Teaching and Evaluation Scheme for Final Year B. Tech.

Department of Automation and Robotics

Semester: VII

Department: Automation and Robotics **Rev:** Course Structure/01/NEP/2023-24

Class: B.Tech **Semester:** VII

Course Code	Type of Course	Name of the course	Teaching Scheme			Evaluation scheme					Credit
			L	T	P	CA1	CA2	MSE	ESE	Total	
23AR4701	PCC	Artificial Intelligence and Machine Learning for Robotics	3	0	0	10	10	30	50	100	3
23AR4702	PCC	Embedded system in Robotics	3	0	0	10	10	30	50	100	3
23AR4703	RM	Research Methodology	3	0	0	10	10	30	50	100	3
23AR4704	ELC	Capstone Project-II	0	0	4	25	25	-	50	100	2
23AR4705	PCC	Robot Operating System and Simulation Laboratory	0	0	2	15	15	-	20	50	1
23AR4706	PCC	Machine Learning Laboratory	0	0	2	15	15	-	20	50	1
23AR4707	PCC	Industrial Robotics and Material Handling Laboratory	0	0	2	25	25	-	-	50	1
23AR4708	RM	Research and Industrial Case Studies	0	0	2	25	25	-		50	1
23AR4709	HSSM	Entrepreneurship Development	2	0	0	25	25			50	Audit
23AR4710	PCC	Robot Operating System	2	0	0	25	25			50	Audit
23AR4711X	PEC	Program Elective Course –IV	3	0	0	10	10	30	50	100	3
23ARMDXX	MDM	Multidisciplinary Minor-V	3	0	0	10	10	30	50	100	3
Total			**19**	**0**	**12**	**205**	**205**	**150**	**340**	**900**	**21**

Multidisciplinary Minor-V

Sem	Basket 1 (A-Defense)	Basket 2 (B-Software)	Basket 3 (C-Space)
Sem. VII	Drones and Autonomous Systems (23ARMDA5)	Operating System (23ARMDB5)	Aircraft Design (23ARMDC5)

Program Elective Courses (PEC)

Sem.	Field / Service Robotics	Advanced Manufacturing Technologies For Automation	Advanced Data science Sensors, Drive and Communication Systems	Advanced Robotic Technologies
Sem. VII	Robotic control System (23AR4711A)	Micro and Nano-Electromechanical Systems (23AR4711B)	Fuzzy logic and Neural Network (23AR4711C)	Robot System Design and SLAM

				(23AR4711D)

Artificial Intelligence and Machine Learning for Robotics

23AR4701	PCC	Artificial Intelligence and Machine Learning for Robotics	3-0-0	3 Credits

Teaching Scheme	**Evaluation scheme**
Lecture: 3 hrs/week	CA–I :10 Marks CA–II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Fundamentals of Automation and Robotics, Python Programming

Course Outcomes: At the end of the course, students will be able to:

CO1	Select appropriate artificial intelligence method/algorithm to handle various issues in robotics
CO2	Build various algorithms used in artificial intelligence
CO3	Apply artificial intelligence algorithms to robotics problems
CO4	Make Use of concepts of Machine Learning Environment
CO5	Identify machine learning techniques suitable for a given problem.
CO6	Compare the problems using various machine learning techniques.

Course Contents:

Unit 1: Introduction to artificial intelligent techniques Introduction of AI, Tools for AI such as Mathematical optimization, Probabilistic methods for Bayesian network, Hidden Markov model, statistical learning methods, support vector machines, neural networks, expert systems	[6]
Unit 2: Handling uncertainty and learning Non-monotonic reasoning, probabilistic reasoning, use of certainty factors, fuzzy logic, Concept of learning, learning automation, genetic algorithm, learning by inductions neural network.	[6]
UNIT 3: Search algorithms in AI Algorithms for uninformed and informed search, Heuristics search: hill climbing, branch and bound, best first search, Metaheuristics: Tabu search, ant colony optimization, real coded genetic algorithm.	[6]
Unit 4: Introduction Machine learning Introduction of Machine learning – Learning Input- Output functions: Types of learning – Input Vectors – Outputs. Foundations of Supervised Learning: Decision trees and	[7]

Inductive bias – Logistic regression – Perceptron – Binary classification	
Unit 5: Advanced Supervised Learning Linear models and gradient descent – Naïve Bayes models and probabilistic modeling – Model selection and feature selection – Model Complexity and Regularization	[6]
Unit 6: Unsupervised Learning Curse of dimensionality, Dimensionality Reduction, PCA, Clustering – K-means – Expectation Maximization Algorithm – Mixtures of latent variable models – Supervised learning after clustering – Hierarchical clustering	[6]

Text Books:

1. Russell, S and Norvig, P. 2015. Artificial Intelligence-A Modern Approach,3rd edition, PrenticeHall.
2. Poole, D and Mackworth, A. 2010. Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press
3. Tom Mitchell, Machine Learning_, McGraw Hill, 2015.
4. Peter Flach, _Machine Learning: The Art and Science of Algorithms that make sense of data_, Cambridge, 2014.

Reference Books:

1. Steger, Carsten, Markus Ulrich, Christian Wiedemann. Machine Vision Algorithms and Applications (2nd ed.). Wiley, 2018. ISBN 978-3-527-41365-2.
2. Mikell P Groover, Automation, Production System and Computer Integrated Manufacturing, Prentice Hall, Publications, 2016. ISBN 9789332549814
3. Bhattacharya S., Artificial Intelligence, Laxmi Publications, Ltd., 2008, ISBN9788131804896
4. Chopra Rajiv, Artificial Intelligence, S. Chand Publishing, 2012, ISBN9788121939485
5. Pawar P. J., Evolutionary Computations for Manufacturing, Studium Press, 2019, ISBN: 978-93-85046- 52-0
6. Jain N, Artificial Intelligence: making a system intelligent, 2018, ISBN: 9788126579945
7. Hal Daume III, _A course in Machine Learning_, Todo, 2015.
8. Ethem Alpaydin, Introduction to Machine Learning,The MIT Press, 2004.
9. David MacKay, Information Theory, Inference and Learning Algorithms, Cambridge, 2003

Embedded System in Robotics

23AR4702	PCC	Embedded System in Robotics	3-0-0	3Credits

Teaching Scheme	**Evaluation scheme**
Lecture: 3 hrs/week	CA–I :10 Marks CA–II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Microcontroller and Embedded system

Course Outcomes: At the end of the course, students will be able to:

CO1	Explain the concept of embedded system, microcontroller, different components of microcontroller and their interactions.
CO2	Develop computer programs to implement embedded system solutions.
CO3	Apply a Program for the microcontroller to perform various tasks.
CO4	Develop embedded system applications using the key concepts of embedded systems such as I/O, timers, interrupts and interaction with peripheral devices
CO5	Apply knowledge of Real Time-Based Operating System
CO6	Analyze knowledge of Linux Fundamentals & Device Drivers

