands-On Computer Vision with TensorFlow 2", Packt Publishing, 2020.
2. Gunjan Aggarwal, "Cloud AI Services with Google Cloud: Building Smart Applications with Vision, Language, and Conversation AI", Wiley, 2022.

Evaluation Scheme:

1. TERM WORK assessment must be based on the overall performance of the student with every assignment graded from time to time.
2. The grades will be converted to marks as per 'credit and grading system' manual and should be added and averaged.
3. Based on above scheme grading and TERM WORK assessment should be done

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U12PE712	ARVR Lab	-	4	-	-	2	-

Evaluation Scheme

Course Code	Course Name	In Semester Evaluation		Semester End Exam (OE/POE)		Total (Marks)
		Term work	Min pass	Marks	Min pass	
U12PE712	ARVR Lab	25	40%	25	40%	50

Course Description: The ARVR Lab provides hands-on experience in designing and developing immersive Augmented Reality (AR), Mixed Reality (MR), and Virtual Reality (VR) applications using tools such as Unity and Vuforia. The course focuses on implementing interaction techniques, tracking mechanisms, and visualization methods while addressing real-world challenges in deployment. Through practical experiments based on the core ARVR course, students develop skills to build, evaluate, and optimize immersive solutions for various applications.

Course Objectives:

- To study the fundamentals of Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MR) systems.
- To learn the design and development of immersive applications using tools such as Unity and Vuforia.
- To understand interaction techniques, tracking mechanisms, and visualization methods in AR/VR environments.

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Apply**[3]AR/VR development tools to design and implement immersive applications using Unity and interaction techniques
- **CO2** **Evaluate**[5]tracking, visualization, and deployment challenges to develop effective AR/MR and VR-based solutions..

List of Experiments:

All the experiments will be based on the course content ARVR with course code U12PE711

References:

1. Tony Parisi , "Learning Virtual Reality", O'Reilly Media, 1st Edition, 2015
2. Dieter Schmalstieg& Tobias Höllerer, "Augmented Reality: Principles and Practice" , Pearson / Addison-Wesley, 1st Edition , 2016

Evaluation Scheme:

1. TERM WORK assessment must be based on the overall performance of the student with every assignment graded from time to time.
2. The grades will be converted to marks as per 'credit and grading system' manual and should be added and averaged.
3. Based on above scheme grading and TERM WORK assessment should be done

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U12PE722	Business Intelligence Lab	-	4	-	-	2	-

Evaluation Scheme

Course Code	Course Name	In Semester Evaluation		Semester End Exam (OE/POE)		Total (Marks)
		Term work	Min pass	Marks	Min pass	
U12PE722	Business Intelligence Lab	25	40%	25	40%	50

Course Description: The Business Intelligence Lab provides practical exposure to Python-based techniques for data cleaning, integration, and visualization of business data. The course emphasizes the use of analytical tools, OLAP operations, and key performance indicators (KPIs) to support data-driven decision-making. Through hands-on experiments based on the core Business Intelligence course, students develop skills in analyzing business data, generating insights, and building effective BI solutions for real-world applications**.**

Course Objectives:

- To study the fundamentals of Business Intelligence and data-driven decision-making.
- To learn Python-based techniques for data cleaning, integration, and visualization.
- To understand analytical tools, OLAP operations, and key performance indicators (KPIs).
- To study methods for analyzing business data and generating insights.

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Apply**[3] Python-based BI techniques to clean, integrate, and visualize business data.
- **CO2** **Analyze**[4] business data using Python analytics, OLAP operations, and KPIs to support decision-making

List of Experiments:

All the experiments will be based on the course content Business Intelligence with course code U12PE721

References:

1. Wes McKinney, “Python for Data Analysis”, O’Reilly Media, 2nd Edition, 2019.

2. Jake VanderPlas, “Python Data Science Handbook”, O’Reilly Media, 2016.

Evaluation Scheme:

1. TERM WORK assessment must be based on the overall performance of the student with every assignment graded from time to time.
2. The grades will be converted to marks as per ‘credit and grading system’ manual and should be added and averaged.
3. Based on above scheme grading and TERM WORK assessment should be done

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U12PE732	Devops& MLOPS Lab	-	4	-	-	2	-

Evaluation Scheme

Course Code	Course Name	In Semester Evaluation		Semester End Exam (OE/POE)		Total (Marks)
U12PE732	Devops& MLOPS Lab	Term work	Min pass	Marks	Min pass	50
		25	40%	25	40%	

Course Description:

The DevOps & MLOps Lab provides hands-on experience with containerization, CI/CD pipelines, cloud deployment, and MLOps workflows such as model versioning, deployment, and monitoring, enabling students to build and manage real-world DevOps and machine learning systems.

