SEMINAR AND PROJECT INITIATION COURSE **Course Code : 31500**

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 Software 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/ Manufacturing Technology/ Metallurgical Engineering/ Production Engineering/ Computer Science/ Electronics & Computer Engg.**
Programme Code	**: AE/ AI/ AN/ AO/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CST/ CW/ DE/ DS/ EE/ EJ/ EK/ EP/ ET/ EX/ HA/ IE/ IF/ IH/ LE/ ME/ MK/ MRT/ MY/ 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 th subject /themes of emerging technologies and services of their area of studies. Project initiation enhances project planning skill whic 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 tl 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)**

INTERNSHIP(12 WEEKS) **Course Code : 315004**

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 Software 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/ Manufacturing Technology/ Metallurgical Engineering/ Production Engineering/ Computer Science/ Electronics & Computer Engg.**
Programme Code	**: AE/ AI/ AN/ AO/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CST/ CW/ DE/ DS/ EE/ EJ/ EK/ EP/ ET/ EX/ HA/ IE/ IF/ IH/ LE/ ME/ MK/ MRT/ MY/ 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

INTERNSHIP(12 WEEKS) **Course Code : 315004**

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 (for Working Professionals between 6th and 7th semester) for 12 weeks i.e. commencement of internships will be immediately following the 4th semester (6th semester for Working Professionals) 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 (for Working Professionals 6th Semester)
2	Allocations of Student and Mentor as per availability (Mentor: Student Ratio (1:15)	4th to 6th week of 4th semester (for Working Professionals 6th Semester)
3	Communication with Industry and obtaining its confirmation Sample letter Format	6th to 8th week of 4th semester (for Working Professionals 6th Semester)
4	Securing consent letter from parents/guardians of students (Sample Format 2)	Before 10th week of 4th semester (for Working Professionals 6th Semester)
5	Enrollment of Students for industrial training (Format 3)	Before 12th week of 4rd semester (for Working Professionals 6th Semester)

INTERNSHIP(12 WEEKS) **Course Code : 315004**

6	Issue of letter to industry for training along with details of students and mentor (Format 4)	Before 14th week of 4th Semester (for Working Professionals 6th Semester)
7	Organize Internship Orientation session for students	Before end of 4th Semester (for Working Professionals 6th 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 (for Working Professionals 7th Semester)

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	

INTERNSHIP(12 WEEKS) **Course Code : 315004**

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)**	

INTERNSHIP(12 WEEKS) **Course Code : 315004**

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 :

INTERNSHIP(12 WEEKS) **Course Code : 315004**

Format-3: Students Enrollment for Industrial Training

(Academic Year –)

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

INTERNSHIP(12 WEEKS) **Course Code : 315004**

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.

INTERNSHIP(12 WEEKS) **Course Code : 315004**

INTERNSHIP(12 WEEKS) **Course Code : 315004**

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			

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RAPID PROTOTYPING SYSTEMS **Course Code : 315008**

Programme Name/s : Mechatronics

Programme Code : MK

Semester : Fifth

Course Title : RAPID PROTOTYPING SYSTEMS

Course Code : 315008

I. RATIONALE

Rapid prototyping methods are vital in modern engineering, manufacturing, and design because they allow ideas to be quickly transformed into functioning prototypes. This topic teaches diploma students skills such as solid modeling and 3D printing of cost-effective components. It prepares students to flourish in industrial situations by encouraging creativity, efficiency and practical problem-solving skills.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Apply Rapid Prototyping systems to produce cost-effective 3D printed components.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Develop a 3D solid model for a given drawing.
- CO2 - Select a relevant rapid prototyping process.
- CO3 - Select relevant material for manufacturing of prototype.
- CO4 - Develop the given prototype by using the FDM 3D printing process.

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	
315008	RAPID PROTOTYPING SYSTEMS	RPS	DSC	2	-	4	-	6	2	-	-	-	-	-	50	20	50#	20	-	-	100

RAPID PROTOTYPING SYSTEMS **Course Code : 315008**

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 Select relevant parametric solid modeling software with justification. TLO 1.2 Choose sketcher tools for 2D Drawing. TLO 1.3 Use different modeling tools for 3D Drawing. TLO 1.4 Identify different steps of 3D models for the parts of the given assembly with minimum tree.	**Unit - I Solid Modeling for Rapid Prototyping** 1.1 Overview of parametric solid modeling software 1.2 Drawing/Sketcher, Editing, modify tools: Line, Rectangle, Circle, Trim, Spline, Mirror, etc. 1.3 Dimensioning constraint and Geometrical constraint. 1.4 Part tool: Extrude, Hole, Revolve, Rib, Sweep, swept blend, Pattern, etc. 1.5 Part Editing tool: Trim, Extend, Erase, Mirror etc. 1.6 Part Modify tool: Chamfer, Round, Copy, Move, Draft, etc.	Chalk-Board Presentations Video
2	TLO 2.1 Explain the concept of Rapid Prototyping. TLO 2.2 Select relevant rapid prototyping process with justification.	**Unit - II Introduction to Rapid Prototyping** 2.1 Definition and the concept of Rapid Prototyping (Additive Manufacturing) 2.2 Differences between AM and traditional manufacturing, advantages and limitations. 2.3 Types of Additive Manufacturing Technologies : Stereolithography (SLA), Selective Laser Sintering (SLS), Fused Deposition Modeling (FDM), Digital Light Processing (DLP) , Electron Beam Melting (EBM), Laminated Object Manufacturing (LOM) . Applications, advantages and limitations 2.4 Introduction to 3D Scanner	Chalk-Board Video Presentations

RAPID PROTOTYPING SYSTEMS **Course Code : 315008**

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 the FDM process cycle. TLO 3.2 Select relevant material in the FDM printing process. TLO 3.3 Explain working of the FDM 3D printer and its Parts.	**Unit - III FDM 3D Printing** 3.1 Introduction to the FDM Process 3.2 Generic FDM Process cycle 3.3 Materials for FDM Process PLA, PETG, Nylon, ABS etc. Applications, advantages and limitations 3.4 Working of FDM 3D printer and its Parts- Nozzle, Print Bed, Belts, Motors etc.	Chalk-Board Video Presentations
4	TLO 4.1 Select printing parameters for creating parts. TLO 4.2 Apply post processing operations on 3D printed parts.	**Unit - IV Software and Post processing** 4.1 Overview of Printing Software (Slicer) 4.2 Basic printing process parameters : Layer Height, Shell thickness, Infill Density, Infill Pattern etc 4.3 Post processing : Support removal and Surface Finishing, Painting etc.	Chalk-Board videos 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 Draw Circle, Rectangle, ellipse and simple 2D component using sketcher commands.	1	*Use the sketcher command to draw simple 2D components.	2	CO1
LLO 2.1 Draw Simple 2D components using Trim, Mirror, move, copy commands.	2	*Use the Modify command to draw simple 2D components.	2	CO1
LLO 3.1 Draw Universal coupling using 2D sketcher commands.	3	Use 2D sketcher commands to draw a given component.	2	CO1
LLO 4.1 Develop 3D model of Cylinder, cube, rectangular plate using 3D modeling commands.	4	*Draw component using 3D modeling commands.	2	CO1
LLO 5.1 Develop 3D model of tool post using 3D modeling commands.	5	*Draw 3D model of assembly-1 using basic commands.	2	CO1
LLO 6.1 Develop 3D model of Drill jig using 3D modeling commands.	6	Draw 3D model of assembly-2 using basic commands	2	CO1
LLO 7.1 Develop a 3D model of Oldham's coupling using 3D modeling commands.	7	Draw a 3D model of assembly-3 using basic commands.	2	CO1
LLO 8.1 Develop a 3D model of Universal coupling using 3D modeling commands.	8	*Draw 3D model of assembly-4 using basic commands.	2	CO1
LLO 9.1 Identify different Rapid prototyping processes to prepare prototype models and give justification.	9	Rapid prototyping process	2	CO2
LLO 10.1 Identify different filament materials for FDM 3D printing and give justification.	10	FDM 3D Printing filament	2	CO3
LLO 11.1 Tessellation of CAD file to STL file using printing parameters	11	*Convert the CAD model and configure print settings for optimal results.	2	CO4
LLO 12.1 Apply Print-Bed Calibration and load filament	12	*Print-bed calibration and loading of the filament.	2	CO4

RAPID PROTOTYPING SYSTEMS **Course Code : 315008**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 13.1 Develop the 3D print model of the cube using PLA filament.	13	Print a 3D model of a Solid component	2	CO4
LLO 14.1 Develop a 3D model of any sliding pair of square blocks and square bars using PETG /ABS/Nylon filament.	14	*Print sliding pair using FDM 3D print model.	2	CO4
LLO 15.1 Develop a given Gear Pair 3D print model using different filaments. PETG /ABS/Nylon filament	15	Print FDM 3D model of any Gear Pair.	2	CO4
LLO 16.1 Generate support for curved overhang model	16	Print curved overhang model using FDM 3D printer.	2	CO4
LLO 17.1 Generate support for the square overhang model	17	*Print Square Overhang model using FDM 3D printer	2	CO4
LLO 18.1 Apply Post process to the 3D printed object.	18	Post-process operations to the overhang prototype.	2	CO4
LLO 19.1 Develop ASTM D 638 Tensile Test specimen using PLA filament.	19	*Print the given ASTM D 638 3D print model.	2	CO4
LLO 20.1 Develop Knuckle Joint 3D print model using PLA filament.	20	Print Knuckle Joint 3D model.	2	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) : NOT APPLICABLE

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Hardware: FDM 3D Printer	8,9,10,11,12,13,14,15,16,17,18
2	Software: 3D printing software (slicing software).	8,9,10,11,12,13,14,15,16,17,18
3	Filament PLA, PETG, Nylon, ABS	8,9,10,11,12,13,14,15,16,17,18
4	Hardware: Personal Computer, (i3/i5 or higher),RAM min.4GB.Display wide screen preferable	All
5	Operating system: Windows 7/ Windows 8/ Windows 10 or Higher.	All
6	Software: Any parametric solid modeling software	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	Solid Modeling for Rapid Prototyping	CO1	5	0	0	0	0
2	II	Introduction to Rapid Prototyping	CO2	6	0	0	0	0

RAPID PROTOTYPING SYSTEMS **Course Code : 315008**

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
3	III	FDM 3D Printing	CO3	5	0	0	0	0
4	IV	Software and Post processing	CO4	4	0	0	0	0
Grand Total				**20**	**0**	**0**	**0**	**0**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Lab Wok , Viva

Summative Assessment (Assessment of Learning)

- Practical Exam

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	3	2	2	1	1	-	1			
CO2	3	2	2	-	1	-	1			
CO3	3	2	2	-	1	-	1			
CO4	3	2	2	-	1	-	1			

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	Prof. Sham Tickoo	CATIA V5-6R2023 for Designers	CADCIM Technologies, 21 st Edition 2024,ISBN:-978-1640572409.
2	Prof. Sham Tickoo	Solid Edge ST10 for Designers	BPB,15 th Edition, 2018, ISBN:-978-9387284104.
3	Prof. Sham Tickoo	SOLIDWORKS 2023 for Designers	CADCIM Technologies, USA, 21st edition, 2024, ISBN:-978-1-64057-172-3
4	Ian Gibson, David W. Rosen, Brent Stucker.	Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing	Springer, 2nd Edition, 2014, ISBN:-978-1493921133

RAPID PROTOTYPING SYSTEMS **Course Code : 315008**

Sr.No	Author	Title	Publisher with ISBN Number
5	Ben Redwood, Mr.Filemon Schoffer, Mr.Brian Garret.	The 3D Printing Handbook: Technologies, design and applications	3D Hubs, First Edition, 2017, ISBN:-978-9082748505
6	Sheku Kamara, Kathy S. Faggiani	Fundamentals of Additive Manufacturing for the Practitioner	Wiley, First addition 2021, ISBN:-978-1-119-75038-3
7	Tyler Kerr	3D Printing Introduction to Accessible, Affordable Desktop 3D Printing	Springer Cham, First addition 2022, ISBN978-3-031-19352-1
8	Gary C. Confalone, John Smits, Thomas Kinnare	3D Scanning for Advanced Manufacturing, Design, and Construction	Wiley, First addition,2023 ISBN: 978-1-119-75851-8

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=vjX4PDJcFOI	Solid Modeling
2	https://www.youtube.com/watch?v=t7yv4gSnNkE	Fundamentals of Additive Manufacturing Technologies
3	https://www.youtube.com/watch?v=9JTRqfNAqhM	Introduction to Additive Manufacturing
4	https://www.youtube.com/watch?v=htMr1oFE7Zg	CAD Models for Additive Manufacturing

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**

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MAINTENANCE OF INDUSTRIAL MECHATRONIC SYSTEMS **Course Code : 315009**

Programme Name/s : **Mechatronics**
Programme Code : **MK**
Semester : **Fifth**
Course Title : **MAINTENANCE OF INDUSTRIAL MECHATRONIC SYSTEMS**
Course Code : **315009**

I. RATIONALE

Maintenance of industrial mechatronics systems encompasses strategic requirements such as avoid accident and breakdown. Also minimizing downtime, enhancing reliability, ensuring safety and compliance, optimizing efficiency, supporting quality assurance, and smoothing workforce development. These aspects collectively contribute to sustained operational excellence, cost-effectiveness, and competitive advantage in industrial sectors depending on mechatronics technology.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Maintain different industrial mechatronics system.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Apply different industrial maintenance methods.
- CO2 - Troubleshoot electrical and electronic systems in industry.
- CO3 - Troubleshoot mechanical systems in industry.
- CO4 - Troubleshoot industrial robotics systems.

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	
315009	MAINTENANCE OF INDUSTRIAL MECHATRONIC SYSTEMS	MIM	SEC	1	-	2	-	3	1	-	-	-	-	-	50	20	25@	10	-	-	75

MAINTENANCE OF INDUSTRIAL MECHATRONIC SYSTEMS **Course Code : 315009**

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 importance of industrial Maintenance. TLO 1.2 Describe the types of Maintenance. TLO 1.3 Prepare maintenance plan for mechatronics system. TLO 1.4 Discuss the role and responsibilities of a Mechatronics Maintenance Specialist and steps for troubleshoot.	**Unit - I Fundamental of Industrial Maintenance.** 1.1 Importance of industrial maintenance. 1.2 Types of maintenance: (a) Preventive maintenance (b) Corrective maintenance (c) Total productive maintenance (TPM). 1.3 Prepare Maintenance chart for mechatronics system, fault diagnosis, troubleshoot, repair.	Video Demonstrations Presentations Lecture Using Chalk-Board Hands-on
2	TLO 2.1 Explain importance of drive system and sensor. TLO 2.2 Identify various faults, causes and suggest remedy for failure in servo motor, stepper motor. TLO 2.3 Identify various faults, causes and suggest remedy for failure in sensor. TLO 2.4 Identify various faults causes and suggest remedy for failure in microcontrollers and PLC. TLO 2.5 Prepare maintenance chart for electrical and electronic system. TLO 2.6 Explain safety precaution.	**Unit - II Maintenance of Electrical and Electronic System.** 2.1 Discuss importance of drive system:(a) servo motor (b)stepper motor, and sensor: position sensors, velocity sensors, pressure and torque sensor. 2.2 Explain maintenance of drive system and sensor. 2.3 Explain maintenance of microcontrollers and PLC. 2.4 Explain safety precaution taken during electrical and electronic maintenance.	Video Demonstrations Presentations Lecture Using Chalk-Board Hands-on

MAINTENANCE OF INDUSTRIAL MECHATRONIC SYSTEMS **Course Code : 315009**

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 Identify various faults, causes and suggest remedy for failure in industrial hydraulic pump. TLO 3.2 Identify various faults, causes and suggest remedy for failure in compressors. TLO 3.3 Identify various faults, causes and suggest remedy for failure in valve. TLO 3.4 Identify various faults, causes and suggest remedy for failure in actuator. TLO 3.5 Explain safety precaution.	**Unit - III Maintenance of mechanical system.** 3.1 Explain maintenance of hydraulic pump: Gear pump, Vane pump, lobe pump, axial piston pump. 3.2 Explain maintenance of compressor: vane and screw compressor. 3.3 Explain maintenance of industrial valve and actuator: pressure control valve, pressure relief valve, pressure reducing valve, sequence valve, and linear and rotary actuators. 3.4 Explain leakage finding in hydraulic and pneumatic system. 3.5 Explain safety precaution taken during industrial mechanical maintenance.	Video Demonstrations Presentations Lecture Using Chalk-Board Hands-on
4	TLO 4.1 Describe need of industrial robot and CNC machine. TLO 4.2 Identify fault in industrial robot. TLO 4.3 Implement remedial action to remove minor fault in robot. TLO 4.4 Identify fault in CNC machine. TLO 4.5 Implement remedial action to remove minor fault in CNC machine. TLO 4.6 Describe the interlocking of robot. TLO 4.7 Explain safety precaution.	**Unit - IV Maintenance of industrial robot and CNC machine.** 4.1 Discuss common trouble and suggest remedy in robot operation and CNC machine. 4.2 Introduction on interlocking of robot. 4.3 Explain safety precaution taken during industrial robot and CNC machine maintenance.	Video Demonstrations Presentations Lecture Using Chalk-Board 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 Troubleshoot servo motor, give their causes and suggest remedy. LLO 1.2 Troubleshoot stepper motor, give their causes and suggest remedy. LLO 1.3 Install and test of electrical drive system. LLO 1.4 Follow safety precautions.	1	* Troubleshoot electrical drive system.	2	CO1 CO2
LLO 2.1 Troubleshoot pressure sensor and velocity sensor, give their causes and suggest remedy. LLO 2.2 Troubleshoot position sensor and torque sensor, give their causes and suggest remedy. LLO 2.3 Install and test given sensor. LLO 2.4 Follow safety precautions.	2	Troubleshoot sensors.	2	CO1 CO2

MAINTENANCE OF INDUSTRIAL MECHATRONIC SYSTEMS **Course Code : 315009**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 3.1 Develop preventive maintenance chart for electrical system. LLO 3.2 Develop preventive maintenance chart for electronics system.	3	Prepare preventive maintenance chart, checklist for electrical/electronic system.	2	CO1 CO2
LLO 4.1 Troubleshoot Gear pump and Vane Pump, give their causes and suggest remedy. LLO 4.2 Troubleshoot lobe pump, axial piston pump, give their causes and suggest remedy. LLO 4.3 Install and test of given hydraulic pump. LLO 4.4 Follow safety precautions.	4	* Troubleshoot hydraulic pump.	2	CO1 CO3
LLO 5.1 Troubleshoot Vane compressor, give their causes and suggest remedy. LLO 5.2 Troubleshoot Screw compressor, give their causes and suggest remedy. LLO 5.3 Install and test of given Compressor. LLO 5.4 Follow safety precautions.	5	Troubleshoot Compressor.	2	CO1 CO3
LLO 6.1 Troubleshoot pressure control valve, pressure relief valve, pressure reducing valve, sequence valve, give their causes and suggest remedy. LLO 6.2 Troubleshoot Linear and rotary actuators give their causes and suggest remedy. LLO 6.3 Install and test of given valve and actuator. LLO 6.4 Follow safety precautions.	6	*Troubleshoot valve and actuator.	2	CO1 CO3
LLO 7.1 Develop preventive maintenance chart for hydraulic pump system. LLO 7.2 Develop preventive maintenance chart for compressor system. LLO 7.3 Develop preventive maintenance chart for valve. LLO 7.4 Develop preventive maintenance chart for actuator.	7	Prepare preventive maintenance chart, checklist for mechanical system.	2	CO1 CO3
LLO 8.1 Troubleshoot Microcontroller, give their causes and suggest remedy. LLO 8.2 Troubleshoot PLC, give their causes and suggest remedy. LLO 8.3 Install and test of given microcontroller and PLC. LLO 8.4 Follow safety precautions.	8	*Troubleshoot microcontroller and PLC.	2	CO1 CO2
LLO 9.1 Troubleshoot industrial robot. LLO 9.2 Repair/Replace minor fault in industrial robot. LLO 9.3 Follow safety precautions.	9	*Troubleshoot industrial robot.	2	CO1 CO4

MAINTENANCE OF INDUSTRIAL MECHATRONIC SYSTEMS **Course Code : 315009**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 10.1 Troubleshoot CNC machine. LLO 10.2 Repair/ replace minor fault in CNC machine system. LLO 10.3 Follow safety precaution.	10	*Troubleshoot CNC machine.	2	CO1 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

- Not Applicable.

Assignment

- Not Applicable.

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	CNC lathe/milling machine 250 with standard accessories and multi controller changing facility with simulated control panel.	10
2	AC or DC servo motor (12V to 480V AC or DC), Stepper Motor (Bipolar or unipolar stepper motor from a few volts to 48V DC).	2
3	Position Sensors (Typically 5-24V DC), Velocity Sensors (Typically 5-24V DC), Pressure Sensors (Typically 5-24V DC), Torque Sensors (Typically 5-24V DC).	3
4	Gear Pump (up to 250 bar (3625 psi)), Vane Pump (up to 210 bar), Lobe Pump (up to 15 bar (217 psi)), Axial Piston Pump (up to 420 bar (6091 psi)).	4
5	pressure control valve, pressure relief valve, pressure reducing valve, sequence valve, Linear and rotary Actuator.	5,6

MAINTENANCE OF INDUSTRIAL MECHATRONIC SYSTEMS **Course Code : 315009**

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
6	PLC kit (minimum 8 input/output) and Microcontroller kit.	8
7	Programmable robot trainer kit with standalone servo controller as well as compatible PLC interface with following features: (1) Minimum three linkages (2) Minimum four degree of freedom (3) Different mechanical end effectors (4) Various sensors (5) Compatible robot vision system for inspection.	9
8	General Tools like Adjustable Wrench (e.g., 6 inches, 10 inches), Screwdrivers, Socket Wrench Set (e.g., 1/4-inch, 3/8-inch, 1/2-inch drive), Pliers, Multimeter (Digital) Ammeter (0-25 mA), Voltmeter (0-5V, 0-10V DC). Allen Wrench (Hex Key Set- e.g., 1.5 mm, 2 mm, 3/16 inch), Hammer, Safety Glasses.	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	Fundamental of Industrial Maintenance.	CO1	2	0	0	0	0
2	II	Maintenance of Electrical and Electronic System.	CO2	2	0	0	0	0
3	III	Maintenance of mechanical system.	CO3	3	0	0	0	0
4	IV	Maintenance of industrial robot and CNC machine.	CO4	3	0	0	0	0
Grand Total				**10**	**0**	**0**	**0**	**0**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Lab. Performance, viva voce

Summative Assessment (Assessment of Learning)

- Lab. Performance, viva voce

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	3	2	-	2	2	-	2			

MAINTENANCE OF INDUSTRIAL MECHATRONIC SYSTEMS **Course Code : 315009**

CO2	3	2	2	2	2	-	2			
CO3	3	2	2	2	2	-	2			
CO4	3	2	2	2	2	-	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	R. Keith Mobley.	Maintenance Fundamental	Elsevier Butterworth–Heinemann ISBN: 0750677988, Year 2020.
2	Majumdar S. R.	Oil Hydraulic System- principles and Maintenance.	Tata Mc Graw Hill, ISBN: 9780074637487, Year 2018.
3	Majumdar S. R.	Pneumatic System- principles and Maintenance.	Tata Mc Graw Hill, ISBN: 9780074637487, Year 2017.
4	Madhvi Gupta.	Installation Maintenance and Repair of Electrical Machines and Equipment's.	S.K. Kataria & Sons, ISBN: 9789350145463, Year -2019.
5	Dr. R.S. Khandpur.	TROUBLESHOOTING ELECTRONIC EQUIPMENT: Includes Repair and Maintenance.	McGraw-Hill Education (India) Private Limited, ISBN: 9780070483576, Year-2019.
6	Mark R. Miller, Rex Miller.	Robots and Robotics: Principles, Systems, and Industrial Applications.	McGraw-Hill Education, ISBN: 9781259859786, Year 2017.

