

ESSENCE OF INDIAN CONSTITUTION**Course Code : 313002**

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/ Dress Designing & Garment Manufacturing/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Telecommunication Engg./ Electrical and Electronics Engineering/ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Food Technology/ Computer Hardware & Maintenance/ Hotel Management & Catering Technology/ 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/ Computer Science/ Textile Technology/ Electronics & Computer Engg./ Travel and Tourism/ Textile Manufactures
Programme Code	: AA/ AD/ AE/ AI/ AL/ AN/ AO/ AT/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CST/ CW/ DBT/ DC/ DD/ DE/ DS/ EE/ EJ/ EK/ EP/ ET/ EX/ FC/ HA/ HM/ IC/ ICE/ IE/ IF/ IH/ IS/ IX/ IZ/ LE/ ME/ MK/ ML/ MRT/ MU/ MY/ PG/ PN/ PO/ SE/ TC/ TE/ TR/ TX/
Semester	: Third
Course Title	: ESSENCE OF INDIAN CONSTITUTION
Course Code	: 313002

I. RATIONALE

This course will focus on the basic structure and operative dimensions of Indian Constitution. It will explore various aspects of the Indian political and legal system from a historical perspective highlighting the various events that led to the making of the Indian Constitution. The Constitution of India is the supreme law of India. The document lays down the framework demarcating the fundamental political code, structure, procedures, powers, and sets out fundamental rights, directive principles, and the duties of citizens. The course on constitution of India highlights key features of Indian Constitution that makes the students a responsible citizen. In this online course, we shall make an effort to understand the history of our constitution, the Constituent Assembly, the drafting of the constitution, the preamble of the constitution that defines the destination that we want to reach through our constitution, the fundamental right constitution guarantees through the great rights revolution, the relationship between fundamental rights and fundamental duties, the futurist goals of the constitution as incorporated in directive principles and the relationship between fundamental rights and directive principles.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

ESSENCE OF INDIAN CONSTITUTION**Course Code : 313002**

The aim of this course is to help the student to attain the following industry /employer expected outcome – Abide by the Constitution in their personal and professional life.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - List salient features and characteristics of the constitution of India.
- CO2 - Follow fundamental rights and duties as responsible citizen of the country.
- CO3 - Analyze major constitutional amendments in the constitution.
- CO4 - Follow procedure to cast vote using voter-id.

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	Min						Max	Min	Max	Min	Max	Min		
313002	ESSENCE OF INDIAN CONSTITUTION	EIC	VEC	1	-	-	1	2	1		-	-	-	-	-	-	-	-	50	20	

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.
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ESSENCE OF INDIAN CONSTITUTION**Course Code : 313002**

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 meaning of preamble of the constitution. TLO 1.2 Explain the doctrine of basic structure of the constitution. TLO 1.3 List the salient features of constitution. TLO 1.4 List the characteristics of constitution.	Unit - I Constitution and Preamble 1.1 Meaning of the constitution of India. 1.2 Historical perspectives of the Constitution of India. 1.3 Salient features and characteristics of the Constitution of India. 1.4 Preamble of the Constitution of India.	Presentations Blogs Hand-outs Modules Flipped classrooms Case studies
2	TLO 2.1 Enlist the fundamental rights. TLO 2.2 . Identify fundamental duties in general and in particular with engineering field. TLO 2.3 Identify situations where directive principles prevail over fundamental rights.	Unit - II Fundamental Rights and Directive Principles 2.1 Fundamental Rights under Part-III. 2.2 Fundamental duties and their significance under part-IV-A. 2.3 Relevance of Directive Principles of State Policy under part-IV A.	Presentations Blogs Hand-outs Modules Case Study Flipped Classroom
3	TLO 3.1 Enlist the constitutional amendments. TLO 3.2 Elaborate the elements of Centre-State Relationship TLO 3.3 Analyze the purposes of various amendments.	Unit - III Governance and Amendments 3.1 3.1 Amendment procedure of the Constitution and their types - simple and special procedures. 3.2 The Principle of Federalism and its contemporary significance along with special committees that were setup. 3.3 Major Constitutional Amendment procedure - 1st, 7th, 42nd, 44th, 73rd & 74th, 76th, 86th, 52nd & 91st, 102nd	Cases of Federal disputes with relevant Supreme court powers and Judgements Presentations Blogs Hand-outs Problem based learning

ESSENCE OF INDIAN CONSTITUTION**Course Code : 313002**

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 the importance of electoral rights. TLO 4.2 Write the step by step procedure for process of registration TLO 4.3 Explain the significance of Ethical electoral participation TLO 4.4 Explain the steps to motivation and facilitation for electoral participation TLO 4.5 Enlist the features of the voter's guide TLO 4.6 Explain the role of empowered voter TLO 4.7 Write the steps of voting procedure TLO 4.8 Write steps to create voter awareness TLO 4.9 Fill the online voter registration form TLO TLO 4.10 Follow procedure to cast vote using voter-id.	Unit - IV Electoral Literacy and Voter's Education 4.1 Electoral rights , Electoral process of registration 4.2 Ethical electoral participation 4.3 Motivation and facilitation for electoral participation 4.4 Voter's guide 4.5 Prospective empowered voter 4.6 Voting procedure 4.7 Voter awareness 4.8 Voter online registration https://www.ceodelhi.gov.in/ELCdetails.aspx	Presentations Hand-outs Modules Blogs Problem based Learning

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**

- Outline the procedure to submit application for Voter-id
- Assignments are to be provided by the course teacher in line with the targeted COs.

A1. Prepare an essay on Constitution of India .

A2 Prepare a comparative chart of Unique features of Indian Constitution of India and Constitution of USA

- Assignments are to be provided by the course teacher in line with the targeted COs. A1. Prepare an essay on Constitution of India . A2 Prepare a comparative chart of Unique features of Indian Constitution of India and Constitution of USA A3. Self-learning topics: Parts of the constitution and a brief discussion of each part Right to education and girl enrollment in schools. GER of Girls and Boys. Right to equality. Social Democracy. Women Representation in Parliament and State Assemblies. LGBTQIA+

Micro project

- 1. Organize a workshop-cum discussions for spreading awareness regarding Fundamental Rights of the citizen of the country
- 2. Prepare elaborations where directive principle of State policy has prevailed over Fundamental rights with relevant

ESSENCE OF INDIAN CONSTITUTION**Course Code : 313002**

Supreme Court Judgements.

3. Organize a debate on 42nd, 97th and 103rd Constitutional Amendment Acts of Constitution of India.

Seminar

- 1 Differences in the ideals of Social democracy and Political democracy.
- 2 Democracy and Women's Political Participation in India.
- 3 Khap Panchayat - an unconstitutional institution infringing upon Constitutional ethos.
- 4 Situations where directive principles prevail over fundamental rights.

Group discussions on current print articles.

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- Art 356 and its working in Post-Independent India.
- Women's Reservation in Panchayat leading to Pati Panchayats - Problems and Solutions.
- Adoption of Article 365 in India.
- Need of Amendments in the constitution.
- Is India moving towards a Unitary State Model ?

Activity

- Arrange Mock Parliament debates.
- Prepare collage/posters on current constitutional issues.
- i. National (Art 352) & State Emergencies (Art 356) declared in India.
 - ii. Seven fundamental rights.
 - iii. Land Reforms and its effectiveness - Case study of West-Bengal and Kerala.

Cases: Suggestive cases for usage in teaching:

- A.K. Gopalan Case (1950) : SC contented that there was no violation of Fundamental Rights enshrined in Articles 13, 19, 21 and 22 under the provisions of the Preventive Detention Act, if the detention was as per the procedure established by law. Here, the SC took a narrow view of Article 21.
- Shankari Prasad Case (1951) : This case dealt with the amendability of Fundamental Rights (the First Amendment's validity was challenged). The SC contended that the Parliament's power to amend under Article 368 also includes the power to amend the Fundamental Rights guaranteed in Part III of the Constitution.
- Minerva Mills case (1980) : This case again strengthens the Basic Structure doctrine. The judgement struck down 2 changes made to the Constitution by the 42nd Amendment Act 1976, declaring them to violate the basic structure. The judgement makes it clear that the Constitution, and not the Parliament is supreme.
- Maneka Gandhi case (1978) : A main issue in this case was whether the right to go abroad is a part of the Right to Personal Liberty under Article 21. The SC held that it is included in the Right to Personal Liberty. The SC also ruled that the mere existence of an enabling law was not enough to restrain personal liberty. Such a law must also be "just, fair and reasonable."

Other cases:

1. Kesavananda Bharati Case (1973) : In this case the Hon. SC laid down a new doctrine of the 'basic structure' (or 'basic features') of the Constitution. It ruled that the constituent power of Parliament under Article 368 does not enable it to alter the 'basic structure' of the Constitution. This means that the Parliament cannot abridge or take away a Fundamental Right that forms a part of the 'basic structure' of the Constitution.
2. Mathura Rape Case (1979) : A tribal woman Mathura (aged 14 to 16 years) was raped in Police Custody. The case raised the questions on the idea of 'Modesty of Woman' and here it was a tribal woman who succumbs to multiple patriarchies. Custodial rape was made an offence and was culpable with the detainment of 7 years or more under Section 376 of Indian Penal Code. The weight of proofing the allegations moved from the victim to the offender, once sexual intercourse is established. The publication of the victim's identity was banned and it was also held that rape trials should be conducted under the cameras.

ESSENCE OF INDIAN CONSTITUTION**Course Code : 313002**

3. Puttswamy vs Union of India (2017) : In this landmark case which was finally pronounced by a 9-judge bench of the Supreme Court on 24th August 2017, upholding the fundamental right to privacy emanating from Article 21. The court stated that Right to Privacy is an inherent and integral part of Part III of the Constitution that guarantees fundamental rights. The conflict in this area mainly arises between an individual's right to privacy and the legitimate aim of the government to implement its policies and a balance needs to be maintained while doing the same.

4. Navtej Singh Johar & Ors. v. Union of India (2018) : Hon. SC Decriminalised all consensual sex among adults, including homosexual sex by scrapping down section 377 of the Indian penal code (IPC). The court ruled that LGBTQ community are equal citizens and underlined that there cannot be discrimination in law based on sexual orientation and gender.

5. Anuradha Bhasin Judgement (2020) : The Supreme Court of India ruled that an indefinite suspension of internet services would be illegal under Indian law and that orders for internet shutdown must satisfy the tests of necessity and proportionality. The Court reiterated that freedom of expression online enjoyed Constitutional protection, but could be restricted in the name of national security. The Court held that though the Government was empowered to impose a complete internet shutdown, any order(s) imposing such restrictions had to be made public and was subject to judicial review.

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 judicious 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 : 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	Constitution and Preamble	CO1	4	0	0	0	0
2	II	Fundamental Rights and Directive Principles	CO2	4	0	0	0	0
3	III	Governance and Amendments	CO3	4	0	0	0	0
4	IV	Electoral Literacy and Voter's Education	CO4	3	0	0	0	0
Grand Total				15	0	0	0	0

X. ASSESSMENT METHODOLOGIES/TOOLS**Formative assessment (Assessment for Learning)**

- Assignment, Self-learning and Terms work Seminar/Presentation

ESSENCE OF INDIAN CONSTITUTION**Course Code : 313002****Summative Assessment (Assessment of Learning)****XI. SUGGESTED COS - POS MATRIX FORM**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	1	-	-	-	2	-	-			
CO2	1	-	-	-	2	-	-			
CO3	1	2	-	-	2	-	1			
CO4	-	-	-	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	P.M.Bakshi	The Constitution of India	Universal Law Publishing, New Delhi 15th edition, 2018, ISBN: 9386515105 (Check the new edition)
2	D.D.Basu	Introduction to Indian Constitution	Lexis Nexis Publisher, New Delhi, 2015, ISBN:935143446X
3	B. K. Sharma	Introduction to Constitution of India	PHI, New Delhi, 6th edition, 2011, ISBN:8120344197
4	MORE READS :	Oxford Short Introductions - The Indian Constitution by Madhav Khosla. The Indian Constitution: Cornerstone of a Nation by Granville Austin. Working a Democratic Constitution: A History by Garnville Austin Founding Mothers of the Indian Republic: Gender Politics of the Framing of the Constitution by Achyut Chetan. Our Parliament by Subhash C. Kashyap. Our Political System by Subhash C. Kashyap. Our Constitution by Subhash C. Kashyap. Indian Constitutional Law by Rumi Pal.	Extra Read
5	B.L. Fadia	The Constitution of India	Sahitya Bhawan, Agra, 2017, ISBN:8193413768

XIII. LEARNING WEBSITES & PORTALS

ESSENCE OF INDIAN CONSTITUTION**Course Code : 313002**

Sr.No	Link / Portal	Description
1	http://www.legislative.gov.in/constitution-of-india	Constitution overview
2	https://en.wikipedia.org/wiki/Constitution_of_India	Parts of constitution
3	https://www.india.gov.in/my-government/constitution-india	Constitution overview
4	https://www.toppr.com/guides/civics/the-indian-constitution/the-constitution-of-india/	Fundamental rights and duties
5	https://main.sci.gov.in/constitution	Directive principles
6	https://legallaffairs.gov.in/sites/default/files/chapter%203.pdf	Parts of constitution
7	https://www.concourt.am/armenian/legal_resources/world_constitutions/constit/india/india-e.htm	Parts of constitution
8	https://constitutionnet.org/vl/item/basic-structure-indian-constitution	Parts of constitution

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. 02/07/2024**Semester - 3, K Scheme**

FUNDAMENTALS OF PYTHON PROGRAMMING**Course Code : 313007**

Programme Name/s	: Architecture Assistantship/ Architecture and Interior Design/ Automobile Engineering./ Architecture/ Interior Design & Decoration/ Interior Design/ Mechanical Engineering/ Mechatronics/ Manufacturing Technology/ Production Engineering
Programme Code	: AA/ AD/ AE/ AT/ IX/ IZ/ ME/ MK/ MRT/ PG
Semester	: Third / Fourth / Fifth
Course Title	: FUNDAMENTALS OF PYTHON PROGRAMMING
Course Code	: 313007

I. RATIONALE

Comprehension of programming languages is crucial for diploma engineering graduates, especially as they engage with various software applications in the mechanical engineering domain. Python, being easy to code, potent, and stands out as an ideal language for introducing computing and problem-solving concepts to beginners. This course enables students to write Python programs and utilize various built-in functions/methods of Python modules/libraries to solve specific problems.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

An ability to prepare python programs for solving simple engineering problems.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Use program designing tools and IDE for python.
- CO2 - Employ python building blocks and data types in the programming.
- CO3 - Implement conditional and looping statements in the python programming.
- CO4 - Implement built in functions and modules in the python programming.
- CO5 - Use NumPy for performing operations on list and array.