Course Objectives:

- To study the fundamentals of DevOps and MLOps practices.
- To learn containerization, CI/CD pipelines, and cloud-based deployment techniques.
- To understand MLOps workflows such as model versioning, deployment, and monitoring.
- To study tools and processes used in managing machine learning systems

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Implement**[3]DevOps practices including containerization, CI/CD pipelines, and cloud-based deployment using industry-standard tools
- **CO2** **Evaluate**[5]MLOps workflows for model versioning, deployment, monitoring, and governance in cloud environments

List of Experiments:

All the experiments will be based on the course content Devops&MLOPS with course code U12PE731

References:

1. Chip Huyen, "Designing Machine Learning Systems", O'Reilly Media, 2022.
2. Joakim Verona, "Practical DevOps", Packt Publishing, 2nd Edition, 2018.

Evaluation Scheme:

1. TERM WORK assessment must be based on the overall performance of the student with every assignment graded from time to time.
2. The grades will be converted to marks as per 'credit and grading system' manual and should be added and averaged.
3. Based on above scheme grading and TERM WORK assessment should be done

Programme structure for B. Tech. Final Year Artificial Intelligence and Machine Learning

Semester VIII: Teaching Scheme

Track I: Industry Internship With Capstone Project Track

Course code	Course name	Teaching scheme			Credits assigned			
		Th	Pr	Tu	Th	Pr	Tu	Total credits
U12PE8XX	Program Elective V	3	-	-	3	-	-	3
UXXMM0XX	Multidisciplinary Minor VI	2	-	-	2	-	-	2
U12PR801	Project Phase II	-	8	-	-	4	-	4
U12OT801	Internship/On job Training	-	24	-	-	12	-	12
	Total	**5**	32	-	5	16	-	**21**

Th: Theory, Pr: practical, Tu: Tutorial

Program Elective V			
Vertical I (Data Analytics)		**Vertical II (Data Management))**	
Code	**Course Name**	**Code**	**Course Name**
U12PE811	Recommendation System	U12PE821	Business Analytics
Vertical III (Cloud Computing)			
Code	**Course Name**		
U12PE831	Advanced Cloud Computing		

Note: The Program Elective V and Multidisciplinary Minor VI shall be conducted in online mode, by faculty of SGU or other institute/ University. Students can also opt a course from MOOCs platforms such as SWAYAM, NPTEL, Coursera etc. In case there is no assessment and examination conducted by the MOOCs platforms then the assessment and examination will be conducted by SGU.

Semester VIII: Evaluation Scheme

Track I: Industry Internship with Capstone Project Track

Course code	Course name	*Theory Marks*					Practical Marks		Total
		Evaluation (Theory)				SEE	Evaluation (Lab)		
		T1	T2	FET	Total		Term work	Practical Oral/POE	
U12PE8XX	Program Elective V	10	10	5	25	50	-	-	75
U12MM0XX	Multidisciplinary Minor VI	10	-	5	15	35	-	-	50
U12PR801	Project Phase -I	-	-	-	-	-	50	50	100
U12OT801	Internship/On job Training	-	-	-	-	-	200	100	300

* Minimum passing is 40% for all courses and evaluation head mentioned above. FET – Faculty evaluation for Theory ,T1, T2, Continuous Assessment Test, FEP, Faculty Evaluation for Practical, ESE - End Semester Examination, P/F – Pass/ Fail Course, AU – Audit Course

- Additional Credits for Bachelor's Degree- with Double Minor OR Honours: 12 Credits.