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://youtu.be/f58SW0Hwcf0	Maintenance System
2	https://youtu.be/SR47RaA1Zdk	Hydraulic and pneumatic system.
3	https://youtu.be/nE1C4ghfvac?list=PLgMDNELGJ1CbufZjqWa8uoSlQWKqVwPN7	Sensor and Actuator
4	https://youtu.be/Tp724MqrosA	Stepper motor
5	https://youtu.be/ditS0a28Sko	Servo motor

Note :

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

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EMERGING TRENDS IN MECHANICAL ENGINEERING **Course Code : 315363**

Programme Name/s	**: Automobile Engineering./ Mechanical Engineering/ Mechatronics/ Manufacturing Technology/ Production Engineering**
Programme Code	**: AE/ ME/ MK/ MRT/ PG**
Semester	**: Fifth**
Course Title	**: EMERGING TRENDS IN MECHANICAL ENGINEERING**
Course Code	**: 315363**

I. RATIONALE

As new technologies rapidly transform the manufacturing industry and related sectors, this course on Emerging Trends in Mechanical Engineering is designed to equip diploma pass outs with the latest knowledge essential for their professional growth. The course covers key areas such as green fuels, autonomous and sustainable maintenance practices, data analytics in manufacturing, and the integration of autonomous vehicles. It also explores the use of drones and autonomous technologies in agriculture. By focusing on these current trends, the course aims to enhance the skills of Mechanical, Automobile, Production, and Mechatronics diploma engineers, preparing them to excel in a rapidly evolving technological environment.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Adopt recent trends in mechanical engineering across various mechanical and allied industries.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Select appropriate green fuels for various applications for considering environmental sustainability.
- CO2 - Apply the principles of Autonomous and Sustainable maintenance practices in industry to improve equipment reliability and efficiency.
- CO3 - Identify the levels of autonomy in various mobility systems.
- CO4 - Use data analytics techniques to improve manufacturing processes and systems.
- CO5 - Utilize automated equipment and technologies for various agricultural 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	
315363	EMERGING TRENDS IN MECHANICAL ENGINEERING	ETM	DSC	3	-	-	-	3	1	1.5	30	70*#	100	40	-	-	-	-	-	-	100

EMERGING TRENDS IN MECHANICAL ENGINEERING **Course Code : 315363**

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 Explain the concept of green fuels, including their benefits and advantages. TLO 1.2 Differentiate between the various classes of green fuels based on their sources and production methods. TLO 1.3 Describe different types of green fuels derived from plants.	**Unit - I Green Fuels** 1.1 Green Fuels: Introduction, Characteristics, Benefits and advantages. 1.2 Classes of Green Fuels: 1st Generation, 2nd Generation, 3rd Generation and 4th Generation Green Fuels 1.3 Types and Applications of Green Fuels: Biofuel, Hydrogen fuel, Synthetic fuel, Algae fuel, Bio diesel from plants, Applications of Green Fuels in Automobile, Power and Heat, Aerospace sectors.	Lecture Using Chalk-Board Presentations Video Demonstrations
2	TLO 2.1 Explain the concepts of data analytics, including its types and techniques. TLO 2.2 Describe the role of a data analyst in the manufacturing industry. TLO 2.3 Explain the characteristics of big data and its applications in manufacturing processes.	**Unit - II Recent trends in Manufacturing systems** 2.1 Big Data in Manufacturing: Introduction, Big Data Characteristics, Benefits 2.2 Data Analytics in manufacturing: Introduction, Steps in Data Analytics, Types of Data Analytics, Data Analytics techniques, Applications of Big Data analytics in Manufacturing – Preventive maintenance, Product Design, Production Management Automation, Customer Experience, Supply Chain Improvement, Benefits. 2.3 Data Analytics in Quality Control: Introduction, Applications, Benefits.	Lecture Using Chalk-Board Video Demonstrations Presentations

EMERGING TRENDS IN MECHANICAL ENGINEERING **Course Code : 315363**

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 the levels of autonomy in mobility systems. TLO 3.2 Describe the systems used in autonomous vehicles such as Advanced Driver Assistance Systems (ADAS) and Full Self-Driving (FSD) technologies. TLO 3.3 State the application of Autonomous Vehicles for given mobility system.	**Unit - III Autonomous Vehicles** 3.1 Autonomy in Mobility Systems (Autonomous Vehicle): Levels, Components, Benefits and Challenges. 3.2 Systems used in Autonomous Vehicles: Advanced Driver Assistance Systems (ADAS) and Full Self-Driving (FSD) 3.3 Applications of Autonomy in other Mobility Systems: Autonomous Trains, Autonomous Ships, Autonomous Aircrafts (Unmanned Aircraft Systems (UAS)	Lecture Using Chalk-Board Presentations Video Demonstrations
4	TLO 4.1 Describe the concept of Autonomous and Sustainable Maintenance, including the pillars of Total Productive Maintenance (TPM). TLO 4.2 Explain the procedures of Autonomous and Sustainable Maintenance along with their benefits. TLO 4.3 Describe the role of data analytics in Predictive Maintenance. TLO 4.4 Explain the concept of Computerized Maintenance Management Systems (CMMS).	**Unit - IV Recent Trends in Maintenance** 4.1 Autonomous Maintenance: Concept, Pillars of TPM, Implementation steps, benefits. 4.2 Sustainable Maintenance: Concept, Importance, Implementation steps, benefits. 4.3 Data Analytics in Predictive Maintenance: Introduction, concept of Computerized Maintenance Management System (CMMS).	Lecture Using Chalk-Board Video Demonstrations Presentations
5	TLO 5.1 Explain the role of automation in agriculture field. TLO 5.2 Describe the benefits of automated farm equipment. TLO 5.3 Describe the features and advantages of autonomous tractors and their impact on enhancing agricultural practices. TLO 5.4 Describe the applications and advantages of using drones in agriculture sector. TLO 5.5 Explain significant features of government schemes supporting drone usage in agriculture field.	**Unit - V Recent Trends in Agriculture Engineering** 5.1 Automation in Agriculture: Introduction, Automated Farm Equipments - Agri-robots, Harvesting robots, Inspection and Monitoring Agriculture robots, Automatic Seeding and Planting Machine, AI Operated Irrigation Systems, Benefits 5.2 Autonomous Tractor: Self Driving Tractors, Features and Advantages 5.3 Agricultural Drones: Soil and Field Analysis, Crop Monitoring, Plantation, Crop Spraying, Advantages of Drones, Government Schemes for Drone Usage.	Lecture Using Chalk-Board Presentations Video Demonstrations

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES : NOT APPLICABLE.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING) : NOT APPLICABLE

EMERGING TRENDS IN MECHANICAL ENGINEERING **Course Code : 315363**

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Not Applicable	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	Green Fuels	CO1	5	2	4	4	10
2	II	Recent trends in Manufacturing systems	CO2	6	4	4	8	16
3	III	Autonomous Vehicles	CO3	6	4	4	6	14
4	IV	Recent Trends in Maintenance	CO4	6	2	4	8	14
5	V	Recent Trends in Agriculture Engineering	CO5	7	4	4	8	16
Grand Total				**30**	**16**	**20**	**34**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two Class test of 30 Marks and Average of two Class test

Summative Assessment (Assessment of Learning)

- Online MCQ based examination - 70 marks

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	3	-	-	-	2	-	3			
CO2	3	-	-	-	2	-	3			
CO3	3	-	-	-	2	-	3			
CO4	3	-	-	-	2	-	3			
CO5	3	-	-	-	3	-	3			

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

EMERGING TRENDS IN MECHANICAL ENGINEERING **Course Code : 315363**

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Carlos Ricardo Soccol, Satinder Kaur Brar, Craig Faulds, Luiz Pereira Ramos	Green Fuels Technology: Biofuels (Green Energy and Technology)	Springer International Publishing AG; 1st ed. 2016 edition (19 August 2016); 01149344934, ISBN-13: 978-3319302034
2	Fumio Gotoh	Autonomous Maintenance in Seven Steps: Implementing TPM on the Shop Floor	1st Edition, Productivity Press, ISBN-13: 978-0367199869
3	Samuel Theodore, Daniel Lucky	Autonomous Maintenance	Maintenance Pro, 2023, ISBN-13 ?:979-886417453
4	Matthias Hartwig	Self-driving cars	E-book, 2020, by BMW
5	George Dimitrakopoulos, Aggelos Tsakanikas, Elias Panagiotopoulos	Autonomous Vehicles Technologies, Regulations, and Societal Impacts	Elsevier,2021, ISBN-13: 978-0323901376
6	Yan Li, Hualiang Shi	Advanced Driver Assistance Systems and Autonomous Vehicles	Springer, Singapore,2022, ISBN-13: 978-9811950520
7	P Suresh, T. Poongodi, B Balamurugan, Meenakshi Sharma	Big Data Analytics in Smart Manufacturing: Principles and Practices	December 14, 2022 by Chapman & Hall, ISBN-13: 978-1032065519
8	Rania I.M. AlmoselhyRania I.M. Almoselhy, Ravindran Chandran, Abisha Juliet Mary S J	Current Trends in Agriculture & Allied Sciences (Volume-1)	S. P. Publishing, Bhubaneshwar, Odisa,2023, ISBN-13: 978-9359061382
9	Dr. Suman Lata, Mamta J. Patange, Dr. Anand K. Gore, Suchibrata Chamuah and Dr. Chandana Behera	Recent Trends in Agriculture (Volume-5)	Integrated Publications, New Delhi,2023, ISBN-13: 978-9395118644

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.engieimpact.com/insights/green-fuels	Green Fuels
2	https://www.youtube.com/watch?v=T_S7Q3Uede4	Green Fuels
3	https://www.researchgate.net/publication/359732622_Green_fuels_concepts_benefits_and_studies_in_Nigeria/link/624c10bec7ab230e99cef13a/download?_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6InB1YmxpY2F0aW9uIiwicGFnZSI6InB1YmxpY2F0aW9uIn19	Green Fuels
4	https://nitsri.ac.in/Department/Chemical%20Engineering/BRTL12.pdf	Green Fuels
5	https://www.youtube.com/watch?v=4-R5Sh-xSiI&t=5s	Autonomous Maintenance (Total Productive Maintenance Series TPM)
6	https://www.youtube.com/watch?v=ZJ6tr1kkRDg	Sustainability in Manufacturing
7	https://www.youtube.com/watch?v=HgF7E5q9sU4&t=1s	An introduction to autonomous vehicles
8	https://www.youtube.com/watch?v=gEy91PGGLR0	Autonomous car / self-driving car
9	https://www.youtube.com/watch?v=ACxTcsxSYvE	Data Analytics in Manufacturing

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EMERGING TRENDS IN MECHANICAL ENGINEERING **Course Code : 315363**

Sr.No	Link / Portal	Description
10	https://www.youtube.com/watch?v=31W0EzcfE74	Big data analytics for manufacturing
11	https://www.youtube.com/watch?v=P2YPG8PO9JU	Agricultural Wonder Drone
12	https://www.youtube.com/watch?v=8-uPCmHX3U0	Agricultural Drones
13	https://www.youtube.com/watch?v=JeU_EYFH1Jk	Artificial intelligence comes to farming in India
14	https://www.youtube.com/watch?v=tSdIgGin_rk	Fully autonomous tractor
15	https://www.skillindiadigital.gov.in/courses/detail/32d86c56-efc6-4c33-9c65-17901e296f8e	Kisan Drone Operator
16	https://www.youtube.com/watch?v=q7tFDw5SAAU	Farming with robots
17	https://www.youtube.com/watch?v=_Dmb1GN52no	Spraying robots

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**

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INDUSTRIAL ROBOTICS **Course Code : 315364**

Programme Name/s : **Mechatronics/ Manufacturing Technology**

Programme Code : **MK/ MRT**

Semester : **Fifth**

Course Title : **INDUSTRIAL ROBOTICS**

Course Code : **315364**

I. RATIONALE

Industrial robots are widely used in many industrial applications, to make industries more competitive and efficient. The most obvious impact of industrial robots is that they eliminate many dull, dirty, dear, difficult and dangerous tasks. The use of robot helpful in hazardous and challenging environments. The purpose of industrial robotics course is to provide skilled workforce to the industry.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Operate industrial robot for the given industrial applications.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Select robot for given application.
- CO2 - Select end effectors, actuators and sensors for given robotic applications.
- CO3 - Apply robot vision system for given application.
- CO4 - Develop robot program for given applications.
- CO5 - Indentify future technologies to integrate with 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	
315364	INDUSTRIAL ROBOTICS	IRO	DSC	5	-	4	-	9	3	3	30	70	100	40	25	10	25#	10	-	-	150

INDUSTRIAL ROBOTICS **Course Code : 315364**

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 Explain fundamental terminology in robotics. TLO 1.2 Select robot configuration for the given application. TLO 1.3 Explain basic elements of robotic system. TLO 1.4 Select robot specification for the given application. TLO 1.5 Choose robot motions for the given application. TLO 1.6 Simulate different joints used in robotic systems.	**Unit - I Components of Robotics System** 1.1 Fundamentals of robotics: Introduction, definition, need, brief history, laws of robot. 1.2 Robot configurations: Polar (Spherical), Cylindrical, Cartesian coordinate, Jointed arm (Articuted), SCARA (Selective Compliance Assembly Robot Arm). 1.3 Elements of robot system (Robot Anatomy): Base, Manipulator arm, End Effectors, Sensors and transducers, Actuators and Drives, Control systems. 1.4 Robot specification: Degree of Freedom, Work envelope, Load carrying capacity, Speed of movement, Accuracy, Repeatability, Control Resolution, Spatial resolution. 1.5 Robot motions: Vertical motions, Radial motions, Rotational motions, Pitch motions, Roll motions, Yaw motions. 1.6 Types mechanical joints used in robotics system: Linear Joint, Orthogonal joint, Rotational Joint, Twisting Joint, Revolving Joint (Symbols, Notations).	Lecture Using Chalk-Board PPT Demonstrations Video Flipped Classroom

INDUSTRIAL ROBOTICS **Course Code : 315364**

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 Select end effector for the given application. TLO 2.2 Compare different actuators for robotic system. TLO 2.3 Select robot sensor for the given application.	**Unit - II Robot - Gripper, Actuators and Sensors** 2.1 Robots End Effectors: Types of End Effectors - Gripper and Tools, Grippers- Mechanical, Pneumatic, Magnetic, Vacuum, adhesive, Considerations in gripper selection. 2.2 Actuators and drives: Pneumatic, Hydraulic, Electric. 2.3 Robotic Sensors: Introduction to Sensors in robotics, classification of Sensors – Tactile Sensors, Touch sensors, Force sensors, Force sensing wrist, Joint sensing, Tactile array sensors, Proximity and Range Sensors, Miscellaneous Sensors and Sensor based Systems, Uses of Sensors in Robotics. 2.4 Desirable features of sensors in Robotics.	Lecture Using Chalk-Board PPT Video Case study
3	TLO 3.1 Construct flowchart of robot vision system. TLO 3.2 Describe role of image processing in robot vision system. TLO 3.3 Use of robot vision system for the given application.	**Unit - III Robot Vision System** 3.1 Robot Vision: Introduction, The Sensing and Digitizing Function - Imaging devices, Lighting techniques, Analog to Digital signal conversions (Sampling, Encoding, Image storage). 3.2 Image Processing and Analysis: Image Data reduction, Segmentation, Thresholding, Region growing, Edge detection, Feature extraction, Object Recognition. 3.3 Industrial application of vision controlled Robotic system.	Lecture Using Chalk-Board PPT Video
4	TLO 4.1 Use of different robotic commands for programming robot. TLO 4.2 Describe Robot language structure. TLO 4.3 Select robot programming method for the given application. TLO 4.4 Develop Robot programs for the given industrial application.	**Unit - IV Introduction to Robot Languages & Programming** 4.1 Introduction to Robot Languages: The Textual Robot Languages, Generations of Robot Programming Languages, Robot Language Structure, Constant, Variables and other Data Objects, Motion Commands, End Effecter and Sensor Commands, Computations and Operations, Program Control and Sub-routines, Communications and Data Processing, Monitor Mode Commands. 4.2 Introduction to Robot Programming: Methods of Programming a Robot, Lead through Programming Methods, Robot Programme as a Path in Space, Motion Interpolation, WAIT, SIGNAL and DELAY Commands, Branching, Capabilities and Limitations of Lead through Methods. 4.3 Introduction to Teach Pendant. 4.4 Simple Program for Pick and place activity. 4.5 Simple Program to Palletize the object. 4.6 Simple Program for Inspection (Bolt, PCB, Bearing etc.).	Lecture Using Chalk-Board PPT Video Demonstration

INDUSTRIAL ROBOTICS **Course Code : 315364**

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 Indentify type of robot used for the given industrial applications. TLO 5.2 Identify future technology in robotics for the given industrial applications. TLO 5.3 Explain future use of robots in various application.	**Unit - V Robot Applications & Future Technology** 5.1 Robots in material handling. 5.2 Robots in processing operations - Spot welding, Continuous arc welding, Plastic spray coating, Die-casting, molding, Forging operation. 5.3 Robots in automated assemblies & inspections. 5.4 Future technology in robotics: Introduction, Robot intelligence, Advanced sensor capabilities (3D Vision), Telepresence and related technologies, Mechanical design features (Direct Drive robot, Multiple arm coordinate robot), Mobility, locomotion and navigation, Universal hand, System integration and network. 5.5 Future applications of Robots: Military operations, Fire-fighting operations, under sea operations, Space operations, Industry 4.0, AI in industrial robotics.	Lecture Using Chalk-Board PPT Video Case study Field 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 Identify different robotic components and its working for the given system.	1	*Robotic components and its working.	2	CO1
LLO 2.1 Simulate the robot configuration with 3 DoF for planer robot.	2	*Robot motion simulation of Cartesian Robot using software.	2	CO1
LLO 3.1 Simulate the robot configuration with 4 DoF for spatial robot.	3	Robot motion simulation of SCARA Robot using software.	2	CO1
LLO 4.1 Simulate the robot configuration with 6 DoF for spatial robot.	4	Robot motion simulation of Articulated Robot (6 DoF) using software.	2	CO1
LLO 5.1 Use end effector for the given application.	5	*End effector interfacing with robotic system.	2	CO2
LLO 6.1 Use sensors for the given robotic system.	6	Sensor interfacing with robotic system.	2	CO2
LLO 7.1 Operate robot with different motion commands for the given situation.	7	*Robot simulation by using motion commands.	2	CO4
LLO 8.1 Operate robot with different end effector commands for the given application.	8	Robot simulation by using end effector commands.	2	CO4
LLO 9.1 Develop program for path movement. LLO 9.2 Operate robot for the given path movement.	9	Program for specific path movement of robot.	2	CO4
LLO 10.1 Develop program for pick and place activity. LLO 10.2 Operate robot for pick and place activity.	10	Program for pick and place activity.	2	CO4

INDUSTRIAL ROBOTICS **Course Code : 315364**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 11.1 Develop program for palletizing the object. LLO 11.2 Operate robot for palletizing the object.	11	*Program for palletizing the object.	2	CO4
LLO 12.1 Calibrate the vision system with robot coordinate system.	12	Calibration of robot vision system	2	CO3
LLO 13.1 Develop program for inspection of the object. LLO 13.2 Use robot vision system for inspection.	13	*Program for inspection. (Bolt, PCB, Bearing etc.)	2	CO3 CO4
LLO 14.1 Interface PLC with robotic system for the given application.	14	*PLC interfacing with robotic system as per standard procedure.	2	CO4
LLO 15.1 Use robot vision system for sorting the given objects on shape basis.	15	Program for sorting objects as per shape (square, cicle etc).	2	CO3 CO4 CO5
LLO 16.1 Develop program for spot/ arc welding operation. LLO 16.2 Operate robot for welding application.	16	*Program for spot/ arc welding operation.	2	CO4 CO5
LLO 17.1 Develop program for spot painting operation. LLO 17.2 Operate robot for painting application.	17	Program for painting operation.	2	CO4 CO5
LLO 18.1 Develop program for tightening and loosing the fasteners with torque gun. LLO 18.2 Operate robot for assembly work with torque gun.	18	*Program for tightening and loosing the fasteners with torque gun.	2	CO4 CO5
LLO 19.1 Operate robot to write the given word.	19	*Program robot for writing name of your institute.	2	CO4 CO5
LLO 20.1 Interface conveyer with robotic system. LLO 20.2 Operate conveyer with robotic system.	20	Program for interfacing of conveyer.	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) : NOT APPLICABLE

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	PLC (Min 8 input/output)	1,16

INDUSTRIAL ROBOTICS **Course Code : 315364**

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
2	Programmable Robot Trainer Kit with standalone servo controller as well as compatible PLC interface with following features: 1) Minimum 3 linkages 2) Minimum 4 degree of freedom (4DoF) 3) Various sensors 4) Compatible Robot vision system for inspection.	1,4,5,6,7,8,9,10,11,12,13,14,16
3	End effector - Grippers – Minimum two (Mechanical, Pneumatic, Vacuum, Magnetic etc.)	1,5,8,10,11,12
4	End effector - Tools – Weld gun, spray gun, torque gun, Pen Holder etc.	1,5,8,10,11,16,17,18,14,15,19
5	Robot offline simulation software	2,3
6	Computers with internet connectivity (Minimum Core i5 Processor, 8GB RAM, 500GB HDD)	2,3,9,10,11,12,13,14

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	Components of Robotics System	CO1	11	4	4	6	14
2	II	Robot - Gripper, Actuators and Sensors	CO2	12	2	6	8	16
3	III	Robot Vision System	CO3	8	2	4	6	12
4	IV	Introduction to Robot Languages & Programming	CO4	12	2	4	12	18
5	V	Robot Applications & Future Technology	CO5	7	2	4	4	10
Grand Total				**50**	**12**	**22**	**36**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- For laboratory learning Maximum 25 Marks and Minimum 10 Marks.
- Two-Class Tests of 30 marks and average of Two-Class Tests out of 30.

Summative Assessment (Assessment of Learning)

- • End Semester External Assessment of Maximum 25 Marks and Minimum 10 Marks for laboratory learning.
- • End Semester Assessment of 70 marks for theory learning.

XI. SUGGESTED COS - POS MATRIX FORM

INDUSTRIAL ROBOTICS **Course Code : 315364**

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	3	3	3	2	-	1	1			
CO2	3	3	3	2	-	1	1			
CO3	3	3	3	3	-	1	1			
CO4	3	3	3	3	-	1	1			
CO5	3	1	1	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	Mikell P. Groover, Michell Weiss, Roger N. Nagel, Nicholas G. Odrey & Ashish Dutta	Industrial Robotics	McGraw Hill Education (India) Pvt. Ltd., Chennai, 2012, ISBN: 9781259006210
2	Ramchandran Nagarajan	Introduction to Industrial Robotics	Pearson Education India, New Delhi, 2016, ISBN: 9789332544802
3	R. K. Rajput	Robotics and Industrial Automation	S. Chand limited, 2014, ISBN: 9788121929974
4	R. K. Mittal & I. J. Nagrath	Robotics and Control	McGraw Hill education India Pvt. Ltd. New Delhi, 2010, ISBN: 9780070482937
5	Ganesh S. Hegde	A Textbook on Industrial Robotics	University Science Press, New Delhi, 2015, ISBN: 9788131805183
6	D. J. Todd	Fundamentals of Robot Technology	British library Cataloguing in Publication Data, 2012, ISBN: 9789401167703
7	Ghosal, Ashitava	Robotics – Fundamental Concepts and Analysis	Oxford University Press, 2006, ISBN: 978019567391

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://nptel.ac.in/courses/112105319	NPTEL Course - Industrial Robotics: Theories for Implementation
2	https://nptel.ac.in/courses/112105249	NPTEL Course - Robotics
3	http://www.mechanalyzer.com/downloads-roboanalyzer.html	Simulation Software- Robo analyzer (Download)
4	http://www.roboanalyzer.com/tutorials.html	Simulation Software - tutorials
5	https://www.youtube.com/watch?v=l1gRr_NI4BU	Introduction to Industrial Robot

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INDUSTRIAL ROBOTICS **Course Code : 315364**

Sr.No	Link / Portal	Description
6	https://www.youtube.com/watch?v=X7iBT5l599c	Industrial Robot Manipulator
7	https://www.youtube.com/watch?v=_canCYWZPsc&t=227s	Animation of Work Envelope
8	http://vlabs.iitkgp.ernet.in/mr/exp0/index.html#	Virtual Lab – IIT Kharagpur

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**

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MECHATRONICS SYSTEMS USING IOT **Course Code : 315365**

Programme Name/s : **Mechatronics**
Programme Code : **MK**
Semester : **Fifth**
Course Title : **MECHATRONICS SYSTEMS USING IOT**
Course Code : **315365**

I. RATIONALE

The course aims to provide with a strong foundation in the principles and technologies of Mechatronics Systems and Internet of Things (IoT), enabling them to create more efficient, innovative, and adaptable systems for a wide range of industrial applications. IoT enables real-time data collection, connectivity and automation across industrial processes to enhance efficiency and decision-making.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Develop IoT-enabled mechatronics systems to improve industrial processes, efficiency, and product quality.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Use different blocks of IoT systems.
- CO2 - Select hardware and IoT components for mechatronics Systems.
- CO3 - Integrate IoT hardware and components for given mechatronics Systems.
- CO4 - Apply different platforms and their interfacing for various Systems.
- CO5 - Develop applications of IoT using various hardware components and platforms.

