Maharashtra State Board Of Technical Education, Mumbai

Learning and Assessment Scheme for Post S.S.C Diploma Courses

Programme Name	**: Diploma In Electronics & Tele-communication Engg. / Electronics & Communication Engg. / Electronics Engineering / Industrial Electronics**		
Programme Code	**: EJ / ET / EX / IE**	**With Effect From Academic Year**	**: 2023-24**
Duration Of Programme	**: 6 Semester**	**Duration**	**: 12 Weeks (Industry) + 10 Weeks (Institute)**
Semester	**: Fifth NCrF Entry Level : 4.0**	**Scheme**	**: K**

Sr No	Course Title	Abbrevation	Course Type	Course Code	Total IKS Hrs for Sem.	Learning Scheme					Credits	Assessment Scheme												
						Actual Contact Hrs./Week			Self Learning (Activity/ Assignment /Micro Project)	Notional Learning Hrs /Week		Paper Duration (hrs.)	Theory				Based on LL & TL				Based on Self Learning		Total Marks
																	Practical						
						CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
													Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
(All Compulsory)																								
1	EMBEDDED SYSTEM	ESY	DSC	315338	-	5	-	2	2	9	3	3	30	70	100	40	25	10	25#	10	25	10	175
2	MOBILE & WIRELESS COMMUNICATION	MWC	DSC	315339	-	5	-	2	2	9	3	3	30	70	100	40	25	10	25#	10	25	10	175
3	ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS	ENDS	AEC	315002	-	1	-	2	-	3	1	-	-	-	-	-	50	20	25@	10	-	-	75
4	SEMINAR AND PROJECT INITIATION COURSE	SPI	AEC	315003	-	-	-	1	2	3	1	-	-	-	-	-	25	10	25@	10	25	10	75
5	INTERNSHIP(12 WEEKS)	ITR	INP	315004	-	-	-	-	-	36 - 40	10	-	-	-	-	-	100	40	100#	40	-	-	200
other (Any - One)																								
6	ADVANCE POWER ELECTRONICS	APE	DSE	315340	-	4	-	2	-	6	2	3	30	70	100	40	25	10	25#	10	-	-	150
	IOT APPLICATIONS	IAU	DSE	315341	-	4	-	2	-	6	2	3	30	70	100	40	25	10	25#	10	-	-	150
	MICROWAVE ENGINEERING & RADAR SYSTEM	MAR	DSE	315342	-	4	-	2	-	6	2	3	30	70	100	40	25	10	25#	10	-	-	150
Total						**15**		**9**	**6**		**20**		**90**	**210**	**300**		**250**		**225**		**75**		**850**

Sr No	Course Title	Abbrevation	Course Type	Course Code	Total IKS Hrs for Sem.	Learning Scheme					Credits	Assessment Scheme										
						Actual Contact Hrs./Week			Self Learning (Activity/ Assignment /Micro Project)	Notional Learning Hrs /Week		Paper Duration (hrs.)	Theory				Based on LL & TL				Based on Self Learning		Total Marks
																	Practical						
						CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
													Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	

Abbreviations : CL- Classroom Learning , TL- Tutorial Learning, LL-Laboratory Learning, FA - Formative Assessment,SA -Summative Assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends : @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 10 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

Note: Notional learning hours for **internship represents the student engagement hours.**

Course Category : Discipline Specific Course Core (DSC) , Discipline Specific Elective (DSE) , Value Education Course (VEC) , Intern./Apprenti./Project./Community (INP) , AbilityEnhancement Course (AEC) , Skill Enhancement Course (SEC) , GenericElective (GE)

ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS **Course Code : 315002**

Programme Name/s	**: Artificial Intelligence/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Cloud Computing and Big Data/ Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Science & Engineering/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Computer Hardware & Maintenance/ Industrial Electronics/ Information Technology/ Computer Science & Information Technology/ Civil & Environmental Engineering/ Computer Science/ Electronics & Computer Engg.**
Programme Code	**: AI/ AN/ AO/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CW/ DE/ DS/ EE/ EJ/ EK/ EP/ ET/ EX/ HA/ IE/ IF/ IH/ LE/ SE/ TE**
Semester	**: Fifth**
Course Title	**: ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS**
Course Code	**: 315002**

I. RATIONALE

Entrepreneurship and Startups are introduced in this curriculum to develop the entrepreneurial traits among the students before they enter into professional life. Exposing and interacting with entrepreneurship and startup eco-system, students will develop entrepreneurial mind set. The innovative thinking with risk-taking ability along with other traits will be inculcated in the students through micro-projects and training. This exposure will be instrumental in orienting the students in transforming them to become job generators after completion of Diploma in Engineering.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Develop project proposals for launching small scale enterprises and starts up.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Identify one's entrepreneurial traits.
- CO2 - Use information collected from stakeholder for establishing/setting up/founding starts up
- CO3 - Use support systems available for Starts up
- CO4 - Prepare project plans to manage the enterprise effectively

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
315002	ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS	ENDS	AEC	1	-	2	-	3	1	-	-	-	-	-	50	20	25@	10	-	-	75

Total IKS Hrs for Sem. : Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 10 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Compare advantages and disadvantages of Entrepreneurship TLO 1.2 Identify entrepreneurial traits through self-analysis TLO 1.3 Compare risk associated with different type of enterprise	**Unit - I Introduction to Entrepreneurship Development** 1.1 Entrepreneurship as a career – charms, advantages, disadvantages , scope- local and global 1.2 Traits of successful entrepreneur: consistency, creativity, initiative, independent decision making, assertiveness, persuasion, persistence, information seeking, handling business communication, commitment to work contract, calculated risk taking, learning from failure 1.3 Types of enterprises and their features : manufacturing, service and trading	Presentations Lecture Using Chalk-Board
2	TLO 2.1 Explain Important factors essential for selection of product/service and selection of process TLO 2.2 Suggest suitable place for setting up the specified enterprise on the basis of given data/circumstances with justification. TLO 2.3 Suggest steps for the selection process of an enterprise for the specified product or service with justification. TLO 2.4 Plan a market study /survey for the specified enterprise	**Unit - II Startup Selection Process** 2.1 Product/Service selection: Process, core competence, product/service life cycle, new product/ service development process, mortality curve, creativity and innovation in product/ service modification / development 2.2 Process selection: Technology life cycle, forms and cost of transformation, factors affecting process selection, location for an industry, material handling. 2.3 Market study procedures: questionnaire design, sampling, market survey, data analysis 2.4 Getting information from concerned stakeholders such as Maharashtra Centre for Entrepreneurship Development[MCED], National Institute for Micro, Small and Medium Enterprises [NI-MSME], Prime Minister Employment Generation Program [PMEGP], Directorate of Industries[DI], Khadi Village Instries Commission[KVIC]	Presentations Lecture Using Chalk-Board

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Explain categorization of MSME on the basis of turnover and investment TLO 3.2 Describe support system provided by central and state government agencies TLO 3.3 State various schemes of government agencies for promotion of entrepreneurship TLO 3.4 Describe help provided by the non governmental agencies for the specified product/service TLO 3.5 Compute breakeven point, ROI and ROS for the specified business enterprise, stating the assumptions made	**Unit - III Support System for Startup** 3.1 Categorization of MSME, ancillary industries 3.2 Support systems- government agencies: MCED, NI MSME, PMEGP,DI, KVIC 3.3 Support agencies for entrepreneurship guidance, training, registration, technical consultation, technology transfer and quality control, marketing and finance. 3.4 Breakeven point, return on investment (ROI) and return on sales (ROS).	Presentations Lecture Using Chalk-Board
4	TLO 4.1 Explain key elements for the given business plan with respect to their purpose/size TLO 4.2 Justify USP of the given product/ service from marketing point of view. TLO 4.3 Formulate business policy for the given product/service. TLO 4.4 Choose relevant negotiation techniques for the given product/ service with justification TLO 4.5 Identify risks that you may encounter for the given type of business/enterprise with justification. TLO 4.6 Describe role of the incubation centre and accelerators for the given product/service.	**Unit - IV Managing Enterprise** 4.1 Techno commercial Feasibility study, feasibility report preparation and evaluation criteria 4.2 Ownership, Capital, Budgeting, Matching entrepreneur with the project 4.3 Unique Selling Proposition [U.S.P.]: Identification, developing a marketing plan. 4.4 Preparing strategies of handling business: policy making, negotiation and bargaining techniques 4.5 Risk Management: Planning for calculated risk taking, initiation with low cost projects, integrated futuristic planning, definition of startup cycle, ecosystem , angel investors, venture capitalist 4.6 Incubation centers and accelerators : Role and procedure	Presentations Lecture Using Chalk-Board

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Collect information of successful entrepreneurial traits	1	*Preparation of report on entrepreneurship as	2	CO1
LLO 2.1 Identify different traits as an entrepreneur from various field LLO 2.2 Suggest different traits from identified problem	2	Case study on ‘Traits of Entrepreneur’	2	CO1

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 3.1 Explore probable risks for identified enterprise.	3	*Case study on 'Risks associated with enterprise	2	CO1
LLO 4.1 Identify new product for development LLO 4.2 Prepare a newly developed product	4	*Preparation of report on 'Development of new Product	2	CO1 CO2
LLO 5.1 Identify Process for development of product for new startup	5	Preparation of Report on ' Process selection 'for new startup	2	CO1 CO2 CO3
LLO 6.1 Develop questioner for market survey	6	*Market survey for setting up new Start up	2	CO2 CO3
LLO 7.1 Interpret the use of Technology Life Cycle	7	A Case study on ' Technology life cycle' of any successful entrepreneur.	2	CO3
LLO 8.1 Use information related to support of startups from Government and non-government agencies' LLO 8.2 Prepare report for setting up startup	8	*Preparation of report on 'Information for setting up new startup' from MCED/MSME/KVIC etc	2	CO3 CO4
LLO 9.1 Compute ROI of successful enterprise.	9	Case study on 'Return on Investment (ROI)'of any successful startup	2	CO3
LLO 10.1 Calculate of ROS of any successful enterprise	10	Case study on 'Return on sales (ROS)'of any successful startup	2	CO3
LLO 11.1 Calculate Brake even point of any enterprise	11	Preparation of report on 'Brake even point calculation' of any enterprise.	2	CO3 CO4
LLO 12.1 Prepare feasibility report of given business	12	*Preparation of report on 'feasibility of any Techno-commercial business"	2	CO4
LLO 13.1 Plan a USP of any enterprise.	13	*A case study based on 'Unique selling Proposition (USP) of any successful enterprise	2	CO4
LLO 14.1 Prepare a project report using facilities of Atal Incubation center.	14	*Prepare project report for starting new startup using 'Atal incubation center (AIC)	2	CO1 CO2 CO3 CO4

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Prepare a 'Pitch- desk' for your start up
- Prepare a business plan for a. Market research b. Advertisement agency c. Placement Agency d. Repair and Maintenance agency e. Tour and Travel agency
- Prepare a 'Social entrepreneurship business plan, plan for CSR funding.
- Prepare a ' Women entrepreneurship business plan ' Choose relevant government scheme for the product/service

- Prepare a business plan for identified projects by using entrepreneurial eco system for the same (Schemes, incentives, incubators etc.)

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Computers with internet and printer facility	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Introduction to Entrepreneurship Development	CO1	4	0	0	0	0
2	II	Startup Selection Process	CO2	2	0	0	0	0
3	III	Support System for Startup	CO3	2	0	0	0	0
4	IV	Managing Enterprise	CO4	2	0	0	0	0
Grand Total				**10**	**0**	**0**	**0**	**0**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Assessment during practicals

Summative Assessment (Assessment of Learning)

- End of term examination

XI. SUGGESTED COS - POS MATRIX FORM

ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS **Course Code : 315002**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	2	2	-	-	3	2			
CO2	2	2	2	2	-	3	2			
CO3	2	2	2	2	-	3	2			
CO4	2	2	2	2	-	3	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Dr. Nishith Dubey, Aditya Vyas , Annu Soman , Anupam Singh	Un- boxing Entrepreneurship your self help guide to setup a successful business	Indira Publishing House ISBN 2023,978-93-93577-70-2
2	Gujral, Raman	Reading Material of Entrepreneurship Awareness Camp	Entrepreneurship Development Institute of India (EDI), GOI, 2016 Ahmedabad
3	Chitale, A K	Product Design and Manufacturing	PHI Learning, New Delhi, 2014; ISBN: 9788120348738
4	Charantimath, Poornima	Entrepreneurship Development Small Business Entrepreneurship	Pearson Education India, New Delhi; ISBN: 9788131762264
5	Khanka, S.S.	Entrepreneurship and Small Business Management	S.Chand and Sons, New Delhi, ISBN: 978-93-5161-094-6

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	http://www.mced.nic.in/allproduct.aspx	MCED Product and Plan Details
2	http://niesbud.nic.in/Publication.html	The National Institute for Entrepreneurship and Small Business Development Publications
3	http://niesbud.nic.in/docs/1standardized.pdf	Courses : The National Institute for Entrepreneurship and Small Business Development
4	https://www.nabard.org/Tenders.aspx?cid=501andid=24	NABARD - Information Centre
5	http://www.startupindia.gov.in/pdffile.php?title=Startup%20India%20Action%20Planandtype=Actionandq=Action%20Plan.pdfandc ontent_type=Actionandsubmenupoint=action	Start Up India
6	http://www.ediindia.org/institute.html	About - Entrepreneurship Development Institute of India (EDII)
7	http://www.nstedb.com/training/training.htm	NSTEDB - Training

ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS **Course Code : 315002**

Sr.No	Link / Portal	Description

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

MSBTE Approval Dt. 24/02/2025 **Semester - 5, K Scheme**

Programme Name/s	**: Automobile Engineering./ Artificial Intelligence/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Cloud Computing and Big Data/ Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Science & Engineering/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/ Electrical Power System/ Electronics & Communication Engg. Electronics Engineering/ Computer Hardware & Maintenance/ Industrial Electronics/ Information Technology/ Computer Scie & Information Technology/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Production Engineering Computer Science/ Electronics & Computer Engg.**
Programme Code	**: AE/ AI/ AN/ AO/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CW/ DE/ DS/ EE/ EJ/ EK/ EP/ ET/ EX/ HA/ IE/ IF/ IH/ LE/ ME/ MK/ PG/ SE/ TE**
Semester	**: Fifth**
Course Title	**: SEMINAR AND PROJECT INITIATION COURSE**
Course Code	**: 315003**

I. RATIONALE

Most of the diploma graduates lack the confidence and fluency while presenting papers or interacting verbally and expressing themselv with a large gathering. Seminar presentation boosts the confidence of the students and prepares them precisely for facing the audienc interviews and group discussions. The course on seminar is to enhance student's ability in the art of academic writing and to present it. also helps broaden the minds of the participants. Through this course on Seminar, students will develop new ideas and perspectives of t subject /themes of emerging technologies and services of their area of studies. Project initiation enhances project planning skill whi establishes measurable objectives and interaction skills.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences: Present a seminar on the selected theme/area of study effectively and confidently to the specific audience and stakeholders. Plan innovative solutions independently or collaboratively to the identified problem statement.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Identify topics of seminar presenting to the large gathering at the institute/conference.
- CO2 - Collect relevant and updated research-based data and information to prepare a paper of seminar presentation.
- CO3 - Apply presentation skills.
- CO4 - Create conducive environment for learning and discussion through seminar presentation.
- CO5 - Identify a problem statement and establish the action plan for the successful completion of the project.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Mark
															Practical							
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA			
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min		
315003	SEMINAR AND PROJECT INITIATION COURSE	SPI	AEC	-	-	1	2	3	1	-	-	-	-	-	25	10	25@	10	25	10	75	

V. General guidelines for SEMINAR and Project Initiation

- The seminar must be related to emerging trends in engineering / technology programme or may be inter/ multi-disciplinary, based on industry expected outcomes of the programme.
- The individual students have different aptitudes and strengths. Therefore, SEMINAR should match the strengths of students. For this purpose, students shall be asked to select the TITLE (Theme)of SEMINAR they would like to prepare and present.
- Seminar titles are to be finalized in consultation with the faculty mentor.

- Seminar must involve logic development of applications of various technologies/ processes applicable in industry.
- Seminar must be assigned to the single student. However, support of other students may be sorted while presenting the seminar
- Students are required to prepare using relevant software tools, write ups for presentation
- Students shall submit One Hard copy and one Soft copy each of the presentation and may be encouraged to keep a recorded copy of t presentation made during the seminar.
- Batch of 3-4 students shall be formed for project initiation.
- Projects give a platform for the students to showcase an attitude of inquiry to identify the problem statement related to the programm Students shall Identify the information suggesting the cause of the problem and possible solutions
- Students shall study and assess the feasibility of different solutions and the financial implications.
- Students should collect relevant data from different sources (books/internet/market/suppliers/experts through surveys/interviews).
- Students shall prepare required drawings/ designs and detailed plan for the successful execution of the work.
- Students may visit the organisation pertaining to the problem statement as part of initial study.

VI.Guidelines for Seminar preparation and presentation :

Once the title/topic of a seminar has been finalized and allotted to the student, the teacher's role is important as guide, mentor and motivator, to promote learning and sustain the interest of the students.

Following should be kept in mind while preparing and presenting the seminar:

- **Seminar Orientation cum -briefing**: the seminar topics/themes should be innovative, novel and relevant to the curriculum of the programme, and also aligned to the expectations of industry.
- **Seminar Literature surve**y: Information search and data collection: the information and data should be authentic, realistic and relev to the curriculum of the programme.
- **Seminar Preparation, and presentation**: The seminar shall be present with suitable software tools and supporting handout/notes. T presentation of seminar should not be more than 20 minutes including Q-A session.

The following guidelines may be followed for Project Initiation

- **Establishing project scope:** Determine the boundaries of the project.
- **Defining project objectives:** Set clear and measurable objectives that align with the project's purpose.
- **Stakeholder identification and analysis:** Perform an exercise in identifying all stakeholders involved in the project and analyzing th needs and expectations.
- **Team Formation:** Carefully build a team with the necessary skills and expertise to execute the project successfully.
- **Documentation.** Create a project planner showcasing the action plan, define the project's scope, outline the project definition, and design of the project. The document has to be made available to all stakeholders

VII. Criteria of Assessment /Evaluation of Seminar

A. Formative Assessment (FA) criteria

The assessment of the students in the fifth semester Progressive Assessment (PA) for 50 marks is to be done based on following crite

A. Suggestive RUBRICS for assessment

Sr. No.	Criteria	Marks
1	Selection Topic/Theme of seminar	05
2	Literature review and data presentation	05
3	Quality of Preparation and innovativeness	05
4	Q-A handling	05
5	Time Management	05
6	Seminar Presentation report	10

Rubrics for assessment of Project Initiation

Sr. No.	Criteria	Marks
1	Selection of Theme of Problem Statement and its innovativeness	05
2	Stages of development of Action plan	05
3	Prototyping	05

The total marks as per above out of 50, shall be converted in proportion of 25 marks.

B. Summative Assessment criteria/

The summative assessment of the students in the fifth semester End-Semester-Examination (ESE) for 50 marks is to be done based on following criteria.
This assessment shall be done by the Faculty.

Suggestive **RUBRICS** may be developed by the faculty

Sr. No.	Criteria	Marks
1	Quality of information/Knowledge presented in SEMINAR	10
2	Creativity, Innovation in SEMINAR presentation	10
3	Response to the question during seminar presentation	10
4	Establishment of Innovative Problem Statement and its presentation	10
5	Objectives of the project and action plan	10

The total obtained marks shall be converted in proportion of 25 marks.

VIII. Suggestive CO-PO Mapping

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/ Development of Solutions	**PO-4** Engineering Tools	**PO-5** Engineering Practices for Society, Sustainability and Environment	**PO-6** Project Management	**PO-7** Life Long Learning	**PSO-1**	**PSO**
CO-1	3	1	0	-	2	2	3		
CO-2	2		2	-	2	1	3		
CO-3	3	1	1	2	1	2	3		
CO-4	2	0	0	2	1	2	3		
CO-5	3	3	3	2	2	3	3		

VIII.Typographical instructions/guidelines for seminar preparation & presentation

- The seminar PPT shall be computer typed (English- British)
- Text Font -Times New Roman (TNR), Size-12 point
- Subsection heading TNR- 12 point bold normal
- Section heading TNR- 12 capital bold
- Chapter Name/ Topic Name – TNR- 14 Capital
- All text should be justified. (Settings in the Paragraph)
- Different colors text/diagrams /tables may used
- The name of the candidate, diploma (department), year of submission,name of the institute shall be printed on the first slide of PPT.

IX.Seminar and Project Initiation Report
On completion and presentation of Seminar, every student will submit a brief report which should contain the following:

- Cover Page (as per annexure 1)
- Title page (as per annexure 2)
- Certificate by the Guide (as per annexure 3)
- Acknowledgment (The candidate may thank all those who helped in the execution of the project).
- Abstract of Paper presented in the seminar (It should be in one page and include the purpose of the seminar & methodology if a .)
- Index

- List of Figures
- Introduction
- Literature Review
- Information/Chapters related to Seminar topic
- Advantages and Disadvantages
- Conclusion
- Project Initiation : a) Description of problem statement. b) Scope and objectives. c) State holder d) Platform/ Equipment/ Resou identification.
- Bibliography
- References

NOTE: Seminar report must contain only relevant – technology or platform or OS or tools used and shall not exceed 25-30 pages.

Details of Softcopy to be submitted:
The soft copy of seminar presentation is required to be provided on the back cover of the seminar report in clear packet, which shoul include the following folders and contents:

1.Presentation (should include a PPT about project in not more than 15 slides)
2.Documentation (should include a word file of the project report)

NOTE: Soft copy must be checked for any harmful viruses before submission.

X. Sample Formats

1) Cover Page - Annexure-I

2) Index - Annexure-II

3) Assessment - Annexure-III

Annexure - I

MSBTE LOGO

SEMINAR Report

Institute Logo

"SEMINAR Title_ _ _ _ _ _ _ _ _ _ _ _ _"

as a partial fulfilment of requirement of the

THIRD YEAR DIPLOMA IN

Submitted by

Name of Student **Enrollment Number**

FOR THE ACADEMIC YEAR 20___20___

(H.O.D) **(Principal)**

(Internal Guide) **(External Examiner)**

Annexure - II

Institute Name

(An Affiliated Institute of Maharashtra State Board of Technical Education)

Table of Contents

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***Students can add/remove/edit chapter names as per the discussion with their guide**

Annexure - III

Format for SEMINAR and PROJECT INITIATION Assessment /Evaluation

Formative Assessment

CRITERIA AND WEIGHTAGE

Enrollment No	**1** Selection Topic/Theme of seminar (5)	**2** Literature review and data presentation (5)	**3**. Quality of Preparation and innovativeness (5)	**4** Q-A handling (5)	**5** Time Management (5)	6. Seminar Presentation report (10)	**7** Selection of Theme of Problem Statement and its innovativeness (5)	**8** Stages of development of Action plan (5)	**9.** Prototyping (5)	**10.** Total (50)	Sc to (

SummativeAssessment

CRITERIA AND WEIGHTAGE

Enrollment No	**1.** Quality of information/Knowledge presented in SEMINAR **10**	**2** Creativity, Innovation in SEMINAR presentation 10	**3**. Response to the question during seminar presentation 10	**4** Establishment of Innovative Problem Statement and its presentation 10	**5** Objectives of the project and action plan 10	Total **(50)**	Scaled to **(25)**

Sign: **Name: ----------** **(Course Expert/s)**	**Sign:** **Name: ----------** **(Program Head)** **(Information Technology)**

Programme Name/s	**: Automobile Engineering./ Artificial Intelligence/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Cloud Computing and Big Data/ Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Science & Engineering/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Computer Hardware & Maintenance/ Industrial Electronics/ Information Technology/ Computer Science & Information Technology/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Production Engineering/ Computer Science/ Electronics & Computer Engg.**
Programme Code	**: AE/ AI/ AN/ AO/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CW/ DE/ DS/ EE/ EJ/ EK/ EP/ ET/ EX/ HA/ IE/ IF/ IH/ LE/ ME/ MK/ PG/ SE/ TE**
Semester	**: Fifth**
Course Title	**: INTERNSHIP(12 WEEKS)**
Course Code	**: 315004**

I. RATIONALE

Globalization has prompted organizations to encourage skilled and innovative workforce. Internships are educational and career development opportunities, providing practical/ hands-on experience in a field or discipline. Summer internship is an opportunity for students to get accustomed to modern industry practices, apply the knowledge and skills they've acquired in the classroom to real-world situations and become familiar with industry environments before they enter the professional world. Keeping this in mind, industrial training is incorporated to all diploma programmes as it enables the student to get equipped with practical skills, soft skills and life skills

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences: Apply skills and practices to industrial processes.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Observe time/resource management and industrial safety aspects.
- CO2 - Acquire professional experience of industry environment .
- CO3 - Establish effective communication in working environment.
- CO4 - Prepare report of assigned activities and accomplishments.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
315004	INTERNSHIP(12 WEEKS)	ITR	INP	-	-	-	-	36 - 40	10	-	-	-	-	-	100	40	100#	40	-	-	200

Legends: # External Assessment

Note: Credits for Industrial Training are in-line of guidelines of NCrF : The industrial training is of 12 weeks considering 36-40 hours per week engagement of students (as per Guidlines of GR of Maharashtra Govt.) under Self Learning with guidance of industry supervisor / Mentor

V General guidelines for organizing Industrial training

The Industry/organization selected for Industrial training/ internships shall be Government/Public Limited/ Private limited / Startup /Centre of Excellence/Skill Centers/Skill Parks etc.

1. Duration of Training - 12 weeks students engagement time
2. Period of Time slot - Between 4th and 5th semester (12 weeks) i.e. commencement of internships will be immediately following the 4th semester exams.
3. Industry area - Engineering Programme Allied industries of large, medium or small-scale, Organization/Govt./ Semi Govt Sectors.

VI Role(s) of Department at the Institute:

Following activities are expected to be performed by the concerned department at the Polytechnics.

Table of activities to be completed for Internship

S.No	Activity	Suggested Schedule WEEKS
1	Collection of information about industry available and ready for extending training with its offered capacity of students (**Sample Format 1**)	1st to 3rd week of 4th Semester
2	Allocations of Student and Mentor as per availability (Mentor: Student Ratio (1:15)	4th to 6th week of 4th semester
3	Communication with Industry and obtaining its confirmation Sample letter Format	6th to 8th week of 4th semester
4	Securing consent letter from parents/guardians of students (Sample Format 2)	Before 10th week of 4th semester
5	Enrollment of Students for industrial training (Format 3)	Before 12th week of 4rd semester
6	Issue of letter to industry for training along with details of students and mentor (Format 4)	Before 14th week of 4th Semester

7	Organize Internship Orientation session for students	Before end of 4th Semester
8	Progressive Assessment of industry training by Mentor	Each week during training period
9	Assessment of training by institutional mentor and Industry mentor	5th Semester ESE

Suggestions-

1. Department can take help of alumina or parents of students having contact in different industries for securing placement.
2. Students would normally be placed as per their choices, in case of more demand for a particular industry, students would be allocated considering their potentials. However preference for placement would be given to students who have arranged placement in company with the help of their parents or relatives.
3. Principal/HOD/Faculty should address students about industrial safety norms, rules and discipline to be maintained in the industry during training before relieving students for training.
4. The faculty members during the visit to industry or sometimes through online mode will check the progress of the student in the training, student attendance, discipline, and project report preparation each week.

VII Roles and Responsibilities of students:

1. Students may interact with the mentor to suggest choices for suitable industry, if any. If students have any contact in industry through their parents or relatives then the same may be utilized for securing placement for themselves and their peers.
2. Students have to fill the forms/formats duly signed by institutional authorities along with a training letter and submit it to a training officer/mentor in the industry on the first day of training.
3. Students must carry with him/her Identity card issued by the institute during the training period.
4. Students should follow industrial dressing protocols, if any. In absence of specific protocol students must wear college uniform compulsorily.
5. Students will have to get all necessary information from the training officer/mentor at industry regarding schedule of training, rules and regulation of the industry and safety norms to be followed. Students are expected to observe these rules, regulations and procedures.
6. Students must be fully aware that if they disobey any rule of industry or do not follow the discipline then non-disciplinary action will be taken .
7. Students must maintain a weekly diary (**Format 6**) by noting daily activities undertaken and get it duly signed from industry mentor or Industrial training in charge.
8. In case students face any major problems in industry such as an accident or any disciplinary issue then they should immediately report the same to the mentor at the institute.

9. Prepare a final report about the training for submitting to the department at the time of presentation and viva-voce and get it signed from a mentor as well as industry training in charge.

10. Students must submit the undertaking as provided in **Format 5**.

VIII Typographical guidelines for Industry Training report

Following is the suggestive format for preparing the training report. Actual report may differ slightly depending upon the nature of industry. The training report may contain the following

1. The training report shall be computer typed (English- British) and printed on A4 size paper.

2. Text Font -Times New Roman (TNR), Size-12 point

3. Subsection heading TNR- 12 point bold normal

4. Section heading TNR- 12 capital bold

5. Chapter Name/ Topic Name – TNR- 14 Capital

6. All text should be justified. (Settings in the Paragraph)

7. The report must be typed on one side only with double space with a margin 3.5 cm on the left, 2.5 cm on the top, and 1.25 cm on the right and at bottom.

8. The training report must be hardbound/ Spiralbound with a cover page in black color. The name of the candidate, diploma (department), year of submission, name of the institute shall be printed on the cover.

9. The training report, the title page should be given first then the Certificate followed by the acknowledgment and then contents with page numbers.

IX Suggestive format of industrial training report

Following format may be used for training report. Actual format may differ slightly depending upon the nature of Industry/ Organization.

- Title Page
- Certificate
- Abstract
- Acknowledgement
- Content Page

Chapter 1	Organization structure of Industry and general layout.
Chapter 2	Introduction to Industry / Organization (history, type of products and services, turn over and number of employees etc.)
Chapter 3	Types of Major Equipments/raw materials/ instruments/machines/ hardware/software used in industry with their specifications, approximate cost, specific use and routine maintenance done
Chapter 4	Processes/ Manufacturing Manufacturing techniques and methodologies and material handling procedures
Chapter 5	Testing of Hardware/Software/ Raw materials/ Major material handling product (lifts, cranes, slings, pulleys, jacks, conveyor belts etc.) and material handling procedures.
Chapter 6	Safety procedures followed and safety gears used by industry.

Chapter 7	Particulars of Practical Experiences in Industry/Organization if any in Production/Assembly/Testing/Maintenance
Chapter 8	Detailed report of the tasks undertaken (during the training).
Chapter 9	Special/challenging experiences encountered during training if any (may include students liking & disliking of workplaces).
Chapter 10	Conclusion
Chapter 11	References / sources of information

X Suggested learning strategies during training at Industry

- Students should visit the website of the industry where they are undergoing training to collect information about products, processes, capacity, number of employees, turnover etc.
- They should also refer to the handbook of the major machines and operations, testing, quality control and testing manuals.
- Students may also visit websites related to other industries wherein similar products are being manufactured.

XI Tentative week wise schedule of Industry Training

Industrial training is a common course to all Diploma programmes , therefore the industry selection will depend upon the nature of the programme and its related industry. The training activity may vary according to nature and size of industry.

The following table details of activities to be completed during industrial training.

Details of Activities to be completed during Industry training
Introduction of Industry and departments.
Study of Layout of Industry, Specifications of Machines , raw materials, components available in the industry
Study of setup and manufacturing processes
Execute given project or work assigned to the students, study of safety and maintenance procedures
Validation from industry mentor regarding project or work allocated
Report writing

XII CO-PO Mapping Table to be created by respective Department/faculty.

XIII. Formative Assessment of training : Suggested RUBRIC

(Note : Allot the marks in proportion of presentations and outcome observed. Marks excluding component of week 11 are to be filled by Institute mentor)

Week No	**Task to be assessed**	**Outcome Achievement - Poor**	**Outcome Achievement - Moderate**	**Outcome Achievement - High**		**Week-wise total Marks**
		Poor Marks	Average Marks	Good Marks	Excellent Marks	

1	Introduction of Industry	Minimal Knowledge of Departments, processes, products and work culture of the company **(Marks –1)**	Moderate Knowledge of Departments, processes, products and work culture of the company **(Marks –2)**	Good Knowledge of Departments, processes, products and work culture of the company **(Marks –3/4)**	Extensive Knowledge of Departments, processes, products and work culture of the company **(Marks –5)**	
2	Presentation of Layout of Industry, Specifications of Machines, raw materials, components available in the industry	Minimal w.r.t. tasks **(Marks –1)**	Moderate w.r.t. tasks **(Marks –2)**	Good w.r.t. tasks **(Marks –3/4)**	Extensive w.r.t. tasks **(Marks –5)**	
3	Participation in setup and manufacturing processes/platforms	Minimal Participation with poor understanding **(Marks –1-8)**	Moderate Participation with poor understanding **(Marks –9-12)**	Good Participation with poor understanding **(Marks –13-17)**	Extensive Participation with poor understanding **(Marks –18-20)**	
4 to 10	Execution of given project or work to the students, Follow of safety and maintenance procedures	Minimal Participation with poor understanding **(Marks –1-8)**	Moderate Participation with lower level understanding **(Marks – 9-12)**	Good Participation with Good understanding **(Marks – 13-17)**	Extensive Participation with excellent understanding **(Marks – 18-20)**	
11	Validation by industry mentor regarding project or work allocated	Minimal Participation with poor performance **(Marks –1-10)**	Moderate Participation with acceptable performance **(Marks – 11-15)**	Good Participation with Good performance **(Marks – 16-20)**	Extensive Participation with excellent performance **(Marks – 21-25)**	
12	Diary writing	• Results are not Presented properly, • Project work is summarized and concluded not acceptable • Future extensions are not specified **(Marks –1-10)**	• Results are Presented just casually • Project work is summarized and concluded casually • Future extensions are casually specified **(Marks –11-15)**	• Results are Presented well and properly, • Project work is summarized and concluded to a Good level • Future extensions are well specified **(Marks –16-20)**	• Results are Presented exhaustively • Project work is summarized and elaborated in excellent manner , concluded • Future extensions are excellently specified **(Marks –21-25)**	

Total Out of :100	

Marks for (FA) are to be awarded for each week considering the level of completeness of activity observed as per table specified in Sr.No. XIII above, from the daily diary maintained . Feedback from industry supervisor shall also be considered.

XIV Summative Assessment (SA) of training:

Academic year : 20 -20

i) Suggested RUBRIC for SA

	Observations from Orals				**Presentations**				**Total (100)**
Enrollment Number	Tasks undertaken (20)	Overall Understanding (20)	Creativity /Innovation demonstrated (10)	Knowledge acquired (10)	Speech Clarity (10)	Body Language (10)	Presentations (10)	Diary , Report writing and / Product (10)	

Name of mentor:
Signature of Mentor

XV FORMATS

Format-1: Collecting Information about Industry/Organization available for training along with capacity

1) Name of the industry/organization:
2) Address/communication details with email :
3) Contact person details:
   a) Name:
   b) Designation:
   c) Email
   d) Contact number/s:

4) Type:

   Govt / PSU / Pvt /

   Large scale / Medium scale / Small scale …..

5) Products/services offered by industry:

6) a) Whether willing to offer Industrial training facility during May/ June for Diploma in Engineering students: **Yes / No.**
   b) If yes, whether you offer 12 weeks training: **Yes/No**
   c) Possible Industrial Capacity:

Students	Programme name/ Title					Total
	Civil	Mechanical	Chemical			
Male						
Female						
Total						

7) Whether accommodation available for interns **Yes / No.**
If yes capacity:_____

8) Whether internship is charged or free:
If charged please specify amount per candidate: _____

Signature of responsible person at Industry:

Format-2: Obtaining Consent Letter from parents/guardians

(Undertaking from Parents)

To,

The Principal,
_____,

Subject: Consent for Industrial Training.
Sir/Madam,

I am fully aware that -

i) My ward studying in _____ semester at your _____ institute has to undergo 12 weeks of Industrial training for partial fulfillment towards completion of Diploma in _____ Engineering.

ii) For this fulfillment he/she has been deputed at_____ industry, located at _____ for Industrial training /internship for the period from _____ to _____ .

With respect to above I give my full consent for my ward to travel to and from the mentioned industry. Further I undertake that –

a) My ward will undergo the training at his/her own cost and risk during training and/or stay.
b) My ward will be entirely under the discipline of the organization where he/she will be placed and will abide by the rules and regulations in face of the said organization.
c) My ward is NOT entitled to any leave during the training period.
d) My ward will regularly submit a prescribed weekly diary, duly filled and countersigned by the training supervisor of the organization to the mentor faculty of the polytechnic.

I have explained the contents of the letter to my ward, who has also promised to adhere strictly to the requirements. I assure that my ward will be properly instructed to take his own care to avoid any accidents/injuries in the industry. In case of any accident neither industry nor the institute will be held responsible.

Signature :
Name : _____
Address : _____

Phone Number :

Format-3: Students Enrollment for Industrial Training

(Academic Year –)

Sr No	Enrollment Number	Name of Student	Name of Industry	Name of Mentor at Institute

Format-4: Issue Letter to the Industry/Organization for the training along with details of students and mentors

To,

The HR Manager,

_____

Subject: Placement for Industrial training of ___ weeks in your organization….

Reference: Your consent letter no: ….

Sir,

With reference to the above we are honored to place the following students from this institute for Industrial training in your esteemed organization as per the arrangement arrived at.

The purpose of this training is to equip the student with some essential skills relevant to the demands of the industry and world of work, as well as to provide exposure to the professional environment and work culture. It is hoped that this training may enhance his/her employability and livelihood opportunities. In view of the above, we kindly request your support in facilitating this Industrial Training for the student. He/she has been adequately oriented and guided on the expectations of this training, including the maintenance of a daily diary during the training period. Additionally, the institute has secured the necessary consent and undertaking from the parent/guardian regarding the guidelines for exit training. In view of all the above industry shall refrain from involving students into the mundane and housekeeping activities. Your cooperation in this regard will be highly appreciated.

Diploma programme in _____ Engg.

Sr.No	Enrollment No	Name of Student	Name and designation of Mentor

Diploma programme in _____ Engg.

Sr.No	Enrollment No	Name of Student	Name and Designation of Mentor

Kindly extend all possible cooperation to the students for above.

Thanking you

Yours sincerely,

(Principal)
Name of the Institute:
with Seal

Cc- To HoD/Mentor

Format-5: Undertaking by the students

TO

Principal

Subject: Undertaking regarding Placement for Industrial training of 12/16/18 weeks duration

I ……Reg No:…….. S/o/D/o. ……Studying in ---------- ---------- at ---------- Institute at ----------fully aware of the Industrial Training requirement and related responsibilities and participation in the ……, Industrial training between From: …… To……..

I assure you that I will be of good behavior and be obedient to the staff and mentor during the ……/Industrial training. I will also abide and will not participate in all activity. I will also discipline myself within the rules and regulations of the Institution. I am also aware that I am participating in the …….. at my own risk and I will not hold the ----------Institute responsible in any way in any eventuality namely Accident /Injury/death or whatever mishap and I myself will be solely responsible for my safety.

Place :Signature of the student

Date :Reg. No.

Format-6: Internships Daily Diary

Name of the Student: _____ Name of the mentor (Faculty) : _____

Enrollment Number: _____ Semester: _____ Academic Year _____

Week	Day & Date	Discussion Topics/Activity	Details of Work Allotted Till Next Session /Corrections Suggested/Faculty Remarks	Signature of Industry Mentor
Week 01	Mon, Date			
	Tue, Date			
	Wed, Date			
	Thu, Date			
	Fri, Date			
	Sat, Date			
.	Mon, Date			
	Tue, Date			
.	Wed, Date			
	Thu, Date			
.	Fri, Date			
.	Sat, Date			
Week n	Mon, Date			
	Tue, Date			
	Wed, Date			
	Thu, Date			
	Fri, Date			
	Sat, Date			

EMBEDDED SYSTEM **Course Code : 315338**

Programme Name/s	**: Automation and Robotics/ Digital Electronics/ Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/ Electronics & Communication Engg./ Electronics Engineering/ Industrial Electronics/ Electronics & Computer Engg./**
Programme Code	**: AO/ DE/ EJ/ EK/ ET/ EX/ IE/ TE**
Semester	**: Fifth**
Course Title	**: EMBEDDED SYSTEM**
Course Code	**: 315338**

I. RATIONALE

Embedded systems are designed for specific tasks to excel in real-time performance, resource utilization and reliability. These systems are playing vital role in modern technology, enabling sophisticated functionalities in a wide array of devices and applications. Embedded systems are integral to the advancement of technology across multiple sectors. By learning this course, students will develop skills to use embedded system for simple applications. It will also enable them to use open-source embedded system for solving real time problems.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help students to attain the following industry/employer expected outcome through various teaching learning experiences:
"Develop simple applications based on embedded system."

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Select the relevant microcontrollers for various industrial applications.
- CO2 - Choose appropriate family of microcontroller for different applications.
- CO3 - Interpret the communication standards of embedded systems.
- CO4 - Analyze the features of Real Time Operating System.
- CO5 - Develop the basic applications using Arduino.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical							
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
315338	EMBEDDED SYSTEM	ESY	DSC	5	-	2	2	9	3	3	30	70	100	40	25	10	25#	10	25	10	175

EMBEDDED SYSTEM **Course Code : 315338**

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 10 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Identify the components of the embedded system and their functions. TLO 1.2 Describe the given characteristic of the specified embedded system. TLO 1.3 Classify the embedded system. TLO 1.4 List the selection factors of the embedded systems.	**Unit - I Overview of Embedded Systems** 1.1 Embedded system, block diagram description, layered model 1.2 Characteristics of embedded system: CPU type, maximum CPU speed, processing power, memory, performance 1.3 Classification of embedded system: small scale, medium scale, sophisticated, stand-alone, reactive/real time (soft and hard real time) 1.4 Selection criteria of embedded system: operating system, reliability, NRE cost, unit cost, size, flexibility, time to prototype, time to market, maintainability, correctness and safety	Lecture using Chalk-Board Presentations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Compare different types of micro controllers used for embedded system designing. TLO 2.2 Describe AVR microcontroller with the help of block diagram. TLO 2.3 Sketch the block diagram of ATmega 8 and describe the functions of each block. TLO 2.4 Compare specifications of microcontrollers ATmega 8 and ATmega 328. TLO 2.5 List the features of Arduino specific microcontrollers.	**Unit - II Microcontroller Architecture** 2.1 Microcontroller Types: PIC, AVR, ARM, features and applications 2.2 AVR microcontroller: types , architecture 2.3 ATmega 8: features, internal architecture 2.4 Programming configurations of ATmega 8: I/O port, peripherals counter, timer 2.5 Comparison of ATmega 8 and ATmega 328 2.6 Features of Arduino specific AVR microcontroller ATmega 168/328	Presentations Lecture using Chalk-Board Site/Industry Visit
3	TLO 3.1 Describe the given type of modes for communication. TLO 3.2 Describe the given communication protocol(s) with relevant sketches. TLO 3.3 Describe the given wireless serial communication interface. TLO 3.4 Differentiate between given protocols for given parameters.	**Unit - III Communication Standards and Protocols** 3.1 Modes of communication: serial, parallel, synchronous and asynchronous 3.2 Communication Protocols its types: Serial: I2C, CAN, USB 3.3 Serial peripheral interface (SPI), IEC 61850 GOOSE (Protocol for Electric power system applications) 3.4 Wireless protocol : IrDA, Bluetooth, Zigbee, WiFi, LORA, LoWPAN	Lecture using Chalk-Board Presentations
4	TLO 4.1 Describe the functions of the given operating system. TLO 4.2 Compare RTOS and general OS for the given parameters. TLO 4.3 Describe features of RTOS with neat sketch. TLO 4.4 Explain deadlock condition in RTOS with suitable sketch.	**Unit - IV Real Time Operating System** 4.1 Operating system: general and real time operating system 4.2 Characteristics of real time operating system: consistency, reliability, scalability, performance, predictability 4.3 Functions of RTOS, Task management: inter task communication and multitasking, Scheduling: scheduling algorithms, resource allocation and interrupt handling 4.4 Features of RTOS: watchdog timer, semaphore 4.5 Deadlock: reasons of occurrence, handling of deadlock	Lecture using Chalk-Board Flipped Classroom Presentations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Enlist the different types of Arduino boards and their major features. TLO 5.2 Describe the working of development board using block diagram. TLO 5.3 Describe the given Arduino functions. TLO 5.4 Write steps to interface the given peripheral with Arduino. TLO 5.5 Interface the given sensor with Arduino.	**Unit - V I/O Interfacing with Arduino** 5.1 Arduino Board: introduction, types: Arduino UNO, NANO, MEGA 5.2 Functional Block Diagram of Arduino, pin functions of Arduino 5.3 Functions used in Arduino: math, analog I/O, digital I/O, timer 5.4 Peripheral interfacing with Arduino: keyboard, LCD, seven segment LED, relay, stepper motor, DC motor 5.5 Sensor interfacing with Arduino: temperature sensor, ultrasonic sensor	Lecture using Chalk-Board Presentations

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify pins and functions of AVR and PIC microcontroller.	1	*Identification of pins of AVR and PIC Microrontroller	2	CO1 CO2
LLO 2.1 Use an Integrated Development Environment (IDE) tool for developing C Programs of ATmega 168/328.	2	Use an IDE for ATmega 168/328 programming	2	CO2
LLO 3.1 Develop AVR C program to perform addition, subtraction, and multiplication operations on two constant data and output the result to port with some delay between each output.	3	*Write C program to perform various arithematic operations	2	CO2
LLO 4.1 Interface 4 x 4 LED matrix with AVR. LLO 4.2 Develop C program to display various patterns.	4	*Interface LED matrix with AVR microcontroller	2	CO2
LLO 5.1 Configure USB protocol on PC .	5	Serial Communication using USB	2	CO3
LLO 6.1 Install Arduino IDE and its development tool for Windows/MacOS/Linux operating systems.	6	*Installation of Arduino IDE for Windows/MacOS/Linux operating Systems	2	CO5
LLO 7.1 Build the circuit using 4 switches and 4 LEDs to Arduino Board. LLO 7.2 Test the LED on/off as per switch positions.	7	Building and Testing switch and LED interface using Arduino	2	CO5
LLO 8.1 Develop programs to perform arithmetic operation using math functions: constrain (), max (), min (), Pow(), sq(), sqrt() uisng Arduino.	8	*Programs to perfrom arithematic operations on Arduino	2	CO5
LLO 9.1 Interface two 16 x 2 LCD modules with Arduino using I2C serial communication protocol.	9	*LCD Interfacing to Arduino board	2	CO5
LLO 10.1 Develop program to read the data from the temperature sensor through Arduino and display on LCD.	10	Temperature sensor interfacing to Arduino board	2	CO5

EMBEDDED SYSTEM **Course Code : 315338**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment

- List different types of sensors and actuators used with embedded system and also write application of each sensor
- Create a program to control a DC motor using PWM (Pulse Width Modulation).
- Interface a temperature sensor with Arduino and display the readings on the serial monitor
- Develop a simple program to blink an LED using assembly language.
- Implement SPI communication to control an LED matrix display.
- Conduct a market survey for various types of Arduino boards available

Micro project

- Control the position of a servo motor using Arduino
- Control home appliances using Arduino and relays
- Design digital soil moisture meter using Arduino
- Implement a digital clock using an RTC (Real-Time Clock) module
- Create a digital thermometer using arduino and a temperature sensor
- Implement an RFID-based door lock system using Arduino
- Create a simple home automation system to control appliances using an AVR/PIC microcontroller
- Measure distances using an ultrasonic sensor and display the results on an LCD
- Interface any I/O deice to Raspberry pi development board

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Components: AVR, PIC Microcontroller	1

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
2	PIC Microcontroller: 32.768 KHz and 20 MHz Crystal, On-Board Debugger, USB Powered or externally powered, Adjustable target voltage	1
3	Temperature sensors; range -55 to 125°C	10
4	Simulation softwares: Arduino IDE, Atmel studio, Microchip studio.	3,4,7,8,9,10
5	Microcontroller kit (AVR ATmega 168/328 board and PIC): single board systems with minimum 8K RAM, ROM memory with battery backup, 16 x 4 LCD display, seven segment display, PC keyboard interfacing facility, cross 'C' compiler, USB, interfacing facility with built in power supply.	4
6	Arduino board UNO/ Nano or available microcontroller: ATmega328P, operating voltage: 5V input voltage (recommended): 7-12V input voltage (limit): 6-20V digital I/O pins: 14 (of which 6 provide PWM output) analog input pins: 6 DC current per I/O Pin: 20 mA DC current for 3.3V pin: 50 mA flash memory: 32 KB (ATmega328P) of which 0.5 KB used by bootloader SRAM: 2 KB (ATmega328P) EEPROM: 1 KB (ATmega328P) clock speed: 16 MHz LED bulit in: 13 dimensions: 68.6 mm x 53.4 mm weight: 25 g	6,7,8,9
7	LCD 16x2 Modules	9
8	Desktop PC with mininum RAM 4GB, Windows OS	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Overview of Embedded Systems	CO1	8	4	4	4	12
2	II	Microcontroller Architecture	CO2	12	2	6	8	16
3	III	Communication Standards and Protocols	CO3	8	2	4	8	14
4	IV	Real Time Operating System	CO4	10	4	6	2	12
5	V	I/O Interfacing with Arduino	CO5	12	2	6	8	16
Grand Total				**50**	**14**	**26**	**30**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two offline unit tests of 30 marks and average of two unit test marks will be consider for out of 30 marks.

•For formative assessment of laboratory learning 25 marks.
•Each practical will be assessed considering 60% weightage to process, 40% weightage to product.

Summative Assessment (Assessment of Learning)

- End semester assessment is of 70 marks.

• End semester summative assessment is of 25 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

EMBEDDED SYSTEM **Course Code : 315338**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	2	2	1	1	-	2			
CO2	3	3	2	2	1	1	2			
CO3	2	2	2	2	1	-	2			
CO4	2	1	2	2	1	1	2			
CO5	3	3	2	3	1	1	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Raj Kamal	Microcontroller Architecture Programming, Interfacing and System Design	Pearson Education India, Delhi, 2012 ISBN: 978-8131759905
2	Muhamed Ali Mazidi, Sarmad Naimi, Sepehr Naimi	AVR Microcontroller and Embedded Systems: Using Assembly and C	Pearson Education India, Delhi, 2013 ISBN: 978-9332518407
3	Dawoud Shenouda Dawoud, Peter Dawoud	Serial Communication Protocols and Standards	River Publishers, Denmark, 2020 ISBN: 978-8770221542
4	David E. Simon	An Embedded Software Primer	Addison-Wesley, Delhi, 2002 ISBN: 978-9332518407
5	J.M.Hughes	Arduino: A Technical Reference	O'REILLY, 2016 ISBN: 978-1491921760
6	Jeremy Blum	Exploring Arduino Tools and Techniques for Engineering Wizardry	John Wiley & Sons, 2019 ISBN: 978-1118549360
7	Michael McRoberts	Beginning Arduino	APRESS, 2011 ISBN: 978-1430232414
8	K. V. K. K. Prasad	Embedded Real –Time Systems concepts, Design & Programming Black Book	Dreamtech Press New Delhi, 2003 ISBN: 978-8177224610
9	Frank Vahid, Tony Givargis	Embedded System Design A Unified Hardware/ Software Introduction	Wiley India, New Delhi,2006 ISBN: 978-0471386780

XIII . LEARNING WEBSITES & PORTALS

EMBEDDED SYSTEM **Course Code : 315338**

Sr.No	Link / Portal	Description
1	https://www.microchip.com/en-us/tools-resources/develop/microchip-studio	Microchip Studio for AVR® and SAM Devices is an integrated development platform from Microchip
2	http://arduino.cc/	Link for Arduino Related Hardware and Software Download and installation
3	https://learn.sparkfun.com/tutorials/what-is-an-arduino	Arduino Basics
4	https://onlinecourses.swayam2.ac.in/aic20_sp04/preview	Introduction and Concepts of Arduino
5	https://support.arduino.cc/	Tutorials, data sheets, guides and other technical documentation
6	http://vlabs.iitkgp.ac.in/rtes/	Virtual lab link for Microcontrollers
7	https://semiconductors.es/datasheet-pdf/219613/ATMEGA32.html	Datasheet for ATmega Microcontrollers
8	https://www.alldatasheet.com/datasheet-pdf/pdf/82338/MICROCHIP/PIC16F877A.html	Datasheet for PIC Microcontroller

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

MOBILE & WIRELESS COMMUNICATION **Course Code : 315339**

Programme Name/s	**: Digital Electronics/ Electronics & Tele-communication Engg./ Electronics & Communication Engg./ Electronics Engineering/ Industrial Electronics**
Programme Code	**: DE/ EJ/ ET/ EX/ IE**
Semester	**: Fifth**
Course Title	**: MOBILE & WIRELESS COMMUNICATION**
Course Code	**: 315339**

I. RATIONALE

The next generation of mobile communications technology has already begun to bring various services to consumers and businesses. Mobile communications technology will be one of the most important drivers of industry, economic ,societal growth and will also generate millions of new jobs. This course will develop the skills to maintain the latest wireless communication based applications like Media, Entertainment, Internet of Things (IoT), Smart cities, Education,Vehicular communication etc. This course will account students with revolution in mobile and wireless communication.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry/employer expected outcome through various teaching learning experiences:
"Maintain mobile and wireless communication system"

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Describe concept of cellular mobile communication systems
- CO2 - Describe terminologies used in GSM systems,features and its architecture.
- CO3 - Compare generations of mobile communication system
- CO4 - Interpret 5G system architecture.
- CO5 - Use relevant wireless technology suitable for various 5G applications.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical							
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
315339	MOBILE & WIRELESS COMMUNICATION	MWC	DSC	5	-	2	2	9	3	3	30	70	100	40	25	10	25#	10	25	10	175

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 10 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Suggest radio spectrum bands used for mobile and wireless communication. TLO 1.2 Describe the features of the given mobile radio standards. TLO 1.3 Explain the given terms with respect to Cellular systems. TLO 1.4 Describe the Basic Cellular systems. TLO 1.5 Explain with relevant sketch the working principle of the different sections of mobile handset unit (3G).	**Unit - I Wireless Communication System** 1.1 Radio spectrum bands for mobile & wireless communication. 1.2 Wireless network generations Mobile Radio standards-AMPS, N AMPS, IS -95, GSM, UMTS . 1.3 Cellular fundamentals: cell, cell structure, cluster, reuse factor, minimum reuse distance. 1.4 Basic cellular system : mobile station, base station, traffic channel (Forward and Reverse) , control channel (Forward and Reverse), frequency reuse, channel assignment strategies. 1.5 Mobile communication system-Block diagram, Mobile Phone Unit : Block diagram of 3G, working, features of transmitter, receiver section, Frequency Synthesizer, Control unit ,Logic Unit of Mobile phone, sensors, speakers, camera, touch screen, motion sensors and other common sensors.	Lecture Using Chalk-Board Video Demonstrations Assignments

MOBILE & WIRELESS COMMUNICATION **Course Code : 315339**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Explain the effect of the given interference on cellular system performance TLO 2.2 Select the relevant method to improve coverage and system capacity of the given cellular system with justification. TLO 2.3 Describe GSM system with relevant sketch.	**Unit - II Basics of Mobile Communication System.** 2.1 Interference : Co-Channel interference, Adjacent Channel Interference. 2.2 Improving Coverage and capacity in cellular systems: Cell splitting, Sectoring, Microcell Zone concept. Repeaters for range extension 2.3 Global System for Mobile Communication(GSM): Architecture,Features and service aspects, GSM and radio aspects. channel types, GSM call routing , Mobile terminated call & mobile originated call sequence, stages of call processing in GSM.	Lecture Using Chalk-Board Video Demonstrations Assignments
3	TLO 3.1 Explain Feature of the 4G standards. TLO 3.2 Describe LTE(4G) Network architecture with relevant sketch . TLO 3.3 Compare Features of next generation wireless standards. TLO 3.4 Describe multiple-input, multiple-output (MIMO). TLO 3.5 Interpret AAS system .	**Unit - III Fundamentals of 4G Communication** 3.1 Limitation of 3G and motivation for 4G. 3.2 LTE enabler Technologies: LTE(4G) Network architecture including eNodeB, MME, SGW, PGW,HSS, PDN. 3.3 Comparison of 1G ,2G, 3G, 4G ,4.5G, 5G. 3.4 Basics of MIMO. 3.5 Massive MIMO (Advanced Antenna Systems - AAS)Defination,diagram,benefits,Beamforming.	Lecture Using Chalk-Board Video Demonstrations Assignments
4	TLO 4.1 Describe 5G network architecture. TLO 4.2 List features of IMT 2020 standards TLO 4.3 Sketch 5G Radio spectrum. TLO 4.4 Elaborate 5G network slicing.	**Unit - IV Introduction to 5G Technology** 4.1 Introduction to 5G: 5G network architecture, 5G enable technologies, 4.2 IMT 2020 standards. 4.3 5G Radio spectrum : low band, medium band,millimeterwave(Ultrahigh) band,5G service providers, 4.4 5G network slicing.	Lecture Using Chalk-Board Video Demonstrations Assignments

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Explain the procedure to connect WiFi. TLO 5.2 Explain the procedure to connect bluetooth. TLO 5.3 List out NFC services . TLO 5.4 Describe Applications of Mobile and Wireless applications.	**Unit - V Recent Wireless Technologies & applications** 5.1 Features ,architecture, frequency band of Wi-Fi , IEEE 802.11a & 802.11g 5.2 Features ,architecture, frequency band of Bluetooth- BLE (Bluetooth 4.0, Bluetooth Low Energy), IEEE 802.15.1. 5.3 NFC services , Introduction to 3GPP Release 18 List of services . 5.4 Applications such as Vehicular communication : V2V,Industrial Automation Application(in detail) & other application such as Media and entertainment ,Retail Industry, Education, Industrial Automation ,Smart Cities, Internet of Things (IoT)Application.	Lecture Using Chalk-Board Video Demonstrations Assignments

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify different sections and components of mobile phone such as ringer section, dialer section, receiver section and transmitter section, camera, microphone, speaker, Dash light.	1	*Identification of different sections of mobile phone	2	CO1
LLO 2.1 Measure voltages of various sections of mobile handset(such as supply of the transmitter /receiver section, battery charger section and power management unit of mobile phone unit).	2	*Measurement of different sections of mobile phone unit	2	CO1
LLO 3.1 Test user Interface section (Keyboard Buzzer, Vibrator, LED,Mic and Speaker) of Mobile phone unit.	3	*Testing of different sections of mobile phone unit	2	CO1
LLO 4.1 Find out relevant information of mobile phone using open source software applications a)Detect the hardware details of mobile handset. b)find out operating system c)locating the tower	4	*Finding out Relevant information of the mobile using relevant softwares	2	CO2
LLO 5.1 Install and authenticate eSIM(virtual SIM) on mobile handset.	5	Installation of eSim on mobile handset	2	CO3
LLO 6.1 Identify Dual sim interface section,Touch screen display section, battery charging circuit, power management unit of 4G or 5G smartphone and test working.	6	Identification of different parts of smartphones using 4G or 5G experimental setup	2	CO4
LLO 7.1 Using appropriate mobile app locate and find Internet signal strength of mobile tower.	7	*Location of nearby tower and find internet connection strength	2	CO4
LLO 8.1 Test functioning of various user interface section of smart phone : buzzer, vibrator, MIC /speaker, handsfree using 4G/5G Kit.	8	Check performance of user interface section of smartphone(4G/5G)	2	CO4
LLO 9.1 Test the hard reset function, hotspot and other networking functions of the given smart phone.	9	Make Hotspot connection on Wifi on any 2 devices	2	CO5
LLO 10.1 Build a Personal Area Network of mobile devices using Bluetooth.	10	*Establish Personal Area Network of at least two devices	2	CO5

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment

- Initiatives by Standard Telecom Agencies.
- 5G Initiatives Taken By Government and Standard Agencies.
- 5G Developments Across the World.
- Key areas in which satellites can play a part in 5G.
- Recent Trends in Telecommunication domain.
- 5G network technology & impact on society.
- Roadmap for 5G Architecture in India.
- By using relevant learning material/tutorials,learn how to simulate 4G/5G/6G.
- Collect relevant information/technical specifications required for 4G/5G/6G communication.
- Compare various service providers considering quality of service and cost.

Industrial Visit

- Industrial Visit to nearest service provider base station.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Mobile Phone Trainer kit: Cellular System : EGSM/GSM 900/ 1800 MHz 1,2 to (3GDualband),Rx frequency band(Down link): EGSM 900: 925-960 MHz,GSM 900 : 935- 960 MHz GSM 1800 : 1805- 1880MHz Tx frequency band (Uplink) : EGSM 900 : 880- 890MHz GSM 900 : 890- 915 MHz GSM 1800 : 1710-1 785MHz Output power : +5 ,+33 dBm 3.2 m W . Channel spacing : 200 KHz Display : TFT, 256 K colours,128X 160 Pixels, 2.0	1,2

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
2	3G GSM Mobile Phone trainer: GSM capability: GSM 900 /1800, E-GSM GSM data services: Asynchronous, Transparent & Non Transparent modes. 14.4 K bits/s, SIM Interface : 3 V RF , Transmitter : Maximum output power : 33 dBm +/- 236dB,(EGSM) Maximum output power : 30 dBm +/- 2 dB (DCS) Minimum output power : 5 dBm +/- 5 dB (EGSM) Minimum output power : 0 dBm +/- 5 dB (DCS 1800)	1,2,3
3	Mobile handset Tools:- Tools to repair any smart phone or mobile phone include - soldering iron, soldering station , solder wire, solder paste, liquid flux, paste flux , jumper wire, tweezers , screwdriver, multimeter, dc power supply, ESD-Safe antistatic wrist strap, mat , apron, hand gloves, LCD tester, Battery tester, PCB holder, PCB Cleaner	1,2,3,7,4,8,9,6,5
4	Digital Multimeter (3,-4 Digital Multimeter) : 4000 counts large LCD display with auto/manual range, No Power OFF under natural operation ,Data Hold, Max/Min value Hold Capacitance, Frequency/Duty Cycle	2,3
5	CRO: Bandwidth : DC-30 MHz (-3 dB)] Ri se time : 12 ns approx Accuracy : ± 3 % Input Impedance : 1 MD 30 pF approx Sensitivity : Internal 5 mm, Ext 0.8 V approx Deflection coefficients : Micro-controller based 12 calibrated steps SmV/Div - 20V/Div 1 -2-5 sequence X-Y mode : Component Testing	2,3
6	Digital Storage Oscilloscope : 100 MHz with 64K color TFT, 16kbps memory, FFT function, alternate triggering, Roll Mode, Math Function, digital filter, waveform recorder,20 automatic measurements, Standard USB host, USB device with waveform analysis software	2,3
7	5G VoLTE Smart Phone Training System: Technology : 5G Sub 6 FDD, 5G Sub 6 TDD, 4G LTE FDD, 4G LTE TDD, 3G WCDMA, 2G GSM ,On board sections : Touch display, Dual SIM interface, user interface, Battery charging circuit, Power management unit, and RF Spectrum Aanalyzer module User interface : Buzzer, Vibrator, Mic, Speaker, Hands free port, and display LEDs Test points : More than 55 nos.	6,10,5
8	4G VoLTE Smart Phone Scientech 2139 :Cellular system : GSM - Band (2 / 3 / 5 / 8); WCDMA - Band (1 / 2 / 5 /8); 4G VoLTE (TDD) - Band (38 / 40 / 41), LTE (FDD) - Band (1 / 3 / 5 / 7 / 8 / 20) Tx/Rx Frequency band : GSM / HSPA / LTE (850, 900, 1800, 1900 MHZ) UMTS/HSPA+ (850, 900, 1900, 2100 MHZ) 4G VoLTE ,WLAN :Wi-Fi 802.11 b/g/n, Wi-Fi Direct	6,8
9	Software app on phone such as AIDA64,Network cell info lite,LTE coverage map,open signal	7,4

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Wireless Communication System	CO1	10	2	4	6	12
2	II	Basics of Mobile Communication System.	CO2	10	4	6	8	18
3	III	Fundamentals of 4G Communication	CO3	8	2	4	4	10
4	IV	Introduction to 5G Technology	CO4	12	4	6	8	18
5	V	Recent Wireless Technologies & applications	CO5	10	2	4	6	12
Grand Total				**50**	**14**	**24**	**32**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two offline unit tests of 30 marks and average of two unit test marks will be consider for out of 30 marks. For formative assessment of laboratory learning 25 marks. Each practical will be assessed considering 60% weightage to process, 40% weightage to product.

Summative Assessment (Assessment of Learning)

- End semester assessment is of 70 marks. End semester summative assessment is of 25 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	1	1	1	3	2	1	3			
CO2	1	1	1	2	2	1	3			
CO3	1	2	3	2	2	1	3			
CO4	1	2	3	2	3	1	3			
CO5	1	2	3	3	3	3	3			
Legends :- High:03, Medium:02,Low:01, No Mapping: - *PSOs are to be formulated at institute level										

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	William C.Y. Lee	Mobile Cellular Telecommunications:	McGraw Hill Education; 2nd edition (1 July 2017); McGraw Hill Education (India) Private Limited. ISBN : 978-0070635999
2	Theodore S. Rappaport	Wireless Communications principles & practice	Pearson Education India; 2nd edition (1 January 2010), ISBN : 978-8131731864
3	T.L.Singal	Wireless Communications	McGraw Hill Education (1 July 2017) (India) Private Limited,New Delhi ISBN : 978-0070681781
4	Leeladhar Malviya, Rajib Kumar Panigrahi, M.V. Kartikeyan.	MIMO Antennas for Wireless Communication	CRC Press; 1st edition (16 December 2020) ISBN : 978-0367530471
5	Simon Haykin,Michael Moher	Modern Wireless Communication	Pearson Education India; 1st edition (1 January 2011), ISBN: 978-8131704431

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.gsma.com/connectivity-for-good/spectrum/5g-spectrum-guide-2/	Spectrum bands
2	https://www.ericsson.com/en/reports-and-papers/white-papers/advanced-antenna-systems-for-5g-networks	5G-networks
3	http://www.eitc.org/research-opportunities/5g-and-beyond-mobile-wireless-technology/5g-and-beyond-technology-roadmap/novel-antennas-and-semiconductor-technology/5g-nr-massive-mimo-technology	MIMO
4	https://telcomatraining.com/what-is-aas-adaptive-antenna-system	AAS antenna
5	https://mobilepacketcore.com/lte-4g-network-architecture/	4G architecture
6	https://www.linkedin.com/pulse/applications-5g-technology-ramya-chandran-swprc	Applications of 5G
7	https://www.rantcell.com/5g-antenna-5g-mmwave-components-for-connectivity.html	mmwave antenna

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

ADVANCE POWER ELECTRONICS **Course Code : 315340**

Programme Name/s	**: Electronics & Tele-communication Engg./ Electronics & Communication Engg./ Electronics Engineering/ Industrial Electronics/**
Programme Code	**: EJ/ ET/ EX/ IE**
Semester	**: Fifth**
Course Title	**: ADVANCE POWER ELECTRONICS**
Course Code	**: 315340**

I. RATIONALE

Advance Power Electronics course is designed to develop skills to use advance power electronic devices and control strategies for complex and industrial applications. This course will equip the students with the required knowledge and skill sets to provide solutions to real-world problems.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help students to attain the following industry/employer expected outcome through various teaching learning experiences:
"Maintain converters, drives comprising of power electronic devices"

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Select relevant protection circuit for different power electronics devices.
- CO2 - Use DC-DC converters for different quadrant applications.
- CO3 - Analyze the performance of multilevel inverters.
- CO4 - Evaluate the performance parameters of voltage stabilizer and uninterrupted power supply.
- CO5 - Maintain electric drives used in various industrial applications.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
315340	ADVANCE POWER ELECTRONICS	APE	DSE	4	-	2	-	6	2	3	30	70	100	40	25	10	25#	10	-	-	150

Total IKS Hrs for Sem. : Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 10 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe construction and working of given power electronic device. TLO 1.2 Suggest suitable power electronics devices for the given application. TLO 1.3 Describe the given protection circuit for the power electronic device with the help of suitable sketch. TLO 1.4 Explain thermal protection used for SCR.	**Unit - I Modern Power Devices and Protection Circuits** 1.1 SIT, MCT and FCT Power devices: Symbol, construction, working , V-I characteristics and applications 1.2 d_i/d_t protection circuit and snubber circuit 1.3 d_V/d_t protection circuit and snubber circuit 1.4 Thermal Protection of SCR : Need, thermal resistance and heat sinks specification	Lecture using Chalk-Board Demonstration Video Demonstrations Presentations
2	TLO 2.1 Describe the control strategies of chopper. TLO 2.2 Classify choppers on the basis of quadrant operation. TLO 2.3 Explain working of a given chopper with suitable sketches (circuit diagram and output waveforms). TLO 2.4 Describe the operation of given type of SMPS with suitable sketches.	**Unit - II DC to DC converters** 2.1 Function of Chopper, types, control strategies of chopper: constant frequency and variable frequency system 2.2 Classification of choppers on the basis of Quadrant operation 2.3 3Chopper Circuit diagram using MOSFET, mode of operation, wave forms : First-quadrant (Type-A),Second-quadrant (Type-B), Type-C (Two-quadrant Type-a), Type-D (Two-quadrant Type-b), Four-quadrant (Type-E) 2.4 SMPS: Fly back converter, Push pull converter	Lecture using Chalk-Board Hands-on Presentations Video Demonstrations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Compare the features of VSI and CSI. TLO 3.2 Describe working principle of current source inverter. TLO 3.3 Select appropriate power electronics components to design three-Phase 180° Mode and 120° mode VSI circuit. TLO 3.4 Describe working principle of Sinusoidal pulse width modulated inverter circuit.	**Unit - III Multi level Inverters** 3.1 Inverter-Concept, types-Voltage Source Inverter(VSI) and Current Source Inverter(CSI) 3.2 Single phase CSI - Working with ideal switches and waveforms (R load) 3.3 Three phase bridge voltage source inverter: 180° mode 120° mode -Working with ideal switches and waveforms (R load) 3.4 Pulse width modulation : need, types: Sinusoidal Pulse Width Modulation (SPWM), Multiple Pulse Width Modulation(MPWM) SPWM: concept, working principle and waveforms	Lecture using Chalk-Board Video Demonstrations Presentations
4	TLO 4.1 Explain need of voltage stabilizer. TLO 4.2 Select relevant voltage stabilizer for the given application. TLO 4.3 Compare the features and specification of On-line and Off-line UPS. TLO 4.4 Compare features of the given types of batteries.	**Unit - IV AC voltage stabilizer and Uninterruptable Power supply** 4.1 Stabilizer: Need, definition, classification, basic block diagram, applications 4.2 Types of stabilizer: Relay type, Servo type, static voltage Stabilizer: Circuit diagram, Working, advantages, disadvantages and applications . 4.3 UPS specification: features of On-line and Off-line UPS Specifications Input Voltage Range, DC Voltage Range, Transient Response, Response Time, Total Harmonic Distortion, output frequency, output waveforms, Transient Recovery, load power factor and types of Protection circuit 4.4 Rechargeable Batteries – Classification- Lithium-Ion (Li-Ion) battery, Lithium Nickel Manganese Cobalt Oxide (NMC) and Lithium Nickel Cobalt Aluminum Oxide (NCA). Specification: back up time, power rating, and transfer time	Lecture using Chalk-Board Demonstration Video Demonstrations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Describe working principle of Variable frequency drives. TLO 5.2 Describe the operation of charge controller used in photovoltaic (PV) System. TLO 5.3 Explain why AC to AC converter used in wind power generation. TLO 5.4 Explain with sketches the working of the Electrical traction system. TLO 5.5 Explain the role of electronic control unit of electric vehicle. TLO 5.6 Describe the working of drive mechanism of electrical vehicle.	**Unit - V Electric Drives and Industrial Applications** 5.1 Variable frequency drives (VFD): Need, Block diagram, working principle, Advantages, disadvantages and its applications 5.2 Charge controller: Concept, types, applications in Photovoltaics (PV) system with block diagram with focus on inverter 5.3 AC to AC converter using DC link: Concept, applications in Wind Power Generation and with focus on VFD 5.4 Electrical traction system: Introduction, function of each block with focus on Drive mechanism and applications 5.5 Electrical vehicle(EV)- Plug-in Electrical vehicle (PEV) and Plug in Hybrid electric Vehicle(PHEV): Block diagram, function of each block with focus on Drive mechanism and applications	Lecture using Chalk-Board Presentations Video Demonstrations Site/Industry Visit

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Test the protection scheme of SCR by d_V/d_t method.	1	*Protection circuit for SCR based on dv/dt method	2	CO1
LLO 2.1 Design and implementation of a Type-A chopper (Power MOSFET based) circuit in MATLAB LLO 2.2 Simulate Type-A chopper and observe the waveforms.	2	Simulation of Type-A chopper (Power MOSFET based) circuit using MATLAB Simulink/SCILAB /relevant software	2	CO2
LLO 3.1 Design and implementation of a Type-E chopper (Power MOSFET based) circuit in MATLAB LLO 3.2 Simulate Type-E chopper and observe the wavefomrs	3	*Simulation of Type-E chopper (Power MOSFET based) circuit using MATLAB Simulink/SCILAB /relevant software	2	CO2
LLO 4.1 Simulate Buck-Boost Converter Circuit using MATLAB/PSIM	4	Simulation of input output voltage of Buck-Boost Converter Circuit by varying duty ratio using MATLAB Simulink/SCILAB /relevant software	2	CO2
LLO 5.1 Simulate a three-phase voltage source inverter circuit operating in 180 degree mode using MATLAB and Simulink and observe the waveforms. LLO 5.2 Simulate a three-phase voltage source inverter circuit operating in 120 degree mode using MATLAB and Simulink and observe the waveforms.	5	Simulation of 180 degree mode and 120 degree mode of three Phase Voltage Source Inverter Circuit using MATLAB Simulink/SCILAB /relevant software	2	CO3

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 6.1 Simulate sinusoidal pulse width modulation (PWM)using MATLAB Simulink/SCILAB /relevant software	6	*Simulation of sinusoidal PWM Waves using MATLAB Simulink/SCILAB /relevant software	2	CO3
LLO 7.1 Set up the UPS in a test environment, ensuring correct connections to input and output loads, and configuring any necessary settings	7	Measurement of voltages at different test points and verify specifications of UPS with the datasheet	2	CO4
LLO 8.1 Measure and record the output voltage of the servo-type voltage stabilizer for a range of AC input voltages.	8	Measurement of the output voltage for servo type voltage stabilizer for different values of ac input voltage	2	CO4
LLO 9.1 Measure the voltage and current of a lithium-ion battery under various operating conditions, such as during charging, discharging, and at rest.	9	*Test Performance of lithium ion battery	2	CO4
LLO 10.1 Measure and record key electrical parameters of the PV system, including voltage, current, and power output from the PV panels.	10	*Test the performance of Charge controller in PV System	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Develop a Battery Management System (BMS) for lithium-ion or other rechargeable batteries, focusing on monitoring and balancing the cells to extend battery life and ensure safety.. (Components: Voltage and temperature sensors Balancing circuitry (resistive or active) Microcontroller or dedicated BMS IC
- Design a DC-DC converter circuit to efficiently step up (boost) or step down (buck) voltage levels for a specific application, such as powering a microcontroller or LED system.
- Develop a small solar-powered lighting system for use in gardens, pathways, or emergency lighting. (Components: PV panel (appropriate size for the desired lighting output) LED lights Rechargeable battery (e.g., Li-ion or NiMH) Charge controller (or a simple battery protection circuit) Light sensor (optional, for automatic control))
- Build a DC-DC converter circuit to efficiently step up (boost) or step down (buck) voltage levels for a specific application, such as powering a microcontroller or LED system.
- Develop a portable solar-powered USB charger for charging small electronic devices such as smartphones or tablets.(Components: PV panel (with enough output to charge devices) DC-DC converter (to step up voltage to 5V USB standard) USB output module Rechargeable battery (optional, for storing energy))
- Build a small, solar-powered fan for ventilation in areas like small rooms or greenhouses.(Components: Small PV panel (sufficient to power a DC fan) DC fan (12V or 5V) Battery for energy storage (optional for continuous operation) Basic DC-DC converter (if needed to match voltage requirements))

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	SCR : Irms=16A, IH=100mA, IL=200mA,IGT=35 to 90mA,VGT= 1 to 3 V,Vrms=1600V	1
2	CRO : Dual Channel, 4 Trace CRT / TFT based Bandwidth 20 MHz/30 Mhz X10 magnification 20 nS max sweep rate, Alternate triggering ,Component tester and with optional features such as Digital Read out , USB interface	1,7,8
3	Multimeter : 2000 count digital display , 1000V DC / 750 V AC ranges, 10A AC/DC range	1,7,8,9,10
4	Regulated power supply: 0- 30 Volt, 2 A with digital display, with S.C. protection	1,8,9
5	MATLAB-SIMULINK / Scilab software, Proteus software, Multisim software	2,3,4,5,6
6	Lamp Load 2 kVA, 10 bulbs each 200 W	7,9
7	Servo Voltage Stabilizer- 2KVA, Output Voltage: 230 V, Load current: 8.5 A, Input Voltage: 170-290 V, Input frequency: 50Hz-60Hz	8
8	"UPS (uninterrupted power supply) kit:Mains : 230V AC 1-phase, 50 Hz,DC input : 12v DC Output : 230v AC(Sine Wave), Battery:12V,26 AH, 60W Bulb:holder with power chord for loading "	8

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Modern Power Devices and Protection Circuits	CO1	6	2	4	4	10
2	II	DC to DC converters	CO2	10	4	6	6	16
3	III	Multi level Inverters	CO3	8	2	6	8	16
4	IV	AC voltage stabilizer and Uninterruptable Power supply	CO4	8	2	4	6	12
5	V	Electric Drives and Industrial Applications	CO5	8	2	4	10	16
Grand Total				**40**	**12**	**24**	**34**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two offline unit tests of 30 marks and average of two unit test marks will be consider for out of 30 marks. For formative assessment of laboratory learning 25 marks Each practical will be assessed considering 60% weightage to process, 40% weightage to product.

Summative Assessment (Assessment of Learning)

- End semester assessment of 70 marks. End semester summative assessment of 25 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	1	1	1	1		2			
CO2	1	2	2	2	2		2			
CO3	1	2	2	2	2		2			
CO4	1	2	2	2	2	2	2			
CO5	1	2	2	2	3	2	3			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Muhammad H. Rashid	Power Electronics: Devices, Circuits, and Applications, 4e	Pearson Education, ISBN-13 978-8120345317
2	M D Singh K B Khanchandani	Power Electronics	McGraw Hill Education, ISBN-13 978-0070583894
3	P.S.Bimbhra	Power Electronics	Khanna Publisher, New Delhi, SBN-13 ?978-8195123124
4	B.R.Gupta And V.Singhal	Power Electronics	S.K.Kataria and Sons, ISBN-13 978-8185749532
5	Madhukar Waware, D.S.More, Vijay Mohale, Abhay Wagh	Power Electronics and Its Applications	Khanna Book Publishing ,ISBN-13 ? : ? 978-9355380425

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.ti.com/lit/ml/slua618a/slua618a.pdf?ts=1673408094214&ref_url=https%253A%252F%252Fwww.google.com%252F	dv/dt Protection, di/dt Protection
2	https://afdc.energy.gov/fuels/electricity-research	Electric Vehicle Smart-Charge Management

ADVANCE POWER ELECTRONICS **Course Code : 315340**

Sr.No	Link / Portal	Description
3	https://nptel.ac.in/courses/108102145	Course on Power Electronics by IIT Bombay
4	https://nptel.ac.in/courses/108101038	Course on Power Electronics by IIT Bombay
5	https://www.youtube.com/watch?v=39toaD7jFZo	electric locomotive circuit diagram | power circuit of locomotive | electric traction
6	https://www.youtube.com/watch?v=VbrQVcrVcmc	DC -DC converters
7	https://www.youtube.com/watch?v=vCrFplXxuaQ&list=PL9JVQL_o-6m_Hw3aF9d81M7SzmmqPfPFN	Power Electronics using MATLAB Simulink
8	https://www.youtube.com/watch?v=dgKmdbuSOVc&list=PL0ocI_oN1DbKGskIeaFidBoL68jMWutF8	Power Electronics using MATLAB Simulink

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

IOT APPLICATIONS **Course Code : 315341**

Programme Name/s	**: Digital Electronics/ Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/ Electronics & Communication Engg./ Electronics Engineering/ Industrial Electronics/ Electronics & Computer Engg.**
Programme Code	**: DE/ EJ/ EK/ ET/ EX/ IE/ TE**
Semester	**: Fifth**
Course Title	**: IOT APPLICATIONS**
Course Code	**: 315341**

I. RATIONALE

The Internet of Things (IoT) explores the emerging concept of enabling objects to communicate with each other and with information systems. IoT lies in its ability to create a more connected, efficient, and innovative world by leveraging interconnected devices. The focus of IoT is to explore the capabilities of various technologies and employ creative thinking methods to develop innovative applications. This course will cover all the component IoT like sensor, microcontroller, cloud, communication protocol and it helps to prepare students to be acquainted with this technological transformation, with the ability to design, create and deploy advance smart IoT solutions.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help students to attain the following industry/employer expected outcome through various teaching learning experiences:
" Maintain system based on Internet of Things (IoT)."

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Interpret the architecture of Internet of Things (IoT).
- CO2 - Select IoT system for given application development.
- CO3 - Integrate sensors and actuators in IoT based system.
- CO4 - Manage IoT communication for data handling.
- CO5 - Develop IoT based applications.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
315341	IOT APPLICATIONS	IAU	DSE	4	-	2	-	6	2	3	30	70	100	40	25	10	25#	10	-	-	150

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 10 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe the architecture of IoT system. TLO 1.2 List types of IoT system. TLO 1.3 Illustrate Physical and logical design of IoT system. TLO 1.4 Elaborate IoT enabling technology for the given application. TLO 1.5 List challenges in IoT based system.	**Unit - I Basics of Internet of Things (IoT)** 1.1 Basics of IoT: need, history, definition, characteristics, architecture of IoT with block diagram, IoT applications 1.2 Types of IoT system 1.3 Physical and logical design of IoT 1.4 Enabling technologies for IoT : Big Data Analytics, Cloud computing, Wireless Sensor Networks, Embedded Systems with example 1.5 IoT system challenges for design and security	Video Demonstrations Lecture Using Chalk-Board Presentations
2	TLO 2.1 Sketch architectural block diagram of NodeMCU. TLO 2.2 Describe the working of communication port of NodeMCU. TLO 2.3 Write procedure to use NodeMCU open-source IoT (Internet of Things) platform for given application. TLO 2.4 Write simple program to transfer data from NodeMCU (ESP 8266) to Arduino IDE.	**Unit - II Fundamental of NodeMcU** 2.1 NodeMCU ESP8266: features, specifications, hardware architecture, GPIO pins 2.2 NodeMCU communication port: UART, I2C,SPI 2.3 Terms used with NodeMCU: firmware, Wi-Fi, NodeMCU ESP8266 development board and its pin configuration 2.4 Arduino Integrated Development Environment - (IDE), Arduino IDE setup, creating, compiling and uploading programs from Arduino IDE to NodeMCU 2.5 Applications using NodeMCU ESP8266 and Arduino IDE. (Use of functions, string, array, timer, I/O function, PWM, interface LED & switch)	Lecture Using Chalk-Board Video Demonstrations Presentations Hands-on

IOT APPLICATIONS **Course Code : 315341**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Select relevant sensor for the given application. TLO 3.2 Select relevant actuators for the given application. TLO 3.3 Describe the function of different input and outputs of the given sensors and actuators along with its technical specifications. TLO 3.4 Write program to interface sensors and actuators for given IoT application.	**Unit - III IoT Sensors and Actuators** 3.1 Linear and Digital input devices, Sensors: LDR, PIR, LM35, DHT11, IR, Gas sensor-MQ 4 3.2 Actuators: Linear and Rotary Actuators, servo motor and servo drive, solenoid valve, motorised actuators relay, stepper motor, IoT enabled actuators 3.3 Programming and Interfacing sensors and actuators with Node MCU: Interfacing Temperature sensor- LM-35, Gas sensor -MQ 4, Humidity sensor- DHT11, Photo sensors- LDR, PIR, IR with NodeMCU (only technical specifications, pin diagram and working expected)	Video Demonstrations Lecture Using Chalk-Board Presentations Hands-on
4	TLO 4.1 Describe the given IoT communication protocol with suitable example. TLO 4.2 Write steps to connect NodeMCU to Wi-Fi network. TLO 4.3 Write step by step procedure to create web Server with NodeMCU. TLO 4.4 Select IoT platform for the given application with suitable reason. TLO 4.5 Describe the procedure for data communication using MQTT protocol. TLO 4.6 Describe the given IoT network technology with suitable application.	**Unit - IV IoT Communication Protocol** 4.1 IoT Protocols: HTTP-REST, MQTT, CoAP, LoRa, NbIoT (features, methods, communication, applications) 4.2 IEEE802.11: Wi-Fi (features, applications), configure Wi-Fi on NodeMCU, Wi-Fi libraries, code for connecting to Wi-Fi networks 4.3 Procedure to create webserver with NodeMCU 4.4 Introduction to IoT cloud platforms: AWS IoT, ThingSpeak, Google Cloud IoT, Microsoft Azure IoT. (Use cases and features) 4.5 Data Communication using MQTT with NodeMCU: connect to a broker, publish and subscribe topics, collect, send and receive data using MQTT 4.6 IoT networking technology : LoRa, NbIoT (Features and applications)	Lecture Using Chalk-Board Presentations Video Demonstrations Hands-on Flipped Classroom

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Explain the role of IoT in Industrial maintenance. TLO 5.2 Describe the integration of IoT in Agriculture. TLO 5.3 Illustrate IoT based smart city application with suitable sketch. TLO 5.4 Describe IoT based smart Energy meter with the help of block diagram. TLO 5.5 Describe IoT based surveillance system. TLO 5.6 Demonstrate IoT system for Smart home with the help of example. TLO 5.7 Explain the role of IoT in Electric vehicle for battery.	**Unit - V IoT Applications** 5.1 Industrial IoT (IIoT): predictive maintenance in manufacturing using IoT sensors to monitor equipment health and prevent failures 5.2 Agriculture: Green house control using IoT, Weather forecasting 5.3 Smart City: Street light control system, Traffic control System, Waste management 5.4 IoT based smart energy meter 5.5 IoT based surveillance system 5.6 Home automation: controlling lights, Fans and smart lock 5.7 EV(Electrical Vehicles) battery management using IoT (only basic working with conceptual block diagram)	Presentations Video Demonstrations Lecture Using Chalk-Board

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Establish a connection between the NodeMCU-ESP8266 and a computer using appropriate cables and drivers. LLO 1.2 Install and configure Arduino IDE for NodeMCU programming.	1	*Installation and configuration of Arduino IDE for NodeMCU	2	CO2
LLO 2.1 Interface LED and switch with NodeMCU to turn ON and OFF LED.	2	Interfacing LED and Switch with NodeMCU	2	CO2
LLO 3.1 Control relay operation using NodeMCU and IR sensor.	3	*Interfacing relay and IR sensor with NodeMCU	2	CO3
LLO 4.1 Measure and display humidity and temperature using DHT 11 and NodeMCU.	4	Interfacing Humidity sensor with NodeMCU	2	CO3
LLO 5.1 Motion detection using PIR sensor and NodeMCU.	5	Interfacing PIR Sensor with NodeMCU	2	CO3
LLO 6.1 Configure NodeMCU to connect to a Wi-Fi network and troubleshoot connectivity issue.	6	*Connecting NodeMCU to Wi-Fi network	2	CO4
LLO 7.1 Use HTTP protocol to send sensor data from NodeMCU to a web server (use any cloud service).	7	*Data Transmission from NodeMCU to Web Server.	2	CO4
LLO 8.1 Set up MQTT communication to publish and subscribe to topics using NodeMCU.	8	Implemention of MQTT Protocol with NodeMCU	2	CO4
LLO 9.1 Measure data from LDR to monitor light intensity and transmit it to cloud. LLO 9.2 Control intensity of LED according to the data received from cloud. (use any cloud service)	9	*Monitoring and controlling light intensity using NodeMCU	2	CO4

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 10.1 Design a smart home system using NodeMCU to Control the lights, Fans and Locking system. (use any cloud service)	10	*Implemention of IoT enabled Smart Home applications	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Interface a glucometer with Node MCU to measure glucose level and it to WebServer.
- Prepare a report of IoT based remote patient Monitoring system (case study).
- Develop IoT based Smart parking system for your institute using NodeMCU.
- Develop IoT Based IPL Scoreboard using NodeMCU to Display Live Score using Cricket API.

Assignment

- Describe the Use of IoT in Electrical Vehicles for Battery charging.
- Describe the architectural block diagram of ESP32 NodeMCU.
- Describe the Use of IoT in Drone Technology.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Acuators-5v Relay, DC Motor	3,10
2	Sensors:LDR-Light dependent resistor, IR- Infrared sensor, PIR sensor, DHT11-Humidity and temperature sensor.	3,4,5,7,9,10
3	Any open source cloud service available (viz. ThingSpeak/ Google cloud / Microsoft Azure/AWS/ others).	7,9,10
4	IoT Trainer kit using NodeMCU with switches and LED's	All
5	Computers/Laptops: with operating system windows 10 or higher version.	All

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
6	Software tools- Arduino IDE (open Source)	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Basics of Internet of Things (IoT)	CO1	6	2	6	4	12
2	II	Fundamental of NodeMcU	CO2	8	4	4	6	14
3	III	IoT Sensors and Actuators	CO3	10	2	4	12	18
4	IV	IoT Communication Protocol	CO4	8	2	4	6	12
5	V	IoT Applications	CO5	8	2	4	8	14
Grand Total				**40**	**12**	**22**	**36**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two offline unit test of 30 marks and average of two-unit test will considered for out of 30 marks.

For formative assessment of laboratory learning 25 marks.
Each practical will be assessed considering 60% weightage to process, 40% weightage to product.

Summative Assessment (Assessment of Learning)

- End semester assessment of 70 marks.

End semester summative assessment of 25 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	2	1	-	1	1	2			
CO2	3	3	3	2	1	1	2			
CO3	3	3	3	2	2	2	3			
CO4	2	2	1	2	1	2	2			
CO5	3	3	3	2	2	2	3			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Arshdeep Bahga, Vijay Madisetti	Internet of Things: A Hands-On Approach	University Press, ISBN: 9788173719547
2	Raj Kamal	INTERNET OF THINGS Architecture and Design Principles	McGraw Hill Education (India) Private Limited, ISBN: 9789390727384
3	Adrin McEwen & Hakim Cassimality	Designing the Internet of things	Wiley India, ISBN: 9781118430620
4	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton, Jerome Henry	IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things	Cisco Press, ISBN: 9781587144561
5	Richard Blum	Sams Teach Yourself Arduino™ Programming in 24 Hours	Pearson Education, Inc. ISBN: 9780672337123
6	Sudip Misra, Anandarup Mukherjee, Arijit Roy	Introduction to IoT	Cambridge University Press, ISBN:9781108842952
7	Rahul Dubey	An Introduction to Internet of Things: Connecting Devices, Edge Gateway, and Cloud with Applications	Cengage India Private Limited, ISBN: 9789353500931931

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_01300094497305395218 75_shared/overview	IoT Platform
2	https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_01329474210427699229893_shared/overview	"Mastering IoT with Arduino". Infosys Spring board online course for Thinkspeak platform.
3	https://www.arduino.cc/en/software	Arduino IDE software
4	https://www.tinkercad.com/projects?subject=arduino&sort=views	Arduino projects on Tinkercad
5	Introduction to Internet of Things - Course (nptel.ac.in)	Complete coverage of IoT
6	https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_01384301295320268828657_shared/overview	IoT Automation with ESP8266 with Projects
7	https://www.guru99.com/iot-tutorial.html	IoT Tutorial: Introduction to Internet of Things (IoT Basics)
8	https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_01300094497305395218 75_shared/overview	IoT Platform

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

MICROWAVE ENGINEERING & RADAR SYSTEM **Course Code : 315342**

Programme Name/s	**: Digital Electronics/ Electronics & Tele-communication Engg./ Electronics & Communication Engg./ Electronics Engineering/ Industrial Electronics/ Electronics & Computer Engg.**
Programme Code	**: DE/ EJ/ ET/ EX/ IE/ TE**
Semester	**: Fifth**
Course Title	**: MICROWAVE ENGINEERING & RADAR SYSTEM**
Course Code	**: 315342**

I. RATIONALE

The knowledge of microwave devices is essential for electronics and communication engineering diploma graduates and they need to assimilate it in order to maintain microwave devices used in telecommunication applications. The basic knowledge of microwave signal generation, propagation, amplification and measurement is vital to maintain RF communication systems. The real-life applications of this course are in point-to-point communication systems on the terrestrial layers, in RADAR, navigation and in space radio communications. This course will help to develop skills to use and maintain the microwave communication system.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help students to attain the following industry/employer expected outcome through various teaching learning experiences.
Maintain telecommunication systems which contains microwave components.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Select waveguide for given microwave communication system.
- CO2 - Test performance of microwave components.
- CO3 - Construct RF circuits using RF devices.
- CO4 - Interpret working of RADAR based systems for range detection.
- CO5 - Maintain SONAR and various types of RADAR systems as microwave application.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
315342	MICROWAVE ENGINEERING & RADAR SYSTEM	MAR	DSE	4	-	2	-	6	2	3	30	70	100	40	25	10	25#	10	-	-	150

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 10 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Define the given parameters of waveguide and transmission lines. TLO 1.2 Identify the relevant frequency band for microwave communication. TLO 1.3 Calculate the cut off wavelength, cut off frequency, characteristic wave impedence, group and phase velocities of the given rectangular waveguide. TLO 1.4 Describe with relevant sketch the field pattern of the given mode of rectangular waveguide. TLO 1.5 Distinguish rectangular waveguide and circular waveguide.	**Unit - I Fundamentals of Transmission Lines and Microwaves** 1.1 Transmission lines: Definitions of standing waves, VSWR, reflection coefficient 1.2 Microwave frequency spectrum, IEEE and OSHA (Occupational Safety And Health Administration) standards and band designations, advantages and disadvantages of microwave signals 1.3 Rectangular waveguide: Cut off wavelength, cut off frequency, characteristic wave impedance, group and phase velocities (Definitions, formulae and Simple numerical) structure, advantages, disadvantages and applications of rectangular waveguide 1.4 Rectangular waveguide modes :TE, TM, TEM, dominant mode, field patterns of TE10, TE20, TE11 modes only 1.5 Circular waveguide: Structure, advantages, disadvantages and applications of circular waveguide, field pattern of TE11 mode only	Lecture Using Chalk-Board Video Demonstrations Flipped Classroom Presentations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Suggest suitable microwave accessories for given application. TLO 2.2 Describe the procedure to build the microwave test bench setup to test given microwave passive component. TLO 2.3 Compare the performance of the given ferrite components. TLO 2.4 Describe with sketches working principle of microwave cavity resonators, phase shifters, Wilkinson power divider.	**Unit - II Microwave Components** 2.1 Microwave accessories: Rotating coupler, bends and corners, tapers and twists (only use and physical structure) 2.2 Multiple junctions: Construction, working principle and applications of E-plane tee, H-Plane tee, magic Tee (Hybrid Tee), rat race junction (Hybrid Ring) and directional couplers (directivity, coupling factor and isolation) 2.3 Ferrites components: Construction, working principle and applications of isolator, circulator and gyrator 2.4 Construction, working principle and applications of Microwave cavity resonators, phase shifters, Wilkinson power divider	Lecture Using Chalk-Board Model Demonstration Video Demonstrations Hands-on Collaborative learning
3	TLO 3.1 Describe frequency limitations of vacuum tubes at microwave frequency. TLO 3.2 Describe working of RF oscillators and amplifiers with neat sketches. TLO 3.3 Compare the performance of different types of microwave diodes. TLO 3.4 Explain the working of heterojunction bipolar transistors and high electron mobility transistor. TLO 3.5 Describe hazards of microwave radiation.	**Unit - III Microwave Tubes and Microwave Semiconductor Devices** 3.1 Limitations of vacuum tubes at microwave frequencies 3.2 Microwave tube oscillators and amplifiers: Reflex klystron, magnetron, gyrotrons, backward wave oscillator, Travelling wave tube 3.3 Microwave diodes: Varactor diode, Gunn diode, tunnel diode, PIN diode, IMPATT diode, TRAPATT diode, BARITT diode (Construction, working principle and applications) 3.4 Construction, working principle and applications : Heterojunction Bipolar Transistors (HBT's), High Electron Mobility Transistors (HEMT's) 3.5 Microwave radiation hazards: Types (HERO,HERP,HERF) and preventive measures from hazards	Lecture Using Chalk-Board Video Demonstrations Case Study Hands-on

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Define various terminologies with respect to RADAR. TLO 4.2 Calculate the maximum RADAR range for the given data. TLO 4.3 Explain with relevant sketches the given types of scanning and tracking methods used for RADAR. TLO 4.4 Describe properties and applications of surface clutter, sea clutter, land clutter with respect to RADAR. TLO 4.5 Describe display methods used in RADAR.	**Unit - IV RADAR Fundamentals** 4.1 Basic block diagram of RADAR system, Doppler effect, Definitions : Radar range, pulse width, Pulse Repetition Frequency (PRF), duty cycle 4.2 RADAR range equation derivation (simple numerical), significance of RADAR range, factors affecting RADAR range 4.3 Antenna Scanning types : Working principle of Horizontal, vertical, helical and spiral, Antenna Tracking types : Working principle of sequential, conical and mono pulse 4.4 Radar clutter : Properties and applications of surface clutter, sea clutter, land clutter 4.5 Display Methods: A-scope, PPI, RHI, RADAR Beacons	Lecture Using Chalk-Board Video Demonstrations Presentations Hands-on Site/Industry Visit
5	TLO 5.1 Describe the given application of microwave in detail. TLO 5.2 Describe basic principle of SONAR with neat sketch. TLO 5.3 Compare different types of RADARs for given application. TLO 5.4 Illustrate given microwave application in real life.	**Unit - V Microwave and RADAR System Applications** 5.1 Working principle of Microwave applications: Biomedical applications of microwaves, Remote Sensing RADAR, MST RADAR, RADAR Radiometer, RADAR based Navigation - Omni-directional ranges and Tactical Air Navigation System (TACAN), Instrument Landing System (ILS), Long Range Navigation system (LORAN) 5.2 SONAR system: Working principle and applications 5.3 Basic pulse RADAR system, CW Doppler RADAR, MTI RADAR (Block diagram, operation and applications) 5.4 Working principle of RADAR applications: Vehicle speed detection, Self-driving cars, Vehicle parking assistance system, Air traffic control system, Weather surveillance RADAR	Lecture Using Chalk-Board Presentations Case Study Site/Industry Visit Hands-on

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Calculate VSWR and reflection coefficient for given length of transmission line.	1	Measurement of VSWR and reflection coefficient for the given length of transmission line	2	CO1
LLO 2.1 Use the frequency meter with microwave test bench setup to determine the frequency and wavelength of waveguide for TE10.	2	* Determination of the frequency and wavelength of rectangular waveguide for TE10 mode	2	CO1

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 3.1 Test the output of microwave test bench setup to ensure power division in microwave tees E- plane, H- plane and E-H plane. LLO 3.2 Interpret the result from reading.	3	* Measurement of power division in microwave tees E- plane, H- plane and E-H plane using microwave test bench setup	2	CO2
LLO 4.1 Evaluate coupling factor and insertion loss of given circulator. LLO 4.2 Evaluate coupling factor and insertion loss of given Isolator.	4	* Determination of coupling factor and insertion loss of the given circulator and isolator	2	CO2
LLO 5.1 Calculate various parameters to test performance of microwave phase shifter.	5	Measurement of phase shift of microwave phase shifter	2	CO2
LLO 6.1 Test the performance of Reflex Klystron Microwave Tube. LLO 6.2 Calculate tuning range.	6	* Determination of tuning range of Reflex Klystron Microwave Tube	2	CO3
LLO 7.1 Test the performance of Gunn diode. LLO 7.2 Calculate output power and frequency.	7	Determination of output power and frequency of Gunn diode and plot its V-I characteristics	2	CO3
LLO 8.1 Use Doppler RADAR to detect maximum range.	8	* Determination of the maximum range of Doppler RADAR	2	CO4
LLO 9.1 Calculate the rotations per minute of a moving object (e.g., Fan, Pendulum,etc) based on RADAR.	9	Determination of the rotations per minute (RPM) of a moving object using RADAR	2	CO4
LLO 10.1 Investigate the effect of pulse repetition frequency on Radar range equation and observe the waveform. LLO 10.2 Observe the waveform of effect of radial velocity of the target on doppler frequency generation for various frequency bands. LLO 10.3 Test the effect of blind speed on the performance of MTI RADAR. LLO 10.4 Investigate the effect of pulse repetition frequency on clutter attenuation.	10	* Simulation of RADAR based practicals using any freeware/open-source simulation software	2	CO4 CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Build a RADAR working model using Cardboard, Gear motor, Switch, Battery, Color Paper,etc.
- Develop a RADAR working model using Arduino Uno, Servo Motor, Breadboard, Ultrasonic Sensor (HC-SR04), Jumper Wires, etc.
- Measure attenuation of the given attenuator using microwave test bench setup.

- Measure the gain of the Horn antenna using given microwave test bench setup.

Assignment

- Solve given numericals based on Cut off wavelength, cut off frequency, characteristic wave impedance, group and phase velocities of rectangular waveguide.
- Solve given numericals based on RADAR range equation.
- Draw neat sketches of RADAR systems.
- Study microwave components (active and passive) and draw neat sketches.
- Draw field patterns of TE and TM modes of rectangular waveguide.

Student activities

- Prepare a power point presentation on various types of microwave antennas.
- Prepare report on Comparative performance of microwave semiconductor devices/microwave tubes.
- To perform microwave waveguide simulations using freeware/Open source software's.
- Conduct a Library / Internet based survey of RADAR displays and submit detail report of it.
- Conduct a market survey of consumer microwave components and submit detail report of it.
- Prepare a poster on microwave radiation hazards and its protective measures.
- To Illustrate the working principle of the following a. Microwave Tubes b. EM wave propagation prepare /download an animation and share with the class.

Visit

- Visit a place where waveguides are used for microwave communication (such as earth Station, Radio station, telephone exchange, airport. TV broadcast, navigation center) and prepare the report.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Microwave Test Bench -X Band (Klystron based) / or any other equivalent, Klystron Power Supply, Klystron tube with Klystron mounts, Frequency meter, Variable attenuator, Detector mount, Wave guide stand, SWR meter and oscilloscope, E Plane Tee, H Plane Tee and Magic Tee Isolator and Circulator, Directional Coupler, Horn Antenna proto type	1,2,3,4,5,6
2	Desktop computer/Laptop, List of software : RF Tool box: MATLAB and SIMULINK or any other open source software like EZNEC, HFSS-CST, VSim, Microwave office	10

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
3	Microwave test bench -X Band (GUNN Diode based)/ or any other equivalent, Gunn oscillator, Gun power supply, PIN modulator, Isolator, Frequency meter, Variable attenuator, Detector mount, Wave guide stands, SWR Meter. Cables and accessories	7
4	RADAR Trainer Kit (X Band)/or any other equivalent technical specifications: Transmitting Frequency : 10 GHz, Output Power : 10 to 15mW, Operating Voltage : 8.6 V or adjustable, Antenna : Horn and parabolic dish with LNA and mounting , IF Output : Audio range, Power Supply : 230V +/- 10%, 50Hz	8,9

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Fundamentals of Transmission Lines and Microwaves	CO1	6	4	4	4	12
2	II	Microwave Components	CO2	6	2	4	6	12
3	III	Microwave Tubes and Microwave Semiconductor Devices	CO3	10	2	8	6	16
4	IV	RADAR Fundamentals	CO4	8	4	4	6	14
5	V	Microwave and RADAR System Applications	CO5	10	6	4	6	16
Grand Total				**40**	**18**	**24**	**28**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two offline unit tests of 30 marks and average of two unit test marks will be considered for out of 30 marks.

Summative Assessment (Assessment of Learning)

- End semester assessment of 70 marks. End semester summative assessment of 25 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	1	2	1	-	1	2			
CO2	1	2	2	2	-	1	2			

CO3	1	2	2	2	1	2	2			
CO4	2	2	1	2	2	2	3			
CO5	3	3	3	3	2	1	3			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	D. M. Pozar	Microwave Engineering	John Wiley Publication;4th edition (2013) ISBN: 978-8126541904
2	R. E. Collins	Foundation for Microwave Engineering	Wiley Publication;2nd edition (2007) ISBN: 978-8126515288
3	V. C. Kshirsagar	Microwave and RADAR Engineering	Synergy knowledgeware, Mumbai. ISBN: 978-93-833-5228-9
4	K.K. Sharma	Fundamentals of Microwave and RADAR Engineering	S.Chand and Company New Delhi,2011, ISBN:9788121935371
5	B. Smith and M. H. Carpentier	The Microwave Engineering Handbook (E-Book)	Springer International Publication;1st edition
6	Terman, Frederick Emmons:	Electronic and Radio Engineering	McGraw-Hill,Fourth Edition,ISBN:601421982320:
7	Merrill Skolnik	Introduction to Radar Systems	McGraw-Hill,ISBN-13: 978-0070445338, ISBN-10: 9780070445338

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://onlinecourses.nptel.ac.in/noc24_ee115/preview	Swayam NPTEL videos on Microwave Engineering
2	https://onlinecourses.nptel.ac.in/noc23_ee133/preview	Swayam NPTEL videos on Principles And Techniques Of Modern Radar Systems
3	https://home.sandiego.edu/~ekim/e194rfs01/	University of San Diego EEE 194 Section 4: RF & Microwave Engineering Spring 2001
4	https://youtu.be/uPXLJfmrCUA?si=OQzaEtDiZeMjrnqV	Design E plane tee using cst microwave studio
5	https://youtu.be/EoWDC4FJK7Q?si=bSJ8Fz8Vb6NsbqG4	Design H Plane Tee using CST microwave studio
6	https://youtu.be/pGbY59Q9smo?si=QrVy6HUM83g87tdU	Design and analysis of Magic Tee.
7	https://portal.coepvlab.ac.in/vlab/auth/home?dept=2&lab=2	Virtual Microwave Lab (IIT Dayalbagh)

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students