K. E. Society's

Rajarambapu Institute of Technology, Rajaramnagar

(An Empowered Autonomous Institute, Affiliated to Shivaji University, Kolhapur)

Syllabus for B.Tech. Robotics & Automation

To be Implemented for **2023-27** NEP Batch

Department of Robotics & Automation

Class: S. Y. B. Tech. (Robotics & Automation) **Semester:** III

Course Code	Course	Teaching Scheme				Evaluation Scheme				
		L	T	P	Credits	Scheme	Theory (Marks %)		Practical (Marks %)	
							Max.	Min. for Passing	Max.	Min. for Passing
RA201	Fundamentals of Robotics & Automation	3	-	-	3	ISE	20	40	----	----
						UT1	15		----	----
						UT2	15		----	---
						ESE	50	40	----	----
RA203	Engineering Mechanics	2	-	-	2	ISE	20	40	----	----
						UT1	15		----	----
						UT2	15		----	----
						ESE	50	40	----	----
RA205	Sensors and Instrumentation	3	-	2	4	ISE	20	40	----	----
						UT1	15		----	----
						UT2	15		----	----
						ESE	50	40	----	----
RA207	Analog and Digital Electronics	2	-	-	2	ISE	20	40	----	----
						UT1	15		----	----
						UT2	15		----	----
						ESE	50	40	----	----
RA209	Materials and Manufacturing Technology	3	-	-	3	ISE	20	40	----	----
						UT1	15		----	----
						UT2	15		----	----
						ESE	50	40	----	----
	Multidisciplinary Minor - I	3	-	-	3	ISE	20	40	----	----
						UT1	15		----	----
						UT2	15		----	----
						ESE	50	40	----	----
RA211	Engineering Mechanics Lab.	-	-	2	1	ISE	----	----	100	50
RA213	Analog and Digital Electronics Lab.	-	-	2	1	ISE	----	----	100	50
RA215	Object Oriented Programming Lab.	-	-	2	1	ISE	----	----	50	50
						ESE	----	----	50	50
RA217	Technical Aptitude - I	-	-	2	1	ESE	----	----	100	50
	Professional Skills Development and Foreign Languages	-	-	2	1	ISE	----	----	100	50
	TOTAL	**16**	**-**	**12**	**22**					
	TOTAL CONTACT HOURS	**28**								

ISE = In Semester Evaluation, UT-1 = Unit Test-1, UT-2 = Unit Test-2, ESE = End Semester Exam.

Total Contact Hours/week : **28**

Total Credits : **22**

Technical Aptitude Courses : Engineering Mechanics, Materials and Manufacturing Technology, Analog & Digital Electronics

Rajarambapu Institute of Technology Robotics and Automation Dept. Rajaramnagar

Professional Skills Development and Foreign Languages Courses

Sr. No.	Course Name	Course Code
1	Professional Leadership Skills	SH2634
2	Interpersonal Skills	SH2614
3	Innovation Tools and Methods for Entrepreneurs	SH2694
4	Personal Effectiveness and Body Language	SH2594
5	German Language – III	SH2734
6	Japanese Language – III	SH2714

Note:

1. A student has to complete any two courses out of six choices offered under Choice Based Professional Skills Development Programme. A course in each semester will be allocated without any repetition.
2. Foreign Language course selected in F. Y. B. Tech. Sem-I will remain the same with next levels in Sem-III & IV. (No new entries in S. Y. B. Tech. Sem-III)

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Syllabus for B.Tech. Robotics & Automation

To be Implemented for **2023-27** NEP Batch

Department of Robotics & Automation

Class: S. Y. B. Tech. (Robotics & Automation) **Semester:** IV

Course Code	Course	Teaching Scheme				Evaluation Scheme					
							Theory (Marks %)			Practical (Marks %)	
		L	T	P	Credits	Scheme	Max	Min. for Passing		Max.	Min. for Passing
RA202	Mathematics for Robotics & Automation	3	-	-	3	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15			---	---
						ESE	50	40		---	---
RA204	Strength of Materials	3	-	-	3	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15			---	---
						ESE	50	40		---	---
RA206	Control Systems	3	-	2	4	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15			---	---
						ESE	50	40		---	---
RA208	Robot Kinematics	3	-	-	3	ISE	20	40	40	---	---
						UT1	15			--	---
						UT2	15			---	---
						ESE	50	40		---	---
	Modern Indian Language	2	-	-	2	ISE	100	50		---	---
	Multidisciplinary Minor - II	3	-	-	3	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15			---	---
						ESE	50	40		---	---
RA210	Machine Drawing Lab.	-	-	4	2	ISE	---	----		100	50
						ESE					
SH2174	Environmental Science	1	-	2	2	ISE	50	40	40	---	---
						ESE	50	40		---	---
RA212	Technical Aptitude - II	-	-	2	1	ESE	---	----		100	50
	Professional Skills Development and Foreign Languages	-	-	2	1	ISE	---	---		100	50
	TOTAL	**18**	-	**12**	**24**						
	TOTAL CONTACT HOURS	**30**									

ISE = In Semester Evaluation, UT-1 = Unit Test-1, UT-2 = Unit Test-2, ESE = End Semester Exam.

Total Contact Hours/week : **30**

Total Credits : **24**

Technical Aptitude Courses : Mathematics for Robotics & Automation, Strength of Materials, Robot Kinematics

Note: Students are required to undergo industrial / field training of minimum two weeks in the vacation of Semester-IV and its evaluation will be carried out in the Semester-V.

Note: Students are required undergo scholastic aptitude training of minimum two weeks in the vacation of Semester-IV and it's evaluation will be carried out in the Semester-V as an audit course.

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Professional Skills Development and Foreign Languages Courses

Sr. No.	Course Name	Course Code
1	Professional Leadership Skills	SH2634
2	Interpersonal Skills	SH2614
3	Innovation Tools and Methods for Entrepreneurs	SH2694
4	Personal Effectiveness and Body Language	SH2594
5	German Language – IV	SH2644
6	Japanese Language – IV	SH2624

Sr. No.	Modern Indian Language: Subject Name	Course Code
1	मराठी भाषिक कौशल्यविकास	SH202
2	हिंदी कथा साहित्य एवं प्रयोजमूलक हिंदी	SH204

Class: T. Y. B. Tech. (Robotics & Automation) **Semester:** V

Course Code	Course	Teaching Scheme				Evaluation Scheme					
							Theory (Marks %)			Practical (Marks %)	
		L	T	P	Credits	Scheme	Max.	Min. for Passing		Max.	Min. for Passing
RA301	Electric Drives and Control	2	-	-	2	ISE	20	40	40	---	---
						UT1	15				
						UT2	15			---	---
						ESE	50	40		---	---
RA303	Design of Machine Elements	3	-	-	3	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15				
						ESE	50	40		---	---
	Program Elective - I	2	-	-	2	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15				
						ESE	50	40		---	---
	Open Elective - I	3	-	-	3	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15				
						ESE	50	40		---	---
	Multidisciplinary Minor - III	3	-	-	3	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15				
						ESE	50	40		---	---
RA323	Programmable Logic Controllers and SCADA	2	-	-	2	ISE	20	40	40	---	----
						UT1	15			---	---
						UT2	15				
						ESE	50	40		---	---
	Multidisciplinary Minor - IV	1	-	2#	2	ISE	---	---		50	50
						ESE	---	---		50	50
RA313	PLC & SCADA Lab.	-	-	2	1	ISE	---	---		50	50
						ESE	---	---		50	50
RA315	Advanced Manufacturing Lab.	-	-	2	1	ISE	---	---		100	50
RA317	Robotics Technology Lab I	-	-	2	1	ISE	---	---		100	50
RA319	Summer Internship	-	-	-	1	ISE	---	---		100	50
RA321	Massive Open Online Course (MOOC)	---	--	--	1	ISE	--	---		100	50
SH3035	Scholastic Aptitude- I	1	-	2	Audit	ISE	100	50 (P/NP)		---	----
	TOTAL	**17**	**-**	**10**	**22**						
	TOTAL CONTACT HOURS	**24+3***									

ISE = In Semester Evaluation, UT-1 = Unit Test-1, UT-2 = Unit Test-2, ESE = End Semester Exam.

Total Contact Hours/week : 27
Total Credits : 22

- **# End Semester Examination of Multidisciplinary Minor - IV will be based on practical oral examination only.**

- **Note: Students are required undergo scholastic aptitude training of minimum two weeks in the vacation of Semester-V and it's evaluation will be carried out in the Semester-VI as an audit course.**
- *** Contact hours of scholastic aptitude are not accounted in teaching load during semester.**

Program Elective – I:

Sr. No.	Course Code	Course
1	RA305	Industrial Design and Applied Ergonomics
2	RA307	Computer Integrated Manufacturing Systems
3	RA309	Finite Element Analysis
4	RA311	Wireless Sensors Networks for Robotics

Open Elective I			
Sr. No.	**Course Code**	**Open Elective Subject Name**	**Offered by the department**
1	OE3044	Renewable Energy Sources	Robotics & Automation
2	OE3064	Environmental Impact Assessment	Civil Engineering
3	OE3104	Network Administration	Computer Science and Engineering
4	OE3381	Disaster Management	Civil Engineering
5	OE341	Energy Audit and Management	Electrical Engineering
6	OE343	Data Science	Computer Science & Engineering (Artificial Intelligence and Machine Learning)
7	OE365	Distributed Systems	Computer Science and Information Technology
8	OE347	New Product Design & Development	Mechanical Engineering
9	OE349	Non-Conventional Energy Sources	Mechanical Engineering
10	OE351	Hydrogen & Fuel Cell Technology	Mechanical Engineering
11	OE353	Factory Automation	Mechatronics Engineering Dept.
12	OE355	Cyber Physical System	Mechatronics Engineering Dept.
13	OE357	Internet of things	Electronics & Telecommunication Engineeing
14	OE359	Drone technology	Electronics & Telecommunication Engineeing
15	OE361	Object Oriented Modeling and Design	Computer Science and Information Technology
16	OE363	Robotics Engineering & Applications	Robotics & Automation

Class: T. Y. B. Tech. (Robotics & Automation) **Semester:** VI

Course Code	Course	Teaching Scheme				Evaluation Scheme				
		L	T	P	Credits	Scheme	Theory (Marks %) Max.	Theory (Marks %) Min. for Passing		Practical (Marks %) Max.	Practical (Marks %) Min. for Passing
RA302	Microcontrollers and Embedded systems	3	-	-	3	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15				
						ESE	50	40		---	---
RA304	Research Methodology	2	-	-	2	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15				
						ESE	50	40		---	---
	Program Elective - II	3	-	-	3	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15				
						ESE	50	40		---	---
	Open Elective - II	3	-	-	3	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15				
						ESE	50	40		---	---
	Multidisciplinary Minor - V	3	-	-	3	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15				
						ESE	50	40		---	---
RA322	Industrial Engineering	3	-	-	3	ISE	20	40	40	---	----
						UT1	15			---	---
						UT2	15				
						ESE	50	40		---	---
RA314	Robotics Technology Lab II	-	-	2	1	ISE	---	---		100	50
						ESE	---	---		50	50
RA316	Programming and Simulation Lab	-	-	4	2	ISE	---	---		50	50
						ESE	---	---		50	50
RA318	Microcontrollers and Embedded Systems Lab	-	-	2	1	ISE	---	---		100	50
RA320	Capstone Project Phase - I	-	-	2	1	ISE	---	---		100	50
SH3065	Scholastic Aptitude- II	1	-	2	Audit	ISE	100	50 (P/NP)		---	----
	TOTAL	**18**	-	**12**	**22**						
	TOTAL CONTACT HOURS	**27+3***									

ISE = In Semester Evaluation, UT-1 = Unit Test-1, UT-2 = Unit Test-2, ESE = End Semester Exam.

Total Contact Hours/week : 30
Total Credits : 22

- *** Contact hours of scholastic aptitude are not accounted in teaching load during semester.**

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Program Elective – II:

Sr. No.	Course Code	Course
1	RA306	Fundamentals of Micro-Electro- Mechanical Systems (MEMS)
2	RA308	Mechatronic System Design
3	RA310	Noise and Vibration
4	RA312	Lean Manufacturing

Open Elective II			
Sr. No.	**Course Code**	**Open Elective Subject Name**	**Offered by the department**
1	OE3024	Reliability Engineering	Robotics & Automation
2	OE3084	Materials Management	Civil Engineering
3	OE3182	Industrial Drives	Electrical Engineering
4	OE3284	Supply Chain Management	Mechanical Engineering
5	OE3324	Entrepreneurship Development	Mechanical Engineering
6	OE3401	Cyber Security	Computer Science and Information Technology
7	OE342	Data Mining	CSE(AI&ML)
8	OE344	Supply Chain Analytics	Mechatronics Engineering Dept.
9	OE346	Mobile Robotics	Mechatronics Engineering Dept.
10	OE348	Information Technology Foundation Program	Computer Science and Engineering
11	OE350	Operations Research	Civil Engineering
12	OE352	Image Processing	Electronics & Telecommunication Engineering
13	OE354	Fuzzy logic and Neural Network	Electronics & Telecommunication Engineering
14	OE356	Project Management	Mechanical Engineering
15	OE358	Plumbing (Water and Sanitation)	Civil Engineering
16	OE362	Flexible Manufacturing System	Robotics & Automation
17	OE364	AI for Manufacturing	Computer Science and Information Technology
18	OE366	AI for Cybersecurity	Computer Science and Engineering
19	OE368	AI for Agriculture	CSE(AI&ML)
20	OE370	AI for Sustainability	Electronics & Telecommunication Engineering
21	OE3242	Marketing for Engineers	MBA

Class: Final Year B. Tech. (Robotics & Automation) **Semester:** VII

Course Code	Course	Teaching Scheme				Evaluation Scheme				
							Theory (Marks %)		Practical (Marks %)	
		L	T	P	Credits	Scheme	Max.	Min. for Passing	Max.	Min. for Passing
RA401	Hydraulics and Pneumatics	3	-	-	3	ISE	20	40	---	---
						MSE	30		---	---
						ESE	50	40	---	---
RA403	Industrial Automation	3	-	-	3	ISE	20	40	---	---
						MSE	30		---	---
						ESE	50	40	---	---
RA449	AI & ML for Robotics	3	-	-	3	ISE	20	40	---	---
						MSE	30		---	---
						ESE	50	40	---	---
	Program Elective – III	3	-	-	3	ISE	20	40	---	---
						MSE	30		---	---
						ESE	50	40	---	
	Program Elective - IV	3	-	-	3	ISE	20	40	---	---
						MSE	30		---	---
						ESE	50	40	---	---
	Program Elective – IV Lab.	-	-	2	1	ISE	--	---	50	50
						ESE	--	---	50	50
RA411	Robot Kinematics & Dynamics Lab.	-	-	2	1	ISE	--	---	50	50
RA433	Industrial Automation Lab.	-	-	2	1	ISE	--	---	50	50
						ESE	--	---	50	50
RA435	Hydraulics and Pneumatics Lab.	-	-	2	1	ISE	--	---	100	50
RA437	Capstone Project Phase - II			6	3	ISE	--	---	50	50
						ESE	--	---	50	50
	TOTAL	**15**	**-**	**14**	**22**					
	TOTAL CONTACT HOURS	**29**								

ISE = In Semester Evaluation, MSE = Mid Semester Exam, ESE = End Semester Exam.