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	
315365	MECHATRONICS SYSTEMS USING IOT	MIT	DSE	4	-	2	-	6	2	3	30	70	100	40	25	10	25#	10	-	-	150

MECHATRONICS SYSTEMS USING IOT **Course Code : 315365**

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 different characteristics of IoT Systems. TLO 1.2 Choose Physical and logical design of IoT. TLO 1.3 Compare different technologies used in IoT TLO 1.4 Select IoT enabling technologies. TLO 1.5 Select relevant deployment levels.	**Unit - I Introduction to Internet of Things (IoT)** 1.1 Introduction to IoT 1.2 IoT characteristics 1.3 Physical design of IoT: Things in IoT, IoT Protocols 1.4 Logical design of IoT: IoT Fundamental blocks, IoT Communication Model, IoT Communication API's 1.5 IoT Enabling Technologies: Wireless Sensor Networks, Cloud Computing, Big Data Analytics, Communication Protocols, Embedded Systems 1.6 IoT Levels and Deployment templates — IoT Level-1, IoT Level-2, IoT Level-3, IoT Level-4, IoT Level-5, IoT Level-6	Lecture Using Chalk-Board Video Demonstrations Presentations
2	TLO 2.1 Select relevant sensor for the given application. TLO 2.2 Describe different input and output pins of the sensors. TLO 2.3 Identify relevant magnet relays and switches. TLO 2.4 Select relevant middleware for given IoT Systems.	**Unit - II Sensors and Hardware Platforms** 2.1 Sensors and its different parameters sensed by sensor: Light, Water detector, PIR Sensor, IR Sensor, Touch Sensor, Color Sensor, Tilt Sensor, Smoke Sensor, Gas and Alcohol Sensor. 2.2 Input and output pins of sensors, Magnet relays and switches 2.3 Middleware: M2M, RFID, WSN, SCADA	Lecture Using Chalk-Board Video Demonstrations Presentations

MECHATRONICS SYSTEMS USING IOT **Course Code : 315365**

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 Choose relevant methodology for designing and Integration of given IoT Systems. TLO 3.2 Select relevant methods to deploy IoT application. TLO 3.3 Select logical designing for different applications. TLO 3.4 Identify different protocols for IoT Systems.	**Unit - III Design and Development of IoT Systems** 3.1 IoT Design Methodology: Purpose and requirement specification, Process specification, Domain model specification, Information model specification, Service specification, IoT level specification. 3.2 Device and component integration, Functional view specification, Operational view specification. 3.3 Logical Designing using programming language, application development. 3.4 Interface with Hardware. 3.5 Protocols - The Open Systems Interconnection (OSI) model.	Lecture Using Chalk-Board Video Demonstrations Presentations
4	TLO 4.1 Identify different IoT physical devices. TLO 4.2 Select relevant cloud base platforms for given IoT System. TLO 4.3 Select configuration and interfacing platforms for the given IoT systems.	**Unit - IV IoT Physical Device and End Point** 4.1 Architecture of Physical Devices: Arduino, Raspberry Pi, Intel Galileo, Tibbo project systems. 4.2 Cloud base IoT platforms and other open-source platforms. 4.3 Configuration of hardware platform. 4.4 Interfacing of Arduino, Raspberry Pi.	Lecture Using Chalk-Board Video Demonstrations Presentations
5	TLO 5.1 Identify different home automation systems. TLO 5.2 Write steps to build IoT system to monitor air quality. TLO 5.3 Write steps to build IoT system to monitor climate for agriculture. TLO 5.4 Write steps to develop given health monitoring system.	**Unit - V IoT Applications** 5.1 Home automation: Controlling the lights, Smart Lock. 5.2 Environment and Agriculture: Air quality management, Climate Monitoring for agriculture. 5.3 Health: Heart rate monitoring system, Pulse Oximeter System.	Lecture Using Chalk-Board Video Demonstrations 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 Use USB cables, Wires, Power Supply Units, Transistors, Breadboards, Relay to design IoT systems. LLO 1.2 Operate Multimeter, Tester, Soldering Kit, Wire cutter, Hot glue gun and other components required for designing of IoT. LLO 1.3 Select various Components for designing IoT Systems.	1	*Components for IoT Systems.	2	CO1
LLO 2.1 Operate various components used in open-source prototype board and various microcontroller used in your lab.	2	Components used in open-source prototype board and microcontroller.	2	CO1

MECHATRONICS SYSTEMS USING IOT **Course Code : 315365**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 3.1 Use different sensors with given microcontroller to design IoT Systems.	3	*Sensors integration with microcontroller using breadboard	2	CO2
LLO 4.1 Design a range of LED patterns and control mechanism for various IoT applications.	4	Program to display various patterns using LED.	2	CO2
LLO 5.1 Use various shields (Ethernet and Wi-Fi networking, Bluetooth, GSM cellular networking, motor control, RFID, audio, SD Card memory, GPS, sensors, color LCD screens, and more). LLO 5.2 Determine various performance parameters for shield and breakouts.	5	*Shield interface with controller for obtaining performance of particular shield and breakouts.	2	CO3
LLO 6.1 Build smart application using microcontroller and shields or breakouts.	6	Smart System application using microcontroller and shields or breakouts.	2	CO3
LLO 7.1 Use various protocols for IoT device communication. LLO 7.2 Design application using different types protocols used in IoT communication.	7	Protocols for IoT device communication.	2	CO3
LLO 8.1 Use various platforms for designing IoT Applications. LLO 8.2 Design application using any platform for 4 Digit 7 segment LED display.	8	*Platforms for designing IoT Applications.	2	CO4
LLO 9.1 Design application using Arduino or Raspberry-Pi for Smart Street light system.	9	Smart applications using Arduino or Raspberry-Pi.	2	CO4
LLO 10.1 Use Raspberry pi for stepper motor control. LLO 10.2 Build any application using Raspberry-Pi and stepper motor.	10	*Stepper motor control using Raspberry pi for any one application.	2	CO5
LLO 11.1 Develop smart applications using IoT.	11	Application for home or agriculture automation.	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) : NOT APPLICABLE

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Sensors: Temperature, Light, Ultra-Sonic, Humidity, Water Detector, PIR sensor, Pressure Sensor. IR sensor, Touch Sensor, Color Sensor, Humidity Sensor, Tilt Sensor, Flow and Level Sensor, Smoke, Gas and Alcohol Sensor	3,4,5,6,7,8,9,10,11
2	Arduino, Raspberry pi, Any Open-Source Prototype Board Available in Market	3,4,5,6,7,8,9,10,11
3	Shields: Ethernet and Wi-Fi networking, Bluetooth, GSM cellular networking, motor control, RFID, Audio, SD Card memory, GPS, sensors, color LCD screens	5,6,7,8,9,10,11

MECHATRONICS SYSTEMS USING IOT **Course Code : 315365**

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
4	USB cables, wires, power supply units, transistors, breadboards, relay, Multimeter, Tester, Soldering Kit, wire cutter, Hot glue gun. seven-segment LED, Stepper Motor.	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 Internet of Things (IoT)	CO1	6	2	4	6	12
2	II	Sensors and Hardware Platforms	CO2	6	2	4	6	12
3	III	Design and Development of IoT Systems	CO3	12	4	6	8	18
4	IV	IoT Physical Device and End Point	CO4	8	2	4	8	14
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)

- Test
- Term work

Summative Assessment (Assessment of Learning)

- Theory
- Practical

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	2	-	-	2			
CO2	3	2	2	3	2	-	3			
CO3	2	2	3	3	2	-	2			
CO4	3	1	2	2	1	-	2			
CO5	3	3	3	3	2	3	3			

MECHATRONICS SYSTEMS USING IOT **Course Code : 315365**

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 Pres, ISBN: 9788173719547,1st Edition, Year: 2015
2	Adrin McEwen & Hakim Cassimality	Designing the Internet of things	Wiley India, Ltd, ISBN: 9781118430620, 1st Edition, Year:2013
3	Honobo Zhou	The internet of things in the cloud : a middleware perspective	CRC Press Taylor & Francis Group, ISBN: 9781439893029, Year:2019
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, 1st Edition, Year: 2017
5	Richard Blum	Sams Teach Yourself Arduino™ Programming in 24 Hours	Pearson Education, Inc., ISBN: 9780672337123, 1st Edition, Year: 2014
6	Sean McManus, Mike Cook	Raspberry Pi For Dummies	Wiley India, ISBN: 9781119796824, 4th Edition, Year: 2021

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://intersog.com/blog/development/iot-platforms-overview -arduino-raspberry-pi-intel-galileo-and-others/	IoT Platforms Overview: Arduino, Raspberry Pi, Intel Galileo and Others
2	https://www.guru99.com/iot-tutorial.html	IoT Tutorial: Introduction to Internet of Things (IoT Basics)
3	https://docs.arduino.cc/tutorials/	Tutorials - Arduino Documentation
4	https://azure.microsoft.com/en-in/solutions/iot/iot-technolo gy-protocols	IoT Protocols - The Open Systems Interconnection (OSI) model
5	https://nevonprojects.com/iot-projects/	All IOT Projects List

Note :

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

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PROCESS ENGINEERING **Course Code : 315366**

Programme Name/s : **Mechatronics/ Manufacturing Technology/ Production Engineering**

Programme Code : **MK/ MRT/ PG**

Semester : **Fifth**

Course Title : **PROCESS ENGINEERING**

Course Code : **315366**

I. RATIONALE

Process engineering is the intermediate stage between design and manufacturing of a component. This course focus on the planning, design, development, operations and control of manufacturing processes in an industry. A diploma engineer should understand basic concepts and apply advanced tools and techniques employed in the field of process engineering, so as to achieve the best possible planning and control in a manufacturing environment with continuous improvements.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Prepare process plan sheet for manufacturing of components.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Evaluate a product using various criteria.
- CO2 - Prepare bill of material for a given assembly.
- CO3 - Prepare process plan for a given engineering component.
- CO4 - Construct a part family using group technology.
- CO5 - Select relevant CAPP system for a given engineering component.

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	
315366	PROCESS ENGINEERING	PEN	DSE	4	-	2	-	6	2	3	30	70	100	40	25	10	25#	10	-	-	150

PROCESS ENGINEERING **Course Code : 315366**

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 procedure of design for manufacturing and assembly. TLO 1.2 Analyze various criteria for the given product. TLO 1.3 Explain functions of process engineering department. TLO 1.4 Prepare organizational flow chart for the development of process plans.	**Unit - I Introduction to Product engineering and Process engineering** 1.1 Functions of product engineering department 1.2 Design for Manufacturing and Assembly (DFMA): Definition, Procedure, Guidelines 1.3 Criteria for product analysis (aesthetics, cost, environment, safety, function, material, ergonomics) 1.4 Functions of process engineering department 1.5 Organizational flow chart for development of process plans	Lecture Using Chalk-Board Presentations Video Demonstrations
2	TLO 2.1 Analyze the given assembly using dimensional tolerance stack up methods. TLO 2.2 Select relevant surface finish roughness grade for the given operation. TLO 2.3 Explain bill of materials. TLO 2.4 Select appropriate inspection method for the given component.	**Unit - II Interpretation of part drawing** 2.1 Dimensional tolerance: Tolerance Stack up analysis (Worst case scenario analysis, Statistical analysis), ISO 2768-1: General tolerances values 2.2 Surface Finish: Three elements of surface finish, Surface finish symbols, Roughness grade numbers and it’s finish marks 2.3 Bill of materials (BOM): Define, Importance of BOM, Types of BOM (Engineering BOM, Manufacturing BOM) 2.4 Inspection methods: Need of inspection methods, Types of inspection (based on timing, based on place, based on contact, based on number of samples inspected, based on application)	Lecture Using Chalk-Board Presentations Video Demonstrations

PROCESS ENGINEERING **Course Code : 315366**

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 Describe process planning procedure. TLO 3.2 Identify the factors affecting make or buy decision during process planning for the given component. TLO 3.3 Choose a specific process for manufacturing of the given component. TLO 3.4 Prepare process flow chart for manufacturing of the given component. TLO 3.5 Explain machine and tool selection procedure. TLO 3.6 Specify different manufacturing parameters for the preparation of operation sheet and route sheet.	**Unit - III Process planning** 3.1 Information required to do process planning 3.2 Process planning procedure: Make or Buy Design- factors affecting make or buy decision 3.3 Process selection procedure 3.4 Process analysis: Process flow chart 3.5 Machine and tool selection procedure 3.6 Process plan: Operation sheet and Route sheet	Lecture Using Chalk-Board Presentations Video Demonstrations Site/Industry Visit
4	TLO 4.1 Identify different applications of group technology. TLO 4.2 Differentiate between functional layout and group layout. TLO 4.3 Select various methods for construction of a part family for the set of similar components.	**Unit - IV Group Technology** 4.1 Introduction to Group technology, definitions and applications 4.2 Functional layout and group layout 4.3 Part family construction methods: Visual method, Production flow analysis 4.4 Basic requirement for part family coding system	Lecture Using Chalk-Board Presentations Video Demonstrations
5	TLO 5.1 Draw framework of computer aided process planning. TLO 5.2 Compare types of CAPP systems for given set of criteria. TLO 5.3 Justify role of CAPP in implementation of CIM. TLO 5.4 Describe contribution of artificial intelligence in process planning.	**Unit - V Automation in process planning** 5.1 Framework of computer aided process planning 5.2 Types of CAPP: Generative type and Variant type 5.3 CAPP software systems available in market, programming language used in CAPP software systems 5.4 Contribution of CAPP to CIM 5.5 Artificial intelligence in process planning	Lecture Using Chalk-Board Presentations Case Study Flipped Classroom

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 Measure dimensions of the given component. (e.g. Cotter key or Knuckle pin or square / hexagonal headed bolt/ nut) LLO 1.2 Create CAD model of the given component. (e.g. Cotter key or Knuckle pin or square / hexagonal headed bolt/ nut)	1	Measurement and CAD modelling of the given component.	2	CO1

PROCESS ENGINEERING **Course Code : 315366**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 2.1 Collect the given job from your institute workshop. LLO 2.2 Perform product analysis on the given job using various criteria.	2	* Analysis of the given job using various criteria.	2	CO1
LLO 3.1 List down different components of lathe machine tool post available in your institute workshop. LLO 3.2 Prepare Bill of material for the lathe machine tool post.	3	* Preparation of Bill of material for the given assembly.	2	CO2
LLO 4.1 Identify different standards for selection of dimensional tolerance values. LLO 4.2 Collect samples of industrial drawings of the components from nearest workshop. LLO 4.3 Prepare dimensional tolerance chart for the given industrial drawing using standard ISO 2768-1.	4	Preparation of dimensional tolerance chart for the given industrial drawing of component.	2	CO2
LLO 5.1 Collect samples of industrial drawings of the components from nearest workshop. LLO 5.2 Prepare operation sheet for the given component. LLO 5.3 Prepare route sheet for the given component.	5	* Preparation of operation sheet and route sheet for the given component.	2	CO3
LLO 6.1 Identify the job to be machined on lathe. LLO 6.2 Select manufacturing process parameters for the given job by using production technology handbook.	6	Selection of manufacturing process parameters by using production technology handbook.	2	CO3
LLO 7.1 Prepare process flow chart for manufacturing of the given component. (e.g. nut/bolt/knuckle pin/cotter key,etc)	7	Preparation of process flow chart for manufacturing of the given component.	2	CO3
LLO 8.1 Perform production flow analysis to create part family for the given set of similar components.	8	* Design part family using group technology methods.	2	CO4
LLO 9.1 Prepare machining parameters table for the given component using CAPP software. (speed, feed, depth of cut, machining time,etc)	9	* Prepare a machining parameters table using CAPP software	2	CO5
LLO 10.1 Generate a process plan sheet for the given component using CAPP software.	10	Generation of a process plan sheet using CAPP software.	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) : NOT APPLICABLE

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

PROCESS ENGINEERING **Course Code : 315366**

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Measuring Instruments: - Digital Vernier Caliper (Resolution 0.1 mm, Measuring Range 0-150 mm), Screw pitch gauge(52 Leaves , Narrow design, 4 to 62 TPI, 0.25 to 6.0 mm thread), Profile projector(Light axis: Vertical, Workstage size: 410 x 310 mm, Measuring range: 100 x 100 mm)	1
2	2D CAD software	1
3	Sample industrial assembly and part drawings	2,3,4,5
4	Process plan CAPP software	9,10

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 Product engineering and Process engineering	CO1	6	4	4	4	12
2	II	Interpretation of part drawing	CO2	8	4	4	6	14
3	III	Process planning	CO3	12	4	6	8	18
4	IV	Group Technology	CO4	6	2	4	6	12
5	V	Automation in process planning	CO5	8	4	4	6	14
Grand Total				**40**	**18**	**22**	**30**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two-unit tests of 30 marks and average of two-unit tests.
- For laboratory learning 25 Marks.

Summative Assessment (Assessment of Learning)

- End semester assessment of 70 marks.
- End semester 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	3	-	-	-	-	-	-			

CO2	3	2	2	2	-	-	-			
CO3	3	3	3	2	2	2	3			
CO4	3	2	2	-	2	-	-			
CO5	3	2	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	Khanna O.P.	Industrial Engineering and Management	Dhanpat Rai Publications New Delhi (2018) ISBN-13:9788189928353
2	Samuel Eilon	Production Planning and Control	Collier Macmillan Ltd New Delhi (2015) ISBN-13: 9780023318009
3	Scallan Peter	Process Planning: The Design/Manufacture Interface	Butterworth-Heinemann (2003) ISBN-13: 9780750651295
4	Stephen N. Chapman	Fundamentals of Production Planning and Control	Pearson Education (2007) ISBN-13:9788131717394
5	Hwaiyu Geng	Manufacturing Engineering Handbook	McGraw-Hill Education (2016) ISBN-13:9780071839778

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://archive.nptel.ac.in/courses/110/105/110105155/	Automation In Production Systems and Management SWAYAM NPTEL course
2	https://archive.nptel.ac.in/courses/112/107/112107238/	Operations Management SWAYAM NPTEL course
3	https://www.youtube.com/watch?v=20_K7c65Swg	Computer aided process planning- SWAYAM NPTEL
4	https://egyankosh.ac.in/bitstream/123456789/27107/1/Unit-9.pdf	Computer aided process planning- PDF IGNOU
5	https://egyankosh.ac.in/bitstream/123456789/27217/1/Unit-1.pdf	Process planning- PDF IGNOU
6	https://egyankosh.ac.in/bitstream/123456789/27220/1/Unit-4.pdf	CAPP techniques-PDF IGNOU

Note :

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

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PRODUCT DESIGN AND DEVELOPMENT **Course Code : 315367**

Programme Name/s : **Mechanical Engineering/ Mechatronics/ Production Engineering**
Programme Code : **ME/ MK/ PG**
Semester : **Fifth**
Course Title : **PRODUCT DESIGN AND DEVELOPMENT**
Course Code : **315367**

I. RATIONALE

Design and development are two key elements necessary to create any product. From start to finish, each phase of the product's lifecycle needs careful coordination between these two disciplines for a successful outcome.Each organization should come with innovative ideas to bring up a new product, to maintain a top position in the market. Product design and development is a complete cycle to launch of new industrial products i.e from conceptualization to product realization.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Use principles of product design and development for launching new products in the market.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Apply principles to develop new small industrial products according to customer's requirement for launching.
- CO2 - Use aesthetics and ergonomics principles for developing new products
- CO3 - Apply DFM principles for development of new product
- CO4 - Apply principles of QFD for Quality of new product
- CO5 - Use relevant rapid prototyping methods for development of new product along-with IPR process.

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	
315367	PRODUCT DESIGN AND DEVELOPMENT	PDD	DSE	4	-	2	-	6	2	3	30	70	100	40	25	10	25#	10	-	-	150

PRODUCT DESIGN AND DEVELOPMENT **Course Code : 315367**

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 Explain the criteria of customer's need identification for designing new product. TLO 1.2 Explain principles of product design TLO 1.3 Explain product development process. TLO 1.4 State concept of product development TLO 1.5 Explain Seven step method for testing of product concept with example TLO 1.6 Explain process of implementing customer need for designing new product	**Unit - I Product Development** 1.1 Characteristics of successful product development, Customer need identification 1.2 Definition of product design, principles of good product design, Design by evolution, design by innovation 1.3 Product development process, Phases of process development. flow chart of product development. Tyco product development process 1.4 Concept development- different phases of concept development process, five step concept generation method, Concept classification tree, Concept combination table 1.5 Concept selection- Concept screening, Concept scoring, Seven step method for testing of product concept 1.6 Identification of customer need, Data collection from customer, organize collected data, Establishing relative importance of customer need for designing product with example	Lecture using media Lecture using Chalk-Board

PRODUCT DESIGN AND DEVELOPMENT **Course Code : 315367**

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 Define product architecture TLO 2.2 Classify Modularity TLO 2.3 List different design considerations for machine controls using ergonomics principle. TLO 2.4 Apply relevant aesthetics and ergonomics principles in given situation. . TLO 2.5 List different aspects of aesthetics in product design	**Unit - II Product Architecture** 2.1 Definition of product architecture, Modular and Integral product architecture, its types, Component standardization, Steps for establishing the architecture with example like trailer, Spanners etc 2.2 Ergonomics- definition, necessity of ergonomics in product design. Design consideration for qualitative and quantitative display, Design considerations for controls like knob, levers, handwheel, toggle switch. 2.3 Aesthetics Principles- definition, necessity of aesthetics in product design, consideration of aesthetics in product design, Aspects of Aesthetics in Product Design - form, symmetry, color, continuity, proportion, contrast, impression, surface finish	Lecture using media Model Demonstration
3	TLO 3.1 State importance of Industrial design TLO 3.2 Explain term Design For Manufacturability (DFM) TLO 3.3 State necessity of Product Life Cycle TLO 3.4 Explain the procedure to determine 'Product Life Cycle' for given product.	**Unit - III Industrial Design** 3.1 Importance of industrial design, Industrial design process 3.2 Design for manufacturability (DFM), steps for DFM, design principles for manufacturability , Factors affect on DFM,.Impact of DFM on cost, quality and Time 3.3 Product Life Cycle- definition, importance, stages of Product life cycle, examples for determining product life cycle of Motorcycle, electrical vehicle etc	Lecture Using Chalk-Board Lecture ueing media
4	TLO 4.1 Explain term Value engineering TLO 4.2 State procedure of Problem identification related to value engineering. TLO 4.3 State importance of QFD TLO 4.4 Explain QFD with suitable example. TLO 4.5 Draw House of Quality relationship Matrix for given product.	**Unit - IV Value Engineering** 4.1 Concept, Steps in value engineering, creative thinking, problem identification and value engineering job plan (VEJP). 4.2 Quality Function deployment (QFD) process-need, importance with example, symbols of QFD, voice of customer (VOC),VOC analysis, Quality QFD relationship matrix, roof ranking, Body ranking , importance of QFD 4.3 House of Quality linking customer complaints to technical requirements	Lecture Using Chalk-Board Case Study

PRODUCT DESIGN AND DEVELOPMENT **Course Code : 315367**

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 List different types of Rapid prototyping TLO 5.2 Explain working and constructions of 3-D printer. TLO 5.3 Differentiate FDM and SLA 3 - D printer TLO 5.4 Overview of Patents and IPR (Intellectual Property Right) - Importance of patent, patent rights, criteria for patent, process for filing patents. TLO 5.5 Elaborate the benefits of Patent and IPR TLO 5.6 Explain procedure for filing patent.	**Unit - V Rapid Prototyping and Patent Filing** 5.1 Rapid Prototyping- concepts, principles of rapid prototyping, Types of Rapid Prototyping- Proof of concept prototype, Looks like prototype, Works like prototype 5.2 3-D printer types – Fused deposition Modeling (FDM), Stereolithography (SLA), Selective Laser sintering (SLS), construction and working-. Comparison between different types of 3-D printer 5.3 Planning for prototyping-steps for planning for prototyping, define purpose, establish level of approximation, experimental plan, schedule for procurement, production and testing 5.4 Patents and intellectual property- Importance of patent, patent rights, criteria for patent, process for filing patents.	Lecture using Chalk-Board Video Demonstrations