These are additional credits to be offered from the second year to the final year and will be offered as an option to students.

- Additional Credits for Bachelor's Degree- Honours with Research: Minimum 16- 20 Credits

These are additional credit from same domain to be offered from the second year to the final year and will br offered as an option to students

- Additional Credits for Bachelor's Degree-Honors with Research: Minimum 16-20 Credits. These are additional credits to be offered in the final year and will be offered as an option to students

Programme structure for B. Tech. Final YearArtificial Intelligence and Machine Learning

Semester VIII: Teaching Scheme

Track II: Entrepreneurship Venture Track

Course code	Course name	Teaching scheme			Credits assigned			
		Th	Pr	Tu	Th	Pr	Tu	Total credits
U12PE8XX	Program Elective V	3	-	-	3	-	-	3
UXXMM0XX	Multidisciplinary Minor VI	2	-	-	2	-	-	2
U12EP801	Online Course in Advanced Technology (domain area)	-	-	-	4	-	-	4
U12EP802	Entrepreneurship Project Phase -II	-	24	-	-	12	-	12
	Total	**5**	24	-	9	12	-	**21**

Th: Theory, Pr: practical, Tu: Tutorial

Program Elective V			
Vertical I (Data Analytics)		**Vertical II (Data Management))**	
Code	**Course Name**	**Code**	**Course Name**
U12PE811	Recommendation System	U12PE821	Business Analytics
Vertical III (Cloud Computing)			
Code	**Course Name**		
U12PE831	Advanced Cloud Computing		

Note: The Program Elective V and Multidisciplinary Minor VI shall be conducted in online mode, by faculty of SGU or other institute/ University. Students can also opt a course from MOOCs platforms such as SWAYAM, NPTEL, Coursera etc. In case there is no assessment and examination conducted by the MOOCs platforms then the assessment and examination will be conducted by SGU.

Semester VIII: Evaluation Scheme

Track II: Entrepreneurship Venture Track

Course code	Course name	*Theory Marks*					Practical Marks		Total
		Evaluation (Theory)				SEE	Evaluation (Lab)		
		T1	T2	FET	Total		Term work	Practical Oral/POE	
U12PE8XX	Program Elective V	10	10	5	25	50	-	-	75
UXXMM0XX	Multidisciplinary Minor VI	10	-	5	15	35	-	-	50
U12EP801	Online Course in Advanced Technology (domain area)	-	-	-	25	75	-	-	100
U12EP802	Entrepreneurship Project Phase -II	-	-	-	-	-	200	100	300

* Minimum passing is 40% for all courses and evaluation head mentioned above. FET – Faculty evaluation for Theory ,T1, T2, Continuous Assessment Test, FEP, Faculty Evaluation for Practical, ESE - End Semester Examination, P/F – Pass/ Fail Course, AU – Audit Course

- Additional Credits for Bachelor's Degree- with Double Minor OR Honours: 12 Credits.

These are additional credits to be offered from the second year to the final year and will be offered as an option to students.

- Additional Credits for Bachelor's Degree- Honours with Research: Minimum 16- 20 Credits

These are additional credit from same domain to be offered from the second year to the final year and will br offered as an option to students

- Additional Credits for Bachelor's Degree-Honors with Research: Minimum 16-20 Credits. These are additional credits to be offered in the final year and will be offered as an option to students

Programme structure for B. Tech. Final Year Artificial Intelligence and Machine Learning

Semester VIII: Teaching Scheme

Track III : Higher Opportunity Track

Course code	Course name	Teaching scheme			Credits assigned			
		Th	Pr	Tu	Th	Pr	Tu	Total credits
U12PE8XX	Program Elective V	3	-	-	3	-	-	3
UXXMM0XX	Multidisciplinary Minor VI	2	-	-	2	-	-	2
U12RE801	Online Course in Advanced Technology (domain area)	-	-	-	4	-	-	4
U12RE802	Research Project Phase -II	-	24	-	-	12	-	12
	Total	**5**	24	-	9	12	-	**21**

Th: Theory, Pr: practical, Tu: Tutorial

Program Elective V			
Vertical I (Data Analytics)		**Vertical II (Data Management))**	
Code	**Course Name**	**Code**	**Course Name**
U12PE811	Recommendation System	U12PE821	Business Analytics
Vertical III (Cloud Computing)			
Code	**Course Name**		
U12PE831	Advanced Cloud Computing		

Note: The Program Elective V and Multidisciplinary Minor VI shall be conducted in online mode, by faculty of SGU or other institute/ University. Students can also opt a course from MOOCs platforms such as SWAYAM, NPTEL, Coursera etc. In case there is no assessment and examination conducted by the MOOCs platforms then the assessment and examination will be conducted by SGU.