Total Contact Hours/week : 29
Total Credits : 22

Program Elective – III:

Sr. No.	Course Code	Course
1	RA407	Cyber Security for Industrial Automation
2	RA409	Operations Research
3	RA411	Mobile Robotics
4	RA413	Electric & Autonomous Vehicles

Program Elective – IV:

Sr. No.	Course Code	Course
1	RA415	Industrial Internet of Things
2	RA417	Additive Manufacturing
3	RA419	Drone Technology
4	RA421	Product Lifecycle Management

Program Elective – IV Lab.:

Sr. No.	Course Code	Course
1	RA423	Industrial Internet of Things Lab
2	RA425	Additive Manufacturing Lab
3	RA427	Drone Technology Lab
4	RA429	Product Lifecycle Management Lab

Choice Based Internship Model
Model I: Industry Internship (II)

Class: Final Year B. Tech. (Robotics & Automation) **Semester:** VIII

Course Code	Course	Teaching Scheme				Evaluation Scheme					
		L	T	P	Credit	Scheme	Theory (Marks %)			Practical (Marks %)	
							Max.	Min. for Passing		Max.	Min. for Passing
OE4382	Finance for Engineers (Online Course)	2	-	-	2	ISE	25	40	40	---	---
						ESE	75	40		---	---
OE4362	Engineering Management & Economics (Online Course)	2	-	-	2	ISE	25	40	40	---	---
						ESE	75	40		---	---
IP4024	Industry Internship & Project	-	-	-	1	ISE	---	----		50	50
					2	ESE	---	---		50	50
	TOTAL	-	-	-	**16**						

ISE: In Semester Evaluation, ESE: End Semester Exam

Total Contact Hours/week : --
Total Credits : **16**

Note:
1] Weekly Contact hours are not mentioned as student is expected to be in industry regularly for 20 weeks. However, student needs to report to Institute mentors as and when required.
2] For online course, lecture videos of each unit will be made available through college platform to the students. For each unit, there will be separate assignment. Students need to submit all assignments within specified time.
Weightage: 25% weightage for unit wise assignments + 75% weightage for final exam. Final exam will be held at college campus.

Model II: Research Internship (RI)

Class: Final Year B. Tech. (Robotics & Automation) **Semester:** VIII

Course Code	Course	Teaching Scheme				Evaluation Scheme					
		L	T	P	Credit	Scheme	Theory (Marks %)			Practical (Marks %)	
							Max.	Min. for Passing		Max.	Min. for Passing
OE4382	Finance for Engineers (Online Course)	2	-	-	2	ISE	25	40	40	---	---
						ESE	75	40		---	---
OE4362	Engineering Management & Economics (Online Course)	2	-	-	2	ISE	25	40	40	---	---
						ESE	75	40		---	---
RE4044	Research Internship	-	-	-	12	ISE	---	---		50	50
						ESE	---	---		50	50
	TOTAL	-	-	-	**16**						

ISE: In Semester Evaluation, ESE: End Semester Exam

Total Contact Hours/week : --
Total Credits : 16

Note:
1] Weekly Contact hours are not mentioned as student is expected to be in outside research organization regularly for 20 weeks. However, student needs to report to Institute mentors as and when required.
2] For online course, lecture videos of each unit will be made available through college platform to the students. For each unit there will be separate assignment. Students need to submit all assignments within specified time.
3] Students who opt for a research internship need to undergo a minimum of one month of research internship in outside research organizations or laboratories.

Weightage: 25% weightage for unit wise assignments + 75% weightage for final exam. Final exam will be held at college campus.

Model III: Entrepreneurial Internship (EI)

Class: Final Year B. Tech. (Robotics & Automation) s **Semester:** VIII

Course Code	Course	Teaching Scheme			Credits	Evaluation Scheme					
		L	T	P		Scheme	Theory (Marks %)			Practical (Marks %)	
							Max.	Min. for Passing		Max.	Min. for Passing
ED4104	Project Management (Online Course)	-	-	-	2	ISE	25	40	40	-	-
						ESE	75	40		-	-
ED4044	Commercial Aspects of the Project (Online Course)	-	-	-	2	ISE	25	40	40	-	-
						ESE	75	40		-	-
ED4064	Entrepreneurship Development Program (EDP)	-	-	-	1	ISE	---	--		100	50
ED4084	Entrepreneurial Internship	-	-	-	11	ISE	--	--		50	50
						ESE	--	--		50	50
	TOTAL	-	-	-	**16**						

ISE: In Semester Evaluation, ESE: End Semester Exam

Total Contact Hours/week : -
Total Credits : 16

Note:
1] Weekly Contact hours are not mentioned as student is expected to be in outside research organization regularly for 20 weeks. However, student needs to report to Institute mentors as and when required.
2] For online course, lecture videos of each unit will be made available through college platform to the students. For each unit there will be separate assignment. Students need to submit all assignments within specified time.
3] Students who opt for an entrepreneurial internship need to undergo a minimum of one-month internship at an outside reputed organization or firm
Weightage: 25% weightage for unit wise assignments + 75% weightage for final exam. Final exam will be held at college campus.
4] A one-week Entrepreneurship Development Program (EDP) will be conducted after completion of 7th semester and before start of 8th semester.

B.Tech. in Robotics & Automation with Multidisciplinary Minor

Multidisciplinary Minor

1. Student should choose any one specialization given by the department and complete all the five courses under the specialization
2. Following are the baskets of multidisciplinary minor courses

Multidisciplinary Minor Baskets					
MDM Basket Name	**Sr. No.**	**Course Code**	**Course Name**	**Semester**	**Offered by Department**
Construction Engineering	1	CEMD201	Building Construction and Planning	III	Civil Engineering
	2	CEMD202	Building Estimation and Valuation	IV	
	3	CEMD301	Infrastructure Engineering	V	
	4	CEMD303	Smart Cities and Sustainable Development	V	
	5	CEMD302	Environmental Engineering	VI	
Software Programming	1	CSMD201	Introduction to Data Structures	III	Computer Science & Engineering
	2	CSMD202	Problem solving using JAVA	IV	
	3	CSMD301	Fundamentals of Database Systems	V	
	4	CSMD303	Object-oriented Programming in Python	V	
	5	CSMD302	Artificial Intelligence	VI	
Electrical Power System	1	EEMD201	Electrical Power Generation	III	Electrical Engineering
	2	EEMD202	Power System	IV	
	3	EEMD301	Electrical Machines	V	
	4	EEMD303	Electrical Technology	V	
	5	EEMD302	Smart Grid	VI	
Electronics System Design	1	ECMD201	Electronics Devices and Applications	III	Electronics &Telecommunication Engineering
	2	ECMD202	Electronics Communication Systems	IV	

	3	ECMD301	Advanced Communication Systems	V	
	4	ECMD303	Electronic Product Design	V	
	5	ECMD302	Industrial Electronics	VI	
Software Development	1	CIMD201	Data Structures	III	Computer Science & Information Technology
	2	CIMD202	Computer Algorithms	IV	
	3	CIMD301	Introduction to DBMS	V	
	4	CIMD303	OOP using Java	V	
	5	CIMD302	Software Engineering	VI	
Product Design and Development	1	MEMD203	Design Thinking	III	Mechanical Engineering
	2	MEMD204	Behavioral Engineering and Design	IV	
	3	MEMD305	Product Design Tools and Techniques	V	
	4	MEMD307	Design and Prototyping	V	
	5	MEMD304	Marketing and Business Fundamentals for New Products	VI	
Mechatronics Engineering	1	MCMD201	Fundamentals of Mechatronics	III	Mechatronics Engineering
	2	MCMD202	Industrial Fluid Power	IV	
	3	MCMD301	Sensor and Instrumentation	V	
	4	MCMD303	Industrial Automation	V	
	5	MCMD302	Industrial Robotics	VI	
Artificial Intelligence	1	AIMD201	Object Oriented Programming	III	Computer Science & Engineering (AI-ML)
	2	AIMD202	Data Structures and Algorithms	IV	
	3	AIMD301	Machine Learning	V	
	4	AIMD303	Business Intelligence	V	
	5	AIMD302	Principles of AI	VI	
Robotics & Automation	1	RAMD201	Fundamentals of Robotics & Automation	III	Robotics & Automation
	2	RAMD202	Sensors and Actuators	IV	

	3	RAMD301	Kinematic & Dynamics for Robots	V	
	4	RAMD303	Robot Programming	V	
	5	RAMD302	Industrial Automation & Control	VI	

B.Tech. in Robotics & Automation with Double Minor (Multidisciplinary and Specialization Minor)

Double Minor Degree

1. It is required to complete SIX courses (each of 3 credits) from ONLINE platform to earn total of 18 credits under Double Minor (DM) certification.
2. Student must complete and earn the credits for all the six courses starting from Second Year First semester (3rd semester) to Final Year Second Semester (8th semester).
3. Basket of the DM courses and respective semester is mentioned in the following table.

Sr. No.	Semester	Course	Code
1	III	DM – I	RADM3XXX
2	IV	DM – II	RADM4XXX
3	V	DM – III	RADM5XXX
4	VI	DM – IV	RADM6XXX
5	VII	DM – V	RADM7XXX
6	VIII	DM – VI	RADM8XXX

4. To select course platform, first preference must be given to NPTEL.
5. Other than NPTEL, courses from COURSERA and UDEMY platforms are allowed to register only in following cases,
    a. If timeline of NPTEL course is not in line with timeline of academic calendar.
    b. The suitable succeeding course in line with previous course is not available on NPTEL.
    c. If any other unavoidable circumstances occur.
6. Platform and course selection must be as per recommendation of BoS of the department.
7. Student will get the credits of respective DM course in following conditions,
    a. In case of course selected from NPTEL platform, student have to complete the timely assignments, PASS the exam and secure the certificate.
    b. In case of course selected from COURSERA or UDEMY, student have to secure the certificate and appear for VIVA (oral) exam.
8. While selecting online course, following points must be taken care of,
    a. Selected course must be of basic or fundamental level.
    b. Contents of the course should not be covered in any of the course offered in regular curriculum or not listed in any elective (open or program elective) or in Multidisciplinary Minor (MDM)
    c. Duration of each online course must be of EIGHT weeks for NPTEL and 30+ hours for UDEMY, COURSERA courses.

B.Tech. in Robotics & Automation with Honor and Multidisciplinary Minor

Honors with Multidisciplinary Minors

1. It is required to complete SIX courses (each of 3 credits) from ONLINE platform to earn total of 18 credits under Honor certification.
2. Student must complete and earn the credits for all the six courses starting from Second Year First semester (3rd semester) to Final Year Second Semester (8th semester).
3. Basket of the Honor courses and respective semester is mentioned in the following table.

Sr. No.	Course	Code
1	Honor - I	RAHNXXX
2	Honor - II	RAHNXXX
3	Honor - III	RAHNXXX
4	Honor - IV	RAHNXXX
5	Honor - V	RAHNXXX
6	Honor - VI	RAHNXXX

4. To select course platform, first preference must be given to NPTEL.
5. Other than NPTEL, courses from COURSERA and UDEMY platforms are allowed to register only in following cases,
    a. If timeline of NPTEL course is not in line with timeline of academic calendar.
    b. The suitable succeeding course in line with previous course is not available on NPTEL.
    c. If any other unavoidable circumstances occur.
6. Platform and course selection must be as per recommendation of BOS.
7. Student will get the credits of respective Honor course in following conditions,
    a. In case of course selected from NPTEL platform, student have to complete the timely assignments, PASS the exam and secure the certificate.
    b. In case of course selected from COURSERA or UDEMY, student have to secure the certificate and appear for VIVA (oral) exam.
8. While selecting online course, following points must be taken care of,
    a. Selected course must be of advanced level and not basic or fundamental level.
    b. Contents of the course should not be covered in any of the course offered in regular curriculum or not listed in any elective (open or program elective)
    c. Duration of each online course must be of EIGHT weeks for NPTEL and 30+ hours for COURSERA, UDEMY courses.

B. Tech. in Robotics & Automation - Honors with Research and Multidisciplinary Minor

Honors with Research and Multidisciplinary Minor

The student will work on Research Project or Dissertation for 18 Credits in the Fourth Year in respective discipline. The distribution of 18 Credits for Research project in Sem-VII and Sem-VIII is given below. To get B. Tech. in Robotics & Automation - Honors with Research and Multidisciplinary Minor degree, Student need to earn total 206 Credits which consist of 170 credits of regular Multidisciplinary Minor courses, 18 Credits of Honor courses and 18 credits of Research courses.

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

Course Code	Course	Teaching Scheme				Evaluation Scheme					
		L	T	P	Credits	Scheme	Theory (Marks %) Max.	Theory (Marks %) Min. for passing		Practical (Marks %) Max.	Practical (Marks %) Min. for passing
REH401	Intellectual Property Rights	-	-	-	2	ISE	50	40	40	---	---
						ESE	50	40		---	---
REH403	Research Project (Synopsis) Phase - I	-	-	-	2	ISE	--	--	--	50	50
						ESE	--	--		50	50
REH405	Research Specific Core Course - I (Online NPTEL course)	-	-	-	3	ISE	50	40	40	--	--
						ESE	50	40		--	--
	TOTAL	-	-	-	7						

ISE: In Semester Evaluation, ESE: End Semester Exam.

Note: For Evaluation of Online NPTEL course ISE Marks will be marks obtained by students in the assignments given by NPTEL, students who will secure NPTEL certification will be only eligible for ESE of the same course which will be conducted at institute

Class: Final Year B. Tech. **Semester:** VIII

Course Code	Course	Teaching Scheme				Evaluation Scheme					
		L	T	P	Credit	Scheme	Theory (Marks %) Max.	Theory (Marks %) Min. for passing		Practical (Marks %) Max.	Practical (Marks %) Min. for passing
REH402	Research Project Phase - II	-	-	-	11	ISE	--	--	--	50	50
						ESE	--	--		50	
	TOTAL	-	-	-	11						

ISE: In Semester Evaluation, UT-I: Unit Test-I, UT-II: Unit Test-II, ESE: End Semester Exam.

Class: - **Final Year B. Tech.**	Semester- **VII**
Course Code: **RA401**	Course Name: **Hydraulics and Pneumatics**

L	T	P	Credits
3	--	--	3

Course Description:
Hydraulic and Pneumatic Power is used as a power source in many automation applications where hydraulic and pneumatic systems are used to obtain the required force and torque. The theory course on Hydraulics and Pneumatics serves the purpose to introduce the final year undergraduate students with the fundamental concepts of Hydraulics and Pneumatics. The course helps the students to develop an ability to design hydraulic and pneumatic circuits for the given application because of an opportunity given to them to study hydraulic pumps, actuators, valves and pneumatic system components.