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 Draw layout of Simple product evolution diagram	1	*Layout of simple product evolution diagram	2	CO1
LLO 2.1 Draw diagram of existing bench available in the classroom. LLO 2.2 Apply ergonomics principle to classroom bench LLO 2.3 Draw diagram of modified / developed bench using ergonomic principle.	2	*Development of existing Classroom bench/Chair/Drawing table/Laboratory table using relavant ergonomics principles.	4	CO2
LLO 3.1 Draw sketch of any component available in the laboratory LLO 3.2 Apply aesthetic principles to the development of a given product. LLO 3.3 Draw sketch of modified product	3	Development of product using aspects of aesthetics in product designing	2	CO2
LLO 4.1 Select any simple product from Market LLO 4.2 Apply DFM principle for development of identified product as per requirement LLO 4.3 Write a report of identified product using DFM	4	Draw flow chart for accepting design of new product using DFM principle	2	CO3

PRODUCT DESIGN AND DEVELOPMENT **Course Code : 315367**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 5.1 Collect specification of bicycle using manufacturer's catalogue. LLO 5.2 Determine product life cycle of identified bicycle LLO 5.3 Draw product life cycle diagram of identified bicycle	5	*Determination of product life cycle of Bicycle	2	CO2 CO3
LLO 6.1 Draw Roof and Body of House of Quality. LLO 6.2 Prepare questionnaire for customers/users to know technical requirements. LLO 6.3 Apply principles of QFD for drawing House of Quality. LLO 6.4 Draw House of Quality diagram for given product	6	*Build House of Quality for steel cupboard / computer bench/ furniture available in the laboratory	4	CO1 CO4
LLO 7.1 Draw diagram of developed product LLO 7.2 Produce prototype of developed product	7	Development of prototype of any simple object using cardboard/plywood etc	2	CO1 CO2 CO5
LLO 8.1 Draw flow chart for filing a patent using Governemnt website	8	* Draw flow chart for filing patent (IPR act 2005)for given product usiing Government of India website.	2	CO5
LLO 9.1 Develop model using solid modeling software	9	Use of 3-D printer	4	CO1 CO5
LLO 10.1 Draw diagram of identified product LLO 10.2 Produce prototype of identified product	10	Development of prototype of any identified product from the market	2	CO1 CO2 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)

Activity based on voice of customer

- Prepare a brief report based on voice of customer through survey

PRODUCT DESIGN AND DEVELOPMENT **Course Code : 315367**

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	3 D printer (FDM)- size- 200x200x250 mm, layer resolution 0.08 mmto 0.4 mm,print speed 40-120 mm/sec,Nozzle size 0.4mm,Filament- ABS/PLA/Composit	12,13
2	Computer systems and peripherials-2GB RAM,CPU1GHz,Disk Space-1.2 GB for 64 bit platform,OS ,minimum .single core ,Graphic card, sound card	All
3	Solid Modeling software such as Creo,Solid Edge, Solid works or equivalent	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	Product Development	CO1	9	4	4	8	16
2	II	Product Architecture	CO2	6	2	4	6	12
3	III	Industrial Design	CO3	9	4	4	8	16
4	IV	Value Engineering	CO4	10	4	4	8	16
5	V	Rapid Prototyping and Patent Filing	CO5	6	2	2	6	10
Grand Total				**40**	**16**	**18**	**36**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Mid term tests Rubrics for COs Assignment, Self-learning and Terms work Seminar/Presentation

Summative Assessment (Assessment of Learning)

- End of Term Examination Viva-voce Lab. performance

XI. SUGGESTED COS - POS MATRIX FORM

PRODUCT DESIGN AND DEVELOPMENT **Course Code : 315367**

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	3	-	2	2	3			
CO2	-	-	3	-	2	3	3			
CO3	-	2	-	-	2	2	3			
CO4	-	2	2	-	-	3	3			
CO5	-	-	-	2	2	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	K.T.Ulrich	Product Design and Development	6th edition, McGrawhill Publication, 2023 ISBN 9780071086950
2	A.K.Chitale, R.C.Gupta	Product Design and Manufacturing	7th edition, PHI publication 2023, ISBN-13-978-9391818722
3	Richard Morris	Fundamentals of Product Design	2nd edition,2023, Bloomsbury Visual Arts Publication, ISBN 13- 978-1350398856
4	M.M.Soreas	Ergonomics in Design	1st edition,2016 CRC Press Publication, ISBN13- 978-0367356903

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://archive.nptel.ac.in/courses/112/107/112107217/	NPTEL lecture on product design steps and analysis
2	https://www.youtube.com/watch?v=mqC4Wn_OK-I	Value engineering
3	https://archive.nptel.ac.in/courses/112/107/112107217/	NPTEL Lecture on Ergonomics for Product Design
4	https://archive.nptel.ac.in/courses/112/107/112107217/	NPTEL Lecture on QFD
5	https://archive.nptel.ac.in/courses/112/107/112107217/	NPTEL Lecture on Functional Analysis Technique
6	https://archive.nptel.ac.in/courses/112/107/112107217/	NPTEL Lecture on Rapid Prototyping
7	https://archive.nptel.ac.in/courses/112/107/112107217/	NPTEL Lecture on Rapid Prototyping Processes
8	https://www.youtube.com/watch?v=dYPW5Rlwn8g	Working of 3 D printer
9	https://archive.nptel.ac.in/courses/112/107/112107217/	NPTEL lecture on product life cycle
10	https://www.youtube.com/watch?v=X1KONQw02H8	Quality of House
11	https://www.youtube.com/watch?v=Lo-AFCv2ggE	Product design and development

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PRODUCT DESIGN AND DEVELOPMENT **Course Code : 315367**

Sr.No	Link / Portal	Description
12	https://onlinecourses.nptel.ac.in/noc21_me83/preview	NPTEL lecture on product design and development
13	https://www.youtube.com/watch?v=iRMsd-X_e-0	QFD Analysis
14	https://archive.nptel.ac.in/courses/112/107/112107217/	NPTEL Lecture on VEJP
15	https://archive.nptel.ac.in/courses/112/107/112107217/	NPTEL lecture on Value engineering Concepts

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	**: Architecture Assistantship/ Architecture and Interior Design/ Automobile Engineering./ Artificial Intelligence/ Agricultural Engineering/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Architecture/ Cloud Computing and Big Data/ Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Software Technology/ Computer Science & Engineering/ Bamboo Technology/ Fashion & Clothing Technology/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Food Technology/ Computer Hardware & Maintenance/ Instrumentation & Control/ Instrumentation & Control Engineering/ Industrial Electronics/ Information Technology/ Computer Science & Information Technology/ Instrumentation/ Interior Design & Decoration/ Interior Design/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Medical Laboratory Technology/ Manufacturing Technology/ Medical Electronics/ Metallurgical Engineering/ Production Engineering/ Printing Technology/ Polymer Technology/ Surface Coating Technology/ Computer Science/ Textile Technology/ Electronics & Computer Engg.**
Programme Code	**: AA/ AD/ AE/ AI/ AL/ AN/ AO/ AT/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CST/ CW/ DBT/ DC/ DE/ DS/ EE/ EJ/ EK/ EP/ ET/ EX/ FC/ HA/ IC/ ICE/ IE/ IF/ IH/ IS/ IX/ IZ/ LE/ ME/ MK/ ML/ MRT/ MU/ MY/ PG/ PN/ PO/ SC/ SE/ TC/ TE**
Semester	**: Fifth / Sixth**
Course Title	**: MANAGEMENT**
Course Code	**: 315301**

I. RATIONALE

Effective management is the cornerstone of success for both organizations and individuals. It empowers diploma engineers/ professionals to accomplish their tasks with finesse and efficiency through strategic planning and thoughtful execution, projects can optimize finances, enhance safety measures, facilitate sound decision-making, foster team collaboration and cultivate a harmonious work environment. The diploma engineers require leadership and management skills with technical knowledge of the core field to carry out various tasks smoothly. This course aims to instill fundamental management techniques, empowering diploma engineers/ professionals to enhance their effectiveness in the workplace.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the students to attain the following industry identified outcome through various teaching learning experiences: Apply the relevant managerial skills for achieving optimal results at workplace.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Use relevant management skills to handle work situation

MANAGEMENT **Course Code : 315301**

- CO2 - Apply appropriate techniques of product, operations and project management
- CO3 - Use comprehensive tools of recent management practices
- CO4 - Plan suitable marketing strategy for a product / service
- CO5 - Utilize supply chain and human resource management techniques for effective management

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	
315301	MANAGEMENT	MAN	AEC	3	-	-	1	4	2	1.5	30	70*#	100	40	-	-	-	-	25	10	125

Total IKS Hrs for Sem. : 1 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.* 15 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.

MANAGEMENT **Course Code : 315301**

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 Justify the importance of management thoughts in Indian knowledge system. TLO 1.2 Describe the importance of management in day to day life. TLO 1.3 Explain Henry Fayol's principles of management. TLO 1.4 Describe the role of each level of management in its management hierarchy. TLO 1.5 Practice the self management skills for a given situation TLO 1.6 Apply the required managerial skills for a given situation	**Unit - I Introduction to Management** 1.1 Evolution of management thoughts from ancient/medieval to modern times in India (IKS) 1.2 Management: meaning, importance, characteristics, functions & challenges. 1.3 Introduction to scientific management- Taylor's & Fayol's principles of management 1.4 Levels & functions of management at supervisory level. 1.5 Self management skills: Self awareness, self discipline, self motivation, goal setting, time management, decision making, stress management, work life balance and multitasking 1.6 Overview of Managerial Skills: negotiation skills, team management, conflict resolution, feedback, leadership	Presentations Case Study Interactive session Quiz competition Mixed Picture Puzzle
2	TLO 2.1 Identify the appropriate creativity technique for new product development TLO 2.2 Describe the new product development process for a product / service TLO 2.3 Comprehend the importance of various strategic steps Product Management TLO 2.4 Elaborate Agile product management TLO 2.5 Explain the significance of the Project Management TLO 2.6 Describe the various tools of project management	**Unit - II Product, Operations and Project Management** 2.1 Creativity and innovation management: creativity techniques - brainstorming, checklist, reverse brainstorming, morphological analysis, six thinking hats. 2.2 New product development, change management 2.3 Product Management -meaning, strategic steps for sustainable design of a product 2.4 Agile product management- concept, benefits, principles and manifesto 2.5 Project Management: importance, areas within project management,4Ps and phases 2.6 Tools of Project Management: PERT and CPM, GANTT & Chart Overview of Estimate and Budget	Presentations Case Study Video Demonstrations Presentations Role Play

MANAGEMENT **Course Code : 315301**

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 Understand the importance of quality management tools TLO 3.2 Explain the importance of various techniques for optimization and waste minimization TLO 3.3 State the importance of ISO quality standards TLO 3.4 Describe ERP TLO 3.5 State the importance of ISO TLO 3.6 Recognize the importance of customer satisfaction as a competitive advantage	**Unit - III Management Practices** 3.1 Quality circle, kaizen, Six Sigma, TQM 3.2 5S, Kanban card system, TPM, Lean Manufacturing: Meaning, Steps and Importance 3.3 Quality Standards and ISO: Meaning, ISO 9001:2016, ISO 14000, OSHA 2020 3.4 The overview of ERP along with example 3.5 Service quality and customer/client satisfaction, servicescape	Presentation Case study Interactive session Quiz Video Demonstration Lecture Using Chalk-Board
4	TLO 4.1 Explain the importance of marketing techniques TLO 4.2 Explain the importance of needs, wants and desires in marketing TLO 4.3 Interpret the traditional and digital marketing techniques TLO 4.4 Plan different aspects of an event management	**Unit - IV Marketing Management** 4.1 Marketing management: meaning, significance, Seven P's of Marketing 4.2 Needs, wants and demands in marketing. Customer relationship management 4.3 Types of marketing: traditional and digital marketing 4.4 Event management: types, different aspects of event management, crisis management	Case Study Interactive session based video Role Play Flipped Classroom Presentations
5	TLO 5.1 State the importance of supply chain and logistics management TLO 5.2 Explain the components of supply chain and logistics Management TLO 5.3 Describe the role of information technology in supply chain & logistics management TLO 5.4 State the significance of Human Resource Management TLO 5.5 Analyze the various methods of recruitment, selection and training for an organization TLO 5.6 List the qualities of a successful supervisor	**Unit - V Supply Chain & Human Resource Management** 5.1 The overview of Supply Chain and logistics Management 5.2 Components of Supply Chain and logistics Management 5.3 Role of information technology in supply chain & logistics management 5.4 Overview of Human Resource Management-Meaning,significance,scope and principles 5.5 Recruitment, selection and training of human resources. Chalk Circle 5.6 Qualities of a successful supervisor /team leader and types of leadership	Presentations Video Demonstrations Case Study Collaborative learning Video Demonstrations Chalk-Board

MANAGEMENT **Course Code : 315301**

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES : NOT APPLICABLE.

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

Assignment / Article

- Make a one page note based on a book of management you read.
- Write a short article on inventory management exploring online learning resources.
- Prepare a report on ISO standards applicable to your field. a. IATF 16949-2016 / SLA-TS 16949-2016, - Automotive Industry b. ISO 22000 — Food safety management c. ISO 50001 — Energy management d. ISO/IEC 27001 - Cyber Security e. ISO/DIS 4931-1 - Buildings and civil engineering works
- Prepare a 4 quadrant matrix of time management for managing the tasks.
- Prepare a report on any one software used for Supply Chain and Logistics Management.
- Prepare a GANTT Chart for project management related to your field.

Note Taking

- Watch a Tedx Talk Video on managerial skills and take notes in the form of keywords.

Case Study

- Prepare a case study and discuss the same on following topics a.Self Management Skills b.Six Thinking Hats c.Kaizen d.Quality Circle e.Safety Measures in different organizations related to your field
- Study the recruitment and selection process of any organization related to your field.
- Prepare a case study on management lessons based on life of Chhatrapati Shivaji Maharaj
- Conduct outbound training on managerial skills. Make a video and upload on social media.

Quizes

- Participate in online quizzes related to areas of management .

Assignment

- Workshops to be conducted for students on following topics a. creativity techniques b. time management c. stress management d. negotiation and conflict e. goal setting f. meditation new product development

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.

MANAGEMENT **Course Code : 315301**

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED : NOT APPLICABLE

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 Management	CO1	13	8	6	4	18
2	II	Product, Operations and Project Management	CO2	8	2	4	6	12
3	III	Management Practices	CO3	8	4	4	6	14
4	IV	Marketing Management	CO4	8	2	4	6	12
5	V	Supply Chain & Human Resource Management	CO5	8	4	4	6	14
Grand Total				**45**	**20**	**22**	**28**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- MCQ Based Class Test, Self Learning Activities / Assignment

Summative Assessment (Assessment of Learning)

- Summative Assessment (Assessment of Learning) MCQ based

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	-	-	2	3			
CO2	1	3	3	-	1	3	3			
CO3	1	3	1	-	1	1	3			
CO4	1	2	2	-	1	2	3			
CO5	1	1	2	-	1	2	3			

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

XII. SUGGESTED LEARNING MATERIALS / BOOKS

MANAGEMENT **Course Code : 315301**

Sr.No	Author	Title	Publisher with ISBN Number
1	A. K. Gupta	Engineering Management	S. Chand, ISBN: 81-219-2812-5, 2007, 2nd Edition
2	O. P. Khanna	Industrial Engineering &management	Dhanpat Rai Publication, ISBN: 978-8189928353, 2018
3	Harold Koontz and Heinz Weinrich	Essentials of Management	Tata McGraw Hill Education ISBN: 9789353168148, 2020, 12th edition
4	E. H. McGrath	Basic Managerial Skills for All	PHI ISBN: 978-8120343146, 2011, 9th Edition
5	Andrew DuBrin	Management Concepts and Cases	Cengage Learning, ISBN: 978-8131510537, 2009, 9th edition
6	K. Dennis Chambers	How Toyota Changed the World	Jaico Books ISBN: 978-81-8495-052-6, 2009
7	Jason D. O'Grandy	How Apple changed the Wolrd	Jaico Publishing House ISBN: 978-81-8495-052-0, 2009
8	Subhash Sharma	Indian Management	New Age International Private Limited ; ISBN-978-9389802412, 2020, 1st edition
9	Chitale, Dubey	Organizational Behaviour Text and Cases	PHI LEARNING PVT. LTD., ISBN: 978-9389347067, 2019, 2nd Edition

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.debonogroup.com/services/core-programs/six-thinking-hats/	Six Thinking Hats
2	https://hbr.org/1981/09/managing-human-resources	HR Management
3	https://theproductmanager.com/topics/agile-product-management/	Agile Product Management
4	https://www.cdlogistics.ca/freight-news/the-5-components-of-supply-chain-management	Supply Chain Management
5	https://www.infosectrain.com/blog/understanding-the-concepts-of-gantt-chart-and-critical-path-methodology-cpm	PERT, CPM, GANTT Chart
6	https://www.simplilearn.com/best-management-tools-article	Management Tools
7	https://www.psychometrica.in/free-online-psychometric-tests.html	Psychometric Tests
8	https://www.investopedia.com/terms/e/erp.asp	ERP
9	https://asq.org/quality-resources/quality-management-system	QMS
10	https://testlify.com/test-library/creative-thinking/	Psychometric Tests
11	https://www.mindtools.com/	Management Skills
12	https://www.investopedia.com/terms/d/digital-marketing.asp	Digital Marketing

Note :

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

CAPSTONE PROJECT **Course Code : 316004**

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 Software 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/ Manufacturing Technology/ Metallurgical Engineering/ Production Engineering/ Computer Science/ Electronics & Computer Engg.**
Programme Code	**: AE/ AI/ AN/ AO/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CST/ CW/ DE/ DS/ EE/ EJ/ EK/ EP/ ET/ EX/ HA/ IE/ IF/ IH/ LE/ ME/ MK/ MRT/ MY/ PG/ SE/ TE**
Semester	**: Sixth**
Course Title	**: CAPSTONE PROJECT**
Course Code	**: 316004**

I. RATIONALE

Capstone projects in engineering study are considered important as it allow students to integrate and apply the knowledge and skills acquired throughout their academic program and effectively demonstrating their learning of programme by tackling a real-world problem, ultimately keeping them well prepared for the job market. The capstone project is usually the final assignment and plays a vital role in preparing students for the world of work to its practical applications and ability to help hone students' professional knowledge and skills. Normally, capstone projects are developed in collaboration with industries or businesses, providing students with valuable insights. Capstone projects has been considered as an integral part of diploma curriculum. It helps learners to perform and demonstrate skills gained due to early courses of Diploma study independent. Therefore, this is considered as a course of final year/semester study.

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 professional skills for solving , executing and demonstrating solutions to real-world problems

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Elaborate the identified field problem from the perspective of project work at institute.
- CO2 - Conduct feasibility & viability analysis (using data collection, experiments, Simulation , Coding) to validate required resources, cost, support of the project work.
- CO3 - Apply the acquired knowledge and skills in providing solutions to the real field/industrial problems.
- CO4 - Present Project and its output/ findings / achievements alongwith its exhibits.

CAPSTONE PROJECT **Course Code : 316004**

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	
316004	CAPSTONE PROJECT	CPE	INP	-	-	2	2	4	2	-	-	-	-	-	50	20	50#	20	50	20	150

V. General guidelines for PROJECT WORK

- The Project- problems must be related to the programme or may be interdisciplinary, based on the industry expected outcomes.
- The individual students have different aptitudes and strengths. Project work, therefore, should match the strengths of students. For this purpose, students should be asked to identify the type of project work they would like to execute.
- Project titles are to be finalized in co-ordination/consultation with the Faculty mentor. However, faculty may form a team of students as per specific roles- Literature survey/data collection, data Analysts, model/prototype developers, testers, Project managers using IoTs ITES and software /application development. Study type project is NOT advisable.
- Project must be assigned to a group of 3-4 students under the guidance of identified faculty mentor.
- Students are required to prepare a prototype/working model/software of the Project and simultaneously prepare a report.
- Students shall Submit One Hard copy and one Soft copy each of Project Report and soft-copy of the project code or the working model.
- Students must maintain a project execution diary having the progress steps and details. The concerned faculty should check the diary on a weekly basis and accordingly interact with students based on the progress shown and keep proper record with feedback if any.
- Project shall address National Thrust area such as Environment, Digitization, Automation, sustainability and similar domains.
- Student shall try to use the national and international standards wherever possible (processes / materials / equipments etc ..)

VI. Project facilitation guidelines:

Once the Project statement has been finalized and allotted to the students, the Faculty Mentor role is very important as guide, motivator, catalyser to promote learning and sustain the interest of the students. At the same time the Faculty Mentor is not expected to guide the students on each step, otherwise it will curb the creativity of the students-group. The Faculty Mentor has to work as a mentor. Following should be kept in mind while facilitating the project at the institute:

1.Project orientation cum -briefing: the project should be relevant to the curriculum of the programme. The project shall be cost effective taking safety aspects, ethical issues, environmental issues and confidentiality as per expectation of industry(if any) into consideration, The work may be industry Sponsored.

2.Information search and data collection: the information and data should be realistic and relevant to the problem /project. Hypothetical data is not to be taken into consideration.

3.Implementation and Monitoring: The project must have important steps /milestones to achieve as per the time frame/action plan prepared by students and faculty. The monitoring mechanism such as daily/weekly dairy **(Format given below)** must be clearly explained and delineated for the students.

VII.Criteria of Assessment /Evaluation of Project work

A. Formative Assessment (FA) criteria

The **Formative Assessment** (FA) of the students for 50 marks is to be done based on following criteria.

Appropriate RUBRICS may be used for assessment

Rubrics for Assessment of the team

Sr.No.	Criteria	Marks
1	Project Selection & Problem definition	05
2	Literature survey and data collection/ Gathering	05
3	Design / concept of project/ Working - Execution of Project	10
4	Stage wise progress as per Action plan/milestone	05
5	Quality Report Writing	05

Rubrics for Individual Assessment

Sr.No.	Criteria	Marks
1	Contribution as a team member	05
2	Depth of Knowledge	10
3	Presentation	05

B. Summative Assessment Criteria

- The summative assessment for 50 marks is to be done and based on following criteria. This assessment shall be done by the faculty mentor and External examiner.

Sr.No.	Criteria	Marks
1	Capstone Project Completion as per plan	10
2	Project related Requirement Analysis & Designing	10
3	Developing a Solution with proper justifications, Teamwork	10
4	Project Report Writing	10
5	Project Presentation	10

(**NOTE :** Team based and Individual performance based summative assessment may include Innovativeness , Technology used , user friendliness , cost effectiveness , society benefits etc..)

SUGGESTED RUBRIC FOR SUMMATIVE ASSESSMENT OF CAPSTONE PROJECT

PROJECT ASSESSMENT

CAPSTONE PROJECT **Course Code : 316004**

Project Title:				
Project Assessment Rubric				
Performance	**Excellent**	**Good**	**Fair**	**Poor**
Criteria	**9-10 marks.**	**6-8 marks.**	**4-5 marks.**	**0-3 marks**
Capstone Project Completion	Excellent	Good	Fair	Poor
	The project is completed as per tasks described in synopsis.	**The project is completed but require minor modifications.**	**The project is completed but require several modifications.**	**The project is not completed as per tasks described in synopsis.**
Project related Requirement Analysis & Designing	**9-10 marks.**	**6-8 marks.**	**4-5 marks.**	**0-3 marks**
	Effectively contributed in requirement analysis and designing.	**Partially Contributed in requirement analysis and designing.**	**Attempted to contribute in requirement analysis and designing**	**No contribution in requirement analysis and designing.**
Developing a Solution with proper justifications , Teamwork	**9-10 marks.**	**6-8 marks.**	**4-5 marks.**	**0-3 marks**
	Developed the critical solution modules with Innovation, optimized design and worked very well with the team.	**Developed some solutions with higher complexity and worked well with the team.**	**Attempted to develop few solutions and worked with the team.**	**No contribution in developing a solution and in the team.**
Project Report Writing	**9-10 marks.**	**6-8 marks.**	**4-5 marks.**	**0-3 marks**
	Worked very well to submit an excellent project report .	**Worked well to submit the project report with covering all the aspects of a standard report.**	**Tried to submit the project report but standard of report was not satisfactory.**	**No contribution in project report writing.**
Project Presentation	**9-10 marks.**	**6-8 marks.**	**4-5 marks.**	**0-3 marks**
	Presented the project work flawlessly.	**Presented the project work very nice.**	**Presented the project work not so well.**	**Presentation skill is not up to the mark.**
Project Group Members				
ROLL NUMBER/Enrollment Number				
NAME				

Comments (if any)

NOTE : " These are suggestive rubrics Faculty mentor and external examiner may frame different rubrics as per Programme need and assigned Project work "

C. Self Learning Assessment

Self Learning Assessment **Max Marks -50**

Sr.No.	Criteria	Max Marks	Marks Obtained
1	Project Selection & Problem definition	10	
2	Literature survey and data collection/ Gathering	05	
3	Design / concept of project/ Working - Execution of Project	15	
4	Stage wise progress as per Action plan/milestone/ psychomotor motor skills acquired	10	
5	Quality Report Writing	10	

VIII. CO-PO Mapping

CO-PO mapping will vary project wise and shall be prepared by concerned faculty for the given project

IX. Typographical instructions/guidelines for Project report writing

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

a. The PROJECT report shall be computer typed (English- British) and printed on A4 size paper.
b. Text Font -Times New Roman (TNR), Size-12 point
c. Subsection heading TNR- 12 point bold normal
d. Section heading TNR- 12 capital bold
e. Chapter Name/ Topic Name – TNR- 14 Capital
f. All text should be justified. (Settings in the Paragraph)
g. 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.
h. The training report must be hardbound/ Spiralbound with cover page in black colour. The name of the candidate, diploma (department), year of submission, name of the institute shall be printed on the cover [Refer sample sheet (outer cover)]
i. The training report, the title page [Refer sample sheet (inner cover)] should be given first then the Certificate followed by the acknowledgment and then contents with page numbers.