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	Max	Min													
313007	FUNDAMENTALS OF PYTHON PROGRAMMING	FPP	AEC	-	-	2	-	2	1	-	-	-	-	-	25	10	25@	10	-	-	50			

FUNDAMENTALS OF PYTHON PROGRAMMING**Course Code : 313007****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 the functions of different components of computers and peripherals. TLO 1.2 List the applications of computers in the domain of Mechanical Engineering. TLO 1.3 Create flow chart of given programming problem. TLO 1.4 Describe the given feature of Python programming language.	Unit - I Introduction to Python Programming 1.1 Revision of Computer Components (CPU, I/O devices) 1.2 Applications of computer and programming languages in Mechanical engineering domain. 1.3 Program Designing Tools: Algorithm, Flow Chart. 1.4 Introduction and Features of Python: Open source, Interactive, Interpreted, Object-oriented, Platform independent etc., Installation & working of IDEs.	Presentations Hands-on
2	TLO 2.1 Use different Python building blocks. TLO 2.2 Describe different data types of Python programming. TLO 2.3 Differentiate normal and container data types of Python programming language. TLO 2.4 Write simple Python programs by taking the user's input to solve expressions.	Unit - II Python building blocks & data types 2.1 Python building blocks: Identifiers, Indentation, Comments, Variables, Arithmetic and assignment operators and Expressions. 2.2 Data Types: Integers, float, complex, string and their declaration, data type conversion. 2.3 Accepting input from user: I/O functions. 2.4 Container Types: List, tuple, set and their declaration. 2.5 Write simple python program to display "Welcome" message.	Presentations Hands-on

FUNDAMENTALS OF PYTHON PROGRAMMING**Course Code : 313007**

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 Use basic relational and logical operators in python programs. TLO 3.2 Employ decision control statements in python programs. TLO 3.3 Employ looping statements in python programs.	Unit - III Python operators and Control flow 3.1 Relational and Logical operators. 3.2 Decision making statements: if, if-else, if- elif - else statements. 3.3 Looping statements: while loop, for loop, Nested loops. 3.4 Loop manipulation using continue, pass, break statements.	Demonstration Hands-on
4	TLO 4.1 Use built-in functions in Python programs. TLO 4.2 Use built-in modules in Python programs. TLO 4.3 Develop user-defined functions in Python for the given purpose.	Unit - IV Python functions and modules 4.1 Functions: Use of built-in functions, data conversion functions, abs, pow, min, max, round, ceil, floor etc. 4.2 Modules: Use of built-in modules- math cmath, random and statistics. 4.3 User-defined function: Function definition, function calling, function arguments and parameter passing, Return statement, scope of variables.	Demonstration Hands-on
5	TLO 5.1 Manipulate the given list. TLO 5.2 Perform different operations on list. TLO 5.3 Use NumPy arrays for faster operations.	Unit - V List and arrays in python 5.1 List: define list (one and multi-dimension), accessing, deleting and updating values in list. 5.2 Basic list operations: slicing, repeating, concatenation and iteration. 5.3 NumPy array: Generate NumPy arrays and construct multidimensional arrays.	Demonstration 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 Install python IDE. LLO 1.2 Explore the IDE's settings and preferences.	1	Install Python IDE.	2	CO1
LLO 2.1 Draw flow chart for the given problem. LLO 2.2 Write algorithm for the given problem.	2	*Prepare a flow chart and algorithm for simple problem.	2	CO1
LLO 3.1 Use print function to display the message.	3	Write a simple program to display a simple message. (Ex: "Welcome to Python programming")	2	CO2
LLO 4.1 Write and execute a python program to solve a given expression.	4	Write a simple Python program by taking user's input to - - find the area of rectangle - find the area or circle.	2	CO2
LLO 5.1 Write and execute a python program.	5	*Write a program to accept value of Celsius and convert it to Fahrenheit.	2	CO2
LLO 6.1 Use the if - else statement in the python program.	6	Write a python program to find whether the given number is even or odd using if - else statement.	2	CO3

FUNDAMENTALS OF PYTHON PROGRAMMING**Course Code : 313007**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 7.1 Implement the if-elif-else statement in the python program.	7	*Write a python program to check whether a input number is positive, negative or zero using if – elif-else statement.	2	CO3
LLO 8.1 Use appropriate decision-making control statement to solve the given problem.	8	Write a program to accept the three sides of a triangle to check whether the triangle is isosceles, equilateral, right angled triangle.	2	CO3
LLO 9.1 Identify suitable loop and conditional statement for the problem. LLO 9.2 Inscribe the loop and conditional statement in the python program.	9	Write a program that allows the user to input numbers until they choose to stop, and then displays the count of positive, negative, and zero numbers entered (Use while loop).	2	CO3
LLO 10.1 Identify suitable looping statement for multiplication table. LLO 10.2 Implement the for loop for the multiplication table.	10	*Write a python program for printing multiplication table of a given number using for loop. (Ex. 12x1=12 12x2=24 12x10=120)	2	CO3
LLO 11.1 Identify a suitable module for importing a given function. LLO 11.2 Use various mathematical functions available in cmath module.	11	*Write a Python program to demonstrate the use of different mathematical functions (Ex. ceiling, floor etc).	2	CO4
LLO 12.1 Use various functions available in statistics module.	12	*Write a python program to find mean, mode, median and standard deviation using statistics module.	2	CO4
LLO 13.1 Use list data type of Python.	13	Write a python program utilizing a list to display the name of a month based on a given month number.	2	CO5
LLO 14.1 Write programs using Multidimensional list in Python.	14	Write a python program to add or subtract two matrices using multidimensional list.	2	CO5
LLO 15.1 Write programs using Multidimensional list in Python.	15	*Write a python program to multiply two matrices using multidimensional list.	2	CO5
LLO 16.1 Perform metrics operation using NumPy Module	16	*Write a python program to multiply two matrices using NumPy.	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**

- Not Applicable

FUNDAMENTALS OF PYTHON PROGRAMMING**Course Code : 313007****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 judicious 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	Computer System with all necessary peripherals and internet connectivity.	All
2	Any relevant python IDE like IDLE/PyCharm/VSCode/Jupyter Notebook/Online Python Compiler.	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table) : NOT APPLICABLE**X. ASSESSMENT METHODOLOGIES/TOOLS****Formative assessment (Assessment for Learning)**

- Term Work

Summative Assessment (Assessment of Learning)

- 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	2	2	3	-	-	2			
CO2	2	2	2	3	-	-	2			
CO3	2	2	2	3	-	-	2			

FUNDAMENTALS OF PYTHON PROGRAMMING**Course Code : 313007**

CO4	2	2	2	3	-	-	2			
CO5	2	2	2	3	-	-	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -

*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Kenneth A. Lambert	Fundamentals of Python : First Programs , 2E	Cengage Learning India Private Limited, ISBN: 9789353502898
2	Yashavant Kanetkar, Aditya Kanetkar	Let Us Python - 6th Edition	BPB Publications, ISBN: 9789355515414

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.w3schools.com/python/	Python Programming
2	https://www.tutorialspoint.com/python/index.htm	Python Programming
3	https://www.python.org/	Python Programming
4	https://spoken-tutorial.org/tutorial-search/?search_foss=Pyt	Python Programming

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. 02/07/2024**Semester - 3 / 4 / 5, K Scheme**

PRODUCTION DRAWING**Course Code : 313311**

Programme Name/s : Mechanical Engineering/ Mechatronics/ Manufacturing Technology/ Production Engineering/
Programme Code : ME/ MK/ MRT/ PG
Semester : Third
Course Title : PRODUCTION DRAWING
Course Code : 313311

I. RATIONALE

Production drawing is essential for communicating ideas in manufacturing industry as well as other engineering applications. Production drawings illustrate set of instructions to manufacture a product, providing information about dimensions, materials, finishes, tools required, methods of assembly and so on. Therefore, this course has been developed for interpretation and preparation of the production drawing.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Prepare Production drawing of a given part / component as per requirement.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Construct an auxiliary view of given object.
- CO2 - Use convention for representation of material and mechanical components.
- CO3 - Interpret and draw production drawing.
- CO4 - Prepare assembly drawing using given details.
- CO5 - Prepare detail drawing based on the given assembly drawing/data.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme						Credits	Assessment Scheme													
				Actual Contact Hrs./Week			SL	H	NL		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	Max	Min													
313311	PRODUCTION DRAWING	PDR	SEC	2	-	4	2	8	4	4	30	70	100	40	25	10	25@	10	25	10	175			

PRODUCTION DRAWING**Course Code : 313311****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.* 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 Construct an auxiliary view of a given object. TLO 1.2 Construct an incomplete principal view from the given auxiliary view.	Unit - I Auxiliary View 1.1 Auxiliary planes and views. 1.2 Draw Auxiliary view from the given orthographic views. 1.3 Complete the partial view from the given auxiliary and other principal view.	Lecture Using Chalk-Board Model Demonstration Video Demonstrations
2	TLO 2.1 Use IS SP-46 codes for preparing production drawing. TLO 2.2 Prepare production drawing using standard conventions.	Unit - II Conventional representation 2.1 Engineering Material Conventions 2.2 Conventional breaks in pipes, rod and shaft 2.3 Conventional representation of common features like slotted head, radial rib, knurling, serrated shaft, splined shaft, ratchet and pinion, repeated parts, square on shaft, holes on circular pitch, internal and external threads 2.4 Conventional representation of standard parts like ball and roller bearing, gears, springs 2.5 Pipe joints and valves 2.6 Counter sunk and counter bored holes 2.7 Tapers	Lecture Using Chalk-Board Model Demonstration Video Demonstrations

PRODUCTION DRAWING**Course Code : 313311**

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 Calculate tolerances on the given machine components. TLO 3.2 Identify type of fit between mating parts of machine components based on given tolerance values. TLO 3.3 Prepare production drawing using suitable convention and codes.	Unit - III Production Drawing 3.1 Limits, Fits and Tolerances: Definitions, introductions to ISO system of Tolerance. Dimensional tolerances: Terminology, selection and representation of dimensional tolerance- number and grade method. Definitions concerning Tolerancing and Limits system, unilateral and bilateral tolerance, Hole and shaft basis systems, Types of fits- Clearance, transition and Interference, Selection of fit for engineering applications. Calculation of limit sizes and identification of type of fit from the given sizes like 50 H7/s6, 30 H7/d9 etc. 3.2 Geometrical Tolerances: Types of geometrical tolerances, terminology for deviation, representation of geometrical tolerance on drawing. 3.3 General welding symbols, length and size of weld, surface contour and finish of weld, all round and site weld, symbolic representation in Engineering practices and its interpretation. 3.4 Machining symbol and surface texture: Indication of machining symbol showing direction of lay, sampling length, roughness grades, machining allowances, manufacturing methods. Representation of surface roughness on drawing.	Lecture Using Chalk-Board Model Demonstration Video Demonstrations
4	TLO 4.1 Identify various components in given detail drawings. TLO 4.2 Identify sequence of assembling it. TLO 4.3 Prepare assembly drawing from given detailed drawing. TLO 4.4 Prepare bill of material.	Unit - IV Details to assembly 4.1 Introduction to assembly drawing, accepted norms to be observed for assembly drawings, sequence for preparing assembly drawing, Bill of Material (BOM). 4.2 Couplings: Oldham & Universal couplings. 4.3 Bearing: Foot Step & Pedestal Bearing. 4.4 Lathe: Single (pillar type) and square tool Post. 4.5 Bench vice & Pipe Vice. 4.6 Screw-jack 4.7 Drill Jig	Lecture Using Chalk-Board Model Demonstration Video Demonstrations
5	TLO 5.1 Interpret various components in given assembly drawings. TLO 5.2 Identify sequence of dismantling in given assembly drawing. TLO 5.3 Prepare the detailed drawing from given assembly drawing.	Unit - V Assembly to Details 5.1 Basic principles of process of dismantling the assembly into components. 5.2 Couplings: Oldham & Universal couplings. 5.3 Bearing: Foot Step & Pedestal Bearing. 5.4 Lathe: Single (pillar type) and square tool Post. 5.5 Bench vice & Pipe Vice. 5.6 Screw-jack 5.7 Drill Jig	Lecture Using Chalk-Board Model Demonstration Video Demonstrations

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

PRODUCTION DRAWING**Course Code : 313311**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Draw an auxiliary view from given drawing.	1	*Draw an auxiliary view or complete given partial drawing. (any two)	4	CO1
LLO 2.1 Draw an auxiliary view from given drawing.	2	*Draw an auxiliary view or complete given partial drawing. (Continue Sr No 1)	4	CO1
LLO 3.1 Prepare drawing using convention and code as per IS-SP46.	3	*Draw various conventional representations as per IS SP-46	4	CO2
LLO 4.1 Use various tolerances and symbols in drawing.	4	*Draw Dimensional and Geometrical Tolerances, Welding Symbols, Surface Roughness and Machining Symbols on the given figures.	4	CO2 CO3
LLO 5.1 Use various tolerances and symbols in production drawing.	5	Develop Production drawing of machine components showing dimensional and geometrical Tolerance, surface finish etc. (any two)	4	CO2 CO3
LLO 6.1 Draw assembly drawing using standard procedure for assembly of components.	6	Draw an Assembly drawing from the given detailed drawing showing fits, part numbers, bill of material, assembly dimensions (Any one)	4	CO2 CO3 CO4 CO5
LLO 7.1 Draw assembly drawing using standard procedure for assembly of components.	7	Draw an Assembly drawing from the given detailed drawing showing fits, part numbers, bill of material, assembly dimensions. (Sr No 6 continue)	4	CO2 CO3 CO4 CO5
LLO 8.1 Draw assembly drawing using standard procedure for assembly of components.	8	Draw an Assembly drawing from the given detailed drawing showing fits, part numbers, bill of material, assembly dimensions. (Sr No 6 continue)	4	CO2 CO3 CO4 CO5
LLO 9.1 Draw assembly drawing using standard procedure for assembly of components.	9	*Draw an Assembly drawing from the given detailed drawing showing fits, part numbers, bill of material, assembly dimensions. (any one)	4	CO2 CO3 CO4 CO5
LLO 10.1 Draw assembly drawing using standard procedure for assembly of components.	10	*Draw an Assembly drawing from the given detailed drawing showing fits, part numbers, bill of material, assembly dimensions. (Sr No 9 continue)	4	CO2 CO3 CO4 CO5
LLO 11.1 Draw detail drawing using standard procedure for dismantling of given assembly drawing.	11	Draw detailed drawing from the given assembly drawing showing Conventional Representation, Dimensional and Geometrical Tolerances and Surface Finish symbols. (any one)	4	CO2 CO3 CO4 CO5
LLO 12.1 Draw detail drawing using standard procedure for dismantling of given assembly drawing.	12	Draw detailed drawing from the given assembly drawing showing Conventional Representation, Dimensional and Geometrical Tolerances and Surface Finish symbols. (Sr No 11 continue)	4	CO2 CO3 CO4 CO5
LLO 13.1 Draw detail drawing using standard procedure for dismantling of given assembly drawing.	13	Draw detailed drawing from the given assembly drawing showing Conventional Representation, Dimensional and Geometrical Tolerances and Surface Finish symbols. (Sr No 11 continue)	4	CO2 CO3 CO4 CO5

PRODUCTION DRAWING**Course Code : 313311**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 14.1 Draw detail drawing using standard procedure for dismantling of given assembly drawing.	14	*Draw detailed drawing from the given assembly drawing showing Conventional Representation, Dimensional and Geometrical Tolerances and Surface Finish symbols. (any one)	4	CO2 CO3 CO4 CO5
LLO 15.1 Draw detail drawing using standard procedure for dismantling of given assembly drawing.	15	*Draw detailed drawing from the given assembly drawing showing Conventional Representation, Dimensional and Geometrical Tolerances and Surface Finish symbols. (Sr No 14 continue)	4	CO2 CO3 CO4 CO5
Note : Out of above suggestive LLOs - • '*' Marked Practicals (LLOs) Are mandatory. • Minimum 80% of above list of lab experiment are to be performed. • Judicial mix of LLOs are to be performed to achieve desired outcomes.				

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

- Prepare assembly drawing/detailed drawing of machine vice/ lathe tailstock/ tool post etc. by visiting Institute's workshop.
- Prepare report on various types of welding symbols used for fabrication work by Visiting nearby fabrication workshop.
- Any other micro-projects suggested by subject faculty on similar line.
- Prepare detailed drawings of Various IC Engine components using proper measuring instruments by visiting Institute's Power engineering Lab or any other.
- Students should collect Production drawings from nearby workshops/industries and establish item reference numbers on that drawing for convention or tolerance value. Prepare report showing item reference numbers and their meaning.
- Prepare report representing conventional representation of various piping joints by visiting nearby process industries like sugar factory, chemical industries, water treatment plant, etc.

Note :

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

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
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PRODUCTION DRAWING**Course Code : 313311**

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Models, charts of objects for Auxiliary view.	1
2	Models/ Charts of Conventional representation and Production drawing.	3,4,5
3	Models, charts of assembly and details drawings.	6,7,8,9,10,11,12,13,14,15
4	Drawing equipment and instruments for classroom teaching-large size: a. T-square or drafter (Drafting Machine). b. Set square (45-45-90 and 30-60-90) c. Protector. d. Drawing instrument box (containing set of compasses and dividers). Drawing sheets, drawing pencils H,2H, Eraser, Drawing pins / clips	All
5	Drawing Table with Drawing Board of Full Imperial/ A1 size.	All
6	Set of various industrial drawings being used by industries.	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	Auxiliary View	CO1	4	0	0	8	8
2	II	Conventional representation	CO2	4	6	8	0	14
3	III	Production Drawing	CO3	6	4	8	4	16
4	IV	Details to assembly	CO4	8	0	0	16	16
5	V	Assembly to Details	CO5	8	0	0	16	16
Grand Total				30	10	16	44	70

X. ASSESSMENT METHODOLOGIES/TOOLS**Formative assessment (Assessment for Learning)**

- continuous assessment based on laboratory performance.