Course Learning Outcomes:
After successful completion of the course, students will be able to,
CO1. Explain the fundamental concepts and principles of fluid power
CO2. Identify various components of hydraulic and pneumatic systems from their symbols
CO3. Select pump, compressor and actuator for given fluid operated system.
CO4. Select appropriate control valves for given fluid operated system.
CO5. Select and draw hydraulic circuits for given application.
CO6. Select and draw pneumatic circuits for given application.

Prerequisite:
Engineering Mathematics. Fundamentals of Robotics and Automation

Course Content

Unit No	Description	Hrs
1	**Fluid Power Fundamentals and Hydraulic Pumps** Industry 4.0, Fluid Power in Automation Application, Basics of Fluid Power, Types and Properties of Hydraulic Fluids, Governing Laws, Selection of Hydraulic Fluids, Pump Classification, Fixed and Variable Displacement Pumps, Construction, Working, Applications and Selection criteria of Gear Pump, Internal Gear pump, Screw Pump, Vane Pump, Piston Pump, Selection of Hydraulic Pumps, ISO / ANSI Symbols of Hydraulic System Components	06
2	**Hydraulic Actuators** Classification of Hydraulic Actuators, Construction, Working and Applications of Linear Hydraulic Actuators, Seals in Cylinders, Calculation of Cylinder Force, Flow Velocity, Cylinder efficiency, Sizing of Cylinder Tubes, Piston Rod Design, Mounting Style of Cylinders,	06

	Construction, Working and Applications of Rotary Hydraulic Actuators, Vane Motor, Gear Motor, Piston Motor, Selection of Motor, Hydraulic Motor in Circuits, Hydraulic Actuators integrated with Electrical and Electronic Control Systems	
3	**Hydraulic Valves** Control Components in Hydraulic System, Construction, Working and Applications of Direction Control Valves, Pressure Control Valves, Flow Control Valves, , Solenoid and Pilot Operated Direction Control Valves, Compensated and Non-compensated Flow Control Valves, Electro-fluid Control Concepts, Symbolic Representation of Control Valves	**06**
4	**Hydraulic Circuits** Hydraulic Circuits and their Application in Automation, Control of Single and Double -Acting Hydraulic Cylinder, Unloading circuit, Double Pump Circuit, Counterbalance Valve application, Hydraulic Cylinder Sequencing Circuits, Cylinder Synchronizing Circuits, Meter-in circuit, Meter-out circuit and Bleed-off circuit, Speed control of Hydraulic Motors, Regenerative circuits, Selection of Hydraulic Circuits, Electro Hydraulic Circuits, Design of Hydraulic Circuits,	**06**
5	**Pneumatic System and Components** Characteristics of Pneumatic System, Applications, Characteristic of Compressed Air, Perfect Gas Laws, Compressor, Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic Actuator and Types, Pneumatic actuators integrated with electrical and electronic control systems, Use of Logic gates - OR and AND gates in Pneumatic Applications, Electro-Pneumatic System, ISO / ANSI Symbols of Pneumatic System Components	**06**
6	**Pneumatic Circuits** Pneumatic Circuits and their Applications in Automation, Direct and Indirect Control of Single Acting Cylinder, OR and NOT Gates, Direct Control of a Double Acting Cylinder, Indirect Control of Double Acting Cylinder, Selection of Pneumatic Circuits, Electro Pneumatic Circuits, Design of Pneumatic Circuits for Pick and Place Applications and Tool Handling in CNC Machine Tools, Design of Pneumatic Circuits	**06**

References -

Textbooks:

1. S.R. Majumdar, Oil Hydraulic Systems-Principles and Maintenance, Tata McGraw Hill.
2. S.R. Majumdar, Pneumatic Systems-Principles and Maintenance, Tata McGraw Hill.
3. Farel Bradbury, Hydraulic Systems and Maintenance, Butterworth & Co (Publishers) Ltd.
4. R. Srinivasan, Hydraulic and Pneumatic Controls, Vijay Nicole.
5. Anthony Esposito, Fluid Power with Applications, PHI/Pearson Education.

Reference Books:

1. Michael J. Pinches and John G. Ashby, Power Hydraulics, Prentice-Hall
2. Herbert E. Merritt, Hydraulic Control Systems, John Wiley & Sons
3. Peter J Chapple, Principles of Hydraulic System Design, 1st Edition,Coxmoor Publishing Company

Class: **Final Year B.Tech.**	Semester-**VII**
Course Code: **RA403**	Course Name: **Industrial Automation**

L	T	P	Credits
3	-	-	3

Course Description:

This course introduces the fundamentals of Industrial Automation, including automation types, manufacturing systems, transfer lines, material handling, storage systems, identification technologies, and quality control practices. It helps students understand real-world industrial systems, develop analytical and problem-solving skills, and prepare for careers in manufacturing, automation, and process industries.

Course Learning Outcomes:

After successful completion of the course, students will be able to-

CO1. Explain need, basic elements, and systems of industrial automation.
CO2. Analyse the single station cells, transfer lines, and assembly lines.
CO3. Discuss various material handling and identification technologies.
CO4. Suggest quality control and inspection techniques to improve manufacturing processes.
CO5. Discuss the case studies of industrial automation.

Prerequisite: Manufacturing Process

Course Content

Unit No.	Description	Hrs
1.	**Fundamentals of Industrial Automation** Need of automation, Types of Automation: fixed /programmable /flexible automation, Automation principles and strategies. Basic elements of automated systems: power, program and control, Advanced automation functions: Safety monitoring, Maintenance and Repair diagnostics, Error detection and recovery, Levels of automation.	06
2.	**Single Station Manufacturing Cell**	06

	Overview of manufacturing system, Single-Station Manned Cells, Single-Station Automated Cells, Enablers for Unattended Cell Operation, Parts Storage and Automatic Parts Transfer, CNC Machining Centers and Related Machine Tools, Applications of Single-Station Cells, Analysis of Single-Station Cells, Number of Workstations Required, Machine Clusters	
3.	**Transfer Lines and Automated Assembly** Fundamentals, Configurations, Transfer mechanisms, storage buffers, control, applications, Analysis of transfer lines with and without storage buffers. Assembly Automation: Types and configurations, Parts delivery at workstations.	**06**
4.	**Material handling and Identification Technologies** The material handling function, Types of Material Handling Equipment, Design of the System, Conveyor Systems, Automated Guided Vehicle Systems. Automated Storage Systems: Storage System Performance, Automated Storage/Retrieval Systems, Work-in-process Storage, Interfacing Handling and Storage with Manufacturing. Product identification system: Barcode, RFID etc.	**06**
5.	**Quality Control and Inspection in Manufacturing** Quality in Design and Manufacturing, Traditional and Modern Quality Control, Process Variability and Process Capability, Statistical Process Control, Six Sigma, Taguchi Methods in Quality Engineering, ISO 9000, The Six Sigma etc. Inspection Principles and Practices, Inspection Fundamentals, Sampling versus 100% Inspection, Automated Inspection, When and Where to Inspect, Analysis of Inspection Systems.	**06**
6.	**Case Studies of Industrial Automation** Case studies of manufacturing industries and Process industries: Automotive Assembly Line Automation, Warehouse and Material Handling Automation, Automated Bottling/Packaging System etc.	**06**

References –

Textbooks:

1. M. P. Groover, Automation, Production systems and Computer Integrated Manufacturing, Prentice-Hall.
2. M. P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, Wiley.

Reference Books:

1. Webb, John W. Programmable Logic Controllers: Principles and Application, Prentice Hall of India, New Delhi.
2. Petruzella Frank D, Programmable Logic Controllers, Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
3. Amber G.H & P.S. Amber, Anatomy of Automation, PrenticeHall.

Class: - **Final Year B. Tech.**	Semester- **VII**
Course Code: **RA449**	Course Name: **AI & ML for Robotics**

L	T	P	Credits
3			3

Course Description:
This course provides an in-depth study of Artificial Intelligence (AI) and Machine Learning (ML) with a strong focus on applications in robotics, and autonomous systems. The course bridges mathematical foundations, algorithmic development, and real-world implementation for intelligent robotic systems. The course begins with rigorous treatment of linear algebra, probability theory, optimization techniques, and statistical learning principles necessary for understanding modern AI algorithms. Advanced supervised and unsupervised learning techniques are explored in this course.
By the end of the course, students will possess theoretical understanding, computational skills, and practical experience required to develop intelligent robotic systems and AI-enabled automation solutions for advanced engineering applications.

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

CO1. Develop strong mathematical understanding of AIML algorithms.
CO2. Design intelligent decision-making systems for robotics.
CO3. Develop reinforcement learning solutions for robot.
CO4. Integrate AI techniques into robotic perception, planning, and control.
CO5. Apply machine learning algorithms to robotics problems.

Prerequisite:
Write prerequisite required to study this course. Engineering Mathematics, Fundamentals of Robotics and Automation

Course Content

Unit No	Description	Hrs
1	**Introduction to AIML and Mathematical foundation for AIML:** AI vs ML, Intelligent agents and environments. Problem-solving through Search, Tic Tac Toe game. Mathematical Foundations for AIML- Linear algebra (vectors, matrices, eigenvalues), Probability and statistics basics. Bayes theorem, Cost functions and optimization, Gradient descent algorithm	6
2	**Knowledge Representation and Reasoning:** Ontologies, foundations of knowledge representation and reasoning, representing and reasoning about objects, relations, events, actions, time, and space; predicate logic, situation calculus, description logics,	6

	reasoning with defaults, reasoning about knowledge, sample applications. Representing and Reasoning with Uncertain Applications of AI (vision/robotics etc.).	
3	**Supervised Learning** Linear and Logistic Regression (theory + derivation), Support Vector Machines (primal & dual form), Kernel methods, Decision Trees (entropy, Gini index).	6
4	**Machine Learning Classifiers:** K-NN classifier, Perceptrons, Single layer & Multi-layer, Ensemble methods (Random Forest, Gradient Boosting), Model validation (Cross-validation, ROC-AUC), Handling imbalanced datasets.	6
5	**Probabilistic Models & State Estimation** Naïve Bayes classifier, Hidden Markov Models (HMM), Gaussian Mixture Models (GMM), Kalman Filter (linear systems), Extended Kalman Filter (EKF), Particle Filters.	6
6	**AI Integration with Robotics Systems** AI with ROS architecture, AI-based motion planning, Sensor data processing using OpenCV, Natural Language Processing (NLP). Simultaneous Localization and Mapping (SLAM). AI-enabled collaborative robots, Safety and ethical AI in automation.	6

References -Textbooks:

1. Artificial Intelligence: A Modern Approach – Stuart Russell & Peter Norvig
2. Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow – Aurélien Géron

Reference Books:

1. M.C. Trivedi, Data Science and Data Analytics Using Python, Khanna Book Publishing.
2. Daphne Koller and Nir friedman, "Probabilistic Graphical Models", MIT Press, 2009.
3. Russell and P. Norvig, "Artificial Intelligence", Pearson Publication
4. Pattern Recognition and Machine Learning – Christopher Bishop
5. https://www.geeksforgeeks.org/artificial-intelligence/artificial-intelligence-in-robotics/
6. M.C. Trivedi, A Classical Approach to Artificial Intelligence, Khanna Book Publishing.
7. Russell, Stuart and Norvig, Peter, Artificial Intelligence: A Modern Approach" Prentice Hall.
8. Zhongzhi Shi, "Advanced Artificial Intelligence", World Scientific Publishing Company

Class:-**Final Year B. Tech.**	Semester- **VII**
Course Code : RA407	Course Name: **Cyber Security for Industrial Automation**

L	T	P	Credits
3			3

Course Description:
This course focuses on the protection of Industrial Automation Systems (IAS) and Operational Technology (OT) environments from cyber threats. It covers security challenges in PLCs, SCADA, DCS, HMI, and Industrial IoT (IIoT) systems used in smart factories and critical infrastructure.
Students will learn risk assessment, secure network design, industrial communication security, global security standards, and incident response strategies. The course emphasizes practical approaches to securing Industry 4.0 environments through defense-in-depth strategies and compliance with international cyber security frameworks.

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

CO1. Explain the architecture and security challenges of industrial automation systems
CO2. Analyze vulnerabilities and cyber threats affecting PLC, SCADA, and IIoT environments.
CO3. Apply appropriate network security mechanisms to protect industrial control systems.
CO4. Evaluate risks and compliance requirements using established industrial cyber security standards.
CO5. Design secure industrial automation architectures using defense-in-depth principles
CO6. Develop an incident response and recovery plan for industrial cyber-attacks.

Prerequisite:

- Basic knowledge of Industrial Automation (PLC, SCADA, DCS)
- Fundamentals of Computer Networks
- Basic understanding of Operating Systems
- Introductory knowledge of Cyber Security concepts

Course Content		
Unit No	**Description**	**Hrs**
1	**Unit I: Introduction to Cyber Security in Industrial Automation** Basics of Cyber Security concepts, IT vs OT Security differences, Industrial Automation architecture overview, PLC, SCADA, DCS, HMI systems, PERA Model, IDMZ Model for industrial automation system, Cyber threats in industrial environments, Case studies of industrial cyber-attacks	6
2	**Unit II: Industrial Control Systems (ICS) Security** Architecture of ICS (PLC, RTU, SCADA overview), key vulnerabilities in ICS, in PLCs/RTUs, industrial protocols overview (Modbus, DNP3, OPC-UA), basic secure configuration of automation devices, introduction to network segmentation in OT systems	6
3	**Unit III: Network Security for Industrial Automation** Industrial Ethernet and field networks, Firewalls, IDS/IPS in OT networks, VPN and secure remote access, Intrusion detection techniques in automation systems, Zero Trust Architecture for industrial environments	6
4	**Unit IV: Risk Assessment and Security Standards** Basics of risk management, threat identification in industrial systems, overview of cybersecurity standards (IEC 62443, ISO 27001, NIST 800-82), basic compliance concepts, simple vulnerability assessment and auditing concepts	6
5	**Unit V: Industrial IoT (IIoT) and Emerging Technologies** IIoT architecture overview, cloud and edge basics in automation, fundamentals of data security (encryption & key management), introduction to AI-based anomaly detection, key security challenges in IIoT systems	6
6	**Unit VI: Incident Response and Industrial Cyber Defence** Cyber incident lifecycle, Malware and ransomware in industrial environments, Disaster recovery and business continuity planning, Digital forensics in OT systems, Designing resilient and secure automation architectures	6

References -

Text Books:

1. **Eric D. Knapp and Joel Thomas Langill**, *Industrial Network Security: Securing Critical Infrastructure Networks for Smart Grid, SCADA, and Other Industrial Control Systems*, Syngress
2. **Tyler Wrightson**, *Advanced Persistent Threat Hacking: The Art and Science of Hacking Any Organization*, McGraw-Hill Education
3. **Robert Radvanovsky and Jacob Brodsky**, *Handbook of SCADA/Control Systems Security*, CRC Press
4. **Andrew Ginter**, *Engineering Guide to OT Security*, Waterfall Security Solutions

5. Industrial Cybersecurity: Efficiently secure critical infrastructure systems Kindle Edition by Pascal Ackerman.
6. AI-Enhanced Cybersecurity for Industrial Automation by Hari Mohan Pandey and Pawan Kumar Goel.