X. Project Report

On completion of the project work, every student will submit a project report which should contain the following:
1. Cover Page (as per annexure 1)
2. Title page (as per annexure 2)
3. Certificate by the Guide (as per annexure 3)
4. Acknowledgment (The candidate may thank all those who helped in the execution of the project.)
5. Abstract (It should be in one page and include the purpose of the study; the methodology used.)

6. Table of Contents (as per general guidelines): Detailed description of the project (This should be split in various chapters/sections with each chapter/section describing a project activity in totality).

Chapter–1 Introduction (background of the Industry or User based Problem/Task)
Chapter–2 Literature Survey (to finalize and define the Problem Statement)
Chapter–3 Scope of the project
Chapter–4 Methodology/Approach, if any
Chapter-5 Details of designs, working and processes
Chapter-6 Results and Applications

7. Conclusion
8. References (The listing of references should be typed 2 spaces below the heading "REFERENCES" in alphabetical order in single spacing left – justified. It should be numbered consecutively (in square [ ] brackets, throughout the text and should be collected together in the reference list at the end of the report. The references should be numbered in the order they are used in the text. The name of the author/authors should be immediately followed by the year and other details). Typical examples of the references are given below:

NOTE:

1. Project report must contain only a relevant and short mention – technology or platform or tools used. It must be more focussed on project work and its implementation
2. Students can add/remove/edit chapter names as per the discussion with their guide

Formats

Project Report

"Project Title----------"

as a partial fulfilment of requirement of the

THIRD YEAR DIPLOMA IN

Submitted by

1)Name Of Student	**Enrollment Number**
2)Name Of Student	**Enrollment Number**
3)Name Of Student	**Enrollment Number**
4)Name Of Student	**Enrollment Number**

CAPSTONE PROJECT **Course Code : 316004**

Are the bonafide on

FOR THE ACADEMIC YEAR

20-----20---

(H.O.D)

(Principal)

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

Department Name

(If NBA Accredited mention that)
Institute Name

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

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Sr.No.	**Chapter**	**Page No.**
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3.	Chapter–3 Scope of the project	
4	Chapter–4 Methodology/Approach, if any	
5	Chapter-5 Details of designs, working and processes	
6.	Chapter-6 Results and Applications	
7.	REFERENCES	

CAPSTONE PROJECT **Course Code : 316004**

Note:

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

Annexure

PROJECT DIARY (Weekly/Daily)

Name of the Student : _____

Name of Guide (Faculty) : _____

Enrollment Number : _____ Semester: _____Project batch Number : _____

WEEK : _____

Date	Activity carried out (Details)	Achievement of mile stone/step as per plan	Remark of Faculty

Monday			
Tuesday			
Wednesday			
Thursday			
Friday			
Saturday			

Dated Signature of Faculty **Dated Signature of HOD**

MSBTE LOGO INST LOGO

Certificate

This is to certify that

CAPSTONE PROJECT **Course Code : 316004**

Mr./Ms. *bearing examination seat No.* *has*

Satisfactorily completed his/her ***PROJECT*** *entitled*

Along with his/her batchmates in partial fulfillm ent for the

Diploma Course in

< PROGRAMME NAME>

Of the ***Maharashtra State Board of Technical Education*** *at our Polytechnic during the Academic Year20 -20 .*

The Project is completed by a group consisting of Persons under the guidance of the Faculty Guide

Faculty Name and Signature (Internal)	**Faculty Name and Signature (External if applicable)**	**HOD Name and Signature with Department Stamp**
Date and Time		

MSBTE Approval Dt. 04/09/2025 **Semester - 6, K Scheme**

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AUTOMOTIVE MECHATRONICS **Course Code : 316351**

Programme Name/s : Mechatronics
Programme Code : MK
Semester : Sixth
Course Title : AUTOMOTIVE MECHATRONICS
Course Code : 316351

I. RATIONALE

The modern automotive industry is driven by the integration of sophisticated electronics and control systems. The modern vehicles are no longer purely mechanical entities; they are complex, interconnected systems relying on sophisticated electronics, sensors, actuators, and control algorithms. This course in Automotive Mechatronics is meticulously designed to address this paradigm shift, providing diploma engineers with the essential knowledge and practical skills required to navigate and excel in this dynamic field.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the students to attain the following industry identified outcome through various teaching learning experiences: Diagnose fault in automotive mechatronic system

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Identify various automobile systems with their functions and location.
- CO2 - Diagnose performance of given automotive sensors and actuators
- CO3 - Create block diagram of given automotive control system explaining its working and functioning of different components
- CO4 - Perform onboard diagnostics on MPFI and CRDI engine using scan tool and measuring instruments.
- CO5 - Check functionality of vehicle safety device components and advanced driver assistance systems

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	
316351	AUTOMOTIVE MECHATRONICS	AMK	DSC	4	-	2	2	8	4	3	30	70	100	40	25	10	25#	10	25	10	175

AUTOMOTIVE MECHATRONICS **Course Code : 316351**

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.* 15 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 Classify Automobiles on basis of various criteria TLO 1.2 Draw block diagram of general vehicle layout TLO 1.3 List major components of automobile with their location and function TLO 1.4 Sketch block diagram of SI & CI Engine TLO 1.5 Explain working of given power train control system with block diagram TLO 1.6 State necessity, functions and location of given automobile system	**Unit - I Automotive Fundamentals** 1.1 Automobile: Definition, Need of Automobile, Classification of Automobiles. 1.2 Block diagram of general vehicle layout 1.3 Major components of Automobile with their function and location 1.4 Block diagram of Spark Ignition (SI) and Compression Ignition (CI) Engine 1.5 Power train control system: Electronic control system used in Multi-Point Fuel Injection (MPFI) and Common Rail Direct Injection (CRDI) system 1.6 Necessity, functions and locations of following automobile systems. a.Transmission system b.steering system. c.Suspension system. d.Cooling and lubrication system e.Fuel injection and Ignition system. f.Starting and charging system.	Video Demonstrations Presentations Model Demonstration Lecture Using Chalk-Board

AUTOMOTIVE MECHATRONICS **Course Code : 316351**

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 List variables sensed in engine control TLO 2.2 Describe functions of automobile sensors and actuators TLO 2.3 Explain with sketches working and output signals of given automotive sensors TLO 2.4 Explain construction & working of given automotive actuators TLO 2.5 Describe procedure for maintaining given automotive sensors and actuators	**Unit - II Automotive Sensors and Actuators** 2.1 Concepts of an Electronic Engine control system: Inputs to controller, Outputs from controller 2.2 Variable quantity sensed in automotive engine : Air flow rate, speed , pressure, temperature, vibration, concentration of oxygen. 2.3 Sensors in Automotive: Air flow rate sensor, Engine speed sensor, Engine crankshaft angular position sensor, Throttle Position sensor, Manifold Absolute Pressure sensor, Intake Air Temperature sensor, Coolant Temperature sensor, Exhaust gas oxygen sensor, Knock sensor 2.4 Automobile Engine control Actuators:- Fuel injector, Exhaust gas recirculation actuator, Brushless Direct Current (BLDC) Motor	Video Demonstrations Presentations Model Demonstration Lecture Using Chalk-Board Site/Industry Visit
3	TLO 3.1 Explain construction and working of given motion control system TLO 3.2 State advantages and disadvantages of Antilock Braking system (ABS) TLO 3.3 State function of given motion control system TLO 3.4 List types of cruise control system TLO 3.5 Draw the block diagram of given automotive motion control system	**Unit - III Automotive Motion Control System** 3.1 Cruise control system : Location, Types, Construction & working of cruise control system. 3.2 Antilock Braking system (ABS): Function, Construction & working , Advantages & Disadvantages. 3.3 Electronic power steering (EPS) system: Location, function, Construction & working. 3.4 Traction control system (TCS): Function, Construction & working 3.5 Electronic Stability control (ESC): Function, Construction & working 3.6 Integrated Engine control (IEC): Function, Construction & working	Video Demonstrations Presentations Model Demonstration Lecture Using Chalk-Board

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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 Explain diagnostics procedure to given component and system TLO 4.2 List types of On-Board Diagnostics (OBD) Scanner available in market TLO 4.3 Explain OBD II procedure TLO 4.4 State procedure for standalone diagnosis of given component TLO 4.5 Describe six step approach in testing of given automotive component with flow chart TLO 4.6 List diagnostics fault codes with meaning TLO 4.7 State function of given measuring instrument for testing	**Unit - IV Diagnostics and Testing** 4.1 Electronic control system diagnostics 4.2 On-Board Diagnostics (OBD) scanner types 4.3 On-Board Diagnostics (OBD II) Procedure of MPFI/CRDI system 4.4 Standalone diagnosis: Sensors and actuators 4.5 Six step approach for component testing 4.6 Diagnostic Fault codes : Types with their meaning 4.7 Measuring Instruments: Digital multi-meters, Oscilloscope, scan tool, Frequency meters	Video Demonstrations Presentations Model Demonstration Lecture Using Chalk-Board Site/Industry Visit
5	TLO 5.1 Describe the necessity of safety systems in modern vehicles TLO 5.2 Identify the different Advanced Driver Assistance System used in vehicle TLO 5.3 Describe working of given Advanced Driver Assistance System used in vehicle	**Unit - V Safety and Advanced Driver Assistance System** 5.1 Necessity of safety system 5.2 Types of safety-Active and Passive 5.3 Safety and Advanced Driver Assistance System :– Air Bags, Seat Belt, Central Locking, Collapsible Steering, Keyless Entry, Reverse Parking Sensor and Rear View Camera, Active Suspension, Adaptive Cruise Control, Voice Alert System, Automatic Climate Control, General Packet Radio Service (GPRS), Tyre Pressure Warning.	Video Demonstrations Presentations Lecture Using Chalk-Board Model Demonstration 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 Identify automobile systems like (Transmission ,Control ,Suspension ,Electrical and Electronics) LLO 1.2 Draw block diagram of general vehicle layout LLO 1.3 Label the diagram and list major components of automobile	1	*Trace general vehicle layout of given vehicle	2	CO1

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 2.1 Select various tools available in laboratory LLO 2.2 Categorize tools available in laboratory LLO 2.3 Use different hand tools and measuring devices for different application	2	Use of different hand tools and measuring devices	2	CO1 CO4
LLO 3.1 Use relevant tools require to dismantle petrol/diesel engine LLO 3.2 Follow safety procedure as per standard LLO 3.3 Inspect condition of components	3	*Dismantling of 4-stroke engine (Petrol/Diesel)	2	CO1
LLO 4.1 Use relevant tools require to assemble petrol/diesel engine LLO 4.2 Follow safety procedure as per standard LLO 4.3 Inspect condition of components LLO 4.4 Reassemble the petrol/diesel engine	4	*Assembling of 4-stroke engine (Petrol/Diesel)	2	CO1
LLO 5.1 Dismantle given clutch LLO 5.2 Identify components of clutch LLO 5.3 Draw any components of the clutch LLO 5.4 Identify fault in clutch. (if any) LLO 5.5 Assemble clutch	5	Dismantling and Assembling of Clutch	2	CO1
LLO 6.1 Identify and locate the various sensors on vehicle engine LLO 6.2 Write function of each	6	*Identification of sensors and actuators in the given MPFI/CRDI engine	2	CO2
LLO 7.1 Connect the oscilloscope to the oxygen sensor signal wire LLO 7.2 Observe the waveform at idle and while the engine is revved LLO 7.3 Check resistance and voltage output LLO 7.4 Observe sensor performance and relate with engine efficiency and performance	7	*Diagnosis of (waveform, resistance and voltage output) oxygen sensor and throttle position sensor using oscilloscope	2	CO2

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 8.1 Make connection of oscilloscope to the given sensor signal wire LLO 8.2 Observe the waveform at idle and while the engine is revved LLO 8.3 Check resistance and voltage output LLO 8.4 Observe sensor performance and relate with engine efficiency and performance	8	Diagnosis of (waveform, resistance and voltage output) Engine Temperature sensor and manifold absolute pressure sensor using oscilloscope	2	CO2
LLO 9.1 Identify Antilock braking system components LLO 9.2 Identify Electronic stability control system components LLO 9.3 List features of ABS and ESC	9	*Identification of various components of ABS and ESC system	2	CO3
LLO 10.1 Identify various components of given motion control system LLO 10.2 List features of motion control system like cruise control system, EPS, TCS, IEC etc. in vehicle	10	Identification of various components of motion control system like cruise control system, EPS, TCS, IEC etc. in vehicle	2	CO3
LLO 11.1 Search information on digital platform/ by market survey LLO 11.2 Report features of various types of OBD scanner	11	*Preparation of report on OBD Scanner types available in market with manufacturer specifications	2	CO4
LLO 12.1 Connect Scan tool to MPFI engine control unit and enter vehicle identification data LLO 12.2 Interpret the trouble code/s LLO 12.3 Inspect relevant transducer and wiring LLO 12.4 Rectify fault and clear diagnostic trouble code	12	On-Board Diagnosis (OBD-II) of MPFI engine using Scan tool	2	CO4
LLO 13.1 Detect fault using scanner LLO 13.2 Replace faulty sensor, actuator or ECU as required LLO 13.3 Perform onboard diagnostics on CRDI engine	13	On-Board Diagnosis (OBD-II) of CRDI engine using Scan tool	2	CO4
LLO 14.1 Identify types of safety devices used in vehicle LLO 14.2 Check the functionality of the components used in safety devices	14	*Functioning of vehicle Saftey devices components	2	CO5
LLO 15.1 Identify Advanced Driver Assistance Systems LLO 15.2 Check the functionality of Advanced Driver Assistance Systems used in vehicle	15	Demonstration of functional features of Advanced Driver Assistance System used in different vehicles	2	CO5

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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

- Collect specifications and features of control system of vehicle, such as: Traction control system, Stability control, Integrated Engine control and prepare report for the same
- Visit modern service station for observing automobile electronics and computer-controlled systems and prepare a report on the same
- Prepare power point presentation or animation for understanding different automotive components and systems
- Observe videos relevant to practical task. Prepare a list of appropriate tool/ equipment Considering its range/ application. For following applications, tools should be listed: i.Diagnostic tools for MPFI engine ii.Diagnostic tools for CRDI engine
- Observe videos to operate various testing equipment's. Prepare a list of appropriate equipment considering its range/applications
- Collect videos relevant to MPFI, CRDI system
- Collect specifications and features of control system of vehicle, such as: ABS, Electronic suspension systems, Electronic power steering system and prepare report for the same

Micro project

- Choose a modern engine and search information on any one system from website. Prepare a report for the same.
- Case study based on Visit to automobile garage to study a faulty system of engine
- Identify a modern technology used in an engine. Collect relevant information on the technology and its features. Compare the same with older/ modern technologies adopted in other vehicles. Refer internet/ reference books/ manufacturer published literature for the same. Prepare a report
- Prepare a detail report on diagnosis of MPFI engine: following steps to be followed: i.Student should visit the shops/ garage for survey. ii.List out steps of diagnosis. iii.Diagnose a system of an engine using scan tool/multimeter/oscilloscope. iv. Prepare a 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.

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VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	General purpose tools (spanner, ring spanner and socket)-6mm to 32mm	1,2,3,4,5
2	Scan tool: Make reputed manufacturers: On Board Diagnosis (OBD), II Generation scan tool, controlled Network area enabled, color display, operating temperature:0 to 50 degree Celsius, Internal storage: 4AAA Batteries, External Power :7 to 18 Volts; generic tools; accessories: extended cable, OBD II cable; relevant optional accessories.	11,12,13
3	Special purpose tools (piston ring expander, piston ring compressor, valve lifter, spark plug remover, torque wrench), torque wrench range -10 Nm to 200 Nm	2
4	Multiport fuel injection system with sensors, actuators and electronic control module, exhaust gas circulation valve and Positive crankcase ventilation valve make reputed manufacturers power 25 KW@ 5000 RPM to 50 KW @ 5000 RPM: Cubic capacity 1000 CC to 2000 CC	6,7,8
5	Automotive Diagnostic Oscilloscope; Type PC Based or hand-held analog channel: 8; Bandwidth :1000 KHz; Input impedance resistance: 1 M?; Input sensitivity :10mV/div to 5 V/div	7,8
6	Digital Multimeter: Make: Reputed manufacturers -Measure Voltage and Current AC and DC, Resistance, Capacitance, diodes, continuity, frequency, Min-Max functions: LCD Display,0 to 500C operation, Temperature, DC voltage-2mV to 1000V alternating current, current: 2 Ma TO 20 A DC, Diode Test, Continuity Test-Audible buzzer, resistance: 200 ohm to 200 Mega ohm	7,8,11,12,13
7	Four-wheeler vehicle make of TATA, Mahindra or alike in good running condition. OR Cut section working model of four-wheeler transmission system showing all the parts	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	Automotive Fundamentals	CO1	12	4	4	6	14
2	II	Automotive Sensors and Actuators	CO2	14	4	4	8	16
3	III	Automotive Motion Control System	CO3	12	2	6	4	12
4	IV	Diagnostics and Testing	CO4	12	2	4	10	16
5	V	Safety and Advanced Driver Assistance System	CO5	10	2	4	6	12
Grand Total				**60**	**14**	**22**	**34**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Class Test, Term work, Self-Learning

Summative Assessment (Assessment of Learning)

- End Semester Examination Theory , End Semester Examination Practical (External)

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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	3	-	-	3	1	1	1			
CO2	3	2	1	2	1	-	2			
CO3	2	-	-	1	-	-	1			
CO4	3	2	2	3	1	2	3			
CO5	3	-	-	-	2	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	Dr. Kirpal Singh	Automobile Engineering Vol-I & II	Standard Publishers Distributors, New Delhi, 2011, ISBN:978-81-8014-171-3
2	William B. Ribben	Understanding Automotive Electronics	Butterworth-Heinemann, UK, 2017, ISBN 13:978-0128104347
3	A K BABU	Automotive Electrical and Electronics	Khanna Book Publishing Co. Ltd, New Delhi, 2016,ISBN:978-93-82609-69-8
4	Ronald K. Jurgen	Automotive Electronics Handbook	McGraw-Hill Inc.
5	Bosch, Robert	Automotive Handbook	Bentley Publishes, UK, 2014, ISBN:13:978978-1119975564
6	Denton, Tom	Advanced Automotive Fault Diagnosis	Routledge, New York, 2012, ISBN:978-0415725767

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=jAqC0qxIiL8 for MPFI system	MPFI system working
2	https://www.youtube.com/watch?v=KzF8ieiJ9UY for CRDI system	CRDI system working
3	https://www.youtube.com/watch?v=M9dZUOr6n4g for camshaft and crankshaft sensor testing	How to test camshaft and crankshaft sensor
4	https://www.youtube.com/watch?v= 8q6qZQJQEIU for automotive sensors and actuators	Describe different Automotive sensor and actuators

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Sr.No	Link / Portal	Description
5	https://www.youtube.com/watch?v=RR8LsMBwL2I for Scan tool video	Scan tool video
6	https://www.youtube.com/watch?v=NUvWnOd5lFw for Common Rail Diesel Injector Working and Common Failure Points	Working of Common Rail Diesel Injector
7	https://www.youtube.com/watch?v=jKtBSFoAYlg- for cruise control system	What is cruise control system
8	https://www.youtube.com/watch?v=oMDqgcm4ZjU - Park assist system	Working of Park assist system
9	https://www.youtube.com/watch?v=lnK00rtWf68 for Throttle Position sensor cleaning	Cleaning process of Throttle position sensor
10	https://www.youtube.com/watch?v=98DXe3uKwfc - Antilock Braking system	How ABS work
11	https://www.youtube.com/watch?v=CYufBm5Bek8 - working of Air bag	Working of Air bag
12	https://www.youtube.com/watch?v=JIa0nsrQXI0 to read car fault codes and to clear them	How to read car fault codes and to clear fault code
13	www.araiindia.com	Website of The Automotive Research Association of India

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. 04/09/2025 **Semester - 6, K Scheme**

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PLC PROGRAMMING AND SCADA **Course Code : 316352**

Programme Name/s : **Mechatronics**
Programme Code : **MK**
Semester : **Sixth**
Course Title : **PLC PROGRAMMING AND SCADA**
Course Code : **316352**

I. RATIONALE

Contemplating the growing demand for expertise in Advanced Automation Systems within modern industries, learning about Programmable Logic Controller (PLC) programming and SCADA will equip the students with the ability to design and implement control systems and skills for real-time monitoring and data acquisition. This knowledge is critical for optimizing industrial processes, enhancing productivity, and ensuring safety by designing, programming, and maintaining PLC & SCADA based systems.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the students to attain the following industry identified outcome through various teaching learning experiences:: Use PLC & SCADA systems for industrial automation.

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 and functions of different elements of PLC.
- CO2 - Execute different PLC ladder programming instructions.
- CO3 - Maintain PLC-based automation systems.
- CO4 - Develop SCADA screen for simple application.
- CO5 - Select advanced automation systems for industry 4.0 compliance.