Course Contents:

Unit 1: Fundamentals of Embedded System Introduction to embedded systems, Application areas, Categories of embedded system, overview of embedded system architecture, specialities of embedded system: reliability, performance, power consumption, cost, size, limited user interface, software upgradation capability.	[6]
Unit 2: Embedded Hardware Hardware Architecture: CPU, Memory, Clock circuitry, Watchdog timer, Chip select, Input/output devices, power supply; software architecture: services provided by operating system, architecture of embedded operating system, Application software.	[7]
Unit 3: Embedded Communication Interfaces Study of basic communication protocols like, RS232/UART, RS422/RS485USB, Infrared, IEEE 802.11, Ethernet, Bluetooth, Inter-Integrated Circuit bus, Serial Peripheral Interface, Zig-Bee.	[6]
Unit 4: Embedded system programming	[6]

Embedded C-programming concepts, Constants, Variables and Data Types, Operators, Functions, Softwares, interfacing of LED, LCD, motors, and switches. Serial Communication Programming: Introduction to Serial Communication, Types of Serial Communication, Programming of UART, Interfacing of ADC, sensor interfacing, embedded networking.	
Unit 5: Embedded/RealTime Based Operating System Need of RTOS in Embedded system software,Architecture of kernel, task, task-scheduler: task states, context switching, scheduling algorithm; ISR, Semaphores, mailbox, message queues, pipes, events, timers and memory management.	[7]
Unit 6: Linux Fundamentals & Device Drivers Linux Fundamentals, Features of Linux, Linux Commands, File manipulation commands, Editors, directory commands, Introduction to Device Driver, The Role of Device Driver, Types of Device Drivers.	[6]

Text Books:

1. Embedded /Real-Time System- black book by Dr K. V. K. K. Prasad, 2nd edition, Dreamtech press.
2. The 8051 Microcontroller and Embedded Systems – using assembly and C, Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinlay; PHI, 2006 / Pearson, 2006.
3. The 8051 Microcontroller, Kenneth J. Ayala, 3rd Edition, Thomson/Cengage Learning.

Reference Books:

1. K. V. Shibu, Introduction to Embedded Systems, TMH, ISBN: 978-9339219680
2. F. Vahid, Embedded System Design – A unified hardware and software introduction, John Wiley, ISBN: 978-0-471- 38678-0
3. Rajkamal, Embedded Systems, TMH.
4. L. B. Das, Embedded Systems and Integrated approach, Pearson, ISBN: 978-81-317-8766- 5. M. Mazidi, PIC Microcontroller and Embedded System, Pearson

Research Methodology

23AR4703	PCC	Research Methodology	3-0-0	3Credits

Teaching Scheme	**Evaluation scheme**
Lecture: 3 hrs/week	CA–I :10 Marks CA–II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites:

Course Outcomes: At the end of the course, students will be able to:

CO1	Explain the importance of research.
CO2	Utilize appropriate resources for Research
CO3	Analyze the contents of literature for further research
CO4	Simplify a Research Problem.
CO5	Examine Sampling and data Analysis
CO6	Develop effective written and oral Presentation skills

Course Contents:

Unit 1: Introduction to Research Methodology Concepts – meaning – objectives – motivation. Types of research – descriptive research – conceptual research – theoretical research – applied research – experimental research	[6]
Unit 2: Research process Criteria for good research – Problems encountered by Indian researchers. Formulation of Research Task – Literature Review – Importance & Methods – Sources – Quantification of Cause Effect Relations – Discussions– Field Study – Critical Analysis of Facts Generated	[6]
Unit 3: Problem Identification & Formulation Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance Hypothetical proposals for future development and testing, selection of Research task	[6]
Unit 4: Mathematical modeling and simulation Concepts of modeling – Classification of mathematical models – Modeling with – Ordinary differential equations – Difference equations – Partial differential equations – Graphs – Simulation – Process of formulation of model based on simulation	[6]

Unit 5: Sampling Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size. **Data Analysis:** Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association.	[6]
Unit 6: Interpretation, report writing and research ethics Research ethics, Techniques of interpretation – Precautions in interpretation – Significance of report writing – Different steps inreport writing – Layout of research report – Mechanics of writing research report – Layout and format – Style of writing – Typing – References – Tables – Figures – Conclusion – Appendices.	[6]
Text Books: 1.Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition	
Reference Books: 1. J.W. Bames, Statistical Analysis for Engineers and Scientists, McGraw Hill, N.York 2. Schank Fr., Theories of Engineering Experiments, Tata Mc Graw Hill Publication. 3. C. R. Kothari, Research Methodology, New Age Publishers. 4. Willktnsion K. L, Bhandarkar P. L, Formulation of Hypothesis, Himalaya Publication. 5. Ranjit Kumar, Research Methodology, SAGE Publications 6. Ranjit Kumar , Research Methodology, Pearson Publications	

Capstone Project – II

23AR4704	ELC	Capstone Project – II	0-0-2	2 Credits

Teaching Scheme:	**Evaluation scheme:**
Practical: 4hrs/week	CA1: 25 Marks CA2: 25 Marks End Semester Examination: 50 Marks

Pre-Requisites: All Courses

Course Outcomes: At the end of the course, students will be able to:

CO1	Evaluate real life problem and feasibility of solution to the problem
CO2	Build solutions to real life problems with individual and team work through modern
CO3	Improve professional ethics and communication skill and engage with environment

Term Work:

1. At the end of third year, student have to form project batch of minimum 3 and maximum 5 students
2. At the end of semester student have to submit project phase-II report for POE

Course Contents:

- It is expected that the students should complete 100% of the total project work in Semester VII.
- The students should submit the report in a prescribed format, before the end of semester VII.
- The report shall be comprehensive and presented typed on A4 size sheets and bound paper.
- Number of copies to be submitted is number of students plus two.
- The student must submit one graphical abstract and must publish one unpaid journal or conference paper on their project work before end of semester VII.

Course Evaluation:

The evaluation of the project work will be done considering the performance of students in reviews 1, 2, & the final SEE examination.

Review 1: For continuous assessment I students are expected to present their progress of project work till date. This review will ensure the 75 percent project work completeness. The following points can be considered for the preparation of the review 1 presentation:

- Manufacturing/ procurement of components
- Fabrication / Manufacturing of set up
- Experimentation/ Testing
- Data analysis
- Design Validation
- Implementation

Review 2: For continuous assessment II, review 2 will ensure the completeness of the project work and has to submit a comprehensive report of the same. The following points can be considered for the Review 2 presentation:

- Complete demonstration of project.
- Report writing.
- Plagiarism/Similarity report.
- Final draft of journal paper or conference paper.