Reference Books:

1. Joseph Weiss, *Protecting Industrial Control Systems from Electronic Threats*, Momentum Press
2. David J. Teumim, *Industrial Cybersecurity*, Packt Publishing
3. John R. Vacca, *Cyber Security and IT Infrastructure Protection*, Syngress
4. Isaac N. F. Cheng, et al., *Security in Cyber-Physical Systems*, CRC Press
5. NIST, *Guide to Industrial Control Systems (ICS) Security*, National Institute of Standards and Technology
6. International Electrotechnical Commission (IEC), *IEC 62443 Industrial Communication Networks – Network and System Security*, IEC

Class: - **Final Year B. Tech.**	Semester-**VII**
Course Code: **RA409**	Course Name: **Operations Research**

L	T	P	Credits
3	-	-	3

Course Description:
This course introduces the fundamental concepts and techniques of Operations Research for solving engineering and industrial decision-making problems. It covers mathematical modeling, Linear Programming, transportation and network models, project management techniques (CPM & PERT), queuing theory, decision analysis, and inventory management. The course emphasizes optimization methods and their applications in planning, scheduling, resource allocation, and system analysis.

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

CO1. Explain fundamentals of Operations Research and OR models.
CO2. Formulate and solve Linear Programming Problems.
CO3. Analyze transportation models using optimization techniques.
CO4. Apply network models for project planning and scheduling.
CO5. Evaluate queuing and decision-making models.
CO6. Apply inventory management techniques for stock control.

Prerequisite: Possess basic knowledge of mathematics

Course Content

Unit No	Description	Hrs
1	**Introduction OR Foundations** Introduction to Operations Research: Definition, scope, methodology of OR; deterministic & probabilistic models. OR Modeling Framework: Structure and components of mathematical models. Phases of an OR Study: Model formulation, solution procedures, validation, implementation. Classical OR Applications: Shortest path models; assignment-type decision systems	06
2	**Linear Programming:** Linear Programming Formulation: Decision variables, constraints, objective function. Graphical Method: Feasible region, iso-profit/iso-cost concepts. Simplex Method : standard, Big-M, two-phase; sensitivity analysis.	06

3	**Transportation Models:** Balanced/unbalanced cases; IBFS: NWCR, LCM, Vogel's Approximation Method; optimal solution methods: MODI, stepping-stone.	**06**
4	**Network Models:** Shortest path, minimum spanning tree (MST), max-flow, CPM-Construction of networks, critical path, forward and backward path, floats and their significance, PERT- Time estimates, Construction of networks, probability of completing projects by given data.	**06**
5	**Queuing Theory:** Queuing System Structure: Arrival rates, service rates, queue discipline, Queuing Models: M/M/1 model (numerical solutions); M/M/c model (concept), M/M/∞, M/D/1, M/G/1 models; Decision Analysis: Game theory and decision trees	**06**
6	**Inventory Management:** Inventory Models: EOQ, deterministic inventory models, reorder point basics, Applications in General Systems: Waiting lines, stock management and replenishment; probabilistic inventory models, selective inventory control.	**06**

References -

Text Books

1. **Kanti Swarup, P. K. Gupta, Man Mohan** – *Operations Research*, Sultan Chand & Sons.
2. **Prem Kumar Gupta, D. S. Hira** – *Operations Research*, S. Chand & Company.

Reference Books:

1. **Hillier & Lieberman**, Introduction to Operations Research, 11e, McGraw-Hill, 2021
2. **R. Dan Reid, Nada R. Sanders & Sidhartha S. Padhi,** Operations Management, 8th Edition (Indian Adaptation),McGraw-Hill Education, 2024.ISBN: 9789363863262
3. **G. Srinivasan,** Operations Research: Principles and Applications, PHI Learning,
4. **Hamdy A. Taha**, Operations Research: An Introduction, 10e, Pearson, 2017
5. **J.K. Sharma**, Operations Research: Theory and Applications, 5e, Macmillan, 2017
6. **Mikell P. Groover**, Automation, Production Systems, and CIM, 5e (2024), Pearson
7. **Charles E. Ebeling**, Reliability and Maintainability Engineering, 2e, Waveland Press, 2019
8. **A.K. Gupta**, Reliability, Maintainability & Safety Engineering, 2e, 2020

Class: - **Final Year B. Tech.**	Semester- **VII**
Course Code: **RA411**	Course Name: **Mobile Robotics**

L	T	P	Credits
3	-	-	3

Course Description:
This course introduces the fundamentals and practical aspects of mobile robotic systems — including locomotion, perception, navigation, path planning, mapping, and control. Students will learn how mobile robots sense, plan, and act in real environments through theoretical understanding and applied design projects.

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

CO1. Explain foundational concepts in mobile robotics, including kinematics, sensors, and system architecture.
CO2. Analyze mobile robot motion using kinematics and localization techniques.
CO3. Design algorithms for path planning and real-time obstacle avoidance.
CO4. Implement perception, control, and autonomous navigation solutions on robotic platforms.

Prerequisite:
Robotics Fundamentals (kinematics & dynamics), Linear Algebra & Calculus, Programming (Python/C++ experience), Control Systems, Signals & System

Course Content

Unit No	Description	Hrs
1	**Introduction to Mobile Robotics** Evolution & classification of mobile robots, Wheeled, legged, aerial, underwater platforms, Applications: industrial, service, planetary, medical Robot anatomy: actuators, sensors, embedded controllers, System design trade-offs, Real-world examples & case studies	06
2	**Robot Kinematics & Locomotion** Mobile robot coordinate frames, Differential, Ackermann, omnidirectional drives, Forward/inverse kinematics for wheeled robots, Motion constraints (nonholonomic), Trajectory generation basics	06
3	**Perception & Sensors for Mobile Robots** Sensor types: encoders, IMU, LIDAR, ultrasonic, cameras, Sensor models & noise characteristics, Sensor fusion fundamentals, Feature detection (edges, corners), Introduction to computer vision for robotics, edge computation (latency, response time, throughput)	06
4	**Localization & Mapping** Global vs local localization, Complementary filters, Probabilistic localization: Bayes filter, Kalman Filter & Extended KF, Particle Filter	06

	(Monte Carlo Localization), Introduction to SLAM (Simultaneous Localization & Mapping), Mapping representations: grid maps, topological maps	
5	**Path Planning & Obstacle Avoidance** Configuration space & robot footprint, Graph search: Dijkstra, A* algorithms, Sampling-based planners: PRM, RRT, Potential fields & vector fields, Dynamic obstacle avoidance	**06**
6	**Control & Navigation Systems** Feedback & feedforward control basics, PID control for mobile robots, Model predictive control overview, Behavior-based control architecture, Hybrid navigation strategies	**06**

References -

1. Siegwart, R., Nourbakhsh, I. R., & Scaramuzza, D. Introduction to Autonomous Mobile Robots, MIT Press
2. Thrun, S., Burgard, W., & Fox, D. Probabilistic Robotics, MIT Press
3. Siciliano, B., Sciavicco, L., Villani, L., & Oriolo, G Robotics: Modelling, Planning and Control, Springer
4. Corke, P. Robotics, Vision and Control, Springer
5. Ulrich Nehmzow, Mobile Robotics: A Practical Introduction, Publisher : Springer London Ltd

Class: Class: - **Final Year B. Tech.**	Semester:
Course Code: **RA413**	Course: **Electric and Autonomous Vehicles**

L	T	P	Credits
3	-	-	3

Course Description:
This course provides a comprehensive overview of Electric Vehicles (EVs), Hybrid EVs (HEVs), and Autonomous Vehicle (AV) technologies. It covers EV fundamentals, propulsion and motor systems, battery and power electronics, charging infrastructure, vehicle integration, and safety standards. Students will also gain exposure to autonomous vehicle principles, including perception, localization, motion planning, and control strategies. Emphasis is placed on sustainable mobility, emerging technologies, and industry-relevant applications.

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

CO1: Explain EV fundamentals and fuel cell technology.
CO2: Analyze EV propulsion systems and motor characteristics.
CO3: Apply power electronics and battery management in EVs.
CO4: Evaluate EV charging technologies and infrastructure.
CO5: Analyze integration aspects of autonomous electric vehicles.
CO6: Design control strategies for autonomous vehicle systems.

Prerequisite: Automotive Systems, Electric Drives and Controls.

Course Content:

Unit No.	Description	Hrs.
1.	**EV Fundamentals with Fuel Cell Technology:** Overview and evolution of EVs and HEVs, need for electrification, environmental and energy aspects. Comparison of ICE vs EV (characteristics & performance). EV types: BEV, HEV, PHEV, FCEV. Basic EV components and performance parameters. Introduction to Fuel Cell EVs and hydrogen as fuel.	06
2.	**EV Propulsion Systems:** EV propulsion architecture and drivetrain. Traction motors: DC, BLDC, Induction, PMSM. Torque-speed and efficiency characteristics. Motor selection criteria and motor controllers.	06
3.	**EV Power Electronics with Battery Management:** Role of power electronics: converters, inverters, HV/LV systems, PWM, FOC, DTC. Battery fundamentals and electrochemistry. Types: Li-ion,	06

	Metal-Air, alternatives. Battery pack design, safety, BMS, SoC/SoH estimation, charging/discharging behavior.	
4.	**EV Charging Technologies:** Charging methods: AC, DC, onboard, fast, wireless. BaaS and battery swapping. Charging standards, grid integration, smart charging, load management, V2G. Infrastructure planning and power requirements.	**06**
5.	**Vehicle Integration for Autonomous Electric Vehicles:** EV integration challenges, vehicle dynamics, thermal management, safety standards, recycling and lifecycle. Introduction to Autonomous EVs: SAE levels, sensors (LiDAR, RADAR, cameras, ultrasonic), sensor fusion and perception basics.	**06**
6.	**Control Strategies for Autonomous Vehicle Planning Systems:** Localization (GPS/INS, SLAM), HD maps. Path and motion planning (Dijkstra, A*, RRT). Behavior planning and control (speed & steering). V2X communication (V2V, V2I, V2P). Safety standards (ISO 26262), testing, validation, and emerging trends.	**06**

TEXT BOOKS:

1. Husain, I., *Electric and Hybrid Electric Vehicles: Design Fundamentals*, CRC Press, 3rd Edition, 2021.
2. Ehsani, M., Gao, Y., Longo, S., and Ebrahimi, K., *Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design*, CRC Press, 3rd Edition, 2018.
3. Larminie, J. and Lowry, J., *Electric Vehicle Technology Explained*, John Wiley & Sons, 2nd Edition, 2012.
4. Andrea, D., *Battery Management Systems for Large Lithium-Ion Battery Packs*, Artech House, 1st Edition, 2010.
5. Maurer, M., Gerdes, J. C., Lenz, B., and Winner, H., *Autonomous Driving: Technical, Legal and Social Aspects*, Springer, 1st Edition, 2016.

REFERENCE BOOKS:

1. Dhameja, S., *Fundamentals of Electric Vehicles*, SAE International, 1st Edition.
2. Bose, B. K., *Power Electronics and Motor Drives: Advances and Trends*, Academic Press, 2nd Edition, 2020.
3. Rajamani, R., *Vehicle Dynamics and Control*, Springer, 3rd Edition, 2021.
4. Larminie, J. and Dicks, A., *Fuel Cell Systems Explained*, John Wiley & Sons, 3rd Edition, 2012.
5. Siegwart, R., Nourbakhsh, I. R., and Scaramuzza, D., *Introduction to Autonomous Mobile Robots*, MIT Press, 2nd Edition, 2011.
6. Thrun, S., Burgard, W., and Fox, D., *Probabilistic Robotics*, MIT Press, 1st Edition, 2005.
7. Navet, N. and Simonot-Lion, F., *Automotive Embedded Systems Handbook*, CRC Press, 1st Edition.

8. Garcia-Valle, R. and Lopes, J. A. P., *Electric Vehicle Integration into Modern Power Networks*, Springer, 1st Edition, 2013.
9. Noel, L., de Rubens, G. Z., Kester, J., and Sovacool, B. K., *Vehicle-to-Grid: Linking Electric Vehicles to the Smart Grid*, Springer, 1st Edition, 2019.
10. Anderson, J. M. et al., *Autonomous Vehicle Technology: A Guide for Policymakers*, RAND Corporation, 1st Edition, 2016.

Class: - **Final Year B. Tech.**	Semester- **VII**
Course Code: **RA415**	Course Name: **Industrial Internet of Things**

L	T	P	Credits
3	-	-	3

Course Description:
This course provides a comprehensive exploration of Industry 4.0 technologies and the Industrial Internet of Things (IIoT), which are revolutionizing the landscape of modern manufacturing and industrial processes. Students will delve into the fundamental principles, core technologies, and practical applications of Industry 4.0, gaining the knowledge and skills necessary to navigate the complexities of the fourth industrial revolution.

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

CO1. Explain the concept, evolution, design principles, and applications of Industry 4.0 and the Industrial Internet of Things (IIoT).
CO2. Identify and explain the core technologies of Industry 4.0, including AI, additive manufacturing, blockchain, big data analytics, cloud computing, and extended reality technologies.
CO3. Explain data analytics and cyber-physical system architecture for intelligent applications.
CO4. Explain the concept, characteristics, and operational features of a Smart Factory, including connected, optimized, transparent, proactive, and agile systems.
CO5. Analyse IIoT system architecture, industrial sensing techniques, and the role of IIoT in modern industrial processes and plants.
CO6. Evaluate the role of Cloud Computing and Fog Computing in Industry 4.0 and IIoT, including industrial cloud platforms and service-level agreements (SLAs).

Prerequisite:
Manufacturing basics, Embedded Basics

Course Content

Unit No	Description	Hrs
1	**Overview of Industry 4.0 and Industrial Internet of Things – Industry 4.0**: Definition and evaluation of Industry 4.0, Industrial Internet, Applications of Industry 4.0, IIoT – Prerequisites of IIoT, Basics of CPS, CPS and IIoT, Applications of IIoT, Industry 4.0 environment and design principles.	6
2	**Core Technologies of Industry 4.0**: Introduction to core technologies – Artificial Intelligence (AI), Additive Manufacturing (3D Printing), Blockchain Technology, Big Data Analytics, Robot Process Automation (RPA), Cloud Computing, Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR).	6

3	**Big Data & Analytics**: A brief introduction to Big Data Analytics, Introduction to 6C CPS Architecture, 6C CPS Architecture – Level 1 – Collection, 6C CPS Architecture – Level 2 – Conversion, 6C CPS Architecture – Level 3 – Cyber, 6C CPS Architecture – Level 4 – Customization, 6C CPS Architecture – Level 5 – Cognition, 6C CPS Architecture – Level 6 – Configuration.	**6**
4	**Introduction to Smart Factory**: Characteristics of a Smart Factory – Feature 1 – Connected, Feature 2 – Optimized, Feature 3 – Transparent, Feature 4 – Proactive, Feature 5 – Agile.	**6**
5	**Industrial Internet of Things – Basics**: IIoT and Industry 4.0 – IIC, Industrial Internet Systems – Design of industrial internet systems, Impact of industrial internet, Benefits of industrial internet, Industrial sensing – Traditional sensing, Contemporary sensing, Industrial Processes – Features of IIoT for industrial processes, Industrial plant – The future architecture.	**6**
6	**Cloud Computing in Industry 4.0**: Necessity of cloud computing, Cloud computing and IIoT, Industrial cloud platform providers, SLA for IIoT, Fog Computing – Fog computing for IIoT – Applications of fog and their solutions.	**6**

References - Text Books /Reference Books:

1. Introduction to Industrial Internet of Things and Industry 4.0 - Misra, Sudip | Roy, Chandana | Anandarup Mukherjee Publisher: CRC Press (Taylor & Francis Group) PublicationYear:2021 Pages:~370–398 ISBN:9780367897581

Class:- **Final Year B. Tech.**	Semester- **VII**
Course Code: **RA417**	Course Name: **Additive Manufacturing**

L	T	P	Credits
3			3

Course Description:
This course introduces the fundamentals, processes, materials, and applications of Additive Manufacturing (AM), commonly known as 3D printing. It covers design principles, process planning, robotics integration, automation in AM systems, and industrial applications. Students will gain knowledge of major AM technologies such as ASTM International classified processes including FDM, SLA, SLS, DED, and Binder Jetting.
The course emphasizes AM's role in smart manufacturing, robotic fabrication, Industry 4.0, and digital manufacturing ecosystems. Students will also explore software tools, process parameters, quality control, and emerging trends in metal additive manufacturing.