Summative Assessment (Assessment of Learning)

- End term exam- Theory
- End term exam- Practical (Lab performance)

XI. SUGGESTED COS - POS MATRIX FORM

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

PRODUCTION DRAWING**Course Code : 313311**

CO5	3	2	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	Bureau of Indian Standards.	Engineering Drawing Practice for Schools and Colleges IS: SP-46	October 2003, ISBN: 81-7061-091-2
2	Bhatt, N.D.	Engineering Drawing	Charotar Publishing House, 2011, ISBN: 978-93-80358-17-8
3	Bhatt, N.D.; Panchal, V. M	Machine Drawing	Charotar Publishing House, 2011, ISBN: 978-93-80358-11-6
4	Narayan, K. L. Kannaiah, P. Venkata Reddy, K.	Production Drawing	New Age International Publications, 2011, ISBN: 978-81-224-2288-7
5	Sidheswar, N. Kannaiah, P. Sastry, V.V.S.	Machine Drawing	Tata McGraw Hill Education Private Ltd, New Delhi, 2011, ISBN-13: 978-0-07-460337-6

XIII. LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://youtu.be/599ThWCvMVA	Auxiliary View
2	https://youtu.be/k7-POcJfjAU	Auxiliary View
3	https://youtu.be/5Pj7vkcolXk	Introduction to working drawing.
4	https://youtu.be/VRi2LMm6jHU	Assembly
5	https://youtu.be/FqzplEaE4Z0	Details to Assembly

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. 02/07/2024**Semester - 3, K Scheme**

MECHANICAL ENGINEERING MATERIALS**Course Code : 313317****Programme Name/s : Mechanical Engineering/ Mechatronics/ Production Engineering****Programme Code : ME/ MK/ PG****Semester : Third / Fourth****Course Title : MECHANICAL ENGINEERING MATERIALS****Course Code : 313317****I. RATIONALE**

Mechanical diploma technician works in the metal working industry. To meet current and future metal demands it is essential to get material knowledge. Materials like ferrous and non-ferrous metals, polymer, ceramics and composites are widely used in a variety of engineering applications. This course deals with these materials along with advanced materials, their metallurgical considerations, heat treatment processes, structure property relationship and applications. This course will enable diploma engineering students to identify a variety of material and their selection for various applications which is used in connection with smelting, welding, machining, bending, extruding, tapping, soldering, casting, pumping, structural work, crushing, and other industrial processes.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Use relevant mechanical engineering materials & processes based on different 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 suitable material(s) based on desired properties according to application.
- CO2 - Choose relevant alloy steel & Cast iron for mechanical components.
- CO3 - Select relevant non ferrous & powder material components for the engineering application.
- CO4 - Select relevant non metallic & Advanced material for the engineering application.
- CO5 - Use relevant heat treatment processes in given situations.

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	Min			Max	Min	Max	Min	Max	Min	Max	Min	Max	Min			
313317	MECHANICAL ENGINEERING MATERIALS	MEM	DSC	3	-	2	1	6		3	1.5	30	70*#	100	40	25	10	-	-	25	10	150	

MECHANICAL ENGINEERING MATERIALS**Course Code : 313317****Total IKS Hrs for Sem. : 4 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 Interpret the crystal structure of specified materials TLO 1.2 Identify microstructure of the given material with justification. TLO 1.3 Explain with sketches the procedure to prepare a given sample. TLO 1.4 Identify & Interpret the given equilibrium diagram & reactions with justification. TLO 1.5 Identify the given fields of steels on Iron carbon diagrams with justification. TLO 1.6 Choose a relevant hardness tester based on the given situation with justification.	Unit - I Basics of Engineering Materials 1.1 Classification of engineering materials 1.2 Crystal structure, Unit cell and space lattice 1.3 Microstructure, types of microscopes 1.4 Sample preparation, etching process, types of etchants. 1.5 Properties of metals Physical Properties, Mechanical Properties. 1.6 Concept of phase, pure metal, alloy and solid solutions. 1.7 Iron Carbon Equilibrium diagram various phases. Critical temperatures and significance. Reactions on Iron carbon equilibrium diagram 1.8 Hardness testing procedure on Brinell and Rockwell tester.	Lecture Using Chalk-Board Model Demonstration Video Demonstrations

MECHANICAL ENGINEERING MATERIALS**Course Code : 313317**

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 relevant steel for the given application with justification. TLO 2.2 Select the relevant cast irons as white, gray cast iron for the given job with justification. TLO 2.3 Interpret the given material designations. TLO 2.4 Identify the properties of the given composition of cast iron with justification.	Unit - II Steel & Cast Iron 2.1 Broad Classification of steels. i. Plain carbon steels: Definition, Types and Properties, Compositions and applications of low, medium and high carbon steels. ii. Alloy Steels: Definition and Effects of alloying elements on properties of alloy steels. iii. . Tool steels: Cold work tool steels. Hot work tool steels, High speed steels (HSS) iv. Stainless Steels: Types and Applications v. Spring Steels: Composition and Applications. vi. Specifications of steels and their equivalents. 2.2 Steels for following components: Shafts, axles, Nuts, bolts, Levers, crank shafts, camshafts, Shear blades, agricultural equipment, household utensils, machine tool beds, car bodies, Antifriction bearings and Gears. 2.3 Types of cast irons as white. Gray, nodular, malleable 2.4 Specifications of cast iron. 2.5 Selection of appropriate cast iron for engineering applications. 2.6 Designation and coding (as per BIS, ASME, EN, DIN, TIS) of cast iron, plain and alloy steel. 2.7 Use of iron and steel in ancient India; Munda, Tikshna and Kanta types of iron and steels (IKS)	Lecture Using Chalk-Board Model Demonstration Presentations
3	TLO 3.1 Describe the properties and applications of the given copper alloy & aluminium alloy. TLO 3.2 Describe the properties and applications of the given bearing material TLO 3.3 Select relevant non-ferrous material for the specified application with justification. TLO 3.4 Explain various powder manufacturing processes.	Unit - III Non Ferrous Materials & Powder Metallurgy 3.1 Copper and its alloys - brasses, bronzes Chemical compositions, properties and Applications. 3.2 Use of copper in ancient India and its mention in Rigveda (IKS) 3.3 Aluminum alloys -Y-alloy, Hindalium, duralium with their composition and Applications. 3.4 Bearing materials like white metals (Sn based), aluminum, bronzes. Porous, Self-lubricating bearings. 3.5 Powder Metallurgy: Introduction, Advantages, limitations and applications. Preparation of Metal Powders, Basic Steps for Powder Metallurgy.	Model Demonstration Lecture Using Chalk-Board Presentations

MECHANICAL ENGINEERING MATERIALS**Course Code : 313317**

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 Distinguish between metallic and non-metallic materials on the basis of given composition, properties and applications. TLO 4.2 Choose relevant non-metallic material for the given job with justification. TLO 4.3 Select relevant composite material for the given job with justification. TLO 4.4 Suggest relevant alternative materials for the given job with justification.	Unit - IV Non Metallic Materials & Advanced Materials 4.1 Polymeric Materials i. Polymers:- types, characteristics, ii. Properties and uses of Thermoplastics, Thermosetting Plastics and Rubbers. iii. Thermoplastic and Thermosetting Plastic materials 4.2 Characteristics and uses of ABS, Acrylics. Nylons and Vinyls, Epoxides, Melamines and Bakelites 4.3 Rubbers: Neoprene, Butadiene, Buna and Silicons - Properties and applications. 4.4 Ceramics -types of ceramics, properties and applications of glasses and refractories 4.5 Composite Materials - properties and applications of Laminated and Fiber reinforced materials 4.6 Advanced Engineering Materials: Properties and applications of Nanomaterials and smart materials & Biomedical materials.	Lecture Using Chalk-Board Presentations Demonstration
5	TLO 5.1 Describe with sketches the specified heat treatment processes. TLO 5.2 Select the relevant heat treatment processes for given material with justification. TLO 5.3 Explain with sketches the working principle of the given heat treatment furnace. TLO 5.4 Suggest the relevant heat treatment process for the given situation with justification.	Unit - V Heat Treatment processes 5.1 Overview of heat treatment. 5.2 Annealing: Purposes of annealing, Annealing temperature range, Types and applications. 5.3 Normalizing: Purposes of Normalizing, temperature range. Broad applications of Normalizing. 5.4 Hardening: Purposes of hardening, Hardening temperature range, applications 5.5 Tempering: Purpose of tempering Types of tempering and its applications 5.6 Case hardening methods like Carburizing, Nitriding, and Cyaniding. 5.7 Heat treatment Furnaces - Muffle, Box type.	Lecture Using Chalk-Board Video Demonstrations Site/Industry Visit 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 slitting machine to prepare sample of given dimension. LLO 1.2 Use grinding machine & polishing papers to prepare surface of given sample.	1	*Specimen preparation of a given material for microscopic examination.	2	CO1

MECHANICAL ENGINEERING MATERIALS**Course Code : 313317**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 2.1 Use suitable etchant for microscopic examination of given sample. LLO 2.2 Use a metallurgical microscope to observe micro structure of given specimen. LLO 2.3 Interpret the micro structure of given specimen.	2	*Interpretation of microstructure of steels and alloy steels using metallurgical microscope on standard specimens.	2	CO1
LLO 3.1 Use Brinell Hardness tester LLO 3.2 Determine hardness of given sample.	3	*Hardness testing on Brinell Hardness tester of given sample material.	2	CO1
LLO 4.1 Use a Rockwell Hardness tester. LLO 4.2 Determine hardness of given sample.	4	Hardness testing on Rockwell Hardness tester of given sample material.	2	CO1
LLO 5.1 Choose appropriate hardness tester for mild steel. LLO 5.2 Use an appropriate hardness tester for mild steel.	5	Hardness testing on relevant hardness testers of given untreated and heat treated Mild Steels.	2	CO1
LLO 6.1 Choose appropriate hardness tester for alloy steel. LLO 6.2 Use an appropriate hardness tester for alloy steel.	6	Hardness testing on relevant hardness testers of given untreated and heat treated Alloy Steels.	2	CO1
LLO 7.1 Use a metallurgical microscope LLO 7.2 Interpret the microstructure of Cast Iron.	7	*Microstructure of cast iron using metallurgical microscope on standard specimens.	2	CO1 CO2
LLO 8.1 Choose appropriate hardness testers for copper & Brass. LLO 8.2 Use appropriate hardness testers for copper & Brass.	8	Hardness testing on relevant hardness testers of given Copper and Brass specimens.	2	CO1 CO3
LLO 9.1 Choose the appropriate hardness tester for Aluminium. LLO 9.2 Use an appropriate hardness tester for aluminum.	9	Hardness testing on relevant hardness testers of given Aluminium specimens.	2	CO1 CO3
LLO 10.1 Use an appropriate peel tester LLO 10.2 Determine the adhesive strength of cellophane tape and duct tape.	10	*Adhesive strength determination of cellophane tape and duct tape using a relevant peel tester.	2	CO3
LLO 11.1 Use an appropriate peel tester LLO 11.2 Determine the adhesive strength of scotch tape, electrical tape.	11	Adhesive strength determination of scotch tape, electrical tape and masking tape using relevant peel testers.	2	CO3

MECHANICAL ENGINEERING MATERIALS**Course Code : 313317**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 12.1 Perform flame tests. LLO 12.2 Identify different types of plastics. Identification of different types of plastics using flame tests.	12	*Identification of different types of plastics using flame tests.	2	CO3
LLO 13.1 Use a High-temperature oven or electrical current LLO 13.2 Identify behavior of the shape-memory alloy .	13	*Identification of behavior of the shape-memory alloy as a function with regards to temperature using High-temperature oven or electrical current.	2	CO4
LLO 14.1 Use a muffle /box type furnace LLO 14.2 Use various quenching mediums for mild steel. LLO 14.3 Compare the hardness of mild steel.	14	*Comparison of hardness of mild steel using quenching mediums like oil ,water & brine in a muffle /box type furnace .	2	CO1 CO5
LLO 15.1 Use a muffle /box type furnace LLO 15.2 Use various quenching mediums for alloy steel. LLO 15.3 Compare the hardness of alloy steel.	15	Comparison of hardness of alloy steel using quenching mediums like oil ,water & brine in a muffle /box type furnace .	2	CO1 CO5
LLO 16.1 List various ancient Indian material development processes. LLO 16.2 Compare Ancient Indian material development processes with recent processes.	16	Comparison of Ancient Indian material development processes with recent processes.	2	CO1 CO2 CO3 CO4 CO5
Note : Out of above suggestive LLOs - • '*' Marked Practicals (LLOs) Are mandatory. • Minimum 80% of above list of lab experiment are to be performed. • Judicial mix of LLOs are to be performed to achieve desired outcomes.				

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

Micro project

- Collect information related to Types, Properties and applications of smart materials from websites. Present the information in the form of a Chart.
- Collect samples of various types of plastics, ceramics, composites used in day-to-day applications and prepare charts containing properties, applications of the samples.
- Comparative study of various materials used in previous and current generation components of mechanical engineering equipment like IC Engine, Compressor, turbine, pumps, refrigerator, water cooler, Lathe Machine, Milling Machine, Drilling Machine grinding machine (any one) with proper justifications.
- Preparation of a chart of comparison of hardness of various materials.
- Prepare models showing various crystal structures.
- Prepare a puzzle game on Iron-carbon Equilibrium diagram.
- Determine the microstructure of different metallic components (minimum 5) using metallurgical Microscope and compare their microstructure in the given group.

MECHANICAL ENGINEERING MATERIALS**Course Code : 313317****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 judicious 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	Slitting machine Specifications: • Capacity: 18 gauge / 1.2mm • Throat Depth: 24 inch (600mm) • Motor: 1 Hp, 230V, 50 Hz. • Minimum Slitting Width: 1 inch (25.4mm)	1
2	Double Disk polishing machine. Two independent polishing units mounted on a common MS frame, Disc dia 200mm, made of Aluminum. Speed continuously variable upto 950 RPM. Rating - 0.25 HP single phase 220 Volt A.C. provided with sink and swing type laboratory water tap. Waterproof Formica table top.	1
3	Digital Brinell hardness Tester 1) Test loads - 500 to 3000 Kgf. in steps of 250 Kg. 2) Magnification of objective - 14 X 3) Maximum test height - 380 mm. 4) Least count - 0.001 mm. 5) Throat depth - 200 mm.	1,3,5,6,8,9,14,15
4	Digital Rockwell hardness Tester 1) Test loads - 60, 100 & 150 kgf 2) Minor load - 10 kg 3) Max test height - 230 mm 4) Throat depth - 133 mm along with essential accessories.	1,4,5,6,8,9,14,15
5	Digital Peel Strength Tester: Make: XEEPL • Load capacity: 0 - 5 kg; Resolution: 1 gram. • Load Indicator: Microprocessor based digital load indicator with memory facility of peak load. • Clear Distance between two plates: Maximum up to 250 mm. • Speed of testing: 300 mm/minute. • Motor: Synchronous Motor. • Grips: A pair of hard chrome plated grips for thin poly film samples would be supplied. • Paint: Powder coated. • Power requirement: Single phase 230 Volts, 50Hz.	10,11
6	Spring coil of Shape memory sample (NiTi alloy) Burner/ Lighter , Sample Holder	12,13
7	Laboratory box furnace Light weight with ceramic fiber wool insulation. Exterior made of G.I. sheets powder coated. Temperature Controlled by Microprocessor based Auto tune PID digital temperature controller with CR/AL Thermocouple. Temperature Range: 1100°C., Muffle Size (inside): Temperature Range: 1100°C., Muffle Size (inside): 6"x6"x12", Power: 3.5 KW	14,15
8	Standard Samples of Metallurgical Microstructure Plain carbon steels, alloy steels and cast iron (before and after heat treatment) : 03 Each • Aluminum, Copper and Brass/Bronze (before and after heat-treatment): 03 Each Total 36 Specimens	2
9	Trinocular Upright Metallurgical Microscope: Coaxial Body • Body: Trinocular Head inclined at 45-degrees. • Focusing: Both side co-axial focusing knobs. • Nosepiece: Quadruple revolving nosepiece with accurate centering & amp; positive click stops. Trinocular Inverted Metallurgical Microscope (Magnification 100X, 200X, 400X & 800X) Eyepieces - WF 10X, 20X (Paired) Objectives - M 5x, M 10x, M 20x and M 40x (SL) Stage - Built-in graduated mechanical stage of size 165mm.x180mm. is controlled by convenient low coaxial positioned knobs for easy and smooth scanning of specimen.	2,7

MECHANICAL ENGINEERING MATERIALS**Course Code : 313317****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 Engineering Materials	CO1	10	4	4	6	14
2	II	Steel & Cast Iron	CO2	12	4	6	6	16
3	III	Non Ferrous Materials & Powder Metallurgy	CO3	10	4	4	6	14
4	IV	Non Metallic Materials & Advanced Materials	CO4	8	4	4	6	14
5	V	Heat Treatment processes	CO5	5	2	4	6	12
Grand Total				45	18	22	30	70