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	
316352	PLC PROGRAMMING AND SCADA	PPS	SEC	4	-	4	-	8	4	3	30	70	100	40	25	10	25#	10	-	-	150

MSBTE Approval Dt. 04/09/2025 **Semester - 6, K Scheme**

PLC PROGRAMMING AND SCADA **Course Code : 316352**

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.* 15 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 Explain the significance of industrial automation. TLO 1.2 Classify different types of automation used in mechatronic systems. TLO 1.3 Describe types of controls in industrial automation. TLO 1.4 Explain the function of different elements of PLC with the help of block diagram. TLO 1.5 Describe the concept of sinking and sourcing in PLC. TLO 1.6 Explain the advantages of PLCs in industrial automation.	**Unit - I Basics of PLC** 1.1 Introduction to industrial automation: Need of automation, automation hierarchy, types of automation 1.2 Analog control, Digital control (Supervisory control and Direct digital control) 1.3 Architecture of PLCs: Block diagram, CPU, I/O modules, power supply, memory organization, special I/O modules 1.4 Types of PLCs: Compact and modular PLCs, selection criteria of PLC, concept of redundancy in PLC 1.5 PLC power connection (wiring), concept of sinking and sourcing in PLC 1.6 Advantages of PLCs over traditional/hardwired relay logic	Lecture Using Chalk-Board Presentations Video Demonstrations Flipped Classroom

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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 Describe different programming languages used to program PLC. TLO 2.2 Specify appropriate I/O addressing format for the given PLC. TLO 2.3 Explain use of different PLC programming instructions used to write a simple program for performing a given operation. TLO 2.4 Explain the timer and counter instructions with their status bits and waveforms. TLO 2.5 Describe do's and don'ts in the PLC-PC installation procedure.	**Unit - II PLC Programming** 2.1 PLC programming languages: Functional Block Diagram (FBD), Instruction List, Structured text, Sequential Function Chart (SFC), Ladder Programming (Introduction only) 2.2 Basics of ladder programming: PLC I/O addressing formats in ladder logic, relay-type instructions, PLC processor scan cycle 2.3 Programming Timer: Addressing a timer block, status bits, ON delay, OFF delay and reset, retentive timer 2.4 Programming Counter: Addressing a counter block, status bits, UP and DOWN counter, UP-DOWN counter 2.5 Advanced PLC programming: PLC arithmetic/Math instructions, PLC logical instructions, PLC comparison instructions and data handling instruction (Move, Masked Move, Copy, Clear), Analog I/O instructions (Scaling & signal processing) 2.6 Introduction to popular PLC programming software used in industries 2.7 PLC-PC interface, do's and don'ts in PLC installation	Lecture Using Chalk-Board Presentations Video Demonstrations
3	TLO 3.1 Explain basics of Ladder programming for a given Boolean expression. TLO 3.2 Develop Ladder program for simple applications. TLO 3.3 Prepare Ladder program for a given industrial application. TLO 3.4 Describe regular PLC maintenance practices. TLO 3.5 Enlist steps to troubleshoot PLC for a specific application.	**Unit - III PLC Applications and Troubleshooting** 3.1 PLC based simple applications: Ladder programming for latching and seal in circuits, Boolean expressions and logic gates, home automation etc. 3.2 PLC based industrial applications: Motor sequence control, traffic light control, conveyor system, bottle filling plant, car parking, stepper motor control, Elevator control, Electro-hydraulic and electro-pneumatic control, robotic control 3.3 Analog controls: Tank level control, temperature control, pressure control/flow control 3.4 Regular PLC maintenance practices 3.5 Standard steps for PLC troubleshooting	Lecture Using Chalk-Board Presentations Model Demonstration Video Demonstrations Site/Industry Visit

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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 Explain various benefits and applications of SCADA. TLO 4.2 Enlist different SCADA software. TLO 4.3 Explain the architecture of SCADA with the help of sketch. TLO 4.4 Explain the major features of the given communication protocol used for SCADA. TLO 4.5 List the steps in Interfacing of PLC and SCADA system. TLO 4.6 Describe the need and architecture of OPC. TLO 4.7 State the steps in creating simple SCADA screen for a given application.	**Unit - IV SCADA Fundamentals** 4.1 Supervisory Control and Data Acquisition (SCADA): Introduction, need, benefits and typical applications 4.2 Introduction to popular SCADA software used in industries 4.3 SCADA architecture: Types of SCADA architecture, Master Terminal Unit (MTU), Remote Terminal Unit (RTU) 4.4 Network topologies, RS232, RS422, RS485 standards for data communication, communication protocols (Modbus, Field bus, Profibus, Industrial Ethernet) 4.5 Interfacing SCADA system with PLC: Typical connection diagram 4.6 Object linking and embedding for process control (OPC) - need, architecture 4.7 Developing SCADA screen for simple applications - conveyor system, car washing system, Traffic light system and Hydro-power plant	Lecture Using Chalk-Board Presentations Video Demonstrations Flipped Classroom
5	TLO 5.1 Identify the steps in integrating given HMI panel with given PLC. TLO 5.2 AC drives preferred over DC drives in modern automation systems. Justify. TLO 5.3 Draw wiring diagram of VFD to PLC interfacing. TLO 5.4 Explain the architecture of DCS with the help of sketch. TLO 5.5 List various emerging trends in industrial automation.	**Unit - V Advanced Industrial Automation Systems** 5.1 Human-Machine Interface (HMI): Introduction to HMI, Types of HMIs (Touchscreen, Panel-based, PC-based, Steps for integrating PLC with HMI panel 5.2 AC/DC Drives: Fundamentals of Electrical Drives, Applications of VFDs in Mechatronics Systems 5.3 Distributed Control System (DCS): Architecture and Functioning of DCS, DCS-PLC Comparison and Applications, Role of DCS in Process Automation 5.4 Emerging trends in industrial automation: Introduction to Cloud PLC & SCADA, IIOT, Industry 4.0	Lecture Using Chalk-Board Presentations Case Study 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 Identify various parts of PLC. LLO 1.2 Connect PLC to PC.	1	*Identification of various parts of PLC available in your laboratory	2	CO1
LLO 2.1 Develop ladder diagram to test the functionality of logic gates. LLO 2.2 Simulate the ladder diagram for logic gates.	2	*Development of ladder diagram for testing functionality of logic gates	2	CO2
LLO 3.1 Develop ladder diagram for seal in circuit. LLO 3.2 Simulate the ladder diagram for seal in circuit.	3	*Simulation of simple seal in circuit using PLC simulator	2	CO2

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 4.1 Develop ladder diagram for mathematical instructions. LLO 4.2 Simulate the ladder diagram for mathematical instructions.	4	*Simulation of mathematical instruction using ladder program	2	CO2
LLO 5.1 Develop ladder diagram to operate siren using timer. LLO 5.2 Execute the ladder program to demonstrate on hardware.	5	* Activation of siren using Timer in PLC	2	CO2
LLO 6.1 Develop ladder diagram for up counter. LLO 6.2 Execute the ladder program to demonstrate on hardware.	6	Simulation of up counter for certain number of counts to turn on lamp	2	CO2
LLO 7.1 Develop ladder diagram for up/down counter. LLO 7.2 Simulate the ladder diagram to make lamp ON/OFF.	7	*Development of ladder program for up/down counter to make lamp ON/OFF	2	CO2
LLO 8.1 Develop ladder diagram for pulse counting using limit switch / proximity sensor LLO 8.2 Simulate the ladder diagram for pulse counting using limit switch / proximity sensor	8	*Development of ladder diagram for pulse counting using limit switch / proximity sensor	2	CO2
LLO 9.1 Develop ladder diagram for latching circuit. LLO 9.2 Simulate ladder diagram for latching circuit.	9	*Simulation of latching circuit using ladder program	2	CO3
LLO 10.1 Develop ladder diagram for motor sequence control. LLO 10.2 Simulate the ladder diagram for motor sequence control.	10	*Simulation of motor sequence control using ladder diagram	2	CO3
LLO 11.1 Develop ladder diagram for traffic light control. LLO 11.2 Simulate the ladder diagram to demonstrate on hardware.	11	*Implementation of traffic light control using ladder diagram	2	CO3
LLO 12.1 Develop ladder diagram for automated elevator control. LLO 12.2 Simulate the ladder diagram for automated elevator control.	12	Implementation of automated elevator control using ladder diagram	2	CO3
LLO 13.1 Develop ladder diagram for tank level control. LLO 13.2 Simulate the ladder diagram to demonstrate on hardware.	13	*Implementation of tank level control using ladder diagram	2	CO3

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 14.1 Develop ladder diagram for conveyor system. LLO 14.2 Simulate the ladder diagram for conveyor system.	14	Implementation of conveyor system using ladder diagram	2	CO3
LLO 15.1 Develop ladder diagram for rotation of stepper motor. LLO 15.2 Simulate the ladder diagram to demonstrate on hardware.	15	*Development of ladder program for rotating stepper motor in forward direction and reverse direction at constant speed	2	CO3
LLO 16.1 Develop ladder diagram for rotation of DC motor. LLO 16.2 Simulate the ladder diagram to demonstrate on hardware.	16	Development of ladder program for ON/OFF control of DC motor in forward and reverse directions	2	CO3
LLO 17.1 Develop ladder diagram for temperature control using any temperature sensor. LLO 17.2 Simulate the ladder diagram to demonstrate on hardware.	17	Development of ladder program for temperature control using any temperature sensor with heater on off	2	CO3
LLO 18.1 Develop ladder diagram for car parking system. LLO 18.2 Simulate the ladder diagram for car parking system.	18	Implementation of car parking system using ladder diagram	2	CO3
LLO 19.1 Develop ladder diagram for bottle filling application. LLO 19.2 Simulate the ladder diagram to demonstrate on hardware.	19	Development of ladder program for bottle filling application	2	CO3
LLO 20.1 Develop ladder diagram for Electro Pneumatic/Hydraulic system. LLO 20.2 Simulate for Electro-Pneumatic/Hydraulic system.	20	Implementation of Electro-Pneumatic/Hydraulic system using ladder diagram	2	CO3
LLO 21.1 Develop ladder diagram for object sorting system. LLO 21.2 Simulate the ladder diagram for object sorting system.	21	Development of ladder program for object sorting (Metallic & Nonmetallic) system	2	CO3
LLO 22.1 Study different SCADA software and system in the market. LLO 22.2 Select the suitable SCADA software for given application.	22	*Selecting the suitable SCADA software for given application	2	CO4
LLO 23.1 Use various functions of SCADA simulation editor. LLO 23.2 Write the steps to develop simple object.	23	*Development of SCADA mimic screen/diagram for START/STOP logic system to turn ON/OFF light after pressing start-stop switch	2	CO4
LLO 24.1 Design alarm annunciation system in SCADA. LLO 24.2 Simulate using SCADA software.	24	Implementation of alarm annunciation using SCADA	2	CO4

PLC PROGRAMMING AND SCADA **Course Code : 316352**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 25.1 Design liquid level controller system in SCADA. LLO 25.2 Simulate using SCADA software.	25	Implementation of liquid level controlling in Tank by using SCADA	2	CO4
LLO 26.1 Develop SCADA mimic screen for temperature control. LLO 26.2 Simulate using SCADA software and observe reporting & trending.	26	Development of SCADA mimic screen for temperature control using any temperature sensor and observe reporting & trending in SCADA System	2	CO4
LLO 27.1 Develop SCADA mimic screen for hydro-power plant. LLO 27.2 Simulate using SCADA software.	27	Development of SCADA mimic screen for hydro-power plant	2	CO4
LLO 28.1 Develop HMI screen with simple objects. LLO 28.2 Simulate using HMI software.	28	*Designing a simple HMI screen with labels, buttons, and indicators	2	CO5
LLO 29.1 Develop multiple HMI screen for different process sections.	29	Designing multiple HMI screens for different process sections	2	CO5
LLO 30.1 Identify various Industry 4.0 technologies such as IoT, AI, robotics, and cloud computing used in automation.	30	*Visit to any industry 4.0 compliant automation industry	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

- Automatic mixing system: Implement Automatic product mixing control system using PLC.
- Traffic light control: Prepare PLC based simple traffic light control system.
- Railway gate control using PLC.
- Washing machine control using PLC ladder programming.
- Automatic Street light controller: Prepare a SCADA based system to control the street lights as per the intensity of natural light.
- Home automation: Implement a versatile automation system for home that can automate any three home appliances using SCADA.
- Color sensing and sorting of objects: Develop a HMI screen for sorting of different products based on color.

Student activity

- Prepare a Report on general maintenance and troubleshooting methods of PLC.
- Make a report on market survey of different types of SCADA software.
- Prepare a report on "Industry Website Exploration: Automation Tools".
- Explore any virtual lab on PLC to perform an activity and prepare a report on it.

PLC PROGRAMMING AND SCADA **Course Code : 316352**

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	PLC trainer kit (with analog and digital I/Os) along with IEC 1131-3 compatible programming Software	1,2,3,9,4,5,6,7,10,12,11,13,14,15,16,17,18,19,8,20
2	Tank Water Level Kit	13,25
3	Conveyer belt (24 V DC operated) Kit	14,16,19,20
4	Trainer kit for bottle filling plant	14,19
5	Stepper Motor PLC Interfacing Kit	15
6	IEC Standard compatible latest version of SCADA software from any reputed manufacturer like - Ellipse/ Citect/ wonderware - intouch/Json/Wincc/ Cimplicity etc.	22,23,24,25,26,27
7	Min 7’ inch HMI Panel with standard software	28,29
8	Input and output devices for PLC: Lamps, Siren/Buzzer, DC motors, Proximity sensors, Limit switches, Push buttons, RTD/Thermocouple, solenoid valve, hydraulic & pneumatic actuators	5,6,7,12,17,18,19,8,20,25,26
9	Computer System: OS with windows 10 or higher, minimum of 8 GBRAM	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 PLC	CO1	10	4	4	4	12
2	II	PLC Programming	CO2	15	4	8	6	18
3	III	PLC Applications and Troubleshooting	CO3	14	2	4	10	16
4	IV	SCADA Fundamentals	CO4	13	4	6	6	16
5	V	Advanced Industrial Automation Systems	CO5	8	4	2	2	8
Grand Total				**60**	**18**	**24**	**28**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

PLC PROGRAMMING AND SCADA **Course Code : 316352**

Formative assessment (Assessment for Learning)

- Two-Class Tests of 30 marks each and average of Two-Class Tests out of 30.
- For laboratory learning, maximum 25 marks and minimum 10 marks.

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	3	2	-	2	-	-	2			
CO2	3	3	2	3	-	-	2			
CO3	3	2	2	3	2	2	3			
CO4	2	2	3	3	-	-	2			
CO5	2	2	2	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	Petruzella, F.D.	Programmable Logic Controller	Tata-McGraw Hill India, 2010 ISBN: 978-0071067386
2	Bolton, W.	Programmable Logic Controllers	Elsevier Newnes, 2007 ISBN: 978-0750681124
3	John Web, W.; Ronald A. Reis	Programmable Logic Controller	Pearson, 2008 ISBN: 978-0135048818
4	Boyar, S. A.	Supervisory Control and Data Acquisition	ISA Publication, 2009 ISBN: 978-1936007097
5	Manoj, K.S.	Industrial Automation with SCADA Concept, Communication and Security	Notion Press, 2019 ISBN: 978-1684668281

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description

PLC PROGRAMMING AND SCADA **Course Code : 316352**

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=MS3qJq2jvu0	This NPTEL lecture discuss about basics of program logic controllers. Various programming techniques and terms used in PLC are discussed in detail.
2	https://instrumentationtools.com/free-allen-bradley-plc-ladd er-logic-training-course/	Allen Bradley PLC Ladder Logic Training Course.
3	https://www.youtube.com/watch?v=E2WNPXJf-Kw	PLC Introduction. PLC Basics, Components of PLC, Modular PLC Modules, Input Output.
4	https://www.matrikonopc.com/opc-server/opc-data-access-versi ons.aspx?	OPC Data Access (OPC DA) Versions & Compatibility.
5	https://rapidscada.org/?	An open source SCADA software.
6	https://ial-coep.vlabs.ac.in/	Virtual Laboratory on automation.
7	https://www.youtube.com/watch?v=jXRksET5vNo	A foundational understanding of DCS, explaining its structure and functionality within industrial settings.
8	https://ied-nitk.vlabs.ac.in/List%20of%20experiments.html	Virtual Industrial Electric Drives Lab
9	https://www.youtube.com/watch?v=jNEDOdttBNo	Learn Industrial Automation- Free Tutorial PLC SCADA VFD HMI DCS PAC Industry4.0 M580 TIA Courses

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. 04/09/2025 **Semester - 6, K Scheme**

13-08-2026 02:27:02 PM

MICRO-ELECTRO MECHANICAL SYSTEM **Course Code : 316353**

Programme Name/s : **Mechatronics**
Programme Code : **MK**
Semester : **Sixth**
Course Title : **MICRO-ELECTRO MECHANICAL SYSTEM**
Course Code : **316353**

I. RATIONALE

This course equips mechatronics diploma holders with essential MEMS knowledge and skills for industrial applications. Students will learn to identify materials, components, and packaging, alongside understanding the mechanical and electrical principles behind MEMS. The course also covers standard microfabrication processes and hands-on practice for making measurements of physical quantities using microsensors and microactuators.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the students to attain the following industry identified outcome through various teaching learning experiences: Integrate Micro-Electro-Mechanical Systems (MEMS) technology into various processes and applications.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Identify the types of materials and components and packing processes.
- CO2 - Specify the mechanical and electrical properties and principles implied in the given MEMS.
- CO3 - Explain standard microfabrication processes.
- CO4 - Measure physical quantity using relevant microsensors and microactuators.
- CO5 - Prepare a report on the use of MEMS for a given industrial 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	
316353	MICRO-ELECTRO MECHANICAL SYSTEM	MMS	DSC	3	-	4	1	8	4	3	30	70	100	40	25	10	25#	10	25	10	175

MICRO-ELECTRO MECHANICAL SYSTEM **Course Code : 316353**

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.* 15 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 Explain the importance and characteristics of MEMS in Mechatronics. TLO 1.2 List different types of elements used in MEMS. TLO 1.3 List different materials used in MEMS. TLO 1.4 List different properties of MEMS materials. TLO 1.5 Differentiate BIOMEMS, RFMEMS, and MOEMS. TLO 1.6 List the applications of MEMS.	**Unit - I Introduction to MEMS** 1.1 Introduction to MEMS: Overview and definition of MEMS, new trends of MEMS used in engineering and science, microscale systems, and intrinsic characteristics of MEMS. 1.2 Advantages & Disadvantages of MEMS. 1.3 Block diagram of MEMS: micro sensors and micro actuators, microelectronics fabrication process. 1.4 Materials for MEMS: silicon, polymers, ceramics, metals. 1.5 Packaging and integration: glass encapsulation, MEMS process integration strategies. 1.6 Definitions of BIOMEMS, RFMEMS, and MOEMS. 1.7 Applications of MEMS.	Lecture Using Chalk-Board Video Demonstrations Presentations

MICRO-ELECTRO MECHANICAL SYSTEM **Course Code : 316353**

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 various electrical concepts implied by MEMS. TLO 2.2 Explain various mechanical concepts implied by MEMS. TLO 2.3 Calculate resistivity of the semiconductor	**Unit - II Electrical & Mechanical properties and principles of MEMS.** 2.1 Electrical concepts of materials (silicon, polymers, ceramics, metals) related to MEMS: semiconductor materials. 2.2 Calculate charge carrier concentration, conductivity, and resistivity of the semiconductor (only simple numerical based on above). 2.3 Mechanical concepts of materials related to MEMS: Crystal planes and orientation, Internal force analysis, mechanical properties of silicon and related thin films. 2.4 Surface preparation, microhardness testing of materials/metals, microscopic study of materials for microstructure and hardness, Effect of surface finish on MEMS fabrication.	Lecture Using Chalk-Board Video Demonstrations Presentations
3	TLO 3.1 Define micromachining. TLO 3.2 Explain surface micromachining processes. TLO 3.3 Explain micromachining processes. TLO 3.4 Explain bulk micromachining. TLO 3.5 Explain etching processes. TLO 3.6 Explain thin film deposition methods.	**Unit - III MEMS fabrication processes** 3.1 Micromachining – Definition, needs types. 3.2 Surface micromachining: Sacrificial layer processes – steps, MEMS accelerometer, humidity microsensor, micromotors advantages and disadvantages, examples. 3.3 Bulk micromachining: – Advantages and disadvantages, examples (micro nozzle). 3.4 Etching: dry etching, plasma etching, wet etching - principle and processes. 3.5 High Aspect-Ratio Processes: LIGA process, Deep Reactive Ion Etching (DRIE). 3.6 Thin film deposition: Chemical Vapor Deposition (CVD), Physical Vapor Deposition (PVD), evaporation, and sputtering.	Lecture Using Chalk-Board Video Demonstrations Presentations
4	TLO 4.1 Explain the construction of different Micro-sensors. TLO 4.2 Explain the operation of different Micro-sensors. TLO 4.3 Explain the construction of different Micro-actuators. TLO 4.4 Explain the operation of different Micro-actuators.	**Unit - IV Micro sensors and Micro actuators.** 4.1 Electrostatic sensor, the principle of parallel plate capacitors and its applications. 4.2 Thermal sensor: Fundamentals of thermal transfer, thermal bimorph principle. 4.3 Piezoresistive sensor: Materials, piezo resistivity, Piezoelectric sensor: Materials and Piezoelectric effect. 4.4 Actuation using thermal forces, Actuation using shape memory alloys. 4.5 Actuation using piezoelectric crystals. 4.6 Electrostatic actuation. 4.7 Actuation using electrostatic forces (Comb drive actuators), micromotors and micropumps.	Lecture Using Chalk-Board Video Demonstrations Presentations

MICRO-ELECTRO MECHANICAL SYSTEM **Course Code : 316353**

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 Collect the specification, data sheets, and block diagram of given MEMS applications.	**Unit - V Applications of MEMS.** 5.1 Applications of MEMS - (a) Automobile deployment - Airbag, navigation, tyre pressure, (b) Medical field – Microneedle, blood pressure sensor, micropump,(c) Manufacturing industries – Pressure, humidity, level, temperature, (d) Consumer products – Washing machines, printers.	Lecture Using Chalk-Board Video Demonstrations 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 the different MEME devices.	1	*Understand the different MEMS devices.	2	CO1
LLO 2.1 Microscopic study of specimen material	2	*Microscopic analysis of Specimen materials.	2	CO2
LLO 3.1 Check the resistivity of given materials. LLO 3.2 Suggest suitable materials for the given MEMS application.	3	*Measure the electrical resistivity of given MEMS materials.	2	CO2
LLO 4.1 Check the Ra value of given materials. LLO 4.2 Suggest suitable materials for the given MEMS application.	4	*Microscopic analysis for surface finish of different materials.	2	CO2
LLO 5.1 Study of surface finish using a microscope.	5	*Microscopic analysis for surface finish of different materials.	2	CO2
LLO 6.1 Test the surface hardness of MEMS material before application.	6	*Microhardness testing of MEMS materials/metals before application.	2	CO2
LLO 7.1 Test the surface hardness of MEMS material after application	7	*Microhardness testing of MEMS materials/metals after application.	2	CO2
LLO 8.1 Select the microsensors for pressure measurement. LLO 8.2 Measure pressure using microsensors.	8	Pressure measurement using microsensors.	4	CO3
LLO 9.1 Select the microsensors for speed measurement. LLO 9.2 Measure speed using microsensors.	9	Speed measurement using microsensors.	4	CO3
LLO 10.1 Select the microsensors for temperature measurement. LLO 10.2 Measure temperature using microsensors.	10	*Temperature measurement using microsensors.	4	CO3

MICRO-ELECTRO MECHANICAL SYSTEM **Course Code : 316353**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 11.1 Select the microactuator for Mechanical motion measurement. LLO 11.2 Measure mechanical motion using a microactuator.	11	*Mechanical motion measurement. using microactuator – piezoelectric.	4	CO3
LLO 12.1 Select the microactuator for mechanical motion measurement. LLO 12.2 Measure mechanical motion using a microactuator.	12	Mechanical motion measurement. using microactuator – magnetic.	4	CO3
LLO 13.1 Select the microactuator for Mechanical motion measurement. LLO 13.2 Measure Mechanical motion using a microactuator.	13	Mechanical motion measurement. using microactuator – electrostatics.	4	CO3
LLO 14.1 Observe the operation of Surface micromachining. LLO 14.2 Interpret the fabrication process.	14	*Demonstration of surface micromachining. Part - I	2	CO4
LLO 15.1 Observe the operation of Surface micromachining. LLO 15.2 Interpret the fabrication process.	15	Demonstration of surface micromachining. Part - II	2	CO4
LLO 16.1 Observe the operation of bulk micromachining. LLO 16.2 Interpret the fabrication process.	16	Demonstration of bulk micromachining. Part - I	2	CO4
LLO 17.1 Observe the operation of bulk micromachining. LLO 17.2 Interpret the fabrication process.	17	Demonstration of bulk micromachining. Part - II	2	CO4
LLO 18.1 Search information on the use of MEMS in automobile industries by market survey. LLO 18.2 Prepare a report on the same	18	*Case study on the use of MEMS in Automobile industries. (Specifications, data sheets, block diagram, etc.)- Airbag, navigation, tyre pressure (Any one).	4	CO5
LLO 19.1 Search information on the use of MEMS in the medical field by market survey. LLO 19.2 Prepare a report on the same.	19	*Case study on the use of MEMS in the Medical field. (Specifications, data sheets, block diagram, etc.) Medical field – Microneedle, blood pressure sensor, micropump (Any one).	4	CO5
LLO 20.1 Search information on the use of MEMS in manufacturing industries by market survey. LLO 20.2 Prepare a report on the same.	20	Case study on the use of MEMS in Manufacturing industries. (Specifications, data sheets, block diagram, etc.) - Pressure, humidity, level, temperature (Any one).	4	CO5

MICRO-ELECTRO MECHANICAL SYSTEM **Course Code : 316353**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 21.1 Search information on the use of MEMS in consumer products by market survey. LLO 21.2 Prepare a report on the same.	21	Case study on the use of MEMS in Consumer products. (Specifications, data sheets, block diagram, etc.)- Washing machines, printers (Any one).	4	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)

Assignment

- Any other relevant assignment given by subject teacher.
- Prepare a detailed report on MEMS application.
- Numerical on the resistivity and conductivity of MEMS materials.
- Collect the information of various microactuators and microsensors used in industries
- Compare the parameters of different semiconductors used in MEMS.
- Collect information about materials used for MEMS with specifications and compare them.