Course Learning Outcomes:
CO1. After successful completion of the course, students will be able to,
CO2. Explain the fundamentals and classification of Additive Manufacturing processes.
CO3. Compare different AM technologies based on working principles, materials, and applications.
CO4. Apply Design for Additive Manufacturing (DfAM) principles in product development.
CO5. Analyze process parameters and their influence on part quality and mechanical properties.
CO6. Evaluate the integration of robotics and automation in AM systems for industrial applications.

Prerequisite:
Write prerequisite required to study this course. CAD Modelling, Materials and Manufacturing processes.

Course Content

Unit No	Description	Hrs
1	**Introduction to Additive Manufacturing** Evolution of manufacturing: Conventional vs Additive, Rapid Prototyping to Rapid Manufacturing, AM Process Chain, Classification of AM processes (as per ASTM International **standards**), Advantages, limitations, and applications, Role of AM in Industry 4.0	6
2	**Additive Manufacturing Technologies** Photo polymerization - Stereo lithography (SLA), Digital Light Processing (DLP), Material Extrusion- Fused Deposition Modeling (FDM), Process parameters and control, Powder Bed Fusion-Selective	6

	Laser Sintering (SLS), Selective Laser Melting (SLM), Electron Beam Melting (EBM), Directed Energy Deposition (DED)-Laser Metal Deposition (LMD), Binder Jetting & Material Jetting	
3	**Design and Optimization for Additive Manufacturing** CAD for AM, STL file format and slicing, Topology optimization, Lattice structures and lightweight design, Support structures and orientation, Generative design, Case studies in robotics components	**6**
4	**Software Issues for Additive Manufacturing** STL File Format, Binary/ASCII, Calculation of Each Slice Profile. Problems with STL Files, STL Manipulation on the AM Machine, Additional Software to Assist AM. Direct Digital Manufacturing and its Future	**6**
5	**Robotics and Automation in AM** Robotic additive manufacturing systems, Multi-axis 3D printing, Integration of AM with robotic arms, Sensors and process monitoring, AI and machine learning in AM, Automation of post-processing, Cyber-physical systems in digital manufacturing	**6**
6	**Quality Control and Industrial Applications** Defects in AM parts, Non-destructive testing (NDT) methods, Surface finishing techniques, Standards and certification, Applications in aerospace, automotive, biomedical, and robotics, Sustainability and future trends	**6**

References -

Text Books:

1. Ian Gibson, David Rosen, Brent Stucker Additive Manufacturing Technologies, Springer New York
2. Andreas Gebhardt Understanding Additive Manufacturing, Hanser Publications, Cincinnati.

Reference Books:

1. Damir Godec, Joamin Gonzalez, Eujin Pei Julia, Urena Alcazar, A Guide to Additive Manufacturing, Springer

Class: - **Final Year B. Tech.**	Semester- **VII**
Course Code: **RA419**	Course Name: **Drone Technology**

L	T	P	Credits
3			3

Course Description:
This course has objective of introducing students about the accessories of drone and its functionality, to describe the students about mathematical model of quad copter drone and to discuss the implementation models of different drone-based case studies

Course Learning Outcomes:
After completion of this course students will be able to,
After completion of this course students will be able to,

- CO1. Explain the fundamentals of Unmanned Aerial Systems (UAS).
- CO2. Analyze the principles of UAV flight by applying laws of motion to understand drone operations and flight control challenges.
- CO3. Design and select appropriate UAV system components based on application requirements.
- CO4. Integrate drone avionics hardware for reliable UAV operation.
- CO5. Simulate UAV flight control models using suitable software tools.
- CO6. Design and implement autonomous UAV navigation systems.

Prerequisite:
Basic understanding of physics, sensors and actuators, Control systems and python programming is essential

Course Content

Unit No	Description	Hrs
1	**Introduction to Drones:** Unmanned Aerial Systems (UAS), Basics of drones, different types of drones, Applications of drones, Futures of drone technology, Advances in drone technology, challenges in drone technology, Safety requirements in drone, drone Regulations and standards.	**06**
2	**UAV Flight Mechanism:** Working of drone and flow pattern, Laws of Motion, Bernoulli's Principle, four forces of Flight, Movements and operations of multirotor drones, challenges in flight control of multirotor drones.	06
3	**Design of UAV/ or drone systems:** Frame Design and Materials Selection, configuration of drone, modular design Propulsion Systems (Motors, ESCs, Propellers), Flight control system, communication and data links. Payload Design in UAV, Power management in UAV.	06
4	**Avionics Hardware of drones:**	06

	Sensors in drones- pressure sensors, accelerometers, servos in drones, actuators in drones-types, integration, installation and configuration. Power supply and management system, ground control system, Autopilot design, Servos in drones, Gyroscope in drones.	
5	**Modelling, Simulation & Flight control design:** Functions and benefits of drone simulation, Dynamic quad copter system Model, flight control design, 3D visualization, testing & tuning the model, Flight operations, Applicable software for data collection, processing, and analysis	06
6	**Autonomous Navigation Systems and Testing:** GPS-Based Navigation and Waypoint Systems, Obstacle Detection and Avoidance Techniques, Path Planning Algorithms for UAVs, Indoor Navigation and Positioning Systems, Vision-Based Navigation Methods, System ground testing and system in-flight testing.	06

References -

Text Books:

1. John Baichtal, Building your own drones, a beginner 's guide to drones, UAVS, and ROVs Pearson Education,
2. Dr. Nitesh Tivari, Dr. Shekhar Yadav, Dr. V. K. Giri Fundamentals of Drone/UAV Technology, S. K. Kataria & Sons.

Reference Books:

1. R.K.Mittal , I.J.Nagrath, —Robotics and controll Tata McGraw-Hill
2. Muhammad Usman, —Quadcopter modeling and control with Matlab/Simulink implementationl LAB University of Applied Sciences,
3. Ben Rupert, —Drones (The ultimate guide) l, Create Space Independent Publishing Platform.
4. Agam Kumar Tyagi, —Matlab and Simulink for engineersl, Oxford University Press.

Class: - **Final Year B. Tech.**	Semester- **VII**
Course Code: **RA421**	Course Name: **Product Life Cycle Management**

L	T	P	Credits
3	--	--	3

Course Description:
This course provides a comprehensive understanding of Product Lifecycle Management (PLM) and its role in modern product realization and business processes. It covers the principles and benefits of PLM and Product Data Management (PDM), addressing the entire product lifecycle—from concept, design, and development to production, usage, and end-of-life management

Course Learning Outcomes:
This course enables students to

CO1. Familiarize with various strategies of PLM
CO2. Explain the concept of product design and simulation.
CO3. Develop New product development, product structure and supporting systems
CO4. Discuss in detail the concept of product data management.
CO5. Interpret the technology forecasting and product innovation and development in business processes.
CO6. Explain product building and Product Configuration.

Prerequisite:
Basic understanding of product design and engineering drawing, along with familiarity in CAD tools.

Course Content

Unit No	Description	Hrs
1	**Introduction to PLM** Introduction to PLM, Need for PLM, opportunities and benefits of PLM, different views of PLM, components of PLM, phases of PLM, PLM feasibility study. PLM Strategies, strategy elements, its identification, selection and implementation.	**06**
2	**Product Design:** Engineering design, organization and decomposition in product design, product design process, methodical evolution in product design, concurrent engineering, design for 'X' and design central development model. Strategies for recovery at end of life, recycling, human factors in product design. Modelling and simulation in product	**06**

3	**Product Development:** New Product Development, Structuring new product development, building decision support system, Estimating market opportunities for new product, new product financial control, implementing new product development, market entry decision, launching and tracking new product program. Concept of redesign of product.	**06**
4	**Product Data Management** Product Data Management (PDM) –Benefits and Terminology, PDM functions, definition and architectures of PDM systems, product data interchange, portal integration, PDM acquisition and implementation. Information authoring tools.	**06**
5	**Technology Forecasting** Technological change, methods of technology forecasting, relevance trees, morphological methods, flow diagram and combining forecast of technologies Integration of technological product innovation and product development in business processes within enterprises, methods and tools in the innovation process according to the situation	**06**
6	**Product Building and Structures:** Virtual product development tools for components, machines, and manufacturing plants: 3D CAD systems, digital mock-up, model building, model analysis, production (process) planning, and product data technology, Product structures: Variant management, product configuration, material master data, Data models, Life cycles of individual items, status of items	**06**

References -

Text Books:

1. Author-. Grieves, Michael. Product Lifecycle Management, McGraw-Hill, 2006. ISBN 0071452303.
2. Saaksvuori Antti / ImmonenAnselmie, product Life Cycle Management Springer,Dreamtech,3-540- 25731-4.

Reference Books:

1. 1. Stark, John. Product Lifecycle Management: Paradigm for 21st Century Product Realisation, Springer-Verlag, 2004. ISBN 1L852338105
2. Fabio Giudice, Guido La Rosa, Product Design for the environment-A life cycle approach, Taylor & Francis 2006.

Class: - **Final Year B. Tech.**	Semester- **VII**	**L**	**T**	**P**	**Credits**
Course Code: **RA423**	Course Name: **Industrial Internet of Things Lab**	--	--	**2**	**1**

Course Description:
This course provides a comprehensive exploration of Industry 4.0 technologies and the Industrial Internet of Things (IIoT), which are revolutionizing the landscape of modern manufacturing and industrial processes. Students will delve into the fundamental principles, core technologies, and practical applications of Industry 4.0, gaining the knowledge and skills necessary to navigate the complexities of the fourth industrial revolution.

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

CO1. Recognise the concept, evolution, design principles, and applications of Industry 4.0 and the Industrial Internet of Things (IIoT).
CO2. Identify and explain the core technologies of Industry 4.0, including AI, additive manufacturing, blockchain, big data analytics, cloud computing, and extended reality technologies.
CO3. Explain data analytics and cyber-physical system architecture for intelligent applications.
CO4. Explain the concept, characteristics, and operational features of a Smart Factory, including connected, optimized, transparent, proactive, and agile systems.
CO5. Analyze IIoT system architecture, industrial sensing techniques, and the role of IIoT in modern industrial processes and plants.
CO6. Evaluate the role of Cloud Computing and Fog Computing in Industry 4.0 and IIoT, including industrial cloud platforms and service-level agreements (SLAs).

Prerequisite:
Manufacturing basics, Embedded Basics

Practical Content:

Course Content		
Expt. No.	**Description**	**Hrs**
1	Design and fabricate a simple component using additive manufacturing (3D printing) technology and study its industrial applications.	02
2	Develop a digital twin of a simple industrial process using real-time sensor data and virtual modeling tools.	02
3	Implement a predictive maintenance approach by analyzing machine health data such as vibration or current signals.	02
4	Demonstrate smart factory concepts using a mini automation setup integrating sensors, actuators, and controllers.	02
5	Interface industrial sensors such as temperature, proximity, and pressure sensors with a microcontroller and perform real-time data acquisition.	02
6	Implement and study an industrial communication protocol (MQTT) using a publish–subscribe communication model.	02
7	Analyze cybersecurity issues, threats, and protection mechanisms in IIoT-based industrial systems through case studies.	02
8	Design a smart energy monitoring system to measure, analyze, and optimize energy consumption of industrial equipment.	02
9	Implement a fog computing architecture for IIoT applications to process data locally before sending it to the cloud.	02
10	Analyze the 6C Cyber-Physical System architecture for smart manufacturing using an industrial case study	02

Note- Perform any Ten Experiments.

References - Text Books /Reference Books:

1. Introduction to Industrial Internet of Things and Industry 4.0 - Misra, Sudip | Roy, Chandana | Anandarup Mukherjee Publisher: CRC Press (Taylor & Francis Group) PublicationYear:2021 Pages:~370–398 ISBN:9780367897581

Class: - **Final Year B. Tech.**	Semester- **VII**
Course Code: **RA425**	Course Name: **Additive Manufacturing Lab**

L	T	P	Credits
2	-	-	1

Course Description:
This laboratory course provides hands-on exposure to additive manufacturing technologies with emphasis on their applications in robotics and automation. Students will learn 3D modeling, slicing, printer calibration, process parameter optimization, material characterization, and fabrication of functional robotic components. The course focuses on design for additive manufacturing (DfAM), dimensional accuracy, mechanical performance, and integration of printed parts into robotic systems.

Course Learning Outcomes:
After successful completion of the course, students will be able to,
CO1. To explain working principles of major additive manufacturing processes.
CO2. To develop CAD models suitable for additive manufacturing.
CO3. To operate 3D printing systems.
CO4. To evaluate the influence of process parameters on part quality.
CO5. To fabricate and integrate robotic components using AM.

Prerequisite:
Solid modelling, Material testing.

Course Content

Exp No.	Description	Hrs
1	3D Printer Installation, Setup and Calibration.	2
2	Slicing and Toolpath Generation.	2
3	Design and fabricate a Robot components using CAD software and evaluate its printability.	2
4	Investigation of Effect of Process Parameters on Surface Finish .	2
5	Printing with Different Materials.	2
6	Dimensional Accuracy and Tolerance Analysis of printed components.	2
7	Mechanical Testing of Printed Specimens.	2
8	Design for Additive Manufacturing (DfAM) .	2
9	Reverse Engineering and Reproduction.	2
10	Fabrication of Robotic End-Effector / Gripper.	2
11	Mini Project: Fabrication of Robot Subsystem.	2

Note- Perform any Ten Experiments.

References -

Text Books:

1. Arunkrishnan P R, Pijush Ghosh, 3D Printing: A practical and hands-on textbook for mastering 3D printing technology, bpb publisher, India
2. Ian Gibson, David Rosen, Brent Stucker Additive Manufacturing Technologies, Springer New York
3. Andreas Gebhardt Understanding Additive Manufacturing, Hanser Publications, Cincinnati.