Final semester end examination (SEE): For final SEE students are evaluated by panel of one industrial expert, one departmental internal examiner, and project guide.

Robot Operating System and Simulation Laboratory

23AR4705	PCC	Robot Operating System and Simulation Laboratory	0-0-2	1 Credits

Teaching Scheme:	**Evaluation Scheme:**
Practical: 2 hours/week	CA–I :15 Marks CA–II :15 Marks End Semester Exam: 20 Mark

Pre-Requisites: Python Programming, Java Programming, CAD-CAM Automation

Course Outcomes: At the end of the course students will be able to -

CO1	Build skills in CAE analysis for structural and thermal problems, optimizing designs
CO2	Apply for advanced CAD/CAM techniques, including part modeling, complex tool path generation, and CNC -machining capabilities.
CO3	Access generative design optimization to investigate laser engraving depth through practical experiments
CO4	Build ROS concepts to implement robotic applications using topics, services, actions, navigation, manipulation, and vision.

List of Experiments:

Part A

At least minimum 5 experiment should be performed from the following List

1.Part modeling using 3 D software
2.Stuctural analysis problem to be solved using a CAE tools
3.Thermal analysis problem to be solved using CAE tools
4. Investigate the cutting capabilities of the CNC module
5. Evaluate the strength of 3D-printed parts with varying infill densities
6. Explore the software's advanced features for generating complex tool paths and designs.
7. To investigate the relationship between laser power settings and engraving depth on a specific material
8.Generative design optimization using any suitable software

Part B

At least minimum 2 experiment should be performed from the following List

1. ROS Essentials: Introduction to ROS Topics, Services, Actions and Nodes. Simple interaction with the course simulation environment.
2. Autonomous Navigation: Map creation with G-Mapping package, autonomously navigate a known map with ROS navigation.
3. Manipulation: Motion planning, pick and place behaviors using industrial robots with ROS MoveIt
4. Robot Vision: Object detection, pose estimation.

Text Books:

1. Ibrahim Zeid ―Mastering CAD CAM‖ Tata McGraw-Hill Publishing Co.2007
2. Rao, S.S., ―The Finite Element Method in Engineering‖, 5th Edition, Butterworth Heinemann, 2010

Reference Books:

1. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, ―Concepts and Applications of Finite Element Analysis‖, 4th Edition, Wiley Student Edition, 2002.
2. Foley, Wan Dam, Feiner and Hughes - "Computer graphics principles & practice" Pearson, 3 rd edition, 2013..

Machine Learning Laboratory

23AR4706	PCC	Machine Learning Laboratory	0-0-2	1 Credits

Teaching Scheme:	Evaluation Scheme:
Practical: 2 hours/week	CA–I :15 Marks CA–II :15 Marks End Semester Exam: 20 Marks

Pre-Requisites: Python Programming

Course Outcomes: At the end of the course students will be able to -

CO1	Analyze datasets to identify patterns and appropriate preprocessing techniques
CO2	Develop machine learning models for classification, regression, clustering, and prediction tasks.
CO3	Evaluate the performance of machine learning models using suitable performance metrics.
CO4	**Evaluate** solutions for real-world engineering problems using machine learning techniques.

List of Experiments:

At least minimum 10 experiment should be performed from the following List

1. Develop a python program to learn different libraries NumPy.
2. Develop a python program to import and export data using Pandas library functions
3. Demonstrate various data pre-processing techniques for a given dataset.
4. Develop a Python program to demonstrate various Data Visualization Techniques.
5. Develop a python program to implement linear regression Algorithm.
6. Develop Logistic Regression Model for a given dataset.
7. Develop Decision Tree Classification model for a given dataset and use it to classify a new sample.
8. Implement Naïve Bayes Classification in Python.
9. Build KNN Classification model for a given dataset.
    a) Implement Random forest ensemble method on a given dataset.
    b) Implement Boosting ensemble method on a given dataset.
10. Develop a python program to implement K-Means clustering Algorithm.
11. Build Artificial Neural Network model with back propagation on a given dataset.

Text Books:

1. Tom Mitchell, Machine Learning_, McGraw Hill, 2015.
2. . Peter Flach, _Machine Learning: The Art and Science of Algorithms that make sense of data_, Cambridge, 201

Reference Books:

1. Hal Daume III, _A course in Machine Learning_, Todo, 2015.
2. EthemAlpaydin,_Introduction to Machine Learning_,The MIT Press, 2004
3. David MacKay, Information Theory, Inference and Learning Algorithms_, Cambridge, 2003

Industrial Robotics and Material Handling Systems Laboratory

23AR4707	PCC	Industrial Robotics and Material Handling Systems Laboratory	0-0-2	1 Credits

Teaching Scheme:	**Evaluation Scheme:**
Practical: 2 hours/week	CA–I :25 Marks CA–II :25 Marks

Pre-Requisites: Factory Automation, Field and Service Robotics

Course Outcomes: At the end of the course students will be able to -

CO1	Analyze and implement storage solutions and data capturing systems
CO2	Develop proficiency in configuring and programming robot manipulators for tasks
CO3	Develop integrated storage solutions and data capture systems for improving inventory management, supply chain visibility, and operational control.

List of Experiments:

Industrial Robotics and Material handling Systems –(Any Four)

1. Investigate Demonstrate of Material handling systems
2. Analysis of Storage and Data capturing systems
3. Analysis of configuration of robots and motion of robot manipulator
4. Investigate of pick and place industrial robot
5. Study and analysis of robot grippers (includes the problems based on gripper force)
6. Case Study on advanced industrial applications of robots

Robot Programming–(Any Four)

1. Programming using the teach pendant method.
2. Programming on VAL Language
3. Programming the robot for path following operation using any robot

4. Programming the robot for palletizing operation using any robot
5. Programming the robot for pick and place operation using any robot
6. Robot Programming for Color identification/shape identification/path tracking
7. 7. Industrial visit and its report on industrial applications of robots

Text Books:

1. R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi,4th Reprint, 2005.
2. JohnJ.Craig ,Introduction to Robotics Mechanics and Control, Third edition, Pearson Education, 2009.
3. M.P.Groover, M.Weiss, R.N. Nageland N. G.Odrej, Industrial Robotics, McGrawHill Singapore, 1996.