Semester VIII: Evaluation Scheme
Track III : Higher Opportunity Track

Course code	Course name	*Theory Marks*					Practical Marks		Total
		Evaluation (Theory)				SEE	Evaluation (Lab)		
		T1	T2	FET	Total		Term work	Practical Oral/POE	
U12PE8XX	Program Elective V	10	10	5	25	50	-	-	75
UXXMM0XX	Multidisciplinary Minor VI	10	-	5	15	35	-	-	50
U12RE801	Online Course in Advanced Technology (domain area)	-	-	-	25	75	-	-	100
U12RE802	Research Project Phase -II	-	-	-	-	-	200	100	300

* Minimum passing is 40% for all courses and evaluation head mentioned above. FET – Faculty evaluation for Theory ,T1, T2, Continuous Assessment Test, FEP, Faculty Evaluation for Practical, ESE - End Semester Examination, P/F – Pass/ Fail Course, AU – Audit Course

- Additional Credits for Bachelor's Degree- with Double Minor OR Honours: 12 Credits.

These are additional credits to be offered from the second year to the final year and will be offered as an option to students.

- Additional Credits for Bachelor's Degree- Honours with Research: Minimum 16- 20 Credits

These are additional credit from same domain to be offered from the second year to the final year and will br offered as an option to students

- Additional Credits for Bachelor's Degree-Honors with Research: Minimum 16-20 Credits. These are additional credits to be offered in the final year and will be offered as an option to students

Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
U12PE811	**Recommender Systems**	Theory	Practical	Tutorial	Theory	Practical	Tutorial
		03	-	-	**03**	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		Total (Marks)
U12PE811	**Recommender Systems**	T1	T2	FET	Total	Min pass	Marks	Min pass	**75**
		10	**10**	**5**	**25**	**40%**	**50**	**40%**	

Course Description: This course provides a comprehensive study of Recommender Systems, a critical component of modern digital platforms like Netflix, Amazon, and Spotify. Students will explore the evolution of recommendation engines from foundational statistical methods to state-of-the-art Deep Learning architectures. The curriculum covers essential techniques including Content-Based Filtering, Collaborative Filtering, and Matrix Factorization, while also addressing advanced topics like Hybrid Systems and Context-Aware computing. Learners will gain hands-on experience in building personalized systems, dealing with challenges such as the "Cold Start" problem and data sparsity. Furthermore, the course emphasizes the rigorous evaluation of these systems using ranking metrics and A/B testing, alongside ethical considerations like fairness, bias, and privacy in AI-driven personalization

Pre-requisites: Python Programming, Machine Learning

Course Objectives:

- To understand the concepts, evolution, and business value of recommender systems.
- To learn content-based and collaborative filtering techniques.
- To study advanced methods such as matrix factorization and hybrid models.
- To explore deep learning approaches for recommendation systems.
- To discuss recommendation performance and ethical issues.

Course Outcomes: after the end of this course students will be able to

CO1 **Explain**[2]personalization paradigms, feedback models, and foundational data mining concepts for recommender systems.

CO2 **Apply**[3]content-based and collaborative filtering techniques to design recommender systems.

CO3 **Analyze**[4] and implement model-based and hybrid recommender approaches for sparse data environments

CO4 **Apply**[3] deep learning techniques to develop recommender models for modeling complex user behavior.

CO5 **Evaluate**5 recommender systems using ranking metrics, ethical considerations, and governance practices.