Reference Books:

1. Damir Godec, Joamin Gonzalez, Eujin Pei Julia, Urena Alcazar, A Guide to Additive Manufacturing, Springer

Class: - **Final Year B. Tech.**	**Semester-VII**		**L**	**T**	**P**	**Credits**
Course Code: **RA427**	Course Name: **Drone Technology A**		**-**	**-**	**2**	**1**

Course Description: This lab introduces students to the design, simulation, control, and flight operations of Unmanned Aerial Vehicles (UAVs). It includes practical training on assembly, sensor integration, flight controllers, mission planning, and computer vision applications.

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

CO1. Identify and assemble components of UAVs.
CO2. Simulate and analyze drone flight using MATLAB or similar tools.
CO3. Integrate and calibrate sensors for drone navigation.
CO4. Perform autonomous missions using mission planner software.
CO5. Apply basic computer vision techniques in drone operations.

Prerequisite: Basics of Electronics, Control Systems, and Embedded Programming

Course Content

Experiment No	Description	Hrs
3.	Study of drone types, architecture, components, and flight dynamics.	02
4.	Assembly and wiring of quadcopter using flight controller.	02
5.	Configuration and calibration of flight controller using Mission Planner/Q Ground Control.	02
6.	Simulation of quadcopter flight using MATLAB/Simulink or open-source drone simulator(liftoff).	02
7.	Tuning of PID controller for drone stability and altitude control.	02
8.	Interfacing and calibration of IMU and GPS modules, test safety protocols (return-to-home, low battery, GPS loss, battery drop).	02
9.	Manual and semi-autonomous flight tests using RC and telemetry module.	02
10.	Autonomous mission planning and execution using waypoint GPS navigation.	02
11.	Integrate and test Object detection and tracking using onboard camera and OpenCV (ultrasonic or LiDAR sensors).	02
12.	Battery health monitoring, UAV Data Analysis (altitude, velocity, GPS track) and power management during flight.	02

Note- Perform any Ten Experiments.	

References -

Textbooks:

1. Austin, R. 'Unmanned Aircraft Systems: UAVS Design, Development and Deployment,' Wiley.
2. Valavanis, K. P., & Vachtsevanos, G. J., 'Handbook of Unmanned Aerial Vehicles,' Springer.

Reference Books:

1. Pounds, P. E., & Mahony, R. E., 'Modeling and Control of Mini-Flying Machines.'
2. Quan, Q., 'Introduction to Multicopter Design and Control,' Springer.
3. Drone Build and Fly Manuals – PX4/Ardupilot Documentation.

Class: **Final. Year. B. Tech.**	Semester: **VII**
Course Code: **RA429**	Course: **Product Lifecycle Management Lab**

L	T	P	Credits
-	-	2	1

Course Description:
This laboratory course provides practical understanding of Product Lifecycle Management (PLM) through hands-on activities in product design, CAD modeling, product data management, and lifecycle planning. Students learn to apply new product development strategies, financial analysis, innovation integration, and lifecycle control from concept to end-of-life.

Course Learning Outcomes:
After the successful completion of this course, the student should be able to:
CO1. Analyze PLM architecture and lifecycle stages.
CO2. Develop product models and BOM using CAD tools.
CO3. Apply NPD and financial feasibility methods.
CO4. Implement PDM and lifecycle management processes.

Prerequisite: Engineering drawing and CAD software.

Course Content

Expt. No.	Description	Hrs.
1.	Study of PLM Architecture and Lifecycle Stage	02
2.	CAD Modelling and Simulation Revision	02
3.	Product Decomposition and Bill of Materials (BOM) Creation	02
4.	Product Data Management (PDM) Workflow Creation	02
5.	Digital Mock-Up (DMU) Creation of Product Assembly	02
6.	Engineering Change Management (ECR and ECO Processing)	02
7.	Variant Management and Product Configuration	02
8.	Sustainability and End-of-Life Analysis	02
9.	Product Cost Estimation and Target Costing	02
10.	Digital Manufacturing Planning.	02
11.	Technology forecasting using: Relevance Tree Method, Morphological Analysis, Trend Extrapolation.	02
12.	Comprehensive PLM Case Study.	02

Note- Perform any Ten Experiments.

References -

Text Books:

1. Grieves, Michael. Product Lifecycle Management, McGraw-Hill, 2006. ISBN 0071452303.
2. Saaksvuori Antti / ImmonenAnselmie, product Life Cycle Management Springer,Dreamtech,3-540- 25731-4.

Reference Books:

1. Stark, John. Product Lifecycle Management: Paradigm for 21st Century Product Realisation, Springer-Verlag, 2004. ISBN 1L852338105
2. Fabio Giudice, Guido La Rosa, Product Design for the environment-A life cycle approach, Taylor & Francis 2006.

Class: **Final Year B. Tech.**	Semester-VII
Course Code: **RA411**	Course Name: **Robot Kinematics and Dynamics Lab**

L	T	P	Credits
-	-	2	1

Course Description:
This course offers a hands-on exploration of the kinematics, dynamics, and motion analysis of industrial robotic manipulators. Utilizing simulation tools like RoboAnalyzer, students will analyze various robot configurations, operational workspaces, and joint motions. The curriculum focuses on applying Denavit–Hartenberg (DH) conventions to solve both forward and inverse kinematics for multi-DOF and SCARA systems. Additionally, students will evaluate differential motion (velocity and acceleration) using Jacobian matrices and conduct dynamic analyses to compute required joint torques, building a strong analytical foundation for advanced robotic control and trajectory planning.

Course Learning Outcomes:
CO1. Analyze the structural configurations, joint space motion, and operational workspaces of various robotic manipulators using simulation environments.
CO2. Apply Denavit–Hartenberg (DH) conventions to formulate and solve the forward kinematics of multi-DOF serial robotic manipulators.
CO3. Evaluate the inverse kinematics and differential motion (velocity and acceleration) of robotic manipulators using Jacobian matrices.
CO4. Perform dynamic analysis on robotic manipulators to compute the joint torques and forces required for specific trajectory executions.

Prerequisite: Basic electrical and electronics, Fundamentals of Robotics and Automation, Robotics Technology Lab I, Robotics Technology Lab II

Course Content

Expt. No	Description	Hrs
1.	Study of Different Robot Configurations using RoboAnalyzer	
2.	Forward Kinematics of a 2-DOF Robotic Manipulator	02
3.	Forward Kinematics of a SCARA Robot	02
4.	Inverse Kinematics of a SCARA Robot	02

5.	Denavit–Hartenberg (DH) Parameter Assignment for Robotic Manipulators	**02**
6.	Workspace Analysis of a Robotic Manipulator	**02**
7.	Joint Space Motion Simulation of an Articulated Robot	**02**
8.	Velocity Analysis of a Robotic Manipulator using Jacobian Matrix	**02**
9.	Acceleration Analysis of a Robotic Manipulator	**02**
10.	Dynamic Analysis and Joint Torque Calculation of a Robotic Manipulator	**02**
11.	Simulation and Analysis of a Cylindrical Robot using RoboAnalyzer	**02**
12.	Simulation and Analysis of Cartesian Robot using RoboAnalyzer.	**02**

Note- Perform any Ten Experiments.
*Use of real robotic hardware or emulators as optional complement to simulations.

Text Books:

1. Nicholas Odrey, Mitchell Weiss, Mikell P. Groover et al., Industrial Robotics, Second Edition, McGraw-Hill Publication.
2. Saeed B. Niku, Introduction to Robotics: Analysis, Control, Applications, Wiley Publication.

Reference Books:

1. John J. Craig, Introduction to Robotics: Mechanics and Control, Fourth Edition, Pearson Publication.
2. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, Robot Modeling and Control, Wiley Publication.
3. Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, and Giuseppe Oriolo, Robotics: Modelling, Planning and Control, Springer Publication.

Class:- **Final Year B. Tech.**	Semester- **VII**
Course Code: **RA435**	Course Name: **Hydraulics and Pneumatics Lab**

L	T	P	Credits
--	--	2	1

Course Description:
A laboratory course on 'Hydraulics and Pneumatics' offered to final year under-graduate students gives an opportunity to them to conduct physical and virtual tests. The objective is to develop an ability in them to design and analyze hydraulic and pneumatic systems. The contents of the course includes introduction to ISO symbols, performance testing of pumps, test on hydraulic trainer kit, test on pneumatic trainer kit, design of hydraulic system for industrial applications and use of simulation software for design of hydraulic and pneumatic circuits.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

CO1. Identify and interpret ISO symbols used in hydraulics and pneumatics.

CO2. Analyze performance characteristics of hydraulic pumps

CO3. Design and simulate hydraulic circuits for industrial applications.

CO4. Design and simulate pneumatic circuits for industrial applications.

CO5. Select hydraulic circuit and design hydraulic system for an industrial application.

CO6. Select pneumatic circuit and design pneumatic system for an industrial application.

Prerequisite:
Engineering Mathematics. Fundamentals of Robotics and Automation

Course Content

Experiment No.	Description	Hrs
1	Identify the components and draw ISO symbols used in hydraulic and pneumatic circuits.	02
2	Conduct test on gear pump and plot its performance characteristics	
3	Conduct test on Hydraulic trainer kit to study control of double acting cylinder	02
4	Conduct test on Hydraulic trainer kit to study speed control using Meter-In circuit	02

5	Conduct test on Pneumatic trainer kit to demonstrate use of logic functions such as AND/OR/Time Delay.	**02**
6	Conduct test on Pneumatic trainer kit to study control of single acting cylinder	**02**
7	Design of hydraulic drilling system using virtual tool such as Automation studio	**02**
8	Conduct test on pressure relief valve using virtual tool such as Automation studio	**02**
9	Design of intensifiers in hydraulic system using virtual tool such as Automation studio	**02**
10	Design of air distribution in pneumatic system using virtual tool such as Automation studio	**02**
11	Select hydraulic circuit and design hydraulic system for an industrial application	**02**
12	Select pneumatic circuit and design pneumatic system for an industrial application	**02**
13	Industrial visit report on automation in any Industry	**02**
14	Experiments on fault diagnosis or troubleshooting hydraulic/pneumatic circuits	**02**
15	Construct and actuate Electro-Pneumatic circuit / PLC controlled circuit for given application.	**02**

Note- Perform any Ten Experiments.

References -

Text Books:

1. S.R. Majumdar, Oil Hydraulic Systems-Principles and Maintenance, Tata McGraw Hill.
2. S.R. Majumdar, Pneumatic Systems-Principles and Maintenance, Tata McGraw Hill.
3. Farel Bradbury, Hydraulic Systems and Maintenance, Butterworth & Co (Publishers) Ltd.
4. R. Srinivasan, Hydraulic and Pneumatic Controls, Vijay Nicole.
5. Anthony Esposito, Fluid Power with Applications, PHI/Pearson Education.

Reference Books:

1. Michael J. Pinches and John G. Ashby, Power Hydraulics, Prentice-Hall
2. Herbert E. Merritt, Hydraulic Control Systems, John Wiley & Sons
3. Peter J Chapple, Principles of Hydraulic System Design, 1st Edition,Coxmoor Publishing Company

Class: - **Final Year B. Tech.**	Semester-**VII**
Course Code: **RA433**	Course Name: **Industrial Automation Lab.**

L	T	P	Credits
-	-	2	2

Course Description:
The Industrial Automation Laboratory focuses on hands-on training in digital twin technology, PLC/SCADA-based control systems, and DCS architecture used in modern industries. Students design, implement, and test industrial automation applications such as pneumatic actuation systems, tank level control, conveyor systems, pump automation, mixing processes, and temperature control systems. The lab emphasizes system integration, I/O configuration, monitoring, and alarm management to develop practical skills aligned with real-world industrial practices.

Course Learning Outcomes:
After successful completion of the course, students will be able to,
CO1. Develop Digital Twin models for pneumatic actuators and automated sequence control system.
CO2. Design SCADA-based industrial control applications.
CO3. Develop DCS-based industrial control systems with I/O configuration, monitoring, and alarm management.

Prerequisite: PLC programming

Course Content (Lab)

Experiment No	Description	Hrs
1.	Introduction to digital twin technology and platform	02
2.	Digital twin of single acting cylinder	02
3.	Digital twin of double acting cylinder	02
4.	Digital twin of automated sequence and process control	02
5.	Single Tank Filling and Draining Control (SCADA)	02
6.	Conveyor Belt with Object Detection and Counter (SCADA/PLC)	02
7.	Dual Pump Alternate Operation for a Sump Pit (SCADA)	02

8.	Chemical Mixing Process with Two Ingredient Tanks (SCADA)	**02**
9.	Boiler Temperature Control with High-Temp Trip (SCADA)	**02**
10.	Introduction to DCS Architecture and Components	**02**
11.	Interfacing Field Devices with DCS	**02**
12.	Analog and Digital I/O Configuration and Testing	**02**
13.	SCADA-HMI Integration with DCS	**02**
14.	Alarm Management and Event Handling	**02**
15.	Case Study	**02**

Note- Perform any Ten Experiments.

References –

Text Books:

1. M. P. Groover, Automation, Production systems and Computer Integrated Manufacturing, Prentice-Hall.
2. M. P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, Wiley.

Reference Books:

1. Webb, John W. Programmable Logic Controllers: Principles and Application, Prentice Hall of India, New Delhi.
2. Petruzella Frank D, Programmable Logic Controllers, Tata McGraw-Hill Publishing Co. Ltd., New Delhi.

Class: **Final Year B. Tech.**	Semester- **VII**
Course Code: **RA437**	Course Name: **Capstone Project Phase - II**

L	T	P	Credits
-	-	6	3

Course Description:
The capstone project is designed to encourage students to think critically, solve challenging problems, and develop skills such as oral communication, public speaking, research, media literacy, teamwork, planning, self-sufficiency, and goal setting. In most cases, the projects are also interdisciplinary, in the sense that they require students to apply skills or investigate issues across many different subject areas or domains of knowledge. Capstone projects also tend to encourage students to connect their projects to community issues or problems, and to integrate outside-of-school learning experiences. Ultimately, a capstone project represents new work and ideas and allows students to demonstrate the knowledge and skills they have gained during their college career. The students in a group of not more than FOUR will work under the guidance of the project supervisor on the project undertaken by them.
The project work may consist of,

1. To search and select an appropriate topic for the capstone project work, in view of innovations, new products, and solutions to long-standing problems.
2. A comprehensive and up-to-date survey of literature related to the study of a phenomenon or product.
3. Prepare and refine the project proposal to the point where the student should demonstrate that it is worthy of undertaking and should be completed in the time available.
4. Prepare well defined project plan with a budget linked to project activities and outcomes.
5. Apply appropriate methodology to solve critical engineering problems.
6. Design and development of equipment, components, and test setup.
7. Conduct an experiment and test the product and processes for various parameters and interpret the results obtained.
8. Write the technical report.