Reference Books:

1. Groover M. P., "Automation, Production Sysytems, and Computer –Integrated Manufacturing",PearsonEducation,ISBN-81-7808-511-9
2. Deb S.R., "Robotics", Tata McGraw Hill Publications, New Delhi. ISBN 13: 9780070077911
3. Yoram Koren, " Robotics for Engineers", McGraw Hill Book Co. ISBN-10: 0070353999, ISBN-13: 978-0070353992
4. Groover M.P., Weiss M., Nagel R.N., Odrey N.G., "Industrial Robotics Technology - Programming and Applications & McGraw Hill Book Co. ISBN-10: 1259006212, ISBN-13: 978-1259006210
5. Fu K.S., Gonzalex R.C., Lee C.S.G., "Robotics Control Sensing, Vision and intelligence", McGraw Hill Book Co. ISBN 10: 0070226253 / ISBN 13: 9780070226258 7.
6. Hall A.S. Kinematics and Linkage Design", Prentice Hall. ISBN-10: 0881332720, ISBN-13: 978- 0881332728
7. Todd D.J., "Fundamentals of Robot Technology", Wiley Publications, ISBN:978-0-470-20301-9

Research and Industrial Case Studies

23AR4708	RM	Research and Industrial Case Studies	0-0-2	1 Credit

Teaching Scheme	**Evaluation scheme**
Lecture: 2 hrs/week	CA–I :25 Marks CA–II :25Marks

Pre-Requisites: Nil

Course Outcomes: At the end of the course, students will be able to:

CO1	Analyze research literature, patents, and technical information to identify research gaps and formulate engineering problems.
CO2	Evaluate research methodologies, software tools, and industrial case studies to justify appropriate solutions for robotic and automation applications.
CO3	Develop research reports, technical articles, and project presentations by applying scientific writing and data analysis techniques.
CO4	Formulate robotic or automation systems, end effectors, CAD models, simulations, or low-cost automation solutions to address industrial problems.

List of Experiments: Seminars/ Assignments

Part A: Any TWO Research experiments and reports of the following

i. Development of a research plan including research survey, literature review, and discussion of the main idea for the practical implementation of the research results.
ii. Application of any one software used for research, Tabulation and Graphical Presentation, Introduction to AI in research
iii. Review of patents and presentation of the results of the patent search
iv. Preparation of an article based on the results of the work. Project presentation for collective discussion.

Part B: **Students are suggested to choose Industrial case study and prepare a detailed report on problem statement on the same. Refer following suggestive areas for case studies.**

i. Manufacturing / Fabrication of a prototype Robotic / Automated system including selection, concept, design, material, manufacturing the components, assembly of components, testing and performance evaluation.
ii. Improvement of existing Robotic / Automated system.

iii. Design and fabrication of end effectors for robot
iv. Computer aided design, analysis of components such as stress analysis.
v. Modeling and Simulation of Robotic and Automation systems
vi. Robot Kinematics and Dynamic analysis
vii. Low cost automation, Computer Aided Automation in Manufacturing.
viii. Ergonomics and safety aspects of robotic systems
ix. Management Information System.
x. Product design and development
xi. Jigs and Fixtures, dies, tools, special purpose equipment, inspection gauges, measuring instruments for machine tools.
xii. Problems related to Productivity improvements / Value Engineering / Automated Material Handling Systems
xiii. Use of Industry 4.0 by visiting any industry
xiv. Foundry problems and its analysis by visiting any foundry

Course Contents:

Text Books:
1.Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition

Reference Books:
1. J.WBames, Statistical Analysis for Engineers and Scientists, McGraw Hill, N.York
2. Schank Fr., Theories of Engineering Experiments, Tata Mc Graw Hill Publication.
3. C. R. Kothari, Research Methodology, New Age Publishers.
4. Willktnsion K. L, Bhandarkar P. L, Formulation of Hypothesis, Himalaya Publication.

Entrepreneurship Development

23AR4709	HSSM	Entrepreneurship Development	2-0-0	Audit

Teaching Scheme	**Evaluation scheme**
Lecture: 2 hrs/week	CA–I :25 Marks CA–II :25 Marks

Pre-Requisites: Nil

Course Outcomes: At the end of the course, students will be able to:

CO1	Extend the supply of entrepreneurs for rapid industrial development
CO2	Develop small and medium enterprises sector which is necessary for generation of employment
CO3	Identify Industrialize rural and backward regions
CO4	Apply gainful self-employment to educated young men and women for the sources of entrepreneurship.

Course Contents:

Unit 1: Introduction to Entrepreneurship Evolution of the Concept of Entrepreneur Functions of Entrepreneur, Characteristics of an Entrepreneur, Types of Entrepreneurs, Concept of Entrepreneurship, Growth of Entrepreneurship, Barriers of Entrepreneurship, Role of Entrepreneurship in India.	[2]
Unit 2: Small Scale Industries (SSI) Characteristics of Small-Scale Industry, Basis for Classification of Small-Scale Industry: Resource Based, Demand Based, Ancillary, Subsidiary Based or Sub-Controlled Type, Technology Based etc. Government Policy for Small Scale Industry, Growth of SSI in Developing Countries, Role of National and State Agencies Providing Assistance To SSI's.	[2]
Unit 3: Project Identification and Project Formulation Meaning of Project, Project Identification and Selection, Elements of Project Formulation, Concept and Significance of Project Formulation, Meaning, Significance and Contents of Project Report. Accounting for Small Enterprises: Objective of Accounting, Accounting Process, Journal, Ledger, Preparation of Balance Sheet.	[2]
Unit 4: Project Appraisal Concept of Project Appraisal, Project Appraisal Methods, Cash Flows as Costs and Benefits, Payback Period, Average Rate of Return. Discounted Cash Flow Techniques, Working Capital Management, Cost of Capital, Financing of Enterprises, Project Sickness & Corrective Measures, Market Segmentation, Marketing Mix, and Packaging, Pricing Policy, Distribution Channels, and Govt. Purchases from SSIS. Laws Concerning	[2]

Entrepreneur: Income Tax Laws, Excise Duty,The Central Sales Tax Act, Professional Tax, Value Added Tax (VAT), Service Tax, The Payment of Bonus Act Institutional Support Government Policies for Small Scale Entrepreneurs. Women Entrepreneurship: Growth, Problems, Recent Trends.	
Text Books: 1. V. Desai, "Dynamics of Entrepreneurial Development and Management", Hindustan Publishing	
Reference Books: 1.S. S. Khanka, "Entrepreneurial Development", S. Chand and Company Ltd. 2. C. B. Gupta, N. P. Srinivasan, "Entrepreneurship Development in India", S. Chand and Sons. 3. B. Badhai, "Entrepreneurship Development Programme", Mansell Publishing Ltd. 4. House. 5. David H. Holt, "Entrepreneurship", PHI Learning. 6. Roy Rajeev, "Entrepreneurship", Oxford University Press	

Robot Operating System

23AR4710	PCC	Robot Operating System	2-0-0	Audit

Teaching Scheme	**Evaluation scheme**
Lecture: 2 hrs/week	CA–I :25 Marks CA–II :25 Marks