Course Contents			
Module	**Unit**	**Description**	**Hours**
1.0		**Foundations of Recommender Systems**	
1	1.1	Introduction to Personalization: The "Long Tail" phenomenon, implicit vs. explicit feedback, and the taxonomy of recommender systems Personalized vs. Non-personalized).Data Mining Prerequisites: Similarity measures (Cosine, Pearson, Jaccard) and dimensionality reduction concepts (SVD/PCA) for sparse data.	9
	1.2	Non-Personalized Methods: Implementation of popularity-based recommenders and "Trending" algorithms. Association Rule ining: Apriori algorithm and Frequent Pattern Growth for generating "Frequently Bought Together" recommendations.	
2.0		**Traditional Recommendation Techniques**	
2	2.1	Content-Based Filtering (CBF): Item representation using TF-IDF and Vector Space Models; building user profiles from historical data; advantages and limitations of CBF.Collaborative Filtering (CF) - Memory Based: User-Based (k-NN) and Item-Based (Slope One) filtering approaches.	9
	2.2	Challenges in Collaborative Filtering: Addressing the Data Sparsity problem and Scalability issues.The Cold Start Problem: Strategies for handling new users and new items in a collaborative environment.	
3.0		**Model-Based & Hybrid Recommenders**	
3	3.1	Matrix Factorization (MF): Latent factor models, Singular Value Decomposition (SVD), and optimization via Stochastic Gradient Descent (SGD) and ALS.SVD++: Enhancing standard matrix factorization by incorporating implicit feedback signals.	9
	3.2	Hybrid Recommender Systems: Strategies for combining algorithms (Weighted, Switching, Cascade, and Feature Augmentation). Context-Aware Systems: Incorporating contextual information like time, location, and device using pre-filtering and post-filtering techniques.	
4.0		**Deep Learning for Recommender Systems**	
4	4.1	Neural Collaborative Filtering (NCF): Replacing matrix dot products with	9

		Multi-Layer Perceptrons (MLP) and Generalized Matrix Factorization (GMF).Autoencoders: Using AutoRec and Denoising Autoencoders to predict missing ratings in sparse matrices.	
	4.2	Sequence-Aware Recommenders: Application of RNNs and LSTMs for session-based recommendations and modeling temporal dynamics. Embeddings: Applying Word2Vec concepts to generate Item2Vec embeddings for similarity calculations.	
5.0		**Evaluation, Ethics & Real-World Issues**	
5	5.1	Evaluation Metrics: Prediction accuracy (RMSE, MAE) vs. Ranking metrics ,Testing Methodologies: Offline datasets vs. Online A/B testing and conducting user studies.	9
	5.2	Security & Ethics: Detection of Shilling attacks (profile injection); addressing Popularity Bias and Filter Bubbles. Explainability & Privacy: Explainable AI (XAI) for recommendations and privacy-preserving techniques (GDPR compliance).	

Textbooks:

1. Zhe Wang et al., *"Deep Learning Recommender Systems"*, Cambridge University Press, 1st Edition, 2025.
2.Jannach, Dietmar, et al., "Recommender Systems: An Introduction", 1st Edition, Cambridge University Press, 2010.

References:

1. Ricci, Francesco, Rokach, Lior, & Shapira, Bracha, *"Recommender Systems Handbook"*, 3rd Edition, Springer, 2022.

- Internal Assessment (T1, T2 and FET):

1.T1 (Test 1) should be based on first two modules and T2 (Test 2) should be based on next two modules, for 10 marks each.

2.Fifth module will be assessed for 5 marks separately.

- End Semester Examination:

1.Question paper will comprise of 5 questions, each carrying 10 marks.

2.The duration of end semester examination shall be 2 hours.

3.The students need to solve all 5 questions.

4.Question No.1 will be compulsory and based on entire syllabus.

5.Remaining question (Q.2 to Q.5) will be selected from all the modules.

Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
U12PE821	**Business Analytics**	Theory	Practical	Tutorial	Theory	Practical	Tutorial
		03	**-**	**-**	**03**	**-**	**-**

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		Total (Marks)
U12PE821	**Business Analytics**	T1	T2	FET	Total	Min pass	Marks	Min pass	**75**
		10	**10**	**5**	**25**	**40%**	**50**	**40%**	

Course Description

This course focuses on analytical methods and tools used to analyze business data and support managerial decision-making. It covers descriptive, predictive, and prescriptive analytics, statistical analysis, data-driven decision models, and business use cases across domains.