The objective is to prepare the students to examine any design, process, or phenomenon from all angles, to encourage the process of independent thinking and working, and to expose them to industry. Also, to provide students with an opportunity of integrating and apply knowledge from different disciplines of mechanical engineering to conduct an engineering project that is open-ended and requires team collaboration for its completion. Capstone projects can effectively consolidate and further develop generic skills in a disciplinary and interdisciplinary context

Course Learning Outcomes:
After successful completion of the course, students will be able to,
CO1. After successful completion of the course, students will be able to,

CO2. Select and apply appropriate design of experiments, experimental set up, models, or simulation technique for project task.
CO3. Fabricate project or experimental set up, or model and analyze output of models/simulations to provide information for decisions
CO4. Perform feasibility analysis and uses results to choose candidate solutions and evaluates quality of solutions to select the best one
CO5. Collaborates with team members of diverse background and perspectives to achieve a common goal.
CO6. Write technical report and communicate effectively.

Prerequisite:
1. In-depth understanding of all the subjects learned so far.
2. Two weeks in-plant training must be completed.
3. Capstone project phase I must be completed.

Course Content

Students should complete the following work during semester-VII

Design of Product or Process, Analysis, Experimentation /Fabrication, Testing, Modification, Final Report Preparation.

Course Assessment:

Projects will be evaluated using Rubrics that assess

- interim progress presented at the end of the first semester
- the design, development, and final solution assets
- the final written report
- the final oral presentation
- Interpersonal Skills Rubric

Rubrics used to assess the above are provided in Appendix C. Performance of each student should be assessed individually, together with the team's overall performance, by the supervisor, Group chairman, and committee by using the rubrics provided in the Appendices. The project committee should consist of at least four academic staff members with a project supervisor. The average scores of all supervisors for each rubric are combined using the following percentages to get a weighted average grade point.

Phase-II	
Rubric	**Weight**
Design Development & Solution Assets, Interpersonal Skills Rubric	60%
Final Written Report	20%
Final Presentation	20%

Class: **Final Year B. Tech.**	Semester- **VIII**
Course Code: **OE4382**	Course Name: **Finance for Engineers (Online Course)**

L	T	P	Credits
2	-	--	2

Course Description:
This course covers the basic concepts needed to understand the financial decision-making process. All types of organizations and also individuals develop and use financial accounting information in conducting their daily activities. Therefore, this course focuses upon financial accounting information the course introduces the basic concepts and principles of accounting for preparing or analyzing the financial statements. The course also deals with the fundamentals of financial statements, how to measure a company's financial health using financial ratios and major topics in modern finance. With a deep understanding of the financial side of the business, you will be in a better position to make informed decisions and plan for the financial future.

Course Outcomes:
After successful completion of this course, students will be able to,
CO1. Discuss the fundamental aspects of accounting and finance.
CO2. Apply rules of accounting while recording transactions.
CO3. Prepare financial statements and analyze financial position of the firm by applying various techniques.
CO4. Describe the various long term sources of finance available for the business organization

Prerequisite: Basics of Mathematics

Course Content

Unit No	Description	Hrs
1.	**Need for Financial accounting:** Definition & Meaning of Financial Accounting, Need for Accounting, Internal & External Users of Accounting Information, Accounting Principles, Accounting equation	6
2.	**Accounting Mechanics, Process and System:** Rules of Accounting, Preparation of Journal, Ledger, Subsidiary Books, Trial balance.	8
3.	**Preparation of Financial Statement:**	6

	Components of Horizontal financial statement - Trading, Profit & loss account and Balance sheet, adjustment entries.	
4.	**Analysing Health of a Firm:** Key finance terms, Techniques of Analysing Health of a Firm, Classification of Ratios – Liquidity, Leverage, Activity, Profitability	**6**
5.	**Preparation of Cash Flow Statement:** Meaning, sources and uses of cash and its usefulness, Preparation of Cash Flow Statement	**6**
6.	**Long Term Financing:** Long Term Financing: Shares, Debentures, Loan capital, foreign capital, FDI, Euro issues & external borrowings, Venture capital financing.	**4**

Reference
Books:

1. Paul Kimmel, J. Weygandt, D. Kieso, Financial Accounting, WILEY INDIA.
2. S.N. Maheshwari & S.K. Maheshwari, Problems & Solutions in Advanced Accountancy, Vikas Publishing House Pvt. Ltd., New Delhi.
3. M.C. Shukla, T.C. Grewal & S. C. Gupta, Advanced Accounts, S. Chand.
4. Financial Management, M. Y. Khan & P. K. Jain, Tata McGraw-Hill Publishing Company Limited, New Delhi.
5. Financial Management, Dr. Prasanna Chandra, Tata McGraw-Hill Publishing Company Limited.

Class:- **Final Year B.Tech.**	Semester-**VIII**
Course Code: **OE4362**	Course Name: **Engineering Management & Economics (Online Course)**

L	T	P	Credits
2	-	--	2

Course Description:
Engineering management is the application of the practice of management to the practice of engineering. Engineering Management is a specialized form of management that is required to successfully lead engineering or technical personnel and projects. This course consists of two modules i.e. Engineering Management and Engineering Economics. First module deals with managerial skillsets that are required to coach, mentor and motivate technical professionals to the practice of engineering.
Engineering economics is a fundamental skill that all successful engineering firms employ in order to retain competitive advantage and market share. Second module focuses on decision making with reference to economics.

Course Outcomes:
After successful completion of this course, students will be able to,

CO1. Develop administrative, organizational and planning skills to execute engineering project.
CO2. Develop bar chart/mile stone chart for the project.
CO3. Analyze profit/cost data and carry out economic analysis to take optimal decision.
CO4. Calculate depreciation as per various methods.

Prerequisite: Basics of Mathematics

Course Content

Unit No	Description	Hrs
1.	**Managerial skills** Theories of Management Principles of Management (by Henry Fayol), Functions of Management, Planning, Organizing, Staffing, Directing, Co- Ordination, Communication, Motivation and Controlling	04
2.	**Organizational skills** Levels of management, Organizations-elements, types and characteristics of organization, Management by Objectives (MBO)	04
3.	**Planning Tools**	04

	Methods of scientific management- Critical Path Method (CPM), Programme Evaluation & Review Techniques (PERT), Network Crashing, Bar Chart, Mile-Stone chart	
4.	**Methods of Economic Analysis** Economic equivalence, Methods of comparison of alternatives- Present Worth Method, Rate of Return method, Benefit-Cost ratio method, Net Present Value method	**04**
5.	**Make or Buy Decision** Approaches of make or buy decision-Simple cost analysis, Economic analysis, break-even analysis, Payback analysis	**04**
6.	**Depreciation** Methods of Depreciation- Straight line method, Declining balance depreciation, Sum of years digits method, sinking fund method, service output method	**04**

References –

Text Books:

1. Gilbert Daniel R, Freeman R. Edward and Stoner James A. F., Management, Pearson Education.
2. Harold Kerzner, Project Management- A system approach to planning, scheduling and controlling, John Wiley & Sons Inc.
3. Punmia B. C. and Khandelwal K. K., Project Planning, Scheduling and controlling with PERT and CPM, Laxmi Publications Pvt. Ltd.
4. Paneerselvam R., Engineering Economics, Prentice Hall India Learning Private Limited.

Reference Books:

5. Cannice Mark V, Koontz Harold and Weihrich Heinz, Management, McGraw Hill Education (I) Pvt. Ltd.
6. Blank Leland and Tarquin Anthony, Basics of Engineering Economy, Tata McGraw-Hill.
7. Mithani D. M., Managerial Economics- Theory & Applications, Himalaya Publishing House-New Delhi.

Note:- Being online course, lecture videos of each unit will be made available through college platform to the students. For each unit there will be separate assignment. Students need to submit all assignments within specified time.

Weightage: 25% weightage for unit wise assignments + 75% weightage for final exam. Final exam will be held at college campus.

Class:- **Final Year B.Tech.**	Semester-**VIII**
Course Code: **IP4024**	Course Name: **Industry Internship & Project**

L	T	P	Credits
-	-	-	**12**

Course Description:
Internship is designed to expand the depth and breadth of academic learning of students in their particular areas of study. It is an opportunity for students to receive experience in applying theories learned from the classroom to specific experiences with the community and work world. An internship can also heighten awareness of community issues, motivate students to create opportunities, embrace new ideas, and give direction to positive change. A successful internship can give valuable information in making decisions about the direction of future studies or employment. An internship is an opportunity not only to use and develop industry-related knowledge and skills, but also to enhance some of the skills that are transferable to any professional work setting. Students from Final year B.Tech are eligible to do this internship. Selected candidates by college will be permitted for internship of minimum 20 weeks in 8th semester. During this Internship, it is expected that students should identify the problems arising in the industry related to Engineering, and they have to give the solution to the company.

Course Outcomes:

I. Internship

After the successful completion of the IIP- II the student should be able to

CO1. Examine the functioning of the company on the terms of inputs, transformation process and the outputs (products and services)
CO2. Develop an attitude to adjust with the company culture, work norms, code of conduct.
CO3. Recognize and follow the safety norms, Code of conduct.
CO4. Demonstrate the ability to observe, analyse and document the details as per the industry practices.
CO5. Interpret the processes, systems and procedures and to relate to the theoretical concepts- studies.
CO6. Develop the leadership abilities, communication.
CO7. Demonstrate project management and finance sense

II. Project

After the successful completion of the project, the student should be able to;

CO1. Identify the project/problem in the domain of a program relevant for the company.
CO2. Compile the information to the pertaining to the problem identified.
CO3. Analyse the information using the statistical tools/ techniques.
CO4. develop the feasible solution for given problem.
CO5. Analyse the impact of the project on the performance of company/department.

Course Content

I. **Internship :**During Internship, Students should follow guidelines given below.

1. After joining the industry students should learn all the departments and their workings. Furthermore, student should understand how each department of industry is interlinked with one another.
2. Student should correlate the theoretical aspects learned in academics with industry practices.
3. Students should gain a knowledge of new technologies which industry follows.
4. Students should follow the professional codes and ethics.
5. Students should follow all rules and regulations of industry. Special care should be taken regarding safety.

- Work Diary:

Work Diary will be provided to each student, which contains details regarding internship, do's and don'ts and evaluation scheme. Student is required to write the Diary regularly and get it signed by the industry guide periodically. During the visit of Mentor, assigned to the student should be able to go through the Diary to access the work done and write the remarks/ instruction. At the end of internship, student should submit the duly completed diary to the department.

- Duration:

The internship duration is of one complete semester (approximately 20 weeks) between 1st January to 30th May of the respective academic year. Biometric attendance on working days is compulsory.

II. Project :

Students should select technical problems occurring within the industry as a project in consult with industry & Institute mentors.

- Evaluation

Faculty Mentor will be assigned to each student by the Institute who will monitor the progress of internship and project and help the student to sort-out any issues/ problems arising. Mentor of student from college will visit the industry as per the schedule given below.

Sr.No.	Evaluation	Period
1.	At the beginning of the program for orienting Students to the company and finalize the project	During 2nd Week
2.	Review-I (ISE-1)	During 10th week
3.	Review-II (ISE-2)	During 15th week
4.	Review-III (ESE)	During 20th week

*Review-III is end semester examination (ESE), which will be conducted at institute.
*During ESE, students should submit, Project & internship report, Work diary, Internship & project completion certificate issued by industry etc. to respective departments.

Class: - **Final Year B.Tech.**	Semester-**VIII**
Course Code: **OE4382**	Course Name: **Finance for Engineers (Online Course)**

L	**T**	**P**	**Credits**
2	**-**	**--**	**2**

Course Description:
This course covers the basic concepts needed to understand the financial decision-making process. All types of organizations and also individuals develop and use financial accounting information in conducting their daily activities. Therefore, this course focuses upon financial accounting information The course introduces the basic concepts and principles of accounting for preparing or analyzing the financial statements. The course also deals with the fundamentals of financial statements, how to measure a company's financial health using financial ratios and major topics in modern finance. With a deep understanding of the financial side of the business, you will be in a better position to make informed decisions and plan for the financial future.

Course Outcomes:
After successful completion of this course, students will be able to,
CO1. Discuss the fundamental aspects of accounting and finance.
CO2. Apply rules of accounting while recording transactions.
CO3. Prepare financial statements and analyze financial position of the firm by applying various techniques.
CO4. Describe the various long-term sources of finance available for the business organization

Prerequisite: Basics of Mathematics

Course Content

Unit No	**Description**	**Hrs**
1.	**Need for Financial accounting:** Definition & Meaning of Financial Accounting, Need for Accounting, Internal & External Users of Accounting Information, Accounting Principles, Accounting equation	**6**
2.	**Accounting Mechanics, Process and System:** Rules of Accounting, Preparation of Journal, Ledger, Subsidiary Books, Trial balance.	**8**
3.	**Preparation of Financial Statement:** Components of Horizontal financial statement - Trading, Profit & loss account and Balance sheet, adjustment entries.	**6**
4.	**Analysing Health of a Firm:**	**6**

	Key finance terms, Techniques of Analysing Health of a Firm, Classification of Ratios – Liquidity, Leverage, Activity, Profitability	
5.	**Preparation of Cash Flow Statement:** Meaning, sources and uses of cash and its usefulness, Preparation of Cash Flow Statement	**6**
6.	**Long Term Financing:** Long Term Financing: Shares, Debentures, Loan capital, foreign capital, FDI, Euro issues & external borrowings, Venture capital financing.	**4**

References –

Reference Books:

1. Paul Kimmel, J. Weygandt, D. Kieso, Financial Accounting, WILEY INDIA.
2. S.N. Maheshwari & S.K. Maheshwari, Problems & Solutions in Advanced Accountancy, Vikas Publishing House Pvt. Ltd., New Delhi.
3. M.C. Shukla, T.C. Grewal & S. C. Gupta, Advanced Accounts, S. Chand.
4. Financial Management, M. Y. Khan & P. K. Jain, Tata McGraw-Hill Publishing Company Limited, New Delhi.
5. Financial Management, Dr. Prasanna Chandra, Tata McGraw-Hill Publishing Company Limited.

Class:- **Final Year B. Tech.**	Semester-**VIII**
Course Code: **OE4362**	Course Name: **Engineering Management & Economics (Online Course)**

L	T	P	Credits
2	-	--	2

Course Description:
Engineering management is the application of the practice of management to the practice of engineering. Engineering Management is a specialized form of management that is required to successfully lead engineering or technical personnel and projects. This course consists of two modules i.e. Engineering Management and Engineering Economics. First module deals with managerial skillsets that are required to coach, mentor and motivate technical professionals to the practice of engineering.
Engineering economics is a fundamental skill that all successful engineering firms employ in order to retain competitive advantage and market share. Second module focuses on decision making with reference to economics

Course Outcomes:
After successful completion of this course, students will be able to,
CO1. Develop administrative, organizational and planning skills to execute engineering project.
CO2. Develop bar chart/mile stone chart for the project.
CO3. Analyze profit/cost data and carry out economic analysis to take optimal decision.
CO4. Calculate depreciation as per various methods.

Prerequisite: Basics of Mathematics

Course Content

Unit No	Description	Hrs
1.	**Managerial skills** Theories of Management Principles of Management (by Henry Fayol), Functions of Management, Planning, Organizing, Staffing, Directing, Co- Ordination, Communication, Motivation and Controlling	04
2.	**Organizational skills** Levels of management, Organizations-elements, types and characteristics of organization, Management by Objectives (MBO)	04
3.	**Planning Tools** Methods of scientific management- Critical Path Method (CPM), Programme Evaluation & Review Techniques (PERT), Network Crashing, Bar Chart, Mile-Stone chart	04

4.	**Methods of Economic Analysis** Economic equivalence, Methods of comparison of alternatives- Present Worth Method, Rate of Return method, Benefit-Cost ratio method, Net Present Value method	**04**
5.	**Make or Buy Decision** Approaches of make or buy decision-Simple cost analysis, Economic analysis, break-even analysis, Payback analysis	**04**
6.	**Depreciation** Methods of Depreciation- Straight line method, Declining balance depreciation, Sum of years digits method, sinking fund method, service output method	**04**

References –

Text Books:

1. Gilbert Daniel R, Freeman R. Edward and Stoner James A. F., Management, Pearson Education.
2. Harold Kerzner, Project Management- A system approach to planning, scheduling and controlling, John Wiley & Sons Inc.
3. Punmia B. C. and Khandelwal K. K., Project Planning, Scheduling and controlling with PERT and CPM, Laxmi Publications Pvt. Ltd.
4. Paneerselvam R., Engineering Economics, Prentice Hall India Learning Private Limited.

Reference Books:

1. Cannice Mark V, Koontz Harold and Weihrich Heinz, Management, McGraw Hill Education (I) Pvt. Ltd.
2. Blank Leland and Tarquin Anthony, Basics of Engineering Economy, Tata McGraw-Hill.
3. Mithani D. M., Managerial Economics- Theory & Applications, Himalaya Publishing House-New Delhi.

- Note:- Being online course, lecture videos of each unit will be made available through college platform to the students. For each unit there will be separate assignment. Sstudents need to submit all assignments within specified time.
- Weightage: 25% weightage for unit wise assignments + 75% weightage for final exam.
- Final exam will be held at college campus.

Class:- **Final Year B.Tech.**	Semester-**VIII**
Course Code : **RE4044**	Course Name: **Research Internship**

L	T	P	Credits
-	-	-	**12**

Course Description:
Research experience for undergraduates is important not only for conducting research on a topic that has an impact on a current research activity, but also as a tool to enhance undergraduate education. For the engineering technology students, research experiences allow them to carry out in-depth study of engineering concepts, while emphasizing hands-on experiences and practical applications. Participating in research projects strengthens the student's resume, and fulfills the requirements of present-day employers, who demand sound engineering skills in their employees.

Course Outcomes:
After completion of this course, the student will be able to,

CO1. Investigate the technical literature.
CO2. Recognize and evaluate theories, practices, and/or research on a chosen topic by conducting a thorough literature review and submitting a written integrative, critical summary of the current literature.
CO3. Design a research problem and develop a methodology.
CO4. Develop and implement an advanced original research or creative project.
CO5. Develop the ability to explain the conceptual viability of the project and describe the major components involved.
CO6. Develop the ability to explain how the project will impact the relevant body of work.
CO7. Develop advanced discipline-relevant skills and competencies.
CO8. Construct an accurate record of research performed.
CO9. Write a research report and paper.

Course Content

Students should carefully discuss with their research advisor about time expectations to complete the research project.
Degree to which students meet expectations: The following is a minimum set of expectations for every student enrolled for this course for credit:
i) perform a background literature search and review,
ii.) Develop a project plan,
iii.) Perform experimental work or applied experimental work,
iv.) Write and present a research report.
v) Write and submit research paper to any reputed journal/international conference.

- **To submit or publish the research paper in any reputed journal/international conference is a necessary criteria to become eligible for End semester Examination (ESE).**

Quality of the final report and oral presentation: The research advisor will provide clear

expectations of the desired format, content, and deadlines of the final report. The research advisors will grade the final report.

Attendance: In order to provide the measure of performance, the research advisor is expected to complete two mid-term evaluation with the student, accompanied by recommendations for improvement for the remainder of the term. The mid-term evaluation with the student should be accompanied by a one-on-one meeting between the research advisor and the student.

Absences and Make-up Work: Requirements for attendance are as per RR of the Institute

- **Evaluation**

Faculty guide will be assigned to each student by the Institute who will monitor the progress of research project and help the student to sort-out any issues/ problems arising. Schedule of evaluation will be as given below.

Sr.No.	Evaluation	Period
1.	Review-I (ISE-1)	During 10th week
2.	Review-II (ISE-2)	During 15th week
3.	Review-III (ESE)	During 20th week

*Review-III is end semester examination (ESE).

*During ESE, students should submit research Project report, proof of submission of research paper to reputed journal/international conference to respective departments.

*If student is doing research project in outside organization (Research Lab/ institutes), he/she should submit project completion certificate given by outside organization.

Class:- **Final Year B.Tech.**	Semester-**VIII**
Course Code : **ED4104**	Course Name : **Project Management (Online Course)**

L	T	P	Credits
-	-	--	2

Course Description:
To improve and update knowledge of new entrepreneurs in the areas of project preparation & appraisal techniques; decision-making process in the sector of industrial, infrastructure & sustainable opportunities that would lead to improved viability, returns and effective investment decisions. Writing a business plan which can gain interest of the fund providers like venture capitalists and other sources of funding.

Course Outcomes:
After successful completion of the course, students will be able to,
CO1. Prepare business Plan for selected business.
CO2. Make risk analysis & market analysis of selected project.
CO3. Make risk analysis & market analysis of selected project
CO4. Make financial appraisal of selected project.

Prerequisite: General knowledge of economics & clear concept about own business model.

Course Content

Unit No	Description	Hrs
1.	**Project appraisal Introduction**-Project Development Cycle, identifying data requirements and analyzing their suitability for preparation of feasibility studies, project formulation, screening for pre-feasibility studies, stages of feasibility report preparation, Project Analysis including Market Analysis, Technical Analysis & Financial Analysis, applying various techniques and integrating the data gathered into a full-fledged business plan.	06
2.	**Project Analysis**-Environmental Analysis, Risk Analysis, Infrastructure Development & Financing, Risk Management, Risk identification, Qualitative risk analysis, Quantitative risk analysis, Risk planning, Risk control, Evaluating the rewards & risks for sustainable opportunities. National Cost-Benefit Analysis, Financing Sustainable Opportunities.	06
3.	**Business Plan:** What is business plan, Entrepreneurial opportunities and Business Plan. Preparing business plan. (Practical Exercises on preparation of business plan) Components of Business Plan, Executive summary, other components. Project report contents.	06
4.	**Commercial Appraisal:** Economic feasibility and commercial viability, market analysis, Market Research, Industry Analysis, Competitor analysis, defining the target market, market segmentation,	06

	market positioning, building a marketing plan, market strategy.	
5.	**Technical Appraisal:** Operation and Production Plan: Types of production systems, Product design and analysis, New product development, location and layout decisions, project layout, plant and technology choices, product specification and customer needs, production planning and control, Commercializing Technologies	**06**
6.	**Financial Appraisal:** pro forma income statements, financial projections, working capital requirement, funds flow and Cash flow statements; Ratio Analysis. **Project Management Techniques**: Identifying organizational structures Estimating costs and budgeting Using critical path project management tools (WBS, Gantt chart, Project Network Diagram) Establishing the critical path Tracking project milestones Using the program evaluation and review technique (PERT tool) Using process improvement tools (Fishbone, SIPOC) Managing time Controlling quality	**06**

References - Text Books:

1. Dwivedi, A.K.: Industrial Project and Entrepreneurship Development, Vikas Publishing House

Reference Books:

1. Bangs Jr., D.H., *The Business Planning Guide,* Dearborn Publishing Co.
2. Katz, J.A. and Green, R.P., Entrepreneurial Small Business, McGraw Hill
3. Mullins, J. and Komisar R., Getting to Plan B, Harvard Business Press
4. O'Donnell, M., The Business Plan: Step by Step, UND Center for Innovation.
5. Scarborough, N.M. and Zimmerer, T.W., Effective Small Business Management, Pearson
6. Pickle, H.B.and Abrahamson, R.L., Small Business Management, Wiley
7. Desai, V., Dynamics of Entrepreneurial Development & Management, Himalaya Publishing
8. Kao, J., Creativity & Entrepreneurship, Prentice Hall
9. Singh, Narendra, Project Management & Control, Himalaya Publications

Class:- **Final Year B. Tech.**	Semester-**VIII**
Course Code : **ED4044**	Course Name : **Commercial Aspects of the Project (Online Course)**

L	T	P	Credits
-	-	-	**2**

Course Description:
To familiarize students with accounting, mechanics of preparation of financial statements, understanding corporate financial statements, their analysis and interpretation.
The objectives of the course are to build the skills, frameworks and knowledge in entrepreneurial finance. Students will study the financing of small and medium sized businesses & Financial management from the perspective of both the entrepreneur and investors.
This course will also give overall understanding of marketing management which will help them in developing their own marketing decisions & in understanding the importance of market survey techniques. It will help them in conducting suitable market survey for their own selected products.

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

CO1. Interpret basic Financial Terminologies.
CO2. Prepare & analyze financial statements.
CO3. Prepare financial Plan for venture.
CO4. Apply basic principles of marketing for various products.
CO5. Prepare market survey.
CO6. Apply knowledge of marketing management for selected business.

Prerequisite: General knowledge of economics & clear concept about own business model

Course Content

Unit No	Description	Hrs
1.	**Accounting Terminologies**: meaning, nature, functions, types of accounting; basics of financial statements, generally accepted accounting concepts, principles and conventions; double entry system. Accounting Records: Fundamentals of record keeping, the accounting process, transactional analysis, the Adjusting and Closing process. Accounting systems. Computer-based accounting systems. Accounting cycle.	06
2.	**Financial Statements**: Balance sheet: assets, liabilities. Income statement: concept of income, concept of expenses, concept of gain and losses. Components of the income statement. Other concepts of income. Cash flow statements: purpose, components, and categories. Preparation of	06

	cash flow statements: concept, activities. Accounting and pricing.	
3.	**The concept of Financial Management** – Definition, nature, objectives, functions and scope of financial management, Preparation of financial plan – its objectives, essential features, consideration in formulating financial plan, Capitalization: over, under and fair capitalization. Concept of risk and returns, Time value of money.	**06**
4.	**Nature & Scope of Marketing** - Evolution; core marketing concepts, selling concept, marketing concept, Holistic marketing concept, portfolio approach- BCG matrix. Marketing Research- Concept & practice, Steps in Marketing Research, Assessment of demand & supply, Preparation of survey questionnaire.	**06**
5.	**Marketing Environment and STP:** Demographic, economic, political, legal, socio cultural, technological environment (Indian context); environmental scanning to discover marketing opportunities, **Segmentation, Targeting and Positioning**, difference between segmentation, targeting and positioning, customer value proposition.	**06**
6.	**Marketing Mix: Product, Price, Promotion and Place.** **Product Decisions:** Concept of Product, Levels of Product, Product Mix Decisions, Product Line Decisions, Individual Product Decisions, Branding, Product Life-cycle - Stages. **Pricing Decisions:** Meaning, Factors influencing Pricing Decisions, Methods of Pricing **Place Decisions:** Meaning, Channels of Distribution **Promotion Decisions:** Elements of Promotion Mix, Advertising, Publicity, Sales Promotion, Personal Selling, Direct Marketing and Public Relations, Digital Marketing	**06**

References - Text Books:

1. Maheshwari, S.N. and Maheshwari, S.K., Financial Accounting, Vikas Publishing House
2. Leach C.J. and Melicher, R.W. Entrepreneurial Finance, Thomson.
3. For B2C = Kotler, P., Keller, K.L., Koshy, A. and Jha, M.: Marketing Management, Pearson
4. For B2B = Sarin, S. Strategic Brand Management for B2B Markets, Sage.

Reference Books:

1. Ghosh, T.P., Financial Accounting for Managers, Tax-mann Allied Services
2. Gupta, A., Financial Accounting for Management, Prentice Hall
3. Jain, S.P. and Narang, K.L., Advanced Accountancy, Kalyani Publishers.
4. Smith, J.K., Smith, R.L. and Bliss, R.T., Entrepreneurial Finance, Stanford University Press
5. Smith, J.K. and Smith, R.L., Entrepreneurial Finance, Wiley.
6. Rogers, S., Entrepreneurial Finance, McGraw Hill.
7. Chandra, P., Financial Management, McGraw Hill.
8. Kotler P. & Armstrong, G., Principles of Marketing, Pearson

Class:- **Final Year B. Tech.**	Semester-**VIII**
Course Code : **ED4064**	Course Name : **Entrepreneurship Development Program (EDP)**

L	T	P	Credits
-	-	-	1

Course Description:
Student will attend short term intensive EDP program organized either in house or by any authorized agency approved by CIIED.

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

CO1. Apply knowledge of engineering, economics, marketing and finance for formulation of business plan, starting & managing new business.

Prerequisite: General knowledge of business & clear concept about own business model.

Course Content

1. 1 Student will undergo training programs organized by CIIED.
   Programs on marketing, Finance management, project report preparation by professional agencies. Students are required to apply this knowledge for preparing final project report.
2. Student will complete online certification course- **Entrepreneurial & Employability Skill Development Program** by Singapore polytechnic in association with Jugad Funda & Shivaji University, Kolhapur or any other approved agencies.

Evaluation- ISE **50** marks by mentor for-

1. Completion of online certification course- **Entrepreneurial & Employability Skill Development Program** by Singapore polytechnic in association with Jugad Funda & Shivaji University, Kolhapur or any approved agencies.

Active participation in programs by completing various activities/assignments in program.

Class:- **Final Year B.Tech.**	Semester-**VIII**
Course Code : **ED4084**	Course Name: **Entrepreneurship Internship**

L	T	P	Credits
-	-	-	**11**

Course Description:
Students will prepare technically feasible and economically viable detailed project report including market survey.

Course Outcomes:
After successful completion of the course, students will be able to,
CO1. Apply knowledge of engineering, economics, marketing and finance for preparation of project report.
CO2. Make commercial, technical and financial appraisal of project.

Prerequisite: General knowledge of business & clear concept about own business model.

Course Content

Students will start working on collection of data required for business plan. During semester he may require to visit various support organizations, similar industries, suppliers of raw materials, machinery, special service providers. He has to conduct market survey. For this student can go out of campus with prior permission of mentor. Mentor should maintain this record. Students are required to work independently by taking guidance from mentor/Head CIIED/faculty on expert panel of CIIED.
Product prototype & execution of business operation is must & it should be validated by Departmental ED committee.

Continuous efforts taken by student should be observed by mentor for ISE evaluation. At the end of semester detailed project report will be presented before Expert committee for ISE evaluation of 100 marks.
Then student will appear for ESE. Project report evaluation &assessment will be done by a panel of experts appointed by COE.

Evaluation	Weightage	Particulars	converted Marks
ISE	10%	Preliminary project report	10
	20%	Market Survey	20
	20%	Completion of Legal Aspects	20
	50%	Final Report	50
ESE	100%	ESE -Final Report	100