X. ASSESSMENT METHODOLOGIES/TOOLS**Formative assessment (Assessment for Learning)**

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

Summative Assessment (Assessment of 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	1	-	1	-	1	1			
CO2	3	1	-	1	-	1	1			
CO3	3	1	-	1	-	1	1			
CO4	3	1	-	1	-	1	1			
CO5	3	1	-	1	-	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
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MECHANICAL ENGINEERING MATERIALS**Course Code : 313317**

Sr.No	Author	Title	Publisher with ISBN Number
1	Dieter, G.D	Mechanical Metallurgy	McGraw Hill Edu. New Delhi, 2017, ISBN. 978-1259064791
2	Avner, S.H	Introduction to Physical Metallurgy	McGraw Hill Edu. New Delhi, 2017, ISBN. 978-0074630068
3	Rajput, R.K S.	Engineering Materials And Metallurgy	Chand and Company New Delhi, 2006, ISBN 978-8121927093
4	Balasubramaniam R	Callister's Materials Science and Engineering	Wiley, New Delhi, 2014, ISBN 978-8131518052
5	Parashivamurthy, K. I.	Material Science and Metallurgy	Pearson Education India, 2012, ISBN. 978-8131761625
6	Fulay, P.P., Askeland D.R	Essentials of Materials Science and Engineering	Cengage India Private Limited, 2012, ISBN 978-8131520703
7	Kodgire, V.D., Kodgire. S.V	Material Science and Metallurgy for Engineers	Everest Publishing House, 2017, ISBN. 978-8176314008

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=jn9cP6JJ7xA	Iron - Carbon diagram
2	https://www.youtube.com/watch?v=skQRLfU3plM	Heat Treatment Processes
3	https://www.youtube.com/watch?v=E6oCdckcwYQ&list=PLyqSpQzTE6M_ON8uXt-PP8uX6hMWJeYSJ&index=3	Crystal structure
4	https://www.youtube.com/watch?v=c1ZbiBIY6Sc&list=PLxQzQgOy_JvYd32Y6XOWFOnVc4_Dkv7v6&index=38	Ceramics
5	https://www.youtube.com/watch?v=04K0bLwCDdM	Composite materials
6	https://vedicheritage.gov.in/vedic-heritage-in-present-context/metallurgy/	IKS
7	https://www.youtube.com/watch?v=_eM49JlmFp0	Powder Metallurgy

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. 02/07/2024**Semester - 3 / 4, K Scheme**

ANALOG AND DIGITAL ELECTRONICS**Course Code : 313318****Programme Name/s : Mechatronics****Programme Code : MK****Semester : Third****Course Title : ANALOG AND DIGITAL ELECTRONICS****Course Code : 313318****I. RATIONALE**

This course aims to develop skills to test electronic circuits, that is vital for a diploma holder in mechatronics while working in an industry. After studying this course, it is expected that student will develop an insight to identify, build and troubleshoot analog and digital electronic circuits at a wider scale in mechatronics based systems.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry identified outcome through various teaching learning experiences: • Test different electronic circuits for relevant system.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Build different electronic circuits using basic components and diodes.
- CO2 - Interpret working of transistor in electronic circuits.
- CO3 - Use logic gates and Boolean Logic for building digital circuits.
- CO4 - Use combinational and sequential logic circuits for different applications.
- CO5 - Use data converters in electronic 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	Min	Max	Min	Max	Min	Max	Min	
											Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	
313318	ANALOG AND DIGITAL ELECTRONICS	ADE	DSC	4	-	4	-	8	4	3	30	70	100	40	25	10	25#	10	-	-	150

ANALOG AND DIGITAL ELECTRONICS**Course Code : 313318****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 Draw symbols of different semiconductor diodes. TLO 1.2 Explain V-I characteristic of PN junction diode. TLO 1.3 Explain characteristics of zener diode. TLO 1.4 Compare PN junction diode with zener diode. TLO 1.5 Describe working of rectifiers. TLO 1.6 Compare different parameters of rectifiers. TLO 1.7 Illustrate the working principle of filters. TLO 1.8 Explain zener diode as voltage regulator. TLO 1.9 Draw block diagram of DC regulated power supply. TLO 1.10 Build positive/negative power supply using IC 7805/7905.	Unit - I Semiconductor Diodes and Applications 1.1 Symbol, construction and working principle of PN junction diode, zener diode, light emitting diode (LED), photo diode 1.2 Forward and reverse bias. VI characteristics of PN junction diode and zener diode 1.3 Types of rectifiers: Half wave, full wave, bridge rectifier, working principle, circuit diagram, Input and Output voltage waveform 1.4 Performance parameters of rectifier: PIV, ripple factor and efficiency 1.5 Need for filters: circuit diagram and working of L, C, and CLC filter 1.6 Zener diode working as voltage regulator 1.7 Working principle, block diagram of regulated power supply, IC 78XX and IC 79XX, complete DC power supply circuit	Lecture Using Chalk-Board Presentations Demonstration

ANALOG AND DIGITAL ELECTRONICS**Course Code : 313318**

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 Classify unipolar and bipolar devices. TLO 2.2 Describe working of transistor. TLO 2.3 Explain output characteristics of transistor. TLO 2.4 Determine the current gain of transistor. TLO 2.5 Explain working of transistor as switch TLO 2.6 Explain transistor as an amplifier. TLO 2.7 Draw the symbol of N channel JFET and P channel JFET. TLO 2.8 Explain working principle of N channel JFET.	Unit - II Bipolar Junction Transistor and Applications 2.1 Unipolar and bipolar devices 2.2 Types, symbol of BJT, construction and working principle of NPN transistor 2.3 Configurations of transistor CE, CB and CC 2.4 Transistor parameters: alpha beta, input and output resistance, relation between alpha and beta 2.5 Input and output characteristics of CE configuration, saturation active and cut off regions in output characteristics 2.6 Transistor as a switch 2.7 Single stage RC coupled amplifier, circuit diagram function of each component 2.8 JFET symbol, types, construction and working principle	Lecture Using Chalk-Board Presentations Demonstration
3	TLO 3.1 Convert the given number into specified number system. TLO 3.2 Perform binary addition and multiplication. TLO 3.3 Perform subtraction using one's and two's compliment. TLO 3.4 Perform addition of decimal numbers using BCD code. TLO 3.5 Sketch symbols and truth tables of different logic gates. TLO 3.6 State different Boolean Laws. TLO 3.7 Prove De-Morgan's theorems.	Unit - III Number Systems and Logic Gates 3.1 Number system: base or radix of number system, binary, octal, decimal and hexadecimal number system 3.2 Binary addition and multiplication 3.3 Subtraction using 1's compliment and 2's compliment 3.4 Logic gates: Symbol, logic expression and Truth table of basic gates (AND, OR, NOT), universal gates (NAND and NOR) and derived gates (EX-OR, EX-NOR) 3.5 Boolean algebra: Laws of Boolean algebra, De-Morgan's theorems	Lecture Using Chalk-Board Presentations Demonstration

ANALOG AND DIGITAL ELECTRONICS**Course Code : 313318**

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 Implement adder/subtractor using logic gates. TLO 4.2 Explain working of multiplexer and demultiplexer using truth table. TLO 4.3 Draw the symbol and truth table of buffer. TLO 4.4 Draw RS Latch using NAND and NOR gate. TLO 4.5 Explain working of different flip-flops. TLO 4.6 Explain working of counter. TLO 4.7 Explain working of shift register.	Unit - IV Combinational and Sequential Circuits 4.1 Arithmetic circuits: Half and full Adder, half and full subtractor 4.2 Multiplexers and demultiplexers: block diagram working, truth table and applications of multiplexers and demultiplexers 4.3 Buffer: Tristate logic, symbol, truth table, unidirectional and bidirectional buffer 4.4 Basic memory cell: RS Latch using NAND and NOR gate 4.5 Block schematic and truth table of SR, JK, T, and D Flip Flop 4.6 Counters: Synchronous and asynchronous 3-bit 4.7 Shift registers: Types, SISO- right and left shift registers	Lecture Using Chalk-Board Presentations Demonstration
5	TLO 5.1 Classify data converters. TLO 5.2 Explain working principle of ADC/DAC. TLO 5.3 Draw pin diagram of ICs 0808/0809. TLO 5.4 Write broad specifications of ICs 0808/0809.	Unit - V Data Convertors 5.1 Data converters: Types, working of weighted resistor and R-2R ladder circuit 5.2 DAC IC 0808 5.3 ADC: Block diagram, types and working of dual slope ADC, SAR ADC 5.4 ADC IC 0809	Lecture Using Chalk-Board Presentations Demonstration

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 type of given diode. LLO 1.2 Identify terminals of given diode.	1	Identification of various types of diodes	2	CO1
LLO 2.1 Measure forward resistance of PN junction. LLO 2.2 Test the functionality of PN junction diode.	2	Testing of PN junction diode using multimeter	2	CO1
LLO 3.1 Connect the circuit to plot VI characteristics of PN junction diode. LLO 3.2 Plot the VI characteristics of PN junction diode.	3	*Determination of VI characteristics of given PN junction diode	2	CO1
LLO 4.1 Connect the circuit to plot VI characteristics of zener diode. LLO 4.2 Plot the VI characteristics of zener diode.	4	*Determination of VI characteristics of given zener diode	2	CO1
LLO 5.1 Develop the circuit of a half wave rectifier. LLO 5.2 Observe input-output waveforms and measure voltages.	5	Construction of half wave rectifier for observing input-output waveforms	2	CO1

ANALOG AND DIGITAL ELECTRONICS**Course Code : 313318**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 6.1 Develop the circuit of a bridge type full wave rectifier. LLO 6.2 Observe input-output waveforms and measure voltages.	6	*Construction of bridge type full wave rectifier for observing input-output waveforms	2	CO1
LLO 7.1 Make circuit connections to determine the performance of zener diode as voltage regulator. LLO 7.2 Measure output voltage for change in input voltage and load current.	7	*Testing performance of given zener diode as voltage regulator	2	CO1
LLO 8.1 Make connection as per circuit diagram and measure output voltage for voltage regulator IC 7805. LLO 8.2 Make connection as per circuit diagram and measure output voltage for voltage regulator IC 7905.	8	Testing performance of regulated power supply IC 7805 and IC 7905	2	CO1
LLO 9.1 Identify terminals of NPN transistor. LLO 9.2 Identify terminals of PNP transistor.	9	Identification of NPN and PNP transistor using multimeter	2	CO2
LLO 10.1 Make circuit connections to plot input/output characteristics of transistor in CE mode. LLO 10.2 Measure voltages and current to plot input/output characteristics of transistor.	10	*Part I: Determination of input characteristics of NPN transistor in CE mode *Part II: Determination of output characteristics of NPN transistor in CE mode	4	CO2
LLO 11.1 Make connections as per circuit diagram to determine the performance of transistor as a switch. LLO 11.2 Verify transistor as ON and OFF switch.	11	*Testing performance of transistor as a switch	2	CO2
LLO 12.1 Make connections as per circuit diagram to determine the gain and bandwidth of single stage RC coupled amplifier. LLO 12.2 Calculate gain and bandwidth of transistor.	12	*Determination of gain and bandwidth of single stage RC coupled amplifier	2	CO2
LLO 13.1 Test functionality of different ICs using digital IC tester.	13	Testing of different digital IC's using IC tester	2	CO3
LLO 14.1 Make circuit connections to verify truth table of AND, OR, NOT, NAND and NOR logic gates. LLO 14.2 Verify truth table of logic gates and measure the output voltage using multimeter for logic 0 and 1.	14	*Verification of truth table of AND, OR, NOT, NAND and NOR gates	2	CO3

ANALOG AND DIGITAL ELECTRONICS**Course Code : 313318**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 15.1 Verify the truth table of EX-OR and EX-NOR gates. LLO 15.2 Measure the output voltage using multimeter for logic 0 and 1.	15	Verification of truth table of EX-OR and EX-NOR gates	2	CO3
LLO 16.1 Make connection to implement basic logic gates using NAND gate. LLO 16.2 Verify truth table of basic logic gates.	16	*Implementation of basic logic gates using NAND gate	2	CO3
LLO 17.1 Verify De-Morgan's theorem.	17	Verification of De-Morgan's theorem using logic gates	2	CO3
LLO 18.1 Make connections to develop half adder and half subtractor using logic gates. LLO 18.2 Verify truth table of Half Adder and half subtractor.	18	Implementation of half adder and half subtractor using logic gates	2	CO4
LLO 19.1 Construct full adder circuit. LLO 19.2 Verify truth table of full adder.	19	*Implementation of full adder using logic gates	2	CO4
LLO 20.1 Construct full subtractor circuit. LLO 20.2 Verify truth table of Full subtractor.	20	Implementation of full subtractor using logic gates	2	CO4
LLO 21.1 Identify the pins of IC 74151 and make connections as per circuit diagram. LLO 21.2 Verify the truth table of Multiplexer IC 74151.	21	*Implementation of 8:1 multiplexer using IC 74151	2	CO4
LLO 22.1 Identify the pins of IC 74155/74154 and make connections as per circuit diagram. LLO 22.2 Verify the truth table of demultiplexer IC 74155/74154.	22	Verification of truth table of 1:8 demultiplexer using IC 74155/74154	2	CO4
LLO 23.1 Construct RS flip flop using NAND gate. LLO 23.2 Verify its truth table.	23	Implementation of RS flip flop using NAND gates	2	CO4
LLO 24.1 Verify truth table of D and T flip flop.	24	*Implementation of D and T flip flop using JK flip flop IC 7476	2	CO4
LLO 25.1 Test functionality of IC 7476 and make connections as per circuit diagram. LLO 25.2 Verify truth table of 3 bit counter.	25	*Implementation of 3 bit ripple/asynchronous counter using IC 7476/7473	2	CO4
LLO 26.1 Test functionality of IC 7474 and construct circuit diagram. LLO 26.2 Verify Serial in serial out right/left shift operation .	26	Testing of 4 bit SISO shift register using IC 7474	2	CO4
LLO 27.1 Make connections of DAC circuit using R-2R resistive network. LLO 27.2 Measure analog voltage for corresponding digital input.	27	*Testing performance of R-2R resistive network for converting digital data input into analog output	2	CO5

ANALOG AND DIGITAL ELECTRONICS**Course Code : 313318**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 28.1 Make connections of DAC circuit using weighted resistor network. LLO 28.2 Measure analog voltage for corresponding digital input.	28	Testing of performance of weighted resistor network for converting digital data input into analog output	2	CO5
LLO 29.1 Measure digital output for applied analog input voltage.	29	*Verification of operational features of ADC- IC 0809	2	CO5
LLO 30.1 Measure analog output voltage for corresponding digital input.	30	Verification of operational features of DAC- IC 0808	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	Ammeter (0-25 mA), Voltmeter (0-5V, 0-10V DC)	1,2,3,4,5,6,7,8,9,10,11,12
2	Digital Multimeter: 3 1/2 Digit Display with R, V and I measurement and Diode, Transistor testing facility	1,2,3,4,5,6,7,8,9,10,11,12
3	Function Generator with TTL output: 20MHz	12
4	DC Regulated Fixed Power Supply: 5V Short Circuit protection display for voltage and current	13,14,15,16,17,18,19,20,21,22,23,24,25,26
5	Digital and Analog IC tester: To test wide range of ICs such as 74 series	13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30
6	Trainer kits for digital ICs: Trainer kit shall consist of Digital IC's for logic gates, Flip-Flops, Shift Registers, counter along with toggle switches for inputs and bi-color LED at outputs and built in power supply	14,15,16,17,18,19,20,21,22,23,24,25,26
7	Dual Power Supply: +/- 15V	27,28,29,30
8	DC Regulated Power Supply: Variable DC Voltage 0-30V, 2A. Short Circuit protection display for voltage and current	3,4,7,8,9,10,11
9	Cathode ray Oscilloscope (CRO): 0-20 MHz Dual Trace, Dual Beam with Component Tester	5,6,12
10	Trainer kits/bread board, Logic IC's (7400, 7402, 7404, 7408, 7432, 7486, 74266, 7474, 7476, 74151, 741, 74155, 7805. 790 5) Electronic components (Rectifier Diode, LED, Zener Diode, Transistor, Resistors, Capacitors) for performing Practicals	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification**MSBTE Approval Dt. 02/07/2024****Semester - 3, K Scheme**

ANALOG AND DIGITAL ELECTRONICS**Course Code : 313318****Table)**

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Semiconductor Diodes and Applications	CO1	14	4	4	8	16
2	II	Bipolar Junction Transistor and Applications	CO2	14	2	6	8	16
3	III	Number Systems and Logic Gates	CO3	12	4	4	4	12
4	IV	Combinational and Sequential Circuits	CO4	14	2	6	8	16
5	V	Data Convertors	CO5	6	2	4	4	10
Grand Total				60	14	24	32	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.