Pre-Requisites: Fundaments of Automation and Robotics

Course Outcomes: At the end of the course, students will be able to:

CO1	Explain the fundamental concepts of robotics and automation
CO2	Build message communication of robot operating system
CO3	Examine robot operating system
CO4	Develop Program and simulate robot applications
CO5	Simplify robot with embedded system

Course Contents:

Unit 1:Introduction Introduction to robot operating system (ROS), ROS- Objective and components, History of ROS, Terminologies used in ROS, Communication message system used in ROS, Build system, File system	[3]
Unit 2: ROS- Tools and Commands ROS command list and shell commands, ROS executive and information commands, ROS Package commands, ROS tool visualization, ROS GUI development, ROS installation and running tool	[3]
Unit 3: ROS Programming Introduction to ROS programming, Standard unit, Coordinate presentations, Different rules in ROS programming, Creating and running publisher, subscriber nodes	[3]
Unit 4: ROS Manipulator Introduction to ROS manipulator, Basic structure of manipulator, Open manipulator modeling and simulator, Gazebo setting move, Move It, Move group, Setup assistant, Gazebo simulation	[3]
Unit 5: ROS Embedded System OpenCR- Introductio, characteristics, board specification, Establish development environment, rosserial, rosserial server, rosserial client, rosserial protocol, Constrain of rosserial, Installation of rosserial, TurtleBot3 Firmware.	[3]
Text Books: 1."A Gentle Introduction to ROS" by J. M. OKane (Independently Published)	

ISBN:9781492143239

Reference Books:

1. "ROS robotics by example" by C. Fairchild and L. T. Harman (Pakt Publications), ISBN: 9781785286704
2. "Programming Robots by ROS" by M. Quigley, B. Gerkey and W. D. Smart (O Reilly Media Inc.), ISBN: 9781449325503
3.Anis Koubaa, "Robot Operating System", Springer link, 2016. (ii) Anil Mahtani, "Effective Robotics Programming with ROS", Packt Publishing, 2016.
4. Ramkumar Gandhinathan , Lentin Joseph ," ROS Robotics Projects: Build and control robots powered by the Robot Operating System, machine learning, and virtual reality", Packt Publishing Limited, December 2019.
5.SLAM for dummies: https://dspace.mit.edu/bitstream/handle/1721.1/119149/16-412jspring-2005/contents/projects/1aslam_blas_repo.pdf
6. ROS Robot Programming; YoonSeok Pyo I HanCheol Cho I RyuWoon Jung I TaeHoon Lim; https://community.robotsource.org/t/download-the-ros-robot-programming-bookfor-free/5

A. Robotic Control Systems

23AR4711A	PEC	Robotic control System	3-0-0	3 Credits

Teaching Scheme	**Evaluation scheme**
Lecture: 3 hrs/week	CA–I :10 Marks CA–II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Fundamentals of Automation and Robotics, Control System

Course Outcomes: At the end of the course, students will be able to:

CO1	Demonstrate non-linear system behavior by phase plane and describing function methods.
CO2	Apply the stability analysis nonlinear systems by Lyapunov method.
CO3	Organize discrete-time mathematical models in both time domain (difference equations, state equations) and z domain (transfer function using z-transform).
CO4	Analyze transient and steady-state responses and stability and sensitivity of both open-loop and closed-loop linear, time-invariant, discrete-time control systems.
CO5	Apply knowledge of state space and state feedback in modern control systems, pole placement, design of state observers and output feedback controllers
CO6	Analyze the Joint Space and Task Space

Course Contents:

Unit 1:Introduction Basics of robotic system's kinematics and dynamics: Forward and inverse dynamics. Properties of the dynamic model and case studies. Introduction to nonlinear systems and control schemes. Symbolic Modeling of Robots for Direct Kinematic Model and inverse kinematics.	[6]
Unit 2 System Stability and Types of Stability Lyapunov stability analysis, both direct and indirect methods. Lemmas and theorems related to stability analysis, Joint Space and Task Space Control Schemes Position control, velocity control, trajectory control and force control. Description of Force Control tasks, Force Control Strategies, Hybrid Position / Force Control, Impedance Force / Torque Control.	[6]
Unit 3:Linear Control Introduction Control techniques, block diagram, transfer function, signal flow diagram, state space representation, performance and stability of feedback control, Proportional-	[6]

Derivative-Integral (PID) control, selection of PID controller gains, state feedback control, joint controllers.	
Unit 4: Nonlinear Control Schemes Proportional and derivative control with gravity compensation, computed torque control, sliding mode control, adaptive control, observer based control and robust control, Optimal Control: Introduction - Time varying optimal control – LQR steady state optimal control – Solution of Ricatti's equation – Application examples.	[6]
Unit 5: Nonlinear Observer Schemes Design based on acceleration, velocity and position feedback. Numerical simulations using software packages	[6]
Unit 6: Joint Space and Task Space Control Schemes Introduction, manipulator interaction with environment, compliance control, impedance control, force control, position control, velocity control, trajectory control.	[6]

Text Books:

1. R K Mittal, I J Nagrath, Robotics and Control, TMH Publishing Co. Ltd., 2003.
2. R Kelly, D. Santibanez, LP Victor and Julio Antonio, "Control of Robot Manipulators in Joint Space", Springer, 2005.
3. A Sabanovic and K Ohnishi, "Motion Control Systems", John Wiley & Sons (Asia), 2011.

Reference Books:

1. R M Murray, Z. Li and SS Sastry, "A Mathematical Introduction to Robotic Manipulation", CRC Press, 1994.
2. J J Craig, "Introduction to Robotics: Mechanics and Control", Prentice Hall, 2004. 3. J J E Slotine and W Li, "Applied Nonlinear Control", Prentice Hall, 1991.
3. Sebastian Thrun, Wolfram Burgard, Dieter Fox, "Probabilistic Robotics", MIT. (iv) Carlos, Bruno, Georges Bastin, "Theory of Robot Control", Springer, 2012.

B. Micro and Nano Electromechanical Systems

23AR4711B	PEC	Micro and Nano Electromechanical System	3-0-0	3 Credits

Teaching Scheme	**Evaluation scheme**
Lecture: 3 hrs/week	CA–I :10 Marks CA–II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Basic

Course Outcomes: At the end of the course, students will be able to:

CO1	Explain knowledge of Nano science and nanotechnology including theory & practical application
CO2	Explain the Potentially apply the concepts of Quantum Dots and Synthesis of Nanostructure Materials in research projects.
CO3	Apply the scaling of Electronic components for producing MEMS switches
CO4	Make use of novel ideas using the concepts of characterization and Nanotechnology application.
CO5	Examine about Nanotechnology Applications
CO6	Select an appropriate micro sensor and micro actuator in a given application.