Course Objectives:

- To Introduce fundamentals of business analytics and data-driven decision-making
- To learn analytical thinking using statistical and data analysis techniques
- To Enable application of predictive and prescriptive analytics models
- To Familiarize students with business analytics tools and real-world use cases
- To Prepare students to solve business problems using analytical approaches

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Explain**[2] business analytics concepts and data-driven decision processes
- **CO2** **Analyze**[4] business problems using statistical and exploratory data analysis
- **CO3** **Apply**[3] predictive analytics techniques to forecast business outcomes
- **CO4** **Evaluate**[5] prescriptive analytics models for optimal decision-making
- **CO5** **Assess**[5] business analytics applications across functional domains

Course Contents

Module	Unit	Description	Hours
1.0		**Introduction to Business Analytics**	
1	1.1	Introduction to Business Analytics, analytics-driven decision-making, role of analytics in organizations, analytics maturity models	9
	1.2	Types of business analytics: descriptive, diagnostic, predictive, and prescriptive analytics; business analytics process	
2.0		**Descriptive Analytics and Data Exploration**	
2	2.1	Data types, data sources, data preparation, data visualization principles	9

	2.2	Descriptive statistics, data summarization, exploratory data analysis, dashboards and reporting	
3.0		**Predictive Analytics**	
3	3.1	Predictive analytics concepts, regression models, correlation analysis, classification techniques	9
	3.2	Time series analysis, forecasting methods, model validation and performance measures	
4.0		**Prescriptive Analytics and Decision Models**	
4	4.1	Prescriptive analytics overview, optimization models, linear programming for business problems	9
	4.2	Decision analysis, simulation models, risk analysis, decision trees	
5.0		**Business Analytics Applications and Emerging Trends**	
5	5.1	Applications of business analytics in marketing, finance, operations, HR, and supply chain management.	9
	5.2	Business analytics software tools, ethical issues, big data analytics, AI-enabled analytics, future trends.	

Text Books

1 James R. Evans, *"Business Analytics"*, Pearson Education, 3rd Edition, 2020.

2. Ramesh Sharda, Dursun Delen and Efraim Turban, *"Business Intelligence, Analytics, and Data Science: A Managerial Perspective"*, Pearson, 4th Edition, 2019.

References

1. effrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, David R. Anderson, Dennis J. Sweeney and Thomas A. Williams, *"Business Analytics: Data Analysis & Decision Making"*, Cengage Learning, 6th Edition, 2021

Internal Assessment (T1, T2 and FET)

1.T1 should be based on first two modules and T2 should be based on next two modules, for 10 marks each.

2.Fifth module will be assessed for 5 marks separately.

Semester End Exam

1.Question paper will comprise of 5 questions, each carrying 10 marks.

2.The duration of semester end examination shall be 2 hours.

3.The students need to solve all 5 questions.

4.Question No.1 will be compulsory and based on entire syllabus.

5.Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
U12PE831	**Advanced Cloud Computing**	Theory	Practical	Tutorial	Theory	Practical	Tutorial
		03	**-**	**-**	**03**	**-**	**-**

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		Total (Marks)
U12PE831	**Advanced Cloud Computing**	T1	T2	FET	Total	Min pass	Marks	Min pass	**75**
		10	**10**	**5**	**25**	**40%**	**50**	**40%**	

Course Description: - This course covers modern cloud architectures, progressing from basic infrastructure and virtualization to advanced cloud-native applications. Students will explore deployment models, container orchestration with Kubernetes, and Microsoft Azure services while learning to automate environments using Infrastructure as Code (IaC). The curriculum also integrates cutting-edge industry trends like Serverless computing, FinOps, and AI-driven operations

Course Objectives: -

- To Understand core cloud components, service models (IaaS, PaaS, SaaS), and deployment strategies.
- To Master virtualization, containerization with Docker, and Kubernetes orchestration.
- To learn scalable cloud infrastructure using IaC, automated migration, and cost-management tools.
- To Implement open-source cloud architectures using GitOps and Zero Trust security principles.