Each practical will be assessed considering appropriate % weightage to process and product and other instructions of assessment.

Summative Assessment (Assessment of Learning)

- End semester assessment of 25 marks for laboratory learning.

End semester assessment of 70 marks through offline mode of examination.

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

ANALOG AND DIGITAL ELECTRONICS**Course Code : 313318**

Sr.No	Author	Title	Publisher with ISBN Number
1	Sedha R. S	A text book of Applied Electronics	S. Chand, New Delhi, 2013, ISBN: 9788121928038
2	Mehta, V. K. , Mehta Rohit	Principles of Electronics	S. Chand, New Delhi, 2014, ISBN: 9788121924504
3	Bell, Devid	Fundamentals of Electronics Devices and Circuits	Oxford University Press, International edition, USA, 2015, ISBN: 9780195425239
4	B.L.Thereja	Basic Electronics Solid State	S. Chand New Delhi, ISBN: 9788121925556
5	Jain, R. P.	Modern Digital Electronics	McGraw-Hill Publishing, New Delhi. 2011, ISBN:978007066 9116
6	Maini, Anil K.	Digital Electronics Principles and Integrated Circuits	Wiley India, Delhi, 2016, ISBN: 9788126514663
7	Leach, D. P. Malvino A. P., Saha G.	Digital Principles and Applications	McGraw-Hill Publishing, New Delhi.2014, ISBN: 9789339203405
8	Charles H.Roth Jr Larry L. Kinney Raghunandan G.H.	Analog Digital Electronics	Cenege Learning India Pvt.Ltd., ISBN: 9789353502355

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.tutorialspoint.com/basic_electronics/index.htm	Basic Electronics Components
2	https://www.tutorialspoint.com/digital_circuits/index.htm	Digital circuits
3	https://www.iitg.ac.in/cseweb/vlab/Digital-System-Lab/experiments.php	Digital electronics experiments
4	https://www.electronicshub.org/semiconductor-diodes	semiconductor-diodes
5	https://archive.nptel.ac.in/courses/108/105/108105132/	Digital electronics circuits
6	https://www.electronicshub.org/types-of-adc-circuit/	Analog to digital converter
7	https://www.circuitstoday.com/digital-to-analog-converters-d-a	Digital to analog converters
8	https://www.geeksforgeeks.org/shift-registers-in-digital-logic/	Shift registers

Note :

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

INDUSTRIAL MEASUREMENTS**Course Code : 313319**

Programme Name/s : Mechatronics
Programme Code : MK
Semester : Third
Course Title : INDUSTRIAL MEASUREMENTS
Course Code : 313319

I. RATIONALE

Industrial measurement systems are crucial in monitoring and control applications. This course helps to measure industrial process parameters in given situation using suitable sensor or/and transducer.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Select suitable measuring instrument for required measurement process by knowing their working principle.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Apply various performance characteristics of measuring instruments.
- CO2 - Select relevant mechanical transducers for measuring required parameters.
- CO3 - Choose suitable transducers for measuring pressure and temperature.
- CO4 - Select relevant transducers for level and flow measurement.
- CO5 - Use suitable signal conditioning and data acquisition system.

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	
				CL	TL	LL									Practical							
											FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA			
													Max	Max	Max	Min	Max	Min	Max	Min		Max
313319	INDUSTRIAL MEASUREMENTS	IME	DSC	4	-	2	2	8	4	3	30	70	100	40	25	10	25#	10	25	10	175	

INDUSTRIAL MEASUREMENTS**Course Code : 313319****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 block diagram of an instrumentation system. TLO 1.2 Describe performance characteristics of measuring instruments. TLO 1.3 Classify types of error in measurement. TLO 1.4 Define the term Sensor and transducer. TLO 1.5 Select relevant sensor and transducer for a given application.	Unit - I Introduction to measurement system 1.1 Introduction to measurement system-Definition of measurement, Significance of measurement, block diagram of instrumentation system, Standard and calibration. 1.2 Instrument and its performance characteristics- Static characteristics: - Accuracy, Precision, Range, Span, Error, Linearity, Hysteresis, Reproducibility, Repeatability, Dead zone, Span, Range, Threshold. Dynamic Characteristics: - Speed of response, lag, Fidelity, Dynamic error. 1.3 Types of Error- Gross, Systematic and random errors. 1.4 Primary elements of measurement system – Sensors: Working principle and applications of proximity and optical sensor. Transducer -Need and classification a. Mechanical and Electrical b. Active and Passive c. Primary and secondary d. Analog and Digital. 1.5 Selection Criteria of transducer.	Lecture Using Chalk-Board Video Demonstrations Presentations

INDUSTRIAL MEASUREMENTS**Course Code : 313319**

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 construction and working principle of displacement. TLO 2.2 Describe the working principle of different strain measuring transducer. TLO 2.3 Explain construction and working of force measuring transducer with their applications. TLO 2.4 Explain working of dynamometers and torque measuring devices.	Unit - II Displacement, strain, force and torque measurement 2.1 Displacement Measurement- Working principle and construction of resistive transducer-potentiometer, Inductive transducer-LVDT, RVDT. Capacitive transducer. 2.2 Strain Measurement - Strain gauge types, construction and working principle of strain gauge transducer (Bonded and Unbonded). 2.3 Force measurement – Force transducer types, construction and working principle of strain gauge load cell and piezoelectric load cell. 2.4 Torque measurement construction and working principle of inline rotating torque sensor, inline stationary torque sensor, proximity torque sensor and eddy current dynamometer.	Model Demonstration Video Demonstrations Lecture Using Chalk-Board Hands-on
3	TLO 3.1 Define absolute and atmospheric pressure. TLO 3.2 Classify different types of pressure measuring devices. TLO 3.3 Explain construction and working principle of different pressure measuring transducers. TLO 3.4 Classify different types of temperature measuring devices. TLO 3.5 Explain construction and working principle of different temperature measuring transducers. TLO 3.6 Differentiate between optical and radiation pyrometers. TLO 3.7 State applications of pressure and temperature measuring transducers.	Unit - III Pressure and temperature measurement 3.1 Pressure: Definition, units, Types - absolute, Gauge, atmospheric and Vacuum pressure. 3.2 Classifications of pressure measuring devices. 3.3 Elastic pressure transducers- Bourdon tube, Bellow, Diaphragm, Capsule. 3.4 Electrical pressure transducer- -Bourdon tube with LVDT -Piezoelectric Pressure Transducer -Photoelectric pressure transducer. 3.5 Vacuum pressure Measurement -McLeod gauge, Pirani gauge. 3.6 Temperature: units , temperature scales. 3.7 Classifications of temperature measuring transducers. 3.8 Electrical methods -Thermistor - RTD - Thermocouple. 3.9 Pyrometer: Optical and Radiation pyrometers.	Model Demonstration Video Demonstrations Lecture Using Chalk-Board Hands-on

INDUSTRIAL MEASUREMENTS**Course Code : 313319**

Sr.No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Define types of flow. TLO 4.2 List various types of flow measuring devices. TLO 4.3 Explain construction and working principle of different flow measuring transducers. TLO 4.4 Classify different types of level measuring devices. TLO 4.5 Explain construction and working principle of different level measuring transducers. TLO 4.6 Compare direct and indirect methods of level measurement.	Unit - IV Flow and Level measurement 4.1 Flow: Definition, units, Types - laminar, turbulent Reynolds number. 4.2 Classifications of flow measuring transducers a. Variable head flowmeter - Venturi meter - Orifice plate meters b. Variable area flowmeter - Rotameter c. Electrical flow meter - Turbine flow meter -Electromagnetic flow meter - Ultrasonic flow meter (Time difference and Doppler type) -Hot wire anemometer d. Vortex flowmeter- Swirl meter. 4.3 Level, its units, classification of level measuring methods. 4.4 Direct methods -Sight glass - Float type with linear and rotary potentiometer. 4.5 Indirect measurement methods - Capacitive type - Ultrasonic type -Nuclear radiation type - optical level detectors.	Lecture Using Chalk-Board Model Demonstration Video Demonstrations Hands-on
5	TLO 5.1 Classify speed measuring devices. TLO 5.2 Explain working principle of speed measuring transducers with application. TLO 5.3 Explain construction and working principle sound measuring transducer. TLO 5.4 Explain working principle of humidity measuring transducer with application.	Unit - V Speed, sound and humidity measurement 5.1 Speed measurement- Classification of speed transducers Mechanical Tachometer-Revolution Counter. Electrical tachometer-Eddy current tachometer, Tachogenerators (AC and DC). Magnetic Pick-up, Stroboscope. 5.2 Sound measurement- Sound Characteristics, Microphone and its types. 5.3 Construction, working and applications of- -Carbon microphone -Dynamic microphone. 5.4 Humidity measurement Hair hygrometer, Resistive hygrometer and capacitive hygrometer.	Lecture Using Chalk-Board Video Demonstrations Model Demonstration Hands-on
6	TLO 6.1 State the need of signal conditioning system. TLO 6.2 Describe block diagram of signal conditioning circuit. TLO 6.3 Describe block diagram of data acquisition system. TLO 6.4 State the need of non-Linear signal conditioning system.	Unit - VI Signal conditioning system 6.1 Basic signal conditioning-Definition. Need and function. 6.2 Linear signal conditioning-Adder, Subtractor, Instrumentation amplifier. 6.3 Non-Linear signal conditioning- Amplitude modulation- Demodulation, Filtering. 6.4 Data acquisition system-Introduction, Block diagram of DAS.	Video Demonstrations Lecture Using Chalk-Board Site/Industry Visit Hands-on

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

INDUSTRIAL MEASUREMENTS**Course Code : 313319**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify types of error in measurement. LLO 1.2 Apply procedure to find error in measurement.	1	Error measurement in a given instrument.	2	CO1
LLO 2.1 Prepare experimental set-up for displacement measurement. LLO 2.2 Use LVDT to measure displacement. LLO 2.3 Draw LVDT input-output characteristics.	2	*Linear displacement measurement using LVDT.	2	CO1 CO2
LLO 3.1 Prepare experimental set-up for weight measurement. LLO 3.2 Use strain gauge load cell to measure weight. LLO 3.3 Draw strain gauge load cell input-output characteristics.	3	*Weight measurement using strain gauge load cell.	2	CO1 CO2
LLO 4.1 Measure pressure using bourdon tube pressure gauge.. LLO 4.2 Draw input-output characteristics of bourdon tube pressure gauge.	4	*Pressure measurement using bourdon tube.	2	CO1 CO3
LLO 5.1 Measure temperature using RTD. LLO 5.2 Draw RTD input-output characteristics.	5	Temperature measurement using RTD.	2	CO1 CO3
LLO 6.1 Identify steps to calibrate RTD. LLO 6.2 Use NIST data values as standard and calibrate RTD.	6	*Calibration of RTD temperature measuring instruments (Prefer NIST data table as standard).	2	CO1 CO3
LLO 7.1 Use thermocouple to measure temperature. LLO 7.2 Draw thermocouple input-output characteristics.	7	*Temperature measurement using thermocouple.	2	CO1 CO3
LLO 8.1 Identify steps to calibrate thermocouple. LLO 8.2 Use NIST data values as standard and calibrate thermocouple.	8	Calibration of thermocouple temperature measuring instruments (Prefer NIST data table as standard).	2	CO1 CO3
LLO 9.1 Identify type of orifice meter LLO 9.2 Measure flow rate using orifice meter.	9	Flow rate measurement using orifice meter.	2	CO4
LLO 10.1 Identify type of variable area flowmeter. LLO 10.2 Measure flow rate using rotameter.	10	*Flow rate measurement using rotameter.	2	CO4
LLO 11.1 Identify type of level indicator. LLO 11.2 Measure level using float type level indicator.	11	Level measurement using float type level indicator.	2	CO4
LLO 12.1 Identify type of level transducer. LLO 12.2 Measure level using capacitive transducer.	12	Level measurement using capacitive transducer.	2	CO4

INDUSTRIAL MEASUREMENTS**Course Code : 313319**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 13.1 Identify type of speed measuring transducer. LLO 13.2 Measure speed using stroboscope.	13	*Speed measurement using stroboscope.	2	CO2
LLO 14.1 Identify type of sound measuring instrument. LLO 14.2 Measure level using sound meter.	14	Sound intensity measurement using sound meter.	2	CO2
LLO 15.1 Identify type of hygrometer. LLO 15.2 Measure humidity using hair hygrometer.	15	Humidity measurement using hair hygrometer.	2	CO2
LLO 16.1 Select the components to design of signal conditioning circuit. LLO 16.2 Use breadboard to implement signal conditioning circuit for RTD /thermistor/thermocouple. LLO 16.3 Measure output using designed signal conditioning circuit.	16	*Design and implement signal conditioning circuit for RTD /thermistor/thermocouple.	2	CO1 CO3 CO5

Note : Out of above suggestive LLOs -

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

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

- Develop a quarter/ half / full bridge configuration of RTD for temperature measurement.
- Implement op-amp based linearizer for NTC thermistor.
- Develop set-up for force measurement using load cell.
- Build distance measurement set-up using IR sensor.

Assignment

- Evaluate drift in thermocouple.
- Thickness measurement using differential roller LVDT.
- Prepare a specification of sensors and transducers identified during visit to process industry.
- Discover real time applications of dynamometers used in industries.

INDUSTRIAL MEASUREMENTS**Course Code : 313319****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 judicious 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	Capacitive transducer for level measurement: Capacitive probe, Range 0-100mm, Digital Display.	12
2	Stroboscope: range up to 5000 rpm with digital display.	13
3	Sound level meter: Measuring range 30-130 dB, portable and easy to use.	14
4	Thermistor: Range 0- 120 deg. C.	16
5	LVDT displacement measuring kit: measurement range 0-50mm. Micrometer screw gauge assembly for displacement.	2
6	Strain gauge trainer-Strain/force measurement -Sensor-4 arm bridge with strain gauge mounted cantilever 2kg, with digital display.	3
7	Load cell: force measurement range 5-50N, Strain gauge capacity 2kg.	3
8	Bourdon tube pressure gauge: C type.	4
9	RTD(Pt-100) 0- 150 deg. C.	5,6,16
10	Dual-Well Dry-Well temperature calibrator 0 to 350 deg. C.	5,6,7,8,16
11	Glass thermometer: Range 0- 100 deg. C.	6,8
12	Thermocouple: Range 0- 1500 deg. C.	7,8,16
13	Flow measurement set-up (Venturi meter, orifice and rotameter).	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 measurement system	CO1	8	2	2	4	8
2	II	Displacement, strain, force and torque measurement	CO2	10	2	4	6	12
3	III	Pressure and temperature measurement	CO3	12	2	6	8	16
4	IV	Flow and Level measurement	CO4	10	2	4	6	12
5	V	Speed, sound and humidity measurement	CO2	12	2	4	6	12
6	VI	Signal conditioning system	CO5	8	2	2	6	10
Grand Total				60	12	22	36	70

INDUSTRIAL MEASUREMENTS**Course Code : 313319****X. ASSESSMENT METHODOLOGIES/TOOLS****Formative assessment (Assessment for Learning)**

- For laboratory learning 25 marks.
- Two unit tests of 30 marks and average of two unit tests.
- Each practical will be assessed considering appropriate % weightage to process and product and other instructions of assessment.

Summative Assessment (Assessment of Learning)

- End semester assessment of 70 marks through offline mode of examination.
- End semester assessment of 25 marks for laboratory learning.
- End semester assessment of 70 marks through offline mode of examination
- End semester assessment of 70 marks through offline mode of examination.

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			
CO2	3	2	1	2	2	1	2			
CO3	3	2	1	2	2	1	2			
CO4	3	2	1	2	2	1	2			
CO5	3	2	1	2	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	Singh, S.K.	Industrial Instrumentation and Control.	Mc Graw Hill Publishing House, 2013,ISBN:978-0-07-026222-5.
2	Rajput, R.K.	Mechanical Measurement and Instrumentation.	S.K.Kataria and Sons, 2017, ISBN:81-88458-83-X.
3	Sawhney, A.K. , Sawhney,Puneet	Mechanical Measurements and Instrumentation and Control.	Dhanpat Rai Publication, 2013, ISBN:9786000598884.
4	Nakra, BC Choudhary, KK	Instrument measurement and analysis.	Mc Graw Hill Publishing House, 2016, ISBN:978-9385880629,ISBN:9385880624.
5	Venketashan, S.P.	Mechanical Measurement.	Ane Books India,2022, ISBN:978-3-030-73619-4.

INDUSTRIAL MEASUREMENTS**Course Code : 313319**

Sr.No	Author	Title	Publisher with ISBN Number
6	Kumar, D.S	Mechanical Measurements and Control	Metropolitan Book Co. Pvt. Ltd. 2015,ISBN: 9781200041246.

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://archive.nptel.ac.in/courses/112/107/112107242/	Mechanical measurement system.
2	https://archive.nptel.ac.in/courses/108/105/108105064/	Industrial Instrumentation.
3	https://www.youtube.com/watch?v=T2C-19ZZhbg&t=7s	Strain gauge.
4	https://www.youtube.com/watch?v=AwZnWtkzuRQ	Dynamometer.
5	https://www.youtube.com/watch?v=qSRhstdL9WA	Pressure Measuring devices.
6	https://www.youtube.com/watch?v=2ABljUmax0w&t=1s	Temperature measuring devices.
7	https://www.youtube.com/watch?v=D_vbjofZl5E&t=1s	Flow measuring devices.
8	https://www.youtube.com/watch?v=hL2ofn12x_M	Introduction of signal conditioning circuit and operational amplifier.

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. 02/07/2024**Semester - 3, K Scheme**

ELEMENTS OF ELECTRICAL ENGINEERING**Course Code : 313320****Programme Name/s : Mechatronics****Programme Code : MK****Semester : Third****Course Title : ELEMENTS OF ELECTRICAL ENGINEERING****Course Code : 313320****I. RATIONALE**

Any technical person is expected to have basic knowledge of electrical engineering as they have to work in different engineering fields that deals with various types of electrical machines and equipment. This course will enable the students to apply the fundamental concepts of electrical engineering for understanding of other higher semester courses as well as later in the world of work.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Apply basic principles of electrical engineering to solve the electrical engineering problems.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Determine various parameters in a given electrical circuit.
- CO2 - Use principles of magnetic circuits in electrical devices.
- CO3 - Select DC motor and transformer for specific applications.
- CO4 - Select AC motor and special purpose motor for given application.
- CO5 - Select electrical measuring instruments and protective devices.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SL	LH		NLH	Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
				CL	TL	LL						Practical				Based on SL						
												FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
														Max	Max	Max	Min	Max	Min	Max	Min	
313320	ELEMENTS OF ELECTRICAL ENGINEERING	EEE	AEC	3	-	2	1	6	3	3	30	70	100	40	25	10	-	-	25	10	150	

ELEMENTS OF ELECTRICAL ENGINEERING**Course Code : 313320****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 given terms of electric circuits. TLO 1.2 Compare AC and DC. TLO 1.3 Apply Ohms law, KCL, KVL to electrical circuits. TLO 1.4 Compare single phase and three phase circuits. TLO 1.5 Calculate equivalent resistance and other parameter of a given circuit.	Unit - I Basic Fundamentals 1.1 Introduction to voltage, current, EMF, potential difference, work, power, energy and its units 1.2 Direct current (DC), Alternating current (AC) 1.3 Resistor, Inductor, Capacitor 1.4 Ohms law, KCL, KVL 1.5 Definitions - Cycle, frequency, phase, period, maximum value, average value, R.M.S. value 1.6 Series and parallel circuit of resistance 1.7 Compare single phase and Three phase circuits 1.8 Numerical on KCL, KVL, series and parallel circuit	Lecture Using Chalk-Board Presentations Video Demonstrations
2	TLO 2.1 Interpret the terms related to a magnetic circuit. TLO 2.2 Compare of electric and magnetic circuit. TLO 2.3 Plot B-H curve and hysteresis loop of the given magnetic materials. TLO 2.4 Describe Faraday's laws of electromagnetic induction, Fleming's right-hand rule, Lenz's law.	Unit - II Magnetic Circuit and Electromagnetism 2.1 Definition of magnetic lines of force, magnetic flux, flux density, magneto-motive-forces (mmf), magnetic field strength, reluctance 2.2 Comparison of electric and magnetic circuit 2.3 Magnetization curve (B - H curve), hysteresis loop of the given magnetic materials 2.4 Faraday's laws of electromagnetic induction, Fleming's right-hand rule, Lenz's law 2.5 Statically and dynamically induced emf	Lecture Using Chalk-Board Presentations Video Demonstrations

ELEMENTS OF ELECTRICAL ENGINEERING**Course Code : 313320**

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 construction and working of DC motor. TLO 3.2 List different types of DC motor and its applications. TLO 3.3 Explain construction and working of transformer. TLO 3.4 Interpret the EMF equation and transformation ratio of two winding transformer. TLO 3.5 Calculate transformation ratio(K) of transformer. TLO 3.6 Compare auto transformer and two winding transformer.	Unit - III DC Motors and Transformer 3.1 DC motor construction and working principle of operation 3.2 Types of DC motor and its applications 3.3 Transformer construction and working principle of operation 3.4 EMF equations and transformation ratio of transformer 3.5 Numerical on EMF equations and transformation ratio of transformer 3.6 Losses in a transformer 3.7 Introduction of auto transformer and compare it with two winding transformers	Lecture Using Chalk-Board Presentations Video Demonstrations
4	TLO 4.1 Explain construction and working of single-Phase induction motor. TLO 4.2 Classify single phase induction motors. TLO 4.3 Explain construction and working of three Phase induction motor. TLO 4.4 List the applications of single phase and three phase induction motors. TLO 4.5 Explain construction and working of different types of FHP motors and list its applications. TLO 4.6 Illustrate need of starters. TLO 4.7 Select the appropriate drives for the specified motor.	Unit - IV AC Machine and Special purpose motor 4.1 Single-phase induction motor – construction, working principle and application 4.2 Types of single-phase induction motor – split phase, capacitor start induction run, capacitor start capacitor run, permanent capacitor, shaded pole induction motor 4.3 Three phase induction motor – construction, operation and types and its application 4.4 Other Motors (FHP): Universal motor, servo motor, stepper motor – construction, working and applications 4.5 Need of starters 4.6 Classification of drives, factors for selection of drives for different motors	Lecture Using Chalk-Board Presentations Video Demonstrations
5	TLO 5.1 List of applications of different measuring instruments. TLO 5.2 List of applications of different measuring instruments. TLO 5.3 List the applications of MCB, MCCB and ELCB. TLO 5.4 Explain necessity of earthing.	Unit - V Measuring Instruments and Protective Devices 5.1 Use of AC and DC ammeter, voltmeter, wattmeter, digital multimeter, clip on meter, tachometer, megger, tachometer energy meter, (applications only) 5.2 Operation of fuses and its types 5.3 Operation and application of MCB, MCCB and ELCB 5.4 Necessity of earthing and types of earthing	Lecture Using Chalk-Board Presentations 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
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ELEMENTS OF ELECTRICAL ENGINEERING**Course Code : 313320**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Connect the meter in the given circuit. LLO 1.2 Measure electrical parameters. LLO 1.3 Compare the readings of digital multimeter with that of analog meter.	1	* Measurement of various electrical quantities by using analog meters and digital multimeters	2	CO1
LLO 2.1 Connect the resistors in series and parallel. LLO 2.2 Find the equivalent resistance of series and parallel connection.	2	Measurement of equivalent resistance of series and parallel connection	2	CO1
LLO 3.1 Connect the DC / AC source with resistive load. LLO 3.2 Verify Ohm's Law equipment.	3	Verification of Ohm's law	2	CO1
LLO 4.1 Verify Kirchhoff's laws.	4	*Verification of Kirchhoff's current and voltage law	2	CO1
LLO 5.1 Verify of Faraday's law of electromagnetic induction (statically induced emf).	5	*Verification of Faraday's law of electromagnetic induction (statically induced emf)	2	CO2
LLO 6.1 Verify of Faraday's law of electromagnetic induction (dynamically induced emf).	6	Verification of Faradays law of electromagnetic induction (dynamically induced emf)	2	CO2
LLO 7.1 Draw B-H curve for the given magnetic material.	7	Determination of B-H curve for the given magnetic material	2	CO2
LLO 8.1 Identify the various parts of DC motor.	8	Identification of various parts of DC motor	2	CO3
LLO 9.1 Measure speed control of DC motor.	9	* Speed control of DC series motor by armature resistance control method	2	CO3
LLO 10.1 Determine the transformation ratio.	10	*Determination voltage and current ratio of single-phase transformer	2	CO3
LLO 11.1 Identify the various parts of three- phase induction motor.	11	Identification of various parts of three phase induction motor and its function	2	CO4
LLO 12.1 Identify various parts of stepper motor.	12	*Dismantling/assembling /testing a stepper motor and its types	2	CO4
LLO 13.1 Experiment with speed reversal of three phase induction motors.	13	*Using phase sequence change the direction of rotation of three-phase induction motor	2	CO4
LLO 14.1 Determine the fusing current by operate fuse in an electrical circuit.	14	* Performance of fuse in electrical circuit	2	CO5
LLO 15.1 Investigate the operation of MCB at normal and abnormal condition.	15	Performance of MCB in electrical circuit	2	CO5

ELEMENTS OF ELECTRICAL ENGINEERING**Course Code : 313320**

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)

Micro project

- Collect the different types of small rating fuses and make demonstration charts. (Collect different types of small rating fuse, distribute fuse according to types, mention the rating and application of fuse)
- Connect two small battery cells (AA size) make series and parallel connection. Measure the voltage of both connections. (Collect small battery cells, connect battery cells in series and parallel, connect the voltmeter to measure voltage)

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	Single phase auto-transformer- Input: 0 to 230 V, 10 A, Output: 0 to 270 V (2 Qty)	1,2,3,4,5,6,7,10,14,15
2	Stripper, Hammer, Plier, Tester, Standard wire gauge etc.	1,2,3,4,5,6,7,9,10,12,13
3	DC and AC Ammeter, 0-10/20 A (5 Qty)	1,2,3,4,5,6,7,9,10,13,14,15
4	DC and AC Voltmeter, 0-150/300 V (5 Qty)	1,2,3,4,5,6,7,9,10,13,14,15
5	Digital Multimeter (2 Qty)	1,2,3,4,5,6,7,9,10,13,14,15
6	Connecting wires	1,2,3,4,5,6,7,9,10,13,14,15
7	Loading rheostat – 7.5 KW, 230 V (5 Qty), 3 Phase, 4 wire balanced load, (Each branch having equal load) (1 Qty), Load – wire wound fixed resistors	1,2,3,4,7,9
8	Lamp bank: 230 V, 0 to 20 A. (1 Qty)	1,2,3,9,10,14,15
9	Tachometer – Non contact type, (0-10000rpm) (1 Qty)	1,9
10	Single phase transformer: 1 KVA, 1 Phase, 230/115 V, Air closed, enclosed type. (2 Qty)	10
11	Stepper motor kit (1 Qty)	12

ELEMENTS OF ELECTRICAL ENGINEERING**Course Code : 313320**

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
12	Three phase auto transformer – 15 KVA, Input: 0 to 415V, 3 Phase, 50Hz, output: 0 to 415 V, 30A per line, Air cooled (1 Qty)	13
13	3 Phase Induction motor, 3HP/5HP, 415 V, 50 H Z, 1140 RPM (1 Qty)	13
14	Fuse (5A/10A, 230V, 50Hz)	14
15	Fuse Wire	14
16	MCB(1A/2A/3A/4A/5A/6A)	15
17	DC Source (24 V)	3,9
18	DC series and shunt motor (up to 230V, 5 HP) (1 Qty)	8,9

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

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Basic Fundamentals	CO1	10	4	6	6	16
2	II	Magnetic Circuit and Electromagnetism	CO2	6	2	4	4	10
3	III	DC Motors and Transformer	CO3	10	4	4	6	14
4	IV	AC Machine and Special purpose motor	CO4	12	4	8	6	18
5	V	Measuring Instruments and Protective Devices	CO5	7	4	4	4	12
Grand Total				45	18	26	26	70

X. ASSESSMENT METHODOLOGIES/TOOLS**Formative assessment (Assessment for Learning)**

- Two unit tests of 30 marks will be conducted and average of two-unit tests considered
- For formative assessment of laboratory learning 25 marks
- Each practical will be assessed considering appropriate percentage weightage to process and product and other instructions of assessment

Summative Assessment (Assessment of Learning)

- End semester assessment of 70 marks through offline mode of examination
- For self learning assessment (SLA) of 25 marks

XI. SUGGESTED COS - POS MATRIX FORM

ELEMENTS OF ELECTRICAL ENGINEERING**Course Code : 313320**

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	2	-	2			
CO2	3	1	-	2	2	-	2			
CO3	3	2	-	2	2	-	2			
CO4	3	2	-	2	2	-	2			
CO5	3	2	-	2	2	-	3			
Legends :- High:03, Medium:02,Low:01, No Mapping: - *PSOs are to be formulated at institute level										

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	V. K. Mehta, Rohit Mahta	Basic Electrical Engineering	S. Chand Publication, ISBN:978-81-219-0871-9
2	P. V. Prasad, S. Sivanagaraju	Electrical Engineering Concepts and Application	Cengage Publication, ISBN:978-81-315-1787-1
3	V. K. Mehta, Rohit Mahta	Principles of Electrical Engineering and Electronics	S. Chand Publication, ISBN:978-81-219-4298-0
4	B. L. Theraja	Electrical Technology - Volume I	S. Chand and Co. New Delhi, ISBN:978-81-219-2440-5
5	B. L. Theraja	Electrical Technology - Volume II	S. Chand and Co. New Delhi, ISBN:978-81-219-2437-5

XIII. LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://youtu.be/XT-UmPviH64?si=MLIZBB5BgOA2SWBk	Electromagnetic induction
2	https://youtu.be/M-QfX2fvpp4?si=xpZDAiX3-_7xrnnr	Basic magnetic circuits
3	https://archive.nptel.ac.in/courses/117/106/117106108/	Basic electrical circuits
4	https://archive.nptel.ac.in/courses/108/105/108105155/	Electrical machines-1
5	https://youtu.be/ivP_8w4FegE?si=5BLH_hvyhros570A	1 phase and 3 phase electrical system
6	https://youtu.be/9Xgn40eGcqY?si=YQy0vmxQ_yGR8-tz	Miniature circuit breaker
7	https://youtu.be/ikLhqUCQKkc?si=8VqRbV1zZlQUSYLd	Earth leakage circuit breaker
8	https://youtu.be/wgxcxOUjfro	Fuse

Note :

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

ELEMENTS OF ELECTRICAL ENGINEERING

Course Code : 313320

MSBTE Approval Dt. 02/07/2024

Semester - 3, K Scheme

THEORY OF MACHINES**Course Code : 313313**

Programme Name/s	: Automobile Engineering./ Mechanical Engineering/ Mechatronics/ Manufacturing Technology/ Production Engineering
Programme Code	: AE/ ME/ MK/ MRT/ PG
Semester	: Third / Fourth
Course Title	: THEORY OF MACHINES
Course Code	: 313313

I. RATIONALE

Diploma Engineer should be able to identify and interpret various elements of machines in day-to-day life when they come across various machines in practice. In maintaining various machines, a Diploma Engineer should have sound knowledge of fundamentals of machine and mechanism. TOM subject imparts the kinematics involved in different machine elements and mechanisms like I.C. engine, cam-follower, belt-pulley, gear, flywheel etc. This course serves as a prerequisite for other courses such as Machine Design of higher semester etc.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

This course will enable the students to: Apply the knowledge & skills related to machine, mechanism & motions according to field applications.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Apply knowledge and skill related to different mechanisms and its motion in given situation.
- CO2 - Determine velocity and acceleration for given mechanism.
- CO3 - Develop a Cam profile for given type of Follower and its motions in given situation.
- CO4 - Select the suitable power transmission devices for the given field/industrial application.
- CO5 - Use knowledge and skills related to balancing of masses and vibration for various 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	Min	Max	Min	Max	Min	Max	Min	
313313	THEORY OF MACHINES	TOM	DSC	4	-	2	-	6	3	3	30	70	100	40	25	10	-	-	-	-	125

THEORY OF MACHINES**Course Code : 313313****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 Identify various links and pairs in the given mechanism. TLO 1.2 Identify various type motion in the given pair. TLO 1.3 Identify various kinematic chain in the given configuration. TLO 1.4 Estimate degree of freedom for given configuration. TLO 1.5 Explain different inversion of mechanism. TLO 1.6 Select suitable inversion of mechanism for different application.	Unit - I Fundamentals and Types of Mechanism 1.1 Kinematics of Machines: - Definition of statics, Dynamics, Kinematics, Kinetics, Kinematic link and its types, Kinematic pair and its types, constrained motion and its types 1.2 Kinematic chain (locked chain, constrained chain and unconstrained chain with equation), Degree of freedom (Kutzbach equation) 1.3 Mechanism and Inversion: Mechanism and Inversion of Mechanism, Difference between machine and structure. 1.4 Inversion of Kinematic Chain a) Inversion of four bar chain: Beam engine, Coupling rod of Locomotive, Watt's indicator mechanism. b) Inversion of single slider Crank chain: Reciprocating I.C. engine, Whitworth quick return mechanism, Rotary Engine, Oscillating cylinder engine, Crank and slotted lever quick return Mechanism, Hand Pump mechanism c) Inversion of Double Slider Crank Chain: Elliptical trammel, Scotch Yoke Mechanism, Oldham's Coupling	Classroom Lecture Model Demonstration Video Demonstrations Hands-on Presentations

THEORY OF MACHINES**Course Code : 313313**

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 velocity and acceleration in mechanism. TLO 2.2 Draw velocity and acceleration diagram/polygon by relative velocity/ Klein's construction method following standard procedure . TLO 2.3 Determine linear and angular velocity of links in the given mechanism. TLO 2.4 Determine linear and angular acceleration of links in the given mechanism.	Unit - II Velocity and Acceleration in Mechanism 2.1 Concept of relative velocity and acceleration of a point on a link, Inter-relation between linear and angular velocity and acceleration. 2.2 Drawing of velocity and acceleration diagram of a given configuration, diagrams of simple Mechanisms: four bar chain and single slider crank chain (Limited up to 4 Links). 2.3 Determination of velocity and acceleration of point on link by relative velocity method (Excluding Coriolis component of acceleration) . 2.4 Klein's construction to identify velocity and acceleration of different links in single slider crank mechanism (When crank rotates with uniform velocity only).	Lecture Using Chalk-Board Video Demonstrations
3	TLO 3.1 Explain Cam and its terminology with field application. TLO 3.2 Identify the type of motion of Follower. TLO 3.3 Classify Cams and Followers. TLO 3.4 Draw Cam profile as per the given condition of Follower.	Unit - III Cam and Follower 3.1 Introduction to Cams and Followers, definition and applications of Cams and Followers, Cam terminology. 3.2 Classification of Cams and Followers. 3.3 Different follower motions and their displacement diagrams - Uniform velocity, simple harmonic motion, uniform acceleration and retardation. 3.4 Drawing of profile of radial Cam with knife-edge and roller Follower with and without offset (reciprocating motion only).	Lecture Using Chalk-Board Model Demonstration Video Demonstrations Presentations
4	TLO 4.1 Identify the different drives for power transmission. TLO 4.2 Select suitable drive for a particular application. TLO 4.3 Calculate various quantities like velocity ratio, belt tensions, angle of contact, power transmitted in belt drives. TLO 4.4 Enlist advantages and disadvantages of chain drive. TLO 4.5 Identify the different types of gear trains. TLO 4.6 Compare belt drive, chain drive and gear drive for given parameters.	Unit - IV Power transmission (Belt, Chain and Gear) 4.1 Belt Drive: a) Type of belts, flat belt, V-belt & its applications, material for flat and V-belt, Selection of belts b) Angle of lap, length of belt (No derivation), Slip and creep, Determination of velocity ratio of tight side and slack side tension, Power transmitted by belt. (numerical on power transmission by belt) 4.2 Chain Drives: Types of chains and sprockets, Advantages & Disadvantages of chain drive over other drives (No numerical on Chain drive). 4.3 Gear Drives: a) Classification of gears, Law of gearing, Concept of Conjugate profile (Involute only) Spur gear terminology. b) Types of gear trains, Train value & velocity ratio for simple, compound, reverted and epicyclic gear trains. (No numerical on Gear drive). Comparison between Belt drive, Chain drive and Gear drive	Lecture Using Chalk-Board Presentations Video Demonstrations Model Demonstration

THEORY OF MACHINES**Course Code : 313313**

Sr.No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Explain the concept of balancing. TLO 5.2 Find balancing mass and position of plane analytically and graphically in single plane. TLO 5.3 Explain the basic vibrating system with causes and remedies.	Unit - V Balancing of Masses and Vibration 5.1 Balancing of Rotating Masses: Concept of balancing: Need and types of balancing, Balancing of single rotating mass. 5.2 Analytical and Graphical methods for balancing of several masses revolving in same plane and different plane (Numerical on single plane only). 5.3 Vibration: Fundamentals of Vibration: Definition and concept of Free, Forced, Undamped, Damped vibrations. (no numerical) 5.4 Advantages and Disadvantages of Vibration, Causes and remedies of Vibration, Vibration isolators. Forced vibrations of longitudinal and torsional systems (Concepts only, No numerical and No derivation on vibration).	Lecture Using Chalk-Board Presentations Video Demonstrations Case Study

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 mechanisms available in laboratories/institute premises LLO 1.2 Sketch the identified mechanism.	1	Identification of Mechanisms in the different laboratory and institute premises.	2	CO1 CO3 CO4
LLO 2.1 Identify number of links and pairs of given mechanism LLO 2.2 Identify input link and its motion. LLO 2.3 Identify output link and its motion	2	*Estimation of kinematic data for mechanism available in the laboratory (any one from Group A and any one from Group B) Group A: i) Beam Engine ii) Coupling rod of Locomotive, iii) Watt's indicator mechanism. Group B: i) Reciprocating engine ii) Whitworth quick return mechanism. iii) Rotary Engine iv) Crank and slotted lever quick return Mechanism v) Hand Pump mechanism	2	CO1

THEORY OF MACHINES**Course Code : 313313**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 3.1 Identify number of links and pairs of given mechanism. LLO 3.2 Identify input link and its motion. LLO 3.3 Identify Output link and its motion.	3	Estimation of kinematic data for mechanism available in the laboratory (any one from Group A and any one from Group B) Group A: i) Elliptical trammel, ii) Scotch Yoke Mechanism, iii) Oldham's Coupling Group B: i) Bicycle free wheel sprocket mechanism ii) Geneva mechanism iii) Ackerman's steering gear mechanism iv) Foot operated air pump mechanism	2	CO1
LLO 4.1 Determine degree of freedom of given mechanism	4	*Degree of Freedom of given mechanism by using Kutzbach equation. (Any five mechanisms available in the Laboratory)	2	CO1
LLO 5.1 Measure the ratio of time of cutting stroke to the return stroke in shaping operation.	5	*Quick return mechanism used in a shaper machine	2	CO1
LLO 6.1 Draw velocity and acceleration polygon of four bar chain. LLO 6.2 Calculate angular velocity and linear velocity of a link using given data.	6	Velocity and Acceleration of four bar chain by relative velocity method. (Two Problem on A2 size Sheet.)	2	CO2
LLO 7.1 Draw velocity and acceleration polygon of single slider crank chain. LLO 7.2 Calculate angular velocity and linear velocity of a link using given data.	7	*Velocity and Acceleration of single slider crank chain by relative velocity method. (Two Problem on A2 size Sheet.)	2	CO2
LLO 8.1 Draw a space diagram of a single slider crank mechanism LLO 8.2 Measure the velocity and acceleration of links using Klien's construction method.	8	Velocity and Acceleration of Slider crank chain by Klien's Construction Method.	2	CO2

THEORY OF MACHINES**Course Code : 313313**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 9.1 Generate cam profile for given follower to obtain desired follower motion	9	Cam profile for knife edge Follower. (Two problem on A2 size sheet, at least one problem on offset follower)	2	CO3
LLO 10.1 Generate cam profile for given follower to obtain desired follower motion	10	Cam Profile for roller follower. (Two Problem on A2 size sheet, at least one problem on offset follower)	2	CO3
LLO 11.1 Identify displacement of follower with cam rotation	11	*Measurement of follower displacement with Cam rotation for knife edge follower and roller follower	2	CO3
LLO 12.1 Measure the angular speed using tachometer. LLO 12.2 Compute the length of belt and slip	12	*Estimation of slip, length of belt, angle of contact in an open and cross belt drive.	2	CO4
LLO 13.1 Identify the type of gears and gear train.	13	Identification of gears and gear train in Lab and Machine shop.	2	CO4
LLO 14.1 Identify the type of gears and gear train. LLO 14.2 Construct gear train for desirable velocity ratio	14	*Preparation of different Gear trains from the given gears.	2	CO4
LLO 15.1 Construct balanced system for rotating masses.	15	*Balancing of rotating unbalanced system	2	CO5

Note : Out of above suggestive LLOs -

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

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

NA

- NA

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

MSBTE Approval Dt. 02/07/2024

Semester - 3 / 4, K Scheme

THEORY OF MACHINES**Course Code : 313313**

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Working Model of Beam Engine, Coupling rod of Locomotive, Watt's indicator mechanism, Reciprocating engine, Whitworth quick return mechanism, Rotary Engine, Crank and slotted lever quick return Mechanism, Hand Pump mechanism	1,2,4
2	Shaper machine available in institute workshop	1,2,4,5
3	Working Models of Elliptical trammel, Scotch Yoke Mechanism, Oldham's Coupling, Bicycle free wheel sprocket Mechanism, Geneva mechanism, Ackerman's steering gear Mechanism, Foot operated air pump mechanism	1,3,4
4	Working models of Flat belt and V belt arrangement for demonstration	1,4,12
5	Experimental cam follower set up: Machine consist of a cam shaft driven by a D.C. motor/Manual operated. The shaft runs in a double ball bearing. At the free end of the cam shaft a cam can be easily mounted. The follower is properly guided in bushes and the type of the follower can be changed to suit the cam under test. A graduated circular protractor is fitted coaxial with the shaft and a dial gauge can be fitted to note the follower displacement for the angle of cam rotation. A spring is used to provide controlling force to the follower system.	11
6	Tachometer: optical type of tachometer (digital Tachometer) Range speed minimum 0 to 2000RPM or more	12
7	Belt drive test bench A test bench comprising of following pulleys, belts, electrical motor, arrangement for adjusting belt tensions and regulating speed of the driving motor and a suitable mounting frame	12
8	Working Model of Gear Trains: i) Simple Gear Train ii) Compound Gear train iii) Reverted Gear Train iv) epicyclic Gear Train	13
9	Different types of Gears with different modules : at least 5 quantity of each gear Spur gear Helical gear (Single /double) Spiral gear Bevel gear	13
10	Experimental set up to arrange gears and shaft such that desired gear train can be obtained for given velocity ratio.	14
11	Static & Dynamic Balancing Machine Single phase motor connected to a shaft, containing 4 rotating masses. Each rotating mass has a facility to insert. Pulley is provided to add weights to balance the unbalance shaft	15
12	Working models of various Cam follower arrangements for demonstration (Radial cam with knife edge and Roller follower models are mandatory)	4,9,10,11

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

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Fundamentals and Types of Mechanism	CO1	16	6	8	4	18
2	II	Velocity and Acceleration in Mechanism	CO2	10	2	4	6	12
3	III	Cam and Follower	CO3	10	4	4	6	14
4	IV	Power transmission (Belt, Chain and Gear)	CO4	16	4	8	4	16
5	V	Balancing of Masses and Vibration	CO5	8	4	4	2	10
Grand Total				60	20	28	22	70

X. ASSESSMENT METHODOLOGIES/TOOLS**MSBTE Approval Dt. 02/07/2024****Semester - 3 / 4, K Scheme**

THEORY OF MACHINES**Course Code : 313313****Formative assessment (Assessment for Learning)**

- Laboratory Performance and Term work, Class Test I & II
- Term work (Lab Manual and drawing sheet), Question and Answers in class room as well as at the time of Practical. Note: Each practical will be assessed considering 60% and 40 % weightage.

Summative Assessment (Assessment of Learning)

- End Semester Board exam- Theory

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			
CO2	3	2	1	-	-	-	-			
CO3	3	2	3	2	-	-	1			
CO4	3	2	1	2	1	-	2			
CO5	3	2	1	2	2	-	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	A. Ghosh, A. K. Malik	Theory Of Mechanisms and Machines	Affiliated East west press ISBN: 978-8185938936
2	S. S. Rattan	Theory Of Machines	Tata McGraw Hill Edu. New Delhi, 2010, ISBN: 978-9353166281
3	R.S. Khurmi, J. K. Gupta	Theory of Machines	S. Chand and Company New Delhi, ISBN: 978-8121925242
4	J. E. Shigely, J. J. Uicker	Theory Of Machines and Mechanisms	Tata McGraw Hill Edu. New Delhi, 2010, ISBN: 978-0198062325
5	R. K. Bansal, Brar J. S.	A text book of Theory of Machine	Khanna Book Publishing CO(P) LTD, New Delhi, ISBN: 9788170084181
6	P. L. Ballaney	Theory Of Machines	Khanna Book Publishing CO(P) LTD, New Delhi, ISBN: 978-8174091222
7	Sadhu Singh	Theory of Machines	Pearson Education ISBN: 978-8131760697
8	S.S. Rao	Mechanical Vibrations	Pearson Education 2018 ISBN: 978-9353062569
9	G.K. Grover	Mechanical Vibration	978-8185240565

THEORY OF MACHINES**Course Code : 313313****XIII . LEARNING WEBSITES & PORTALS**

Sr.No	Link / Portal	Description
1	http://www.mechanalyzer.com/downloads.html	Mech Analyzer is a free software developed to simulate and analyze the mechanisms
2	https://www.youtube.com/watch?v=oTcC_xXfdrA	Coupling Rod Locomotive
3	https://www.youtube.com/watch?v=8shK6kbu7Xk	Piston cylinder animation showing application of cam and gear train
4	https://www.youtube.com/watch?v=yHHeicPbEzg	Simple Beam Engine
5	https://www.youtube.com/watch?v=yHHeicPbEzg	Knife edge follower and Radial Cam
6	https://www.youtube.com/watch?v=Rib-_ZK8KfE	Roller follower with Radial Cam
7	https://www.youtube.com/watch?v=AODiJYtxuSw	Gear train animation
8	https://www.youtube.com/watch?v=kIVYeSlxucU	Types of Belt drives
9	https://www.udemy.com/course/theory-of-machines-determine-degrees-of-freedom-in-a-system/	Degree of freedom
10	https://archive.nptel.ac.in/courses/112/106/112106270/	Online NPTL lectures of Theory of machine
11	https://play.google.com/store/apps/details?id=com.pinjara_imran5290.Belt_Length_Calculator&hl=en&gl=US&pli=1	Belt length calculator Application (play store app)
12	https://psmotion.com/mechdesigner/feature/cam-design-analysis	Design of Cam software
13	https://www.vlab.co.in/broad-area-mechanical-engineering	Virtual Lab
14	https://opac.library.iitb.ac.in/	Digital Central Library
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. 02/07/2024**Semester - 3 / 4, K Scheme**

ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS**Course Code : 314014**

Programme Name/s	: Architecture Assistantship/ Architecture and Interior Design/ Automobile Engineering/ Agricultural Engineering/ Architecture/ Fashion & Clothing Technology/ Dress Designing & Garment Manufacturing/ Food Technology/ Instrumentation & Control/ Instrumentation & Control Engineering/ Instrumentation/ Interior Design & Decoration/ Interior Design/ Mechanical Engineering/ Mechatronics/ Medical Laboratory Technology/ Manufacturing Technology/ Medical Electronics/ Metallurgical Engineering/ Production Engineering/ Printing Technology/ Surface Coating Technology/ Textile Technology/ Travel and Tourism/ Textile Manufactures
Programme Code	: AA/ AD/ AE/ AL/ AT/ DC/ DD/ FC/ IC/ ICE/ IS/ IX/ IZ/ ME/ MK/ ML/ MRT/ MU/ MY/ PG/ PN/ SC/ TC/ TR/ TX
Semester	: Fourth / Fifth / Sixth
Course Title	: ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS
Course Code	: 314014

I. RATIONALE

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

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

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

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

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

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SL	LH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks	
				CL	TL	LL									Practical				SLA			
											FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA			
															Max	Min	Max	Min	Max	Min		Max
314014	ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS	EDS	AEC	1	-	2	1	4	2	-	-	-	-	-	50	20	25@	10	25	10	100	

ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS**Course Code : 314014****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 Compare advantages and disadvantages of Entrepreneurship TLO 1.2 Identify entrepreneurial traits through self-analysis TLO 1.3 Compare risk associated with different type of enterprise	Unit - I Introduction to Entrepreneurship Development 1.1 Entrepreneurship as a career – charms, advantages, disadvantages , scope- local and global 1.2 Traits of successful entrepreneur: consistency, creativity, initiative, independent decision making, assertiveness, persuasion, persistence, information seeking, handling business communication, commitment to work contract, calculated risk taking, learning from failure 1.3 Types of enterprises and their features : manufacturing, service and trading	Presentations Lecture Using Chalk-Board
2	TLO 2.1 Explain Important factors essential for selection of product/service and selection of process TLO 2.2 Suggest suitable place for setting up the specified enterprise on the basis of given data/circumstances with justification. TLO 2.3 Suggest steps for the selection process of an enterprise for the specified product or service with justification. TLO 2.4 Plan a market study /survey for the specified enterprise	Unit - II Startup Selection Process 2.1 Product/Service selection: Process, core competence, product/service life cycle, new product/ service development process, mortality curve, creativity and innovation in product/ service modification / development 2.2 Process selection: Technology life cycle, forms and cost of transformation, factors affecting process selection, location for an industry, material handling. 2.3 Market study procedures: questionnaire design, sampling, market survey, data analysis 2.4 Getting information from concerned stakeholders such as Maharashtra Centre for Entrepreneurship Development[MCED], National Institute for Micro, Small and Medium Enterprises [NI-MSME], Prime Minister Employment Generation Program [PMEGP], Directorate of Industries[DI], Khadi Village Industries Commission[KVIC]	Presentations Lecture Using Chalk-Board

ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS**Course Code : 314014**

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

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

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

ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS**Course Code : 314014**

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

Note : Out of above suggestive LLOs -

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

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

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

ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS**Course Code : 314014**

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

Note :

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

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

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

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

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Introduction to Entrepreneurship Development	CO1	5	0	0	0	0
2	II	Startup Selection Process	CO2	4	0	0	0	0
3	III	Support System for Startup	CO3	3	0	0	0	0
4	IV	Managing Enterprise	CO4	3	0	0	0	0
Grand Total				15	0	0	0	0

X. ASSESSMENT METHODOLOGIES/TOOLS**Formative assessment (Assessment for Learning)****Summative Assessment (Assessment of Learning)**

- End of Term Examination - Viva-voce

XI. SUGGESTED COS - POS MATRIX FORM

ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS**Course Code : 314014**

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

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

XII. SUGGESTED LEARNING MATERIALS / BOOKS

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

XIII. LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	http://www.mced.nic.in/allproduct.aspx	MCED Product and Plan Details
2	http://niesbud.nic.in/Publication.html	The National Institute for Entrepreneurship and Small Business Development Publications
3	http://niesbud.nic.in/docs/1standardized.pdf	Courses : The National Institute for Entrepreneurship and Small Business Development
4	https://www.nabard.org/content1.aspx?id=23andcatid=23andmid=530	Government Schemes
5	https://www.nabard.org/Tenders.aspx?cid=501andid=24	NABARD - Information Centre
6	http://www.startupindia.gov.in/pdf/file.php?title=Startup%20India%20Action%20Planandtype=Actionandq=Action%20Plan.pdfandcontent_type=Actionandsubmenupoint=action	Start Up India
7	http://www.ediindia.org/institute.html	About - Entrepreneurship Development Institute of India (EDII)

MSBTE Approval Dt. 21/11/2024**Semester - 4 / 5 / 6, K Scheme**

ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS**Course Code : 314014**

Sr.No	Link / Portal	Description
8	http://www.nstedb.com/training/training.htm	NSTEDB - Training
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. 21/11/2024**Semester - 4 / 5 / 6, K Scheme**

COMPUTER AIDED MECHATRONICS DRAFTING**Course Code : 314015****Programme Name/s : Mechatronics****Programme Code : MK****Semester : Fourth****Course Title : COMPUTER AIDED MECHATRONICS DRAFTING****Course Code : 314015****I. RATIONALE**

The process of drawing and drafting has evolved with the advancement of technology from a manual process into a digital technique. The skills of Computer Aided Drawing and Drafting (CADD) have become an essential element of this evolution process. This course provides the designers with the powerful tools to modernize the creation, modification and visualization of mechatronics drawings.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Apply the knowledge and skills of CADD software to create and read electromechanical drawings efficiently and accurately as per industry standards.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Use basic commands in CADD software.
- CO2 - Draw complex 2D drawings in CADD software using draw and modify tools.
- CO3 - Use CADD software to give dimensions and write text on 2D geometric entities.
- CO4 - Plot given 2D entities using proper plotting parameters in CADD software.
- CO5 - Draw electromechanical circuits in CADD software.

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				
				CL	TL	LL								Practical				SLA				
											FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA			
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min		
314015	COMPUTER AIDED MECHATRONICS DRAFTING	CAM	SEC	-	-	4	2	6	3	-	-	-	-	-	25	10	25#	10	25	10	75	

COMPUTER AIDED MECHATRONICS DRAFTING**Course Code : 314015****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 the importance of computer in drafting and designing. TLO 1.2 Set the CADD workspace and interface for the given situation TLO 1.3 Prepare drawing using User Coordinate System (UCS) and World Coordinate System (WCS) TLO 1.4 Apply different object selection methods in a given situation. TLO 1.5 Use various commands in application menu bar.	Unit - I Fundamentals of CAD Drawing 1.1 Fundamentals of Computer Aided Drafting and its applications, Various Software for Computer Aided Drafting. 1.2 CADD Interface: Application Menu, Quick Access Toolbar, Ribbons, Info Center, Command Window, Graphical Area, Status Bar 1.3 CADD initial setting commands: Snap, grid, Ortho, Osnap, Dynamic input, Limits, Units, Ltscale, Object tracking. 1.4 Co-ordinate System- Cartesian and Polar, Absolute and Relative mode, Direct Distance Entry, UCS, WCS. 1.5 Object Selection methods- picking, window, crossing, fence, last and previous. 1.6 Opening, saving and closing a new and existing drawing.	Video Demonstrations Presentations Hands-on
2	TLO 2.1 Draw simple 2D entities using given draw commands. TLO 2.2 Apply formatting commands TLO 2.3 Determine coordinates, distance, area, length, centroid of the given 2D entity TLO 2.4 Use viewing commands.	Unit - II Draw, Formatting, Enquiry and Zoom Commands 2.1 Draw Command - Line, Polyline, arc, circle, rectangle, polygon, ellipse, spline, block, hatch. 2.2 Formatting commands - Layers, block, linetype, linewidth, color. 2.3 Enquiry commands – distance, area. 2.4 Zoom Commands – all, previous, out, in, extent, Realtime, dynamic, window, pan.	Video Demonstrations Presentations Hands-on

COMPUTER AIDED MECHATRONICS DRAFTING**Course Code : 314015**

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 Draw given complex 2D entities using relevant modify commands. TLO 3.2 Use grip command to manipulate given 2D entity.	Unit - III Modify and Edit Commands 3.1 Modify Command - Erase, trim, extend, copy, move, mirror, offset, fillet, chamfer, array, rotate, scale, lengthen, stretch, measure, break, divide, explode, align. 3.2 Editing Objects by Using Grips - Moving, Rotating, Scaling, Mirroring and Stretching.	Video Demonstrations Presentations Hands-on
4	TLO 4.1 Use various styles of dimensioning to draw 2D entities. TLO 4.2 Apply Geometric and dimension tolerance symbols on the given entity. TLO 4.3 Write text on given 2D entity. TLO 4.4 Prepare table in drawing. TLO 4.5 Prepare new template for drawing as per requirement. TLO 4.6 Plot 2D entities using proper plotting parameters.	Unit - IV Dimensioning, Text and Plot Commands 4.1 Dimensioning commands - Dimension styles, Dimensional Tolerances and Geometrical Tolerances, Modify dimension style. 4.2 Text commands - dtext, mtext command. 4.3 Insert table – table, tablestyle command. 4.4 Template Drawing- Standard template, loading template, create new template. 4.5 Plotting a drawing – adding plotter/printer, page setup, plot style commands.	Video Demonstrations Presentations Hands-on
5	TLO 5.1 Prepare the drawing by circuit builder for given situation. TLO 5.2 Apply Modify Commands TLO 5.3 Insert components in the circuits. TLO 5.4 Apply Edit commands to the circuits	Unit - V Schematic Components and Editing 5.1 Circuit builder, insert pneumatic hydraulic and PID components command. 5.2 Edit, copy, Move, Delete, Scoot, Toggle, NO/NC, Reverse connector, Retag and Swap command. 5.3 Insert-Wire, Multiple bus, 3-phase, Source arrow, Ladder. 5.4 Edit-Wire number, Wire trim, Add rung, Stretch wire, Toggle wire, Flip wire gap.	Video Demonstrations Presentations 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 Use basic commands in CADD for given situation.	1	Basic settings of CADD software	4	CO1
LLO 2.1 Use of draw commands in CADD for given drawing . LLO 2.2 Draw given 2D entities in CADD using Draw commands individually.	2	*Drawing 2-D entities like Line, Polyline, Circle, Rectangle, Polygon and Ellipse by using CADD software.	4	CO1 CO2
LLO 3.1 Use formatting commands in CADD for given drawing. LLO 3.2 Draw given 2D geometries in CADD using Draw, Edit and Modify commands.	3	Drawing simple 2-D objects using any combination of 2 or more commands, like polygon+circle, line+circle, etc.	4	CO1 CO2

COMPUTER AIDED MECHATRONICS DRAFTING**Course Code : 314015**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 4.1 Use draw commands in CADD for given objects . LLO 4.2 Draw 2D entities in CADD using Draw, Edit and Modify commands. LLO 4.3 Apply dimension and write text on 2D geometric entities for given drawing.	4	*Drawing complex 2-D objects like pulley, gear, hexagonal bolts, rivets etc.	4	CO1 CO2 CO3
LLO 5.1 Use basic setting commands in CADD for given situation. LLO 5.2 Draw given 2D entities in CADD. LLO 5.3 Apply dimension and write text on 2D geometric entities.	5	Drawing complex 2-D object like coupling, joints, valves, clamps etc.	4	CO1 CO2 CO3
LLO 6.1 Use basic construction commands in CADD for given object. LLO 6.2 Draw given 2D entities in CADD using first angle of projection . LLO 6.3 Apply dimension and write text on 2D geometric entities.	6	Drawing one problems of orthographic projections using first angle method of projection.	4	CO1 CO2 CO3
LLO 7.1 Use advance construction commands in CADD for given object. LLO 7.2 Draw 2D objects on sectional orthographic in CADD for given situation LLO 7.3 Apply dimension and write text on 2D geometric entities.	7	*Drawing one problem of sectional orthographic projections using First angle method of projection.	4	CO1 CO2 CO3
LLO 8.1 Use advance drawing commands in CADD for given drawing . LLO 8.2 Draw 2D assembly in CADD for given objects. LLO 8.3 Apply dimension and write text on given 2D geometric entities.	8	*Drawing an assembly drawing from the given detailed drawing showing assembly dimensions, part number and bill of Material.	4	CO1 CO2 CO3
LLO 9.1 Draw detailed 2D entities from given assembly in CADD. LLO 9.2 Apply dimension and write text on same 2D geometric entities.	9	Drawing working drawings from given assembly drawing showing conventional representation, dimensions, geometrical tolerances and machining symbols.	4	CO1 CO2 CO3
LLO 10.1 Draw 2D conventional representation for given parts. LLO 10.2 Apply dimension and write text on given 2D geometric entities.	10	Show conventional representation, dimensional, geometrical tolerances, surface finish symbols and bill of material in assembly drawing	4	CO1 CO2 CO3

COMPUTER AIDED MECHATRONICS DRAFTING**Course Code : 314015**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 11.1 Use basic commands in ECAD or Circuitmaker software. LLO 11.2 Draw electromechanical circuits using ECAD or Circuitmaker software.	11	*Drawing simple circuit diagram using circuit building commands.	4	CO1 CO2 CO3 CO5
LLO 12.1 Insert basic symbols in ECAD or Circuitmaker for given circuits. LLO 12.2 Draw electromechanical circuits using ECAD or Circuitmaker software.	12	Drawing and modifying simple circuit like SMPS use in computer / amplifier using Edit components command.	4	CO1 CO2 CO3 CO5
LLO 13.1 Insert electropneumatic symbols in ECAD or Circuitmaker for given circuits. LLO 13.2 Draw given electromechanical circuits using ECAD or Circuitmaker	13	*Drawing simple Electro-pneumatic circuit using insert pneumatic and PID components command.	4	CO1 CO2 CO3 CO5
LLO 14.1 Insert Electro-hydraulic symbols in ECAD or Circuitmaker for given circuits. LLO 14.2 Draw given electromechanical circuits using ECAD or Circuitmaker.	14	*Drawing simple Electro-hydraulic circuit using insert pneumatic and PID components command.	4	CO1 CO2 CO3 CO5
LLO 15.1 Use plot/page setup commands in CADD for given drawings. LLO 15.2 Create title block of the institute with institute logo.	15	Prepare a template for your institute of predefined paper size with title block and institute logo.	4	CO1 CO2 CO3 CO4
LLO 16.1 Use print and page setup commands in CADD for given drawings. LLO 16.2 Take printout of given drawings by using print/plot option.	16	*Plot the drawings from Sr. 2 to 14 on Paper with title block and institute logo	4	CO1 CO2 CO3 CO4

Note : Out of above suggestive LLOs -

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

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

- Prepare a drawing of actual machine part or a circuit diagram in the given CADD software. The students maybe assigned a machine part in a group of 4-5 students by the faculty. The student can bring any part from a nearby industry or from the institute itself. The suggested list of machine parts or circuit diagrams is given below. The list is

COMPUTER AIDED MECHATRONICS DRAFTING**Course Code : 314015**

suggestive and faculty can add any other similar micro projects. a. PCB metal box b. Switch board c. Ladder diagrams d. Domestic/ office/ institute laboratory/ Generator wiring diagram

Assignment

- Maintain a separate folder on Computer workstation allotted, in which all above mentioned practical's should be saved and will be submitted as a part of SLA.
- Collect at least one 2D drawing like production / lab or machine wiring / PLC / circuit drawings or layouts from their own institute or nearby workshops / industries / builders / contractors and develop them using computer aided drafting approach.
- Explain at least one problem drawn by the student for drafting to all batch colleagues. Teacher will assign the problem to be explained by student.
- Create groups of 5-6 students identified by the teacher. Assign different problems to each group. Assess at least one 2D drawing of one group by the students of other group and note down mistakes committed by the group. Selected students will also guide other students for correcting mistakes, if any.

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 judicious 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	Networked Licensed latest version of Computer Aided Drafting software, Autocad 2021 or latest version, Ecad.	1,2,3,4,5,6,7,8,9,10,15
2	Circuit-Maker freeware for PCB design	11,12,13,14,15
3	Plotter/Printer with latest versions (A3/A4 size) Laserjet	16
4	CAD workstation with latest configurations for each student. Microsoft Windows 10 or above, with minimum i5 Processor (2.5 GHz) , 8 GB RAM ,512 SDD	All
5	LCD projector with at least 4500 lumens and aspect ratio 16:10. OR Screen/ Interactive board.	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table) : NOT APPLICABLE**X. ASSESSMENT METHODOLOGIES/TOOLS****Formative assessment (Assessment for Learning)**

- Termwork Each practical will be assessed considering - 60% weightage to process and - 40% weightage to product Continuous assessment based on process and product related performance indicators, laboratory experience. The

COMPUTER AIDED MECHATRONICS DRAFTING**Course Code : 314015**

students maybe given actual problems from laboratories like generator wiring, hydraulic/ pneumatic circuits of any equipment in the laboratory.

Summative Assessment (Assessment of Learning)

- Practical Exam of 25 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	2	1	1	2	-	-	3			
CO2	2	1	1	2	-	-	3			
CO3	2	1	1	2	-	2	3			
CO4	2	2	2	2	2	2	3			
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	Prof. Sham Tickoo	AutoCAD 2021 for Engineers & Designers, Basic & Intermediate	BPB Publications, New Delhi 21 February 2021, ISBN: 978-9389898989
2	Sankar Prasad Dey	Autocad 2014 for Engineers Volume 1	Vikas Publications, New Delhi 21 December 2021, ISBN: 978- 9325983373
3	Prof. Sham Tickoo	AutoCAD 2024: A Problem-Solving Approach, Basic and Intermediate	Dreamtech Press publication, New Delhi August 20, 2023, ISBN:1640571778
4	Kulkarni D. M.	Engineering Graphics with AutoCAD	Prentice Hall India Learning Private Limited, New Delhi 1 January 2010, ISBN: 978-8120337831
5	CADfolks	AutoCAD 2021 For Beginners	Kishore Publication, New Delhi, 5 May 2020, ISBN: 978-8194195399
6	Luke Jumper, Randy H. Shih	AutoCAD 2024 Tutorial First Level 2D Fundamentals	SDC Publication, Kansas City USA June 27, 2023, ISBN: 978-1-63057-585-4
7	Sharad K. Pradhan, K K Jain	Engineering Graphics , AICTE Prescribed Textbook	Khanna Book Publishing, New Delhi First Edition, 1 January 2023, , ISBN:978-9391505509
8	MicroCode Engineering, Inc.	Circuitmaker User Manual	MicroCode Engineering, Inc. First edition, 1988-89

COMPUTER AIDED