Course Contents:

Unit 1:Nanoscale Systems Length, energy, and time scales - Quantum confinement of electrons in semiconductor nanostructures: Quantum confinement in 3D, 2D, 1D and zero dimensional structures -Size effect and properties of nanostructures- Landauer - Buttiker formalism for conduction in confined geometries - Top down and Bottom up approach.	[6]
Unit 2 Quantum Dots Excitons and excitonic Bohr radius – difference between nanoparticles and quantum dots - Preparation through colloidal methods - Epitaxial methods- MOCVD and MBE growth of quantum dots - current-voltage characteristics - magneto tunneling measurements - spectroscopy of Quantum Dots: Absorption and emission spectra - photo luminescence spectrum - optical spectroscopy - linear and nonlinear optical spectroscopy.	[6]
Unit 3:Introduction to MEMS And NEMS Working principles as micro sensors (acoustic wave sensor, biomedical and biosensor, chemical sensor, optical sensor, capacitive sensor, pressure sensor and thermal sensor),	[6]

micro actuation (thermal actuation, piezoelectric actuation and electrostatic actuation–micro gripers, motors, valves, pumps, accelerometers, fluidics and capillary electrophoresis, active and passive micro fluidic devices, Pizoresistivity, Pizoelectricity and thermoelectricity, MEMS/NEMS design, processing, Oxidation, Sputter deposition, Evaporation, Chemical vapor deposition etc.	
Unit4:Introduction Electronic Scaling Scaling of physical systems – Geometric scaling & Electrical system scaling. The SingleElectron Transistor: The Single- Electron Transistor Single-Electron Transistor Logic, Other SET and FET Structures, Carbon Nanotube Transistors (FETs and SETs), Semiconductor Nanowire FETs and SETs,Coulomb Blockade in a Nanocapacitor, Molecular SETs and Molecular Electronics.	[6]
Unit 5:Nanotechnology Applications Applications of nanoparticles, quantum dots, nanotubes and nanowires for nano device fabrication – Single electron transistors, coulomb blockade effects in ultra-small metallic tunnel junctions - nanoparticles based solar cells and quantum dots based white LEDs – CNT based transistors – principle of dippenlithography	[6]
Unit 6: Micro sensors and Micro actuators Smart Sensor, Actuator and Transducer Technologies, Smart Sensors: Accelerometers; Force Sensors; Load Cells; Torque Sensors; Pressure Sensors; Microphones; Sensor Arrays Smart Actuators: Displacement Actuators; Force Actuators; Power Actuators; Vibration Dampers; Shakers; micro Fluidic Pumps; micro Motors Smart Transducers: Ultrasonic Transducers; Sonic Transducers	[6]
Text Books: 1. G. Timp, Nanotechnology. Editor, AIP press, Springer-Verlag, New York, 2007 2. Stephen D. Senturia, Microsystem Design, Kluwer Academic Press, 2005. 3. Marc Madou, Fundamentals of microfabrication & Nanofabrication, 2013, March 30.	
Reference Books:	
1. Hand book of Nanostructured Materials and Technology, Vol.1-5, Editor:- Hari Singh Nalwa; Academic Press, USA(2000). Hand book of Nanoscience, Engineering and Technology (The Electrical Engineering handbook series), Kluwer Publishers,2002 2. C.J. Brinker, G.W. Scherrer and Sol-Gel Science, Academic Press, Boston, Dec 11, 2016. 3. Nanoscale characterization of surfaces & interfaces, N John Dinardo, Weinheim Cambridge: Wiley-VCH, 2nd ed.,2000. 4. T. Fukada&W.Mens, Micro Mechanical system Principle & Technology, Elsevier, 2012. 5. Julian W.Gardnes, Vijay K. Varda, Micro sensors MEMS & Smart Devices, 2001.	

C. Neural Network and Fuzzy logic

23AR4711C	PEC	Neural Network and Fuzzy logic	3-0-0	3 Credits

Teaching Scheme	**Evaluation scheme**
Lecture: 3 hrs/week	CA–I :10 Marks CA–II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Sensor and Instrumentation

Course Outcomes: At the end of the course, students will be able to:

CO1	Identify and describe Fuzzy Inference Systems and their roles in building intelligent machines
CO2	Make use of the feasibility of applying Neural Networks and Fuzzy systems for a particular problem
CO3	Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems
CO4	Apply neural networks to pattern classification and regression problems
CO5	Make use of use existing software tools to solve real problems using Neural Networks and Fuzzy Systems
CO6	Evaluate solutions by Neural Networks and Fuzzy systems for given problems.

Course Contents:

Unit 1::Neural Networks Introduction Humans and Computers, Organization of the Brain, Biological Neuron, Biological and Artificial Neuron Models, Hodgkin-Huxley Neuron Model, Integrate-and-Fire Neuron Model, Spiking Neuron Model, Characteristics of ANN, McCulloch-Pitts Model, Historical Developments, Potential Applications of ANN. Neuron, Nerve structure and synapse, Artificial Neuron and its model, activation functions,	[7]
Unit 2:Essentials of Artificial Neural Networks Artificial Neuron Model, Operations of Artificial Neuron, Types of Neuron Activation Function, ANN Architectures, Classification Taxonomy of ANN – Connectivity, Neural Dynamics (Activation and Synaptic), Learning Strategy (Supervised, Unsupervised, Reinforcement), Learning Rules, Types of Application	[6]
Unit 3: Neural Networks Architecture Single layer and multilayer feed forward networks, recurrent networks. Various learning techniques; perception and convergence rule, Auto-associative and hetro-associative	[7]

memory, perceptron model, solution, single layer artificial neural network, multilayer perception model; back propagation learning methods, effect of learning rule co-efficient ;back propagation algorithm, factors affecting back propagation training, applications	
Unit 4: Fuzzy LogicIntroduction Basic concepts of fuzzy logic, Fuzzy sets and Crisp sets, Fuzzy set theory and operations, Properties of fuzzy sets, Fuzzy and Crisp relations, Fuzzy to Crisp conversion	[7]
Unit5: Fuzzy Logic: Fuzzy Membership, Rules Membership functions, interference in fuzzy logic, fuzzy if-then rules, Fuzzy implications and Fuzzy algorithms, Fuzzyfications&Defuzzificataions, Fuzzy Controller, Industrial applications.	[7]
Unit6: Fuzzy Logic Applications Operations of Fuzzy relation, Defuzzification, Fuzzy rule base and approximate reasoning, Fuzzy Inference Systems, Design a fuzzy logic controller: Mamdani and Sugeno Architecture	[6]
Text Books: 1. S. Rajsekaran& G.A. Vijayalakshmi Pai, "Neural Networks,Fuzzy Logic and Genetic Algorithm:Synthesis and Applications" Prentice Hall of India. 2. N.P.Padhy,"Artificial Intelligence and Intelligent Systems" Oxford University Press.	
Reference Books: **1.** Siman Haykin,"NeuralNetowrks"Prentice Hall of India **2.** Timothy J. Ross, "Fuzzy Logic with Engineering Applications" Wiley India. **3.** Kumar Satish, "Neural Networks" Tata Mc Graw Hill 4. Neural Networks and Fuzzy Logic System by Bart Kosko, PHI Publications.	

D. Robot System Design and SLAM (Simultaneous Localization and Area Mapping)

23AR4711D	PEC	Robot System Design and SLAM (Simultaneous Localization and Area Mapping)	3-0-0	3 Credits

Teaching Scheme	**Evaluation scheme**
Lecture: 3 hrs/week	CA–I :10 Marks CA–II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Fundamental of Automation and Robotics

Course Outcomes: At the end of the course, students will be able to:

CO1	Explain the features and uses of Robotic Operating System (ROS) and allied software
CO2	Identify the tool of Robotic Operating System (ROS)
CO3	Identify the Simultaneous Localization and Mapping (SLAM)
CO4	Apply SLAM principles to simultaneously perform robot localization and environment
CO5	Identify the robot navigation and object manipulation for a given application
CO6	Make use of robot vision for real-world applications.

Course Contents:

Unit 1: :Introduction Industrial Applications of Robots, Industrial Environments and Constraints, Free Open Source Software for Robot Simulation, Robotic Operating System (ROS), Gazebo, MoveIt, Ubuntu, Python, Installing and Configuring Simulation Softwares.	[6]
Unit 2: Robotic Operating System (ROS) Fundamentals, Building a ROS Application, ROS Services, ROS Actions, Unified Robot Description Format (URDF)..	[6]
Unit 3: SLAM Simultaneous Localization and Mapping (SLAM) implementation with ROS2 packages and C++. Combining mapping algorithms with the localization concepts	[6]
Unit 4: Introduction to the Mapping and SLAM concepts and algorithms Occupancy Grid Mapping, Mapping an environment with the Occupancy Grid Mapping algorithm, Grid-based FastSLAM: Simultaneous mapping an environment and localize a robot relative to the map with the Grid-based FastSLAM algorithm, Self-Localisation, Path Planning and Obstacle Avoidance, Map-Building and Map Interpretation, Simultaneous	[6]

Localization and Mapping, Navigation using Software Tools.	
Unit 5: Object Manipulation Manipulation Planning Algorithms, Prehension, Manipulation using Software Tools.	[6]
Unit 6: Robot Vision Object Detection, Pose Estimation, Logical Camera, ROS Tools for Vision.	[6]

Text Books:

1. Morgan Quigley, "Programming Robots with ROS: A Practical Introduction to the Robot Operating System", O'Reilly Media, 2015.
2. Carol Fairchild, Dr. Thomas L. Harman, "ROS Robotics by Example", Packt, 2016.

Reference Books:

1. Anis Koubaa, "Robot Operating System", Springer link, 2016.
2. Anil Mahtani, "Effective Robotics Programming with ROS", Packt Publishing, 2016.
3. Ramkumar Gandhinathan , Lentin Joseph ," ROS Robotics Projects: Build and control robots powered by the Robot Operating System, machine learning, and virtual reality", Packt Publishing Limited, December 2019.
4. SLAM for dummies: https://dspace.mit.edu/bitstream/handle/1721.1/119149/16-412jspring-2005/contents/projects/1aslam_blas_repo.pdf
5. ROS Robot Programming; YoonSeok Pyo I HanCheol Cho I RyuWoon Jung I TaeHoon Lim; https://community.robotsource.org/t/download-the-ros-robot-programming-bookfor-free/51

Drones and Autonomous Systems

23ARMDA5	MDM	Drones and Autonomous Systems	3-0-0	3 Credits

Teaching Scheme	**Evaluation scheme**
Lecture: 3 hrs/week	CA–I :10 Marks CA–II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Fundamentals of Automation and Robotics

Course Outcomes: At the end of the course, students will be able to:

CO1	Explain the evolution and classification of Drones / Unmanned aerial Vehicle (UAVs)
CO2	Identify on UAVs technology side of things (i.e. sensors, platforms, navigation, power source, communication, range, altitude and speed)
CO3	Select the commercial applications used by various types of drones such as aerial photography, law enforcement surveillance, and border enforcement.
CO4	Utilize hardware and software for data collection, storage, analytical requirements and system life cycle.
CO5	Apply Indian government airspace policy, regulations, and a comparison of other international regulations, and risk factors
CO6	Make use of the emerging technologies being integrated into the drone market including semi-autonomous and autonomous systems for various applications like crop sensing, emergency response missions, and coordinated swarms

Course Contents:

Unit 1:Introduction to Autonomous Flights History of Autonomous Flights – Principles of Flight – Flight Maneuvers – Showcase of DIY drones	[4]
Unit2: Technologies and Requirements Critical Technologies – Navigation, Sensors and Payloads, Power Sources, Communications – COTS Drone Technologies	[4]
Unit3: Design Fundamentals UAV Classifications – Review of few Successful UAVs – Design Project Planning – Feasibility AnalysisDesign Process – UAV Conceptual Design – UAV Preliminary	[4]

Design – UAV Detail Design – Design Review, Evaluation, Feedback – UAV Design Steps	
Unit4: Principles of UAVs Airframe - Building the Little Dipper Airframe – Step by step build instructions – Power Train – Propellers – Motors – Total Lift – Wrapping UP	[4]
Unit 5: Control and Navigation Flight Controller – Build Instructions of Flight Controller – GPS – Compass – Battery Monitor – Transmitter – Frequency Bands – Different Modes Around the World	[4]
Unit 6: Telemetry Radios, Camera and First Person View (FPV) Equipment Software Monitoring and control – Popular Drone Cameras – FPV for Live stream – Key Flight Safety Rules – PreFlight Checklist and Flight Log information – Laws and Regulation	[4]
Text Books: 1. Terry Kilby and Belinda Kilby Make: Getting Started with Drones, First Edition, Maker Media Inc, San Francisco CA, 2016 2. John Baichtal "Building your own Drones A beginners Guide to Drones, UAVs and ROVs", Que Publishing 2016	
Reference Books: 1. Mohammad H. Sadraey "Design of Unmanned Aerial Systems" First Edition, John Wiley & Sons, Inc., USA 2020 2. R. Jha, "Theory, Design, and Applications of Unmanned Aerial Vehicles", First Edition, CRC Press, 2020 3. Alain Cardon and MhamedItmi "New Autonomous Systems" Volume 1, John Wiley & Sons, Inc. Hoboken, USA. 2016	

Operating System

23ARMDB5	MDM	Operating System	3-0-0	3 Credits

Teaching Scheme	Evaluation scheme
Lecture: 3 hrs/week	CA–I :10 Marks CA–II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Computer Organization & Architecture, Programming Skills

Course Outcomes: At the end of the course, students will be able to:

CO1	Explain Operating system structures
CO2	Build Processes and CPU Scheduling
CO3	Organize for the Process Synchronization
CO4	Apply communication between inter process and synchronization techniques
CO5	Develop page replacement algorithms, memory management problems and segmentation
CO6	Build virtualization and demonstrating the various Operating system tasks and the principle algorithms for enumerating those tasks

Course Contents:

Unit 1:Introduction and Operating system structures Definition, Types of Operating system, Real-Time operating system, System Components: System Services, Systems Calls, System Programs, System structure, Virtual Machines, System Design and Implementation, System Generations	[6]
Unit 2: Processes and CPU Scheduling: Process Concept, Process Scheduling, Operation on process, Inter-process Communication, Cooperating processes, Threads, Multithreading model, Scheduling criteria, Scheduling Algorithms, Thread Scheduling, Multiple-Processor Scheduling, Scheduling Algorithms evaluation.	[6]
Unit 3: Process Synchronization The critical-section problem, Critical regions, Peterson's Solution, Synchronization Hardware, Semaphores, Classical Problems of synchronization, and Monitors Deadlocks: Systems Model, Deadlock characterization, Methods for handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock, Combined approach to deadlock Handling.	[6]
Unit 4: Memory Management	[6]

Basic concept, Logical and Physical address map, Memory allocation: Continuous Memory Allocation, Fixed and variable partition, Internal and external fragmentation and compaction, Paging: Principle of operation, Page allocation – Hardware support for paging, Protection and sharing, Disadvantages of paging; Segmentation. Virtual Memory: Basics of Virtual Memory – Hardware and control structures – Locality of reference, Page fault, Working Set, Dirty page / Dirty bit – Demand paging, Page Replacement algorithms: Optimal, First in First Out (FIFO), Second Chance (SC), Not recently used (NRU) and Least Recently used(LRU).	
Unit 5: Process Synchronization The critical-section problem, Critical regions, Peterson's Solution, Synchronization Hardware, Semaphores, Classical Problems of synchronization, and Monitors Deadlocks: Systems Model, Deadlock characterization, Methods for handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock, Combined approach to deadlock Handling.	[6]
Unit 6:. Virtual Machines Virtualization (Hardware/Software, Server, Service, Network - Hypervisors - Container virtualization - Cost of virtualization - File system interface (access methods, directory structures) - File system implementation (directory implementation, file allocation methods) - File system recovery - Journaling - Soft updates - Log-structured file system - Distributed file system	[6]
Text Books: 1.Abraham Silberschatz, Peter B. Galvin and Greg Gagne, Operating System Concepts, Wiley Publication, 8th Edition, 2008.	
Reference Books: 1. Andrew S. Tanenbaum, Modern Operating System, PHI Publication, 4th Edition, 2015. 2. D. M. Dhamdhere, Systems Programming and Operating Systems, McGraw-Hill, 2nd Edition, 1996. 3. Garry Nutt, Operating Systems Concepts, Pearson Publication, 3rd Edition, 2003. 4. Harvey M. Deitel, An Introduction to Operating Systems, Addison Wesley Publication, 2nd Edition, 1990. 5. Thomas W. Doeppner, Operating System in Depth: Design and Programming, Wiley Publication, 2011.	

Aircraft Design

23ARMDC5	MDM	Aircraft Design	3-0-0	3 Credits

Teaching Scheme	**Evaluation scheme**
Lecture: 3hrs/week	CA-I:10 Marks CA-II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Aircraft Structures-I,Aircraft Structures-II

Course Outcomes: At the end of the course, students will be able to:

CO1	Explain conceptual design of a flight vehicle design and Weight Estimation Process.
CO2	Identify Wing loading, Thrust/ Weight selection, Wing and Fuselage Design
CO3	Apply initial aircraft sizing techniques for engine, geometry, control surfaces, and tail plane design.
CO4	Choose an engine of particular aircraft design
CO5	Identify Configuration Layout and Loft
CO6	Examine Landing Gears and Subsystems

Course Contents:

Unit 1:Introduction of conceptual design of a flight vehicle design and Weight Estimation Process. Aircraft purposes, Payload, cruise & Maximum Speed, Range, Endurance, take off and landing distance, design process, conceptual design. Determination of Fuel Fraction, Maximum Take Off Weight, Basic Empty Weight.	[4]
Unit2: Wing loading, Thrust/ Weight selection, Wing and Fuselage Design Wing loading effect on takeoff, landing, climb, acceleration, range, combat, flight ceiling & glide rate, Airfoil Selection, Wing Geometry, Biplane Wings, Tail geometry, Volume considerations of fuselage, Aerodynamic considerations of fuselage, and drag estimation.	[4]
Unit3: Initial Sizing and Tail plane Sizing Introduction, Rubber Engine Sizing, Fix Engine Sizing, Geometry Sizing, Control Surface Sizing, Airfoil selection Tail arrangement, horizontal and vertical tail sizing, tail plan form shape, Airfoil section type, tail placement	[4]

Unit4: Engine selection, Propulsion and Fuel System integration Propulsion selection, No's of engines, Engine ratings, turbojet engine sizing, propulsion system. Jet engine integration, Propeller engine integration, Fuel system	[4]
Unit 5: Configuration Layout and Loft End products of configuration layout, Conic lofting, Conic fuselage development, Flat wrap fuselage lofting, Circle-To-Square adapter, Fuselage loft verification, Wing/tail layout and loft, Aircraft Layout Procedure, Wetted Area Determination, Volume Determination	[4]
Unit 6: Landing Gears and Subsystems Landing Gear Arrangement, Tire Sizing, Shock absorbers, Castoring wheel geometry, Gear retraction geometry, Sea planes, Sub systems (Hydraulics, Electrical systems, Pneumatic System, Auxiliary/Emergency power, Avionics)	[4]
Text Books: 1. Donaldson B K.; "Analysis of Aircraft Structures"; Cambridge Aerospace Series; 2 nd Edition, 2008. 2. Megson, T.H.G.; "Aircraft Structures for Engineering Students"; Elsevier Ltd; 2 nd Edition 2010	
Reference Books: 1. Aircraft design – A conceptual approach. Author: D.P. Raymer 2. Aircraft conceptual design analysis. Author: Denis Howe 3.Aircraft Performance and Design Author: John D. Anderson, Jr 4.Synthesis of subsonic airplane design Author: E. Torenbeck Publisher: Delft Univ. Press 1977	