Course Outcomes: After the successful completion of the course students will able to:

CO1 **Explain**[2] cloud components, deployment models (Public/Private/Hybrid), and advantages over on-premises systems

CO2 **Analyze**[4] virtualization types, hypervisors, and container orchestration using Docker and Kubernetes.

CO3 **Design**[5] cloud infrastructure using IaC (Terraform) and manage resources through FinOps and monitoring.

CO4 **Deploy**[5] open-source architectures (OpenStack/Eucalyptus) using modern GitOps and Zero Trust security.

CO5 **Develop**[5] cloud-native apps integrated with Serverless, GenAI (LLMOps), and specialized IoT/Healthcare solutions.

Course Contents

Module	Unit	Description	Hours
1.0		**Introduction to Advance Cloud Computing**	
1	1.1	Components of Cloud Computing. Cloud Types and Models: Private Cloud, Community Cloud, Public Cloud, Hybrid Clouds. Cloud Models and Deployment, Advantages over On-Premises, Virtualization in AWS	9
	1.2	Components of Cloud Computing. Cloud Types and Models: Private Cloud, Community Cloud, Public Cloud, Hybrid Clouds. Cloud Models and Deployment, Advantages over On-Premises, Virtualization in AWS	
2.0		**Virtualization**	
2	2.1	Introduction and benefits, Requirement for Virtualization, what is Virtualization, Benefits of Virtualization, How to Virtualize, Types of Virtualizations, , what is Container, Benefits of Docker Containers,	9
	2.2	Orchestration with Kubernetes,MicroVMs (The Middle Ground),WebAssembly (Wasm) in the Cloud,GPU Virtualization for AI.	
3.0		**Advance Cloud Computing Services**	
3	3.1	Cloud Compute & Storage Foundations, Storage Systems, Monitoring and Resource Management, Networking and Connectivity, Database and Application Deployment, Database Services,	9
	3.2	Modern Migration Strategy, Infrastructure as Code (IaC) with Terraform, Cloud Governance & FinOps, AI-Enhanced Databases (Vector Databases), Disaster Recovery (DR) Strategies.	
4.0		**Open-Source Cloud Implementation**	
4	4.1	Open-Source Eucalyptus Cloud Architecture, Open Stack Cloud Architecture, Cloud Administration and Management, Bundling or Uploading Virtual machine images on the Cloud Controller,	9
	4.2	KubeVirt (Merging VMs and Kubernetes), GitOps for Cloud Deployment,Confidential Computing & Zero Trust, GPU& AI Workload Management.	
5.0		**Advance Cloud Applications**	
5	5.1	Dev OPs with cloud Kubernetes Services, SNS (Simple Notification Service), Simple Email Service, Cost Scientific Applications in – Healthcare, Biology, Geo-Science; Business Applications,	9
	5.2	Generative AI Ops (LLMOps),GitOps for Automated Deployment,Green Cloud (Sustainability),Internet of Medical Things (IoMT),AIOps (AI for IT Operations)	

Text Books

1. Rajkumar Buyya, Christian Vecchiola and S. Thamarai Selvi, *"Mastering Cloud Computing"*, McGraw Hill Education (India), Latest Reprint Edition, 2019.

2. Thomas Erl, Ricardo Puttini and Zaigham Mahmood, "Cloud Computing: Concepts, Technology & Architecture", Pearson, 2nd Edition, 2022.

References

1. Buyya R, Broberg J, Goscinski A, "Cloud Computing - Principles and Paradigms", Wiley, 2011.

Internal Assessment (T1, T2 and FET)

1.T1 should be based on first two modules and T2 should be based on next two modules, for 10 marks each.

2.Fifth module will be assessed for 5 marks separately.

Semester End Exam

1.Question paper will comprise of 5 questions, each carrying 10 marks.

2.The duration of semester end examination shall be 2 hours.

3.The students need to solve all 5 questions.

4.Question No.1 will be compulsory and based on entire syllabus.

5.Remaining question (Q.2 to Q.5) will be selected from all the modules.

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