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	Various microsensors and microactuators.	1,8,9,10,11,12,13
2	Experimental setup of temperature measurement using related microsensors.	10
3	Experimental setup of a piezoelectric microactuator for mechanical motion measurement.	11
4	Experimental setup of a magnetic microactuator for mechanical motion measurement.	12
5	Experimental setup of an electrostatic microactuator for mechanical motion measurement.	13

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Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
6	Experimental setup of surface roughness tester for surface evaluation.	2,4,5,6,7
7	Experimental setup to measure the resistivity of the given materials.	3
8	Experimental setup of surface hardness testing using microhardness tester.	5
9	Microscope for microstructure analysis.	6
10	Experimental setup of pressure measurement using related microsensors.	8
11	Experimental setup of speed measurement using related microsensors.	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	Introduction to MEMS	CO1	6	2	4	4	10
2	II	Electrical & Mechanical properties and principles of MEMS.	CO2	10	2	6	6	14
3	III	MEMS fabrication processes	CO3	12	4	6	8	18
4	IV	Micro sensors and Micro actuators.	CO4	12	4	6	8	18
5	V	Applications of MEMS.	CO5	5	2	2	6	10
Grand Total				**45**	**14**	**24**	**32**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Formative assessment (Assessment for Learning)
- Two-unit tests of 30 marks and average of two-unit tests.
- For laboratory learning 25 Marks
- For Self-Learning 25 Marks

Summative Assessment (Assessment of Learning)

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

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	3	2	2	1	2	1	2			

MICRO-ELECTRO MECHANICAL SYSTEM **Course Code : 316353**

CO2	3	1	2	2	2	2	3			
CO3	3	2	2	2	2	2	1			
CO4	3	3	3	3	2	2	2			
CO5	3	3	2	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	Dilip kumar Bhattacharya , Brajesh Kumar Kaushik	Microelectromechanical Systems	CENGAGE Publication, New Delhi,2014, ISBN-10. 9788131525883
2	Tai Ran Hsu	MEMS & Micro systems Design and Manufacture	TMH, New Delhi, 2002, ISBN-10. 007048709X
3	Chang Liu	Foundation of MEMS	Pearson education Inc., 2006 ISBN-10. 0132497360
4	Stephen D Senturia	Microsystem design	Springer Publication, 2000. ISBN-10. 0792372468
5	Hans H. Gatzen, Volker Saile, JurgLeuthold	Micro and Nano Fabrication: Tools and Processes	Springer Publication, 2015. ISBN-13. 978-3662508268
6	Marc J. Madou	Fundamentals of Microfabrication and Nanotechnology	3rd Edition, 2011, CRC Press. ISBN 9780849331800
7	M.D. Singh, J.G. Joshi	Mechatronics	Prentice Learning Pvt. Limited New Delhi, 2006. ISBN 9788120329867

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=O5qTDrZIPeI	Fundamentals of MEMS
2	https://www.youtube.com/watch?v=GaGQrP0D6Zw	Materials for MEMS
3	https://www.youtube.com/watch?v=m8kXG5ZERYI	Applications of MEMS
4	https://www.youtube.com/watch?v=jQF4_hO_2qw	Types of MEMS, MEMS process integrations
5	https://www.youtube.com/watch?v=1qDfxPW02Pw	Calculation of charge carrier concentration
6	https://www.youtube.com/watch?v=STs55uv389Y	Flexural beam bending
7	https://www.youtube.com/watch?v=lHXZkamSMWw	Surface micromachining, Bulk micromachining
8	https://www.youtube.com/watch?v=9UOiSxFB6aA	Electrostatics sensors
9	https://www.youtube.com/watch?v=_iMHP-gaABk	Piezo electric actuators
10	https://www.mdpi.com/2072-666X/13/5/654	Different case studies in MEMS

Note :

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

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COMPUTER AIDED INSPECTION AND QUALITY ASSURANCE **Course Code : 316354**

Programme Name/s : **Mechatronics**
Programme Code : **MK**
Semester : **Sixth**
Course Title : **COMPUTER AIDED INSPECTION AND QUALITY ASSURANCE**
Course Code : **316354**

I. RATIONALE

This course equips diploma engineers with the essential knowledge and skills for modern inspection and quality assurance integrating computer aided technologies. It covers foundational methodology, advance measurements with CMM's ,machine vision for automated inspection, Quality management principles including auditing, six sigma, and statistical tools for process control

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the students to attain the following industry identified outcome through various teaching learning experiences: Apply computer aided inspection and quality control techniques for assuring quality of products and services.

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 measuring instrument for given situation.
- CO2 - Measure common features using coordinate measuring machine.
- CO3 - Identify various elements of machine vision system in context of inspection.
- CO4 - Prepare a plan for quality audit considering the quality standard for a given simple process
- CO5 - Apply various SQC tools to ensure Quality assurance for a given data

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	
316354	COMPUTER AIDED INSPECTION AND QUALITY ASSURANCE	IQA	DSE	4	-	2	2	8	4	3	30	70	100	40	25	10	25#	10	25	10	175

COMPUTER AIDED INSPECTION AND QUALITY ASSURANCE **Course Code : 316354**

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.* 15 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 working principle of Linear measuring instruments. TLO 1.2 Explain the use of gauges for given job with justification. TLO 1.3 State the advantages and disadvantages of Computer Aided Inspection (CAI) TLO 1.4 Explain method of laser-based inspection . TLO 1.5 Compare traditional inspection with laser-based inspection.	**Unit - I Introduction to Metrology and Computer aided inspection** 1.1 Definition of Metrology, objective and types of metrologies, need of inspection, methods of measurements. 1.2 Linear measuring Instruments: Working principle of Vernier caliper, micrometer, height gauge and depth gauge. 1.3 Gauges: Limit gauges. Taylor's principle of Gauge design, Plug gauges , Ring Gauges, Snap gauges. 1.4 Computer-Aided Inspection (CAI):Introduction, need, advantages and disadvantages. Comparison between Traditional Inspection and Computer-Aided Inspection (CAI). 1.5 Laser Metrology in Computer-Aided Inspection (CAI):Introduction, need, method of laser based inspection, advantages and disadvantages . 1.6 Applications of Laser Metrology in Industries, Aerospace & Automotive: High-accuracy component inspection	Lecture Using Chalk-Board Presentations Video Demonstrations Case Study Site/Industry Visit

COMPUTER AIDED INSPECTION AND QUALITY ASSURANCE **Course Code : 316354**

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 principle of working of CMM. TLO 2.2 List the components of CMM. TLO 2.3 Explain the types of CMM. TLO 2.4 List the specifications of CMM. TLO 2.5 Explain procedure for Measurement by CMM.	**Unit - II Co-ordinate measuring machine** 2.1 Introduction to Coordinate Measurement Machine (CMM). 2.2 Contact type CMM – Configurations, parts and its features, types of probes, probe compensation and specifications. 2.3 Non-Contact type CMM –Features, probes, specifications. 2.4 Merits and demerits of CMM. 2.5 Applications of CMM for dimensional and form measurements.	Lecture Using Chalk-Board Presentations Video Demonstrations Site/Industry Visit Case Study Flipped Classroom
3	TLO 3.1 Select the alignment test for the given machine tool with justification. TLO 3.2 Explain the procedure of flatness testing for the given job. TLO 3.3 Explain the procedure for measuring complex dimensions of the given job using machine vision . TLO 3.4 Explain the role of AI in machine vision inspection. TLO 3.5 List the components of automated inspection system	**Unit - III Introduction to Machine Vision Metrology** 3.1 Machine tool metrology: parallelism, flatness, straightness, squareness, roundness, run out alignment tests of Lathe and machine tools (as per IS standard.) using gauges and measuring devices . 3.2 Introduction to Machine Vision Metrology: Machine vision system – Methods for sensing objects. 3.3 Applications of machine vison in metrology. 3.4 AI-Based machine vision techniques. 3.5 Automated Inspection Systems: Computers power automated inspection systems, including machine vision and optical inspection.	Lecture Using Chalk-Board Presentations Model Demonstration Video Demonstrations Site/Industry Visit Hands-on

COMPUTER AIDED INSPECTION AND QUALITY ASSURANCE **Course Code : 316354**

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 Identify quality characteristics for given product TLO 4.2 Explain the parameters of quality economics TLO 4.3 Explain the general procedure to perform the quality audit for the given problem. TLO 4.4 Explain six sigma methodology and tools for quality imporvement TLO 4.5 describe ISO 14000 for environment management system TLO 4.6 describe ISO9001 as a part of QMS TLO 4.7 Explain quality assurance approach for given example	**Unit - IV Quality Control & Quality Assurance** 4.1 Concept and Meaning of Quality Control and Objectives of qualify control. Quality characteristics. 4.2 Quality of design, Quality of conformance and Quality of Performance, 4.3 Quality Economics: Cost of quality, Value of quality, Economics of quality confirmation, Cost of quality appraisal, prevention, external and internal failure cost. 4.4 Quality Audit: functions, Scope of quality audit practices. Difference between inspection & quality control. Role of Quality Inspector and Auditor. Internal and External Quality Audits, 4.5 Six sigma: Methodology, Statistical meaning, six sigma approaches, Introduction to ISO 9001-2008, ISO 14000 and TS 16949 and its implementation. 4.6 Quality Management Systems (QMS): ISO 9001:2015 and Implementing a QMS in an Organization, Documentation and Standard Operating Procedures (SOPs). QMS software ,document management, audit tracking, and non-conformance report. 4.7 Quality Assurance: Definition , Importance, procedure, techniques , Differences Between QC and QA. 4.8 Role of Quality Inspector and Auditor Internal and External Quality Audits, Compliance and Regulatory Requirements	Lecture Using Chalk-Board Presentations Case Study Video Demonstrations Case Study Site/Industry Visit
5	TLO 5.1 Calculate mean, mode and median for the given sample(s) including the frequency histogram, frequency polygon. TLO 5.2 Draw normal distribution curve after calculating the standard deviation (Sigma), variance, range to determine the process capability. TLO 5.3 Draw the control charts (X and R-bar, P-chart and C-chart) for measured data of the given samples. TLO 5.4 Prepare Single/Double sampling plan for the given Lot size (N), Sample size(n), acceptance number(c)	**Unit - V Statistical Quality Control** 5.1 Basics of Statistical concepts, Meaning and importance of SQC. 5.2 Variable and attribute Measurement. Control charts - inherent and assignable sources of variation. Control charts for variables - x bar and R charts, control charts for attributes p, np, C charts. Statistical Process Control (SPC): SPC software to create control charts. 5.3 Process capability of machine (±3sigma or ±6sigma), Cp and Cpk calculations. 5.4 Different types of sampling plans, - sampling methods. 5.5 Acceptance Sampling Concept, Comparison with 100% inspection, Operating Characteristics Curve. Merits and demerits of acceptance sampling.	Lecture Using Chalk-Board Presentations Site/Industry Visit Case Study Video Demonstrations Model Demonstration

COMPUTER AIDED INSPECTION AND QUALITY ASSURANCE **Course Code : 316354**

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 Use Vernier caliper, vernier height gauge, micrometer (use both mechanical and digital) to measure dimensions of a given components.	1	*Measurement of Length and Height by using Vernier Calipers and Vernier Height Gauge of a given components.	2	CO1
LLO 2.1 Measure and verify the dimensions and tolerances of workpieces during quality control processes using gauges	2	Inspection using Dial Indicator /Dial Bore Gauge/Snap Gauge for a given component.	2	CO1
LLO 3.1 Use slip gauges combination to set the adjustable snap gauge Go end and No-Go end for a given dimension.	3	*Arrange the adjustable snap gauge Go end and No-Go end for a given dimension.	2	CO1
LLO 4.1 Analyse the application of laser metrology for quality control and dimensional inspection based on given use case	4	*Perform quality control and dimensional inspection by using laser inspection based on given use case	2	CO1
LLO 5.1 Measure the flatness of given flat object using CMM LLO 5.2 Measure the circularity of given cylindrical object using CMM	5	*Measurement of form using CMM	2	CO2
LLO 6.1 Select the type of probe for CMM	6	*List the types of probes for given situtaion	2	CO2
LLO 7.1 Select the appropriate probe and stylus for measurement LLO 7.2 Set up part fixturing to maintain the product orientation LLO 7.3 Align the product coordinate system with the CMM's coordinate system. LLO 7.4 Measure the dimensions using CMM	7	Measurement of product dimension using Coordinate Measuring Machine (CMM) as per standard procedure	2	CO2
LLO 8.1 Identify components of low-cost vision-based automation solutions in the following areas: Inspection (Object recognition and Pose Estimation) Detection (Presence Verification, Counting).	8	*Components identification of low-cost vision-based automation solutions	2	CO3
LLO 9.1 Set up camera ,lens, lighting ,mounting and fixture LLO 9.2 Capture image of the given components LLO 9.3 Apply image processing techniques to enhance the image quality. LLO 9.4 Extract features that are essential for measurement of required dimension	9	*Inspect the given componenet using machine vision system .	2	CO3
LLO 10.1 Draw relevant control chart by observing the variations in a lot of 20 cylindrical jobs with some nominal outside diameter.	10	Preparation of a relevant control chart by observing the variations in a lot of 20 cylindrical jobs with some nominal outside diameter.	2	CO5

COMPUTER AIDED INSPECTION AND QUALITY ASSURANCE **Course Code : 316354**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 11.1 Choose a simple process - (e,g ,ordering food online, barrowing a library book) LLO 11.2 Create a flow chart or a process map of the steps involved LLO 11.3 Identify potential points of failure or non compliance that an auditor would examine. LLO 11.4 Prepare a quality audit checklist .	11	*Mapping a process for quality audit,.	2	CO4 CO5
LLO 12.1 Calculate mean, mode and median for the given data. LLO 12.2 Draw frequency histogram, frequency polygon for the given data.	12	Calculation of mean, mode and median using frequency histogram, frequency polygon for the given sample.	2	CO5
LLO 13.1 Draw normal distribution curve for given data LLO 13.2 Calculate standard deviation (Sigma), variance, range for given data LLO 13.3 Determine the process capability for given data	13	Determintion of process capability for ±3Sigma or ±6Sigma .	2	CO5
LLO 14.1 Draw and interpret X bar chart for the given data LLO 14.2 Draw and interpret R chart for the given data	14	*Inspection of given variable data using Control chart	2	CO5
LLO 15.1 Draw P- chart for given data. LLO 15.2 Draw C - chart for given data.	15	*Inspection of given attribute data using control chart chart	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)

Assignment

- Prepare a report to interpret effect of errors on the accuracy of instrument and measurement.
- Visit to any nearby shop or industry and list out different gauges used for inspection along with its purpose.
- Visit to any tool room and prepare a report consisting,
  (i)Different advanced measuring instruments.
  (ii)Different measuring standards and calibration process.
  (iii)Care and maintenance of measuring instruments observed.
- Prepare/Download a specification of followings.
  (i)Measuring tools and equipment in metrology laboratory.
  (ii)Machineries in metrology laboratory.

Micro project

- Prepare a report on Quality Management Systems (QMS) for your institute.
- Comparative study of various linear measuring instruments like steel rule, Inside-outside micrometer, Vernier caliper and Digital caliper with proper justification.

- Comparative study of surface finish of various samples machined by various machining / finishing processes using surface roughness tester.
- Prepare a report on calibration procedure of Vernier Caliper and Micrometer followed by NABL Lab.
- Prepare a visit report on measurement systems used in nearby industries / SME / Workshops / Fabrication shops.

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	Digital/manual Vernier Caliper Range 0-150 mm, L.C. 0.02mm	1
2	Vernier Height Gauge and Depth Gauge (mechanical and digital) 0-300 mm	1
3	Tool Maker’s microscope: Dimensions 152 x 152mm, Stage glass size 96 x 96mm, Feeding range 50 x 50 mm, Maximum height 115 mm x 107 mm, Workpiece 5Kg, Light source: 24V, 2W (special bulb), Continuously adjustable light intensity, green filter.	1
4	Display Wall chart showing X bar Chart and R Chart.	11,12,13,14,15
5	Display Wall chart showing “C Chart”	12,13
6	Spirit Level: Base length: 200 mm + 1 mm, Base width: 20 mm + 0 - 1, Height : 25 + 1 mm, Bubble opening : 50 mm x 8 mm (length x width).	4
7	Gauges - plug (3piece) Grade A/X.	5

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 Metrology and Computer aided inspection	CO1	10	2	4	6	12
2	II	Co-ordinate measuring machine	CO2	10	2	4	4	10
3	III	Introduction to Machine Vision Metrology	CO3	10	2	4	6	12
4	IV	Quality Control & Quality Assurance	CO4	15	4	6	8	18
5	V	Statistical Quality Control	CO5	15	4	6	8	18
Grand Total				**60**	**14**	**24**	**32**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two-unit tests of 30 marks and the average of two-unit tests. For laboratory learning 25 Marks For Self-Learning 25 Marks

Summative Assessment (Assessment of Learning)

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

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	-	-	-	3	-	-	3			
CO2	-	-	-	3	-	-	3			
CO3	-	-	-	3	-	-	3			
CO4	-	-	-	3	-	-	3			
CO5	-	-	-	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	Dr. Parthasarathi, Dr. P. Sreenivas	Metrology, Measurements and Computer Aided Inspection	Scientific International Publishing House ISBN: 9789361320309
2	R.K. Rajput	A Textbook of Measurements & Metrology	S.K. Kataria & Sons ISBN 978-93-5014-230-1
3	K Duraivelu and S Karthikeyan	Engineering Metrology and Measurement	Universities Press ISBN 9789386235527
4	Kulkarni V. A.. Bewoor A. K.	Quality Control	Wiley India Pvt. Ltd, New Delhi, 2012. ISBN: 978-81-265-1907-1
5	Ankita Dadwal	Quality Assurance	PharmaMed Press ISBN-10 : 9395039701
6	Mahajan M	Statistical Quality Control	Dhanpat Rai & Co. ISBN-13 : 978-8177000399
7	M.M.M. SARCAR, K. LALIT NARAYAN,	Computer Aided Design and Manufacturing	PHI Learning, ISBN - 9788120333420
8	Sheila Anand	Guide for Machine Vision in Quality Control	Chapman and Hall, ISBN -978-0815349273

XIII . LEARNING WEBSITES & PORTALS

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COMPUTER AIDED INSPECTION AND QUALITY ASSURANCE **Course Code : 316354**

Sr.No	Link / Portal	Description
1	https://elearn.nptel.ac.in/shop/nptel/engineering-metrology/?v=c86ee0d9d7ed	Engineering Metrology
2	https://youtu.be/4O6mfoJWJGc?si=AZaSdaunYusJr7on	Learning about CMM and Metrology
3	https://youtu.be/BPQI1xMXC04?si=hq33GQJUtlvywUbD	Basics of CMM (Coordinate Measuring Machine)
4	https://youtu.be/6eGwbxHOa-A?si=oF-upNkZ3K0QfWq4	Visual Inspection for Defect Detection
5	https://youtu.be/uqEXP14i3QQ?si=qprSEsfNniQLhXAw	Smart Factory - Vision based quality inspection
6	https://youtu.be/60Sk-mq3Cr8?si=wZvKfYzD9lkY8O7Z	Improve Production Quality with Visual Inspection AI
7	https://youtu.be/9fqygvj-O2s?si=nhcV7NKn4Mn4nYmc	Computer Aided Quality Control

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. 04/09/2025 **Semester - 6, K Scheme**

MECHATRONICS IN HEALTH SERVICES

Programme Name/s : **Mechatronics**

Programme Code : **MK**

Semester : **Sixth**

Course Title : **MECHATRONICS IN HEALTH SERVICES**

Course Code : **316355**

I. RATIONALE

Today the healthcare industry increasingly relies on sophisticated mechatronic systems for diagnosis, treatment, monitoring, and rehal equip diploma students in mechatronics with specialized knowledge and skills to work with medical equipment and devices that inc increasing adoption of automation, robotics, and smart systems in healthcare has created a demand for technicians who understand both systems and the specific requirements of the healthcare environment, including safety standards, sterilization protocols and patient consid

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the students to attain the following industry identified outcome through various teaching learning experie maintenance of medical equipment.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Use concept of AI, ML and IoT in health care service equipment and devices.
- CO2 - Rectify the faults in given primary health care device/s using troubleshooting chart.
- CO3 - Troubleshoot the given medical imaging machine.
- CO4 - Check the performance of infusion pump and MEMS drug delivery system.
- CO5 - Prepare a plan for use of robot/s in given medical situation.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Paper Duration	Theory		
				Actual Contact Hrs./Week			SLH	NLH			FA-TH	SA-TH	
				CL	TL	LL					Max	Max	M
316355	MECHATRONICS IN HEALTH SERVICES	MHS	DSE	4	-	2	2	8	4	3	30	70	1

Total IKS Hrs for Sem. : 0 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional L 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 t
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
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 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 Outcom and CO's.

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MECHATRONICS IN HEALTH SERVICES

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcome and CO's.
1	TLO 1.1 Explain the various healthcare systems with its core functions, advantages and disadvantages. TLO 1.2 Interpret various healthcare facilities available in India: its funding, administration and delivery. TLO 1.3 Analyze given case on use of AI and ML in health services. TLO 1.4 Design a simple IoT application for a selected health service.	**Unit - I Introduction to health services** 1.1 Need of health services, Types of healthcare systems: prim secondary, tertiary and quaternary. 1.2 Categories of healthcare facilities available in India: public sectors. 1.3 Role of technology in health services: Artificial Intelligenc Machine Learning (ML) and Internet of Things (IoT).
2	TLO 2.1 Illustrate Primary healthcare equipment. TLO 2.2 Explain Heart rate monitoring system. TLO 2.3 Calculate Body mass index. TLO 2.4 Explain functions of pulse oximeter and glucometer. TLO 2.5 Describe function of Blood pressure monitoring system and digital thermometer. TLO 2.6 Interpret troubleshooting chart for identification of fault in give equipment/device.	**Unit - II Primary healthcare equipment** 2.1 Primary healthcare equipment, Heart rate monitoring syste functional block diagram, working principle, advantages and a 2.2 Body mass index (BMI) measurement system and pulse ox functional block diagram, working principle, advantages and a 2.3 Blood pressure monitoring system, glucometer and digital thermometer: functional block diagram, working principle, adv applications.
3	TLO 3.1 Describe the physical properties of X-rays. TLO 3.2 Identify and describe the components of the given medical imaging machine (X-ray, CT scan and MRI machines). TLO 3.3 Explain the working principle of medical imaging machine (X-ray, CT scan and MRI machines). TLO 3.4 Describe the steps of installation of X-ray, CT scan and MRI machines. TLO 3.5 Describe with sketches the function of CT scan and MRI machine. TLO 3.6 Interpret troubleshooting chart for identification of fault in give medical imaging machine (X-ray, CT scan and MRI machines).	**Unit - III Medical Imaging Machines** 3.1 Block diagram of X-ray machine, control circuit for high v (KV), current (mA), exposure timer circuit. 3.2 Concept of mobile X-ray technology and dental X-ray mac involved in X-ray machine 3.3 Basic principle of CT scan, block diagram of CT scan mac of CT scan machine, clinical application 3.4 Magnetic resonance imaging(MRI): Principle, block diagra magnets, biological effects of MRI imaging, function and appl MRI system 3.5 Installation, maintenance and troubleshooting of X-ray ma scan machine and MRI machine
4	TLO 4.1 Identify the components of the Drug delivery systems. TLO 4.2 Explain the function of infusion pump. TLO 4.3 Describe with sketches the function of Closed-Loop Control in Infusion System. TLO 4.4 Describe the function of given MEMS Drug delivery device. TLO 4.5 Examine the MEMS device for any visible defect, cracks, consistency and repeatability of actuator motion, and packaging.	**Unit - IV Automated drug delivery systems** 4.1 Major components: Transducers, logic unit and activating 4.2 Syringe pump: Working principle, function, applications. 4.3 Infusion pump: Implantable infusion system, closed-loop infusion systems. 4.4 Insulin pumps: Working principle, function, applications. 4.5 MEMS Drug delivery devices: A Miniaturized Wireless M Enabled by Confined Acoustic Streaming
5	TLO 5.1 Describe role of robotics in health science TLO 5.2 Identify Rehabilitation robotics. TLO 5.3 Describe the working of robots used in hospital automation TLO 5.4 Explain concept of AI and robotics in diagnostic	**Unit - V Robotic in health science** 5.1 Role of robotics in health science: Advancements, applicat future directions 5.2 Rehabilitation robotics- assistive robotics, therapeutic appl 5.3 Hospital automation: Disinfection robot (UV light robot), robot (Automate medication dispensing), Logistic robot (Trans supplies, lab samples). 5.4 AI and robotics in diagnostic: Robot-Assisted imaging Lab

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

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tu Titles
LLO 1.1 Enlist health care equipment. LLO 1.2 Give applications of observed health care equipment.	1	* Identification of various Health care equipment a in laboratory
LLO 2.1 Prepare the report on use of AI, ML in health services	2	AI and ML in health service
LLO 3.1 Develop a simple IoT/IoMT application for use in health services	3	*Internet of Things in health services
LLO 4.1 Identify the components of pulse oximeter. LLO 4.2 Compare the result obtained from two different pulse oximeter	4	* Performance of pulse oximeter

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MECHATRONICS IN HEALTH SERVICES

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tu Titles
LLO 5.1 Identify the components of stadiometer LLO 5.2 Check the performance of stadiometer by taking measurement of weight and height LLO 5.3 Suggest measures for accurate performance	5	Performance of stadiometer
LLO 6.1 Identify the components of sphygmomanometer LLO 6.2 Check the performance of sphygmomanometer by taking measurement of blood pressure. LLO 6.3 Suggest measures for accurate performance	6	Performance of sphygmomanometer
LLO 7.1 Identify the components of glucometer LLO 7.2 Check the performance of glucometer by taking measurement of sugar level in blood. LLO 7.3 Suggest measures for accurate performance	7	* Performance of glucometer
LLO 8.1 Identify the components of digital thermometer LLO 8.2 Check the performance of digital thermometer by taking temperature reading. LLO 8.3 Suggest measures for accurate performance	8	Performance of digital thermometer
LLO 9.1 Identify the X-ray machine components. LLO 9.2 Carryout routine maintenance as per the operational manual.	9	*Routine maintenance of X-ray machine
LLO 10.1 Identify the faults using troubleshooting chart. LLO 10.2 Suggest measures to rectify the faults	10	X-ray machine - Fault finding and remedial measu
LLO 11.1 Identify the components of CT Scanner machine. LLO 11.2 Carryout routine maintenance as per the operational manual.	11	Routine maintenance of CT Scanner machine
LLO 12.1 Identify the faults using troubleshooting chart. LLO 12.2 Suggest measures to rectify the faults	12	* CT Scanner machine - Fault finding and remedia measures
LLO 13.1 Identify the MRI machine components. LLO 13.2 Carryout routine maintenance as per the operational manual.	13	Routine maintenance of MRI machine
LLO 14.1 Identify the faults using troubleshooting chart. LLO 14.2 Suggest measures to rectify the faults	14	MRI machine - Fault finding and remedial measur
LLO 15.1 Identify the components of infusion pump LLO 15.2 Carryout routine maintenance as per the operational manual.	15	* Routine maintenance of infusion pump
LLO 16.1 Identify type of robot used in selected situation. LLO 16.2 Develop program for identified situation. LLO 16.3 Execute the program. LLO 16.4 Prepare an action plan for use of robot in selected situation.	16	*Plan for use of robot for any one of given situatio 1. Hospital automation 2.Robotics in diagnostic 3. Robotics in surgery

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 DEVELOPME

Micro project

- Prepare and present a seminar on importance of health service equipment.
- Prepare a report on a visit to diagnosis center on the basis specifications and type of ECG / CT / MRI machine
- Prepare charts and present a seminar on body mass index variation on four-month duration with a group of four students. (take fifteen
- Prepare a report on health service center according to national standards.
- Collect the catalogue of modern equipment used in health services
- * Prepare a report on application, integration and limitations of MEMS accelerometers in wearable drug delivery devices for motion m

(This Microproject is compulsory and students may choose any one from the above list).

Assignment

MECHATRONICS IN HEALTH SERVICES

- Make power point presentation including videos on heart rate measurement
- Identify the faults in X-ray machine
- Collect information of different standards with specification related to medical imaging equipment.
- Carry out comparative study of conventional health care services and modern health care services
- Collect information of robotic in used in health science

Visit

- Arrange a visit to the general hospital either private or government
- Arrange a visit to the nearby diagnostic center.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired sk
- 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 encourag enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered fo

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications
1	CT scanner: gantry aperture size (typically 70cm or more), slice acquisition capabilities (ranging from 16 to 640 slices), X-ray tub or more), and image processing software
2	MRI machine: magnet strength (measured in Tesla, with common strengths being 1.5T and 3T), gradient strength and slew rate, ra system capabilities, and image processing and storage capacity.
3	Infusion pump: Minimum guaranteed flow rate range of 1-1500 mL/hr in either 0.1 or 1 mL/hr increments.
4	Robot offline simulation software
5	Computer with internet connectivity: (Minimum Core i5 Processor, 8GB RAM, 500GB HDD)
6	Pulse oximeter: Pulse rate: Range 30-254bpm - Accuracy: ±2% at 30-254bpm
7	Stadiometer: 20 - 205 cm, 1 mm / 1/8 inch, 337 x 2165 x 590 mm, 13,3 x 85,2 x 23,2 inch, 2,4 kg, 5,3 lbs
8	Sphygmomanometer: Gauge graduated 0 - 300mmHg (min) in 2 (max) mmHg increments, with pressure release valve. Accuracy 81060-1: +/- 3mm Hg.
9	Glucometer : Hand held meter with LCD display mg/dl Reported result range : 20 - 600 mg/dL
10	Digital thermometer: Temperature measurement range 32 – 43 °C (minimum guaranteed)
11	X-ray machine: a high-frequency X-ray generator, a power output of 80kW or more, an exposure range of 40-150kV, and a minim time of 1ms or less.

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

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Lev
1	I	Introduction to health services	CO1	10	4	4
2	II	Primary healthcare equipment	CO2	12	4	8
3	III	Medical Imaging Machines	CO3	16	4	6
4	IV	Automated drug delivery systems	CO4	10	2	6
5	V	Robotic in health science	CO5	12	2	6
Grand Total				**60**	**16**	**30**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two-Class Tests of 30 marks and average of Two-Class Tests out of 30.
- For laboratory learning Maximum 25 Marks and Minimum 10 Marks.
- Self-Learning (Assignment) Question and Answers in class room, Micro Project, Visit report

MECHATRONICS IN HEALTH SERVICES

Summative Assessment (Assessment of Learning)

- End Semester Assessment of 70 marks for theory learning.
- End Semester External Assessment of Maximum 25 Marks and Minimum 10 Marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)						
	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	
CO1	2	1	1	2	-	2	
CO2	3	3	-	2	-	2	
CO3	2	3	-	2	-	2	
CO4	2	1	1	2	-	2	
CO5	2	2	1	2	-	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	Khandpur, R. S.	Hand book of biomedical instrumentation	McGraw Hill Education (India) Private Limited, New Delhi,2014 ISBN: 978-9339205430
2	Cromwel, Leslie; Weibell, Fred J; Pfeiffer, Erich A.	Biomedical instrumentation and measurements	Prentice Hall of India Private Limited, New Delhi, 1995, ISBN: 978-8120306530
3	Anandanatarajan, R.	Biomedical instrumentation and measurements	PHI Learning Private Limited, New Delhi, 2015, ISBN: 978-8120352155
4	Azar, Ahmad Taher	Control Systems Design of Bio-Robotics and Bio-Mechatronics with Advanced Applications	Academic Press Inc, 2019, ISBN: 978-0128174630
5	-	Medical Equipment Maintenance Manual	Ministry of Health and Family Welfare, New Delhi October 2010 (http://www.frankshospitalworkshop.com/organisation/biomed_documents/Medical%20Equip %20Ministry%20of%20Health%20and%20Family%20Welfare,%20New%20Delhi.pdf)

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=230k3sPKYqo	Medical Equipment- Made in India | Umesh Sonar & Rav Talks
2	https://learning.edx.org/course/course-v1:DelftX+SGS1x+1T202 5/home	Biomedical Equipment: Repairing and Maintaining Biom
3	https://youtu.be/QX7Q0a8GxaA?si=WpT8dpxwORLPIi3i	Primary health care throughout our life
4	https://youtu.be/t_eWESXTnic?si=kojUc9hTAnNShOnW	Public Health
5	https://www.foreseemed.com/artificial-intelligence-in-health care	Role of AI and ML in health service
6	https://ordr.net/article/iot-healthcare-examples	Role of IoT/IoMT in health service

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MECHATRONICS IN HEALTH SERVICES

Sr.No	Link / Portal	Description
7	https://www.medicalsearch.com.au/buying-guide/maintenance-and-calibration-of-ecg-machines/f/24930	ECG maintenance and calibration
8	https://www.ncbi.nlm.nih.gov/books/NBK9622/	Blood pressure measurement using sphygmomanometer
9	https://nest360.org/wp-content/uploads/2021/08/Clinical-Job-Aid-Glucometer_Xpress2.pdf	Maintenance of glucometer
10	https://www.youtube.com/watch?v=F7hdNVA2yqU	Production of X Rays animated
11	https://www.medicalsearch.com.au/buying-guide/maintenance-and-care-of-x-ray-machines/f/25057	Maintenance and Care of X-Ray Machines
12	https://info.atlantisworldwide.com/blog/top-5-ct-scanner-issues-how-to-resolve-them	CT Scanner Issues & How to Resolve Them
13	https://www.youtube.com/watch?v=wMSryzRvC8Y	Computed Tomography | CT Scanners | Biomedical Engir
14	https://www.blockimaging.com/blog/bid/80499/top-four-mri-scanner-service-problems-and-solutions	MRI Scanner Service Problems and Solutions
15	https://www.youtube.com/watch?v=nFkBhUYynUw	How does an MRI machine work?
16	https://pmc.ncbi.nlm.nih.gov/articles/PMC10713785/	medical devices for sustained drug delivery
17	https://spj.science.org/doi/10.34133/research.0314	Miniaturized Wireless Micropump Enabled by Confined A
18	https://jai.front-sci.com/index.php/jai/article/view/1008/820	role of robotics in medical science
19	https://nhm.gov.in/New_Updates_2018/NHM_Components/Health_System_Stregthening/Comprehensive_primary_health_care/letter/BMMP_Technical%20Manual.pdf	Biomedical equipment management and maintenance pro

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resou

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SMART MANUFACTURING SYSTEMS **Course Code : 316356**

Programme Name/s : Mechatronics
Programme Code : MK
Semester : Sixth
Course Title : SMART MANUFACTURING SYSTEMS
Course Code : 316356

I. RATIONALE

This course provides students with the fundamental knowledge and practical skills required to work in modern manufacturing environments that leverage Industry 4.0 technologies such as IoT, AI, Robotics, CAM, CNC, PLC, and Cloud Computing. Course bridges the gap between conventional manufacturing and future-ready digital industries, preparing students for careers in automated production systems, industrial robotics, and smart factories.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the students to attain the following industry identified outcome through various teaching learning experiences: Plan smart manufacturing systems for various industrial/ field applications using relevant knowledge & skills.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Compare features of traditional manufacturing, smart manufacturing and Industry 4.0.
- CO2 - Apply digital technologies in manufacturing.
- CO3 - Use smart manufacturing control and monitoring systems.
- CO4 - Apply Automation and Robotics in Smart Manufacturing.
- CO5 - Plan smart manufacturing applications in given industry.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												Total Marks
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
316356	SMART MANUFACTURING SYSTEMS	SMS	DSE	4	-	2	2	8	4	3	30	70	100	40	25	10	25#	10	25	10	175

SMART MANUFACTURING SYSTEMS **Course Code : 316356**

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.* 15 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 Explain Traditional Manufacturing system. TLO 1.2 Explain the need of smart manufacturing system. TLO 1.3 State basic principles of smart manufacturing. TLO 1.4 Explain evolution of smart manufacturing systems. TLO 1.5 List Key technologies of Smart manufacturing. TLO 1.6 Compare features of traditional manufacturing and smart manufacturing system.	**Unit - I Introduction to Smart Manufacturing** 1.1 Traditional manufacturing system. Definition, advantages & applications. 1.2 Need of smart manufacturing system. 1.3 Smart Manufacturing-Definition, basic principles, objectives, types & benefits . 1.4 Evolution of smart manufacturing systems. 1.5 Key components and overview of technologies used in Smart Manufacturing (IIoT, AIML, Big data analytics, Automation & Robotics etc.)	Lecture Using Chalk-Board Presentations Video Demonstrations Flipped Classroom

SMART MANUFACTURING SYSTEMS **Course Code : 316356**

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 need of Industry 4.0. TLO 2.2 Explain Various Technologies of Industry 4.0. TLO 2.3 Draw factory layout with IoT. TLO 2.4 Plan for incorporating industry 4.0 for given manufacturing application. TLO 2.5 Identify the challenges of IoT in Manufacturing. TLO 2.6 Explain need of cloud computing in manufacturing. TLO 2.7 State concept of Digital Twin Technology.	**Unit - II Fundamentals of Industry 4.0** 2.1 Industry 4.0- History, Need & importance. 2.2 Introduction to Technologies of Industry 4.0- IoT, AI, cloud computing, big data, robotics, additive manufacturing. 2.3 Basics of IoT- Concept, Connecting devices and machines, layout. 2.4 Industrial Applications-Real-time monitoring, predictive maintenance, optimized supply chains, and enhanced product tracking. 2.5 Benefits & challenges of IoT in Manufacturing. 2.6 Cloud Computing in Manufacturing- Storing and accessing data in the cloud. Cloud-based manufacturing applications. 2.7 Digital Twin Technology- Concept, benefits & applications.	Video Demonstrations Presentations Site/Industry Visit Lecture Using Chalk-Board
3	TLO 3.1 Describe the process of computer aided manufacturing control. TLO 3.2 Explain step by step process of computer aided quality control (CAQC), PLC & SCADA. TLO 3.3 Describe applications of AIML in smart Manufacturing. TLO 3.4 List Cybersecurity measures.	**Unit - III Digital Manufacturing Technologies** 3.1 Computer aided manufacturing Control (CAMC): Generate computer program in machining. Interfacing part program to CNC. 3.2 Computerized monitoring & control-Computer aided quality control (CAQC), Programmable logic control (PLC), & SCADA. 3.3 Artificial Intelligence & Machine Learning (AIML)-Concept, data collection, storage & processing. Predictive analysis & machine learning. Applications of AI in manufacturing. 3.4 Cybersecurity-Measures & best practices, cybersecurity for industrial control systems.	Video Demonstrations Presentations Site/Industry Visit Lecture Using Chalk-Board Flipped Classroom
4	TLO 4.1 Explain given types of automation. TLO 4.2 Suggest the strategies for automation in given situation. TLO 4.3 Explain role of PLM & SCM in smart Manufacturing. TLO 4.4 List applications of robotics in manufacturing. TLO 4.5 State the function of various types of Cobots.	**Unit - IV Factory automation & Robotics in smart manufacturing** 4.1 Automation in Manufacturing Types of automation: Fixed, programmable, and flexible. 4.2 Strategies in automation-Online inspection, online monitoring, automated guided vehicles (AGVs) and conveyor systems. Process control & optimization, control of plant operations & CIM (Computer Integrated Manufacturing). 4.3 Computer Integrated Manufacturing (CIM)-Role of Product Life Cycle Management, Role of Supply Chain Management (SCM) In Smart Manufacturing. 4.4 Robotics in Manufacturing- Material Handling, Processing operations, Automated assemblies & inspections. 4.5 Collaborative Robot (Cobot)-Definition, types-Power & force limiting, safety monitored stop, speed & separation & hand guiding, industrial robot & Cobot.	Video Demonstrations Presentations Site/Industry Visit Case Study Demonstration

SMART MANUFACTURING SYSTEMS **Course Code : 316356**

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 List different areas of applications of Smart manufacturing. TLO 5.2 Explain Sustainability and environmental considerations in Smart Manufacturing. TLO 5.3 List the Challenges in Smart Manufacturing.	**Unit - V Smart Manufacturing-Implementation & Challenges** 5.1 Implementation- Factories and Assembly Line, Food Industry, Medical, Power Plants, Inventory Management & Quality. 5.2 Data Acquisition and Analysis. Sustainability and environmental considerations in Smart Manufacturing. 5.3 Challenges in smart manufacturing.	Video Demonstrations Case Study Site/Industry Visit 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 Study various manufacturing processes. LLO 1.2 Prepare a manufacturing process report considering traditional manufacturing system.	1	*Report generation of traditional manufacturing systems (Considering any product assembly).	2	CO1
LLO 2.1 Study different network topologies for system communication. LLO 2.2 Built up communication between machines and cloud storage.	2	Communication network between hardware and Cloud storage.	2	CO1 CO2
LLO 3.1 Interpret different methods of data analysis. LLO 3.2 Observe remote factory data Using cloud platforms.	3	Visualization of remote factory data Using cloud platforms.	2	CO1 CO2
LLO 4.1 Draw simple 3D model for path simulation. LLO 4.2 Generate and simulate tool paths using CAM software.	4	*Tool path generation and simulation of simple parts.	2	CO1 CO3
LLO 5.1 Study different machining parameters. LLO 5.2 Perform toolpath simulation and analyze machining parameters.	5	*Tool path simulation & analysis of machining parameters.	2	CO1 CO3
LLO 6.1 Develop CNC part programs for turning operations. LLO 6.2 Operate CNC machine for turning operation.	6	*CNC part program for turning operation.	2	CO1 CO3
LLO 7.1 Develop CNC part programs for milling operations. LLO 7.2 Operate CNC machine for milling operation.	7	CNC part program for milling operation.	2	CO3
LLO 8.1 Study different SCADA software and systems in the market. LLO 8.2 Select Suitable SCADA Software for given application.	8	SCADA software for factory operations.	2	CO3

SMART MANUFACTURING SYSTEMS **Course Code : 316356**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 9.1 Collect machine data for fault prediction. LLO 9.2 Analyze machine data for fault prediction.	9	Machine data collection for fault prediction.	2	CO3
LLO 10.1 Study different types of sensors & actuators used in manufacturing systems. LLO 10.2 Interface proximity sensors and actuators for real-time control with PLC.	10	*Proximity sensors and actuators interface with PLC.	2	CO3
LLO 11.1 Measure part tolerances using Coordinate Measuring Machine (CMM). LLO 11.2 Operate CMM machine for measurement of part tolerance.	11	* CMM for measuring different variables.	2	CO3
LLO 12.1 Study different CIM software for product development. LLO 12.2 Use PLM (Product life cycle Management) software for CIM related to any simple product.	12	PLM software for simple product Manufacturing.	2	CO4
LLO 13.1 Study different CIM software for product development. LLO 13.2 Use Supply Chain Management (SCM) software for CIM related to any simple product.	13	*SCM software for simple product Manufacturing.	2	CO4
LLO 14.1 Study of collaborative robot. LLO 14.2 Analyze different operating parameters of Cobot.	14	Observe actual/Video of collaborative robot.	2	CO4
LLO 15.1 Study industrial robot anatomy. LLO 15.2 Use robots for different Manufacturing processes.	15	*Robots for automated assemblies and inspections.	2	CO4
LLO 16.1 Study of smart manufacturing systems in Industry. LLO 16.2 Analyze different operations in smart manufacturing system.	16	Observe actual/Video of smart manufacturing systems.	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)

Assignment

- Collect information about traditional manufacturing systems & smart manufacturing systems.
- “Smart manufacturing systems are highly efficient than traditional manufacturing systems” Justify.
- Collect an information about cybersecurity for industrial control systems.
- Carry out comprehensive study of technologies used in Smart Manufacturing (IIoT, AIML, Big data analytics, Automation & Robotics etc.)

- Collect information about online inspection, online monitoring, automated guided vehicles (AGVs) and conveyor systems.
- Prepare a report on applications of smart manufacturing systems in various sectors.
- Make power point presentation including videos on AIML, IoT, Cloud computing, Digital twin technology.

Micro project

- Prepare a chart showing basic principles, objectives, types & benefits of Smart Manufacturing.
- Prepare and present a seminar on technologies of Industry 4.0.
- Examine & prepare a report on inspection of parts using CAQC software by CMM/other system.
- Prepare charts on digital twin technology & cloud computing in smart manufacturing.
- Prepare charts on technologies used in Smart Manufacturing systems.
- Prepare a model showing components of smart manufacturing systems.

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	PLC (Min 8 input/output)	10
2	ERP, PLM & SCM software (1+10 user)	12,13
3	Industrial Robot with standalone servo controller as well as compatible PLC interface with following features: 1) Minimum 3 linkages 2) Minimum 6 degree of freedom (6 DoF) 3) Various sensors 4) Compatible Robot vision system for inspection.	14,15
4	Robot offline simulation software-Any suitable freeware	15
5	Computers with internet connectivity (Minimum i7 Core Processor, 8GB RAM, 500GB HDD)	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 Smart Manufacturing	CO1	10	4	4	4	12
2	II	Fundamentals of Industry 4.0	CO2	12	2	8	6	16
3	III	Digital Manufacturing Technologies	CO3	14	2	8	6	16
4	IV	Factory automation & Robotics in smart manufacturing	CO4	14	2	6	8	16

SMART MANUFACTURING SYSTEMS **Course Code : 316356**

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
5	V	Smart Manufacturing-Implementation & Challenges	CO5	10	2	4	4	10
Grand Total				**60**	**12**	**30**	**28**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two-unit tests of 30 marks and average of two-unit tests.
- For laboratory learning 25 Marks
- For Self Learning 25 Marks

Summative Assessment (Assessment of Learning)

- End semester assessment of 70 marks.
- End semester 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	-	3			
CO2	3	2	2	3	2	2	3			
CO3	2	2	2	3	2	2	3			
CO4	2	2	2	3	2	2	3			
CO5	3	2	2	3	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	Alasdair Gilchrist	Industry 4.0: The Industrial Internet of Things	Apress (1 January 2019) ISBN:978-1484249703
2	Dr Shirish Gandhare	Basics and Introduction to Industry 4.0	Notion Press ,ISBN: 9798896730323
3	M. Niranjanamurthy , Sheng-Lung Peng , E. Naresh .	Advances in Industry 4.0: Concepts and Applications (Smart Computing Applications, 5)	De Gruyter ,ISBN:978-3110725360.

SMART MANUFACTURING SYSTEMS **Course Code : 316356**

Sr.No	Author	Title	Publisher with ISBN Number
4	Domanic T Matt , Vladimir Modrak	Implementing Industry 4.0 in SMEs	Springer Nature Switzerland AG, ISBN: 9783030705183
5	Dr. Shruti Vashist, Dr. Sujata Nayak, Mr. Piyush Mahendru and Dr. Prashant Bhardwaj	Industry 4.0: New age of Robotics, Automation and Communication Engineering	AkiNik Publications, ISBN:978-93-5570-343-9
6	M. Groover	CAD/CAM: Computer-Aided Design and Manufacturing	Pearson Education ,ISBN: 978-8174906700

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=7iWriXyI2cE&t=6s	Introduction to IoT
2	https://www.youtube.com/watch?v=gWu2Jxfae74&list=PLbRMhDVUMngdcLdH4-YF1uJI4IuhcDZPR&index=5	IoT networking
3	https://www.youtube.com/watch?v=KqSqyKwVuA8&list=PLbRMhDVUMngdcLdH4-YF1uJI4IuhcDZPR&index=17	Cyber security
4	https://www.youtube.com/watch?v=eKiepu2D-XQ&list=PLbRMhDVUMngdcLdH4-YF1uJI4IuhcDZPR&index=8	Sustainability in Manufacturing
5	https://www.youtube.com/watch?v=JC3cQ2MB_34	Data Handling
6	https://www.youtube.com/watch?v=zLMgdYI82IE&list=PLbRMhDVUMngdcLdH4-YF1uJI4IuhcDZPR&index=14	Virtual & augmented reality
7	https://www.youtube.com/watch?v=CN1gn4J_Plk	Study of Cobots
8	https://www.youtube.com/watch?v=De8MQWbhu3k&list=PLbRMhDVUMngdcLdH4-YF1uJI4IuhcDZPR&index=11	Smart factories
9	https://www.youtube.com/watch?v=C_dYxnTDlPE&list=PLbRMhDVUMngdcLdH4-YF1uJI4IuhcDZPR&index=50	Applications of smart manufacturing in factories assembly line
10	https://www.youtube.com/watch?v=XLY4M0mm05A&list=PLbRMhDVUMngdcLdH4-YF1uJI4IuhcDZPR&index=51	Applications of smart manufacturing in food industries
11	https://www.youtube.com/watch?v=I59n_ScFIp4&list=PLbRMhDVUMngdcLdH4-YF1uJI4IuhcDZPR&index=54	Applications of smart manufacturing in inventory management
12	https://www.youtube.com/watch?v=Tvj4Hmrzj7w&list=PLbRMhDVUMngdcLdH4-YF1uJI4IuhcDZPR&index=65	Applications of smart manufacturing in Virtual reality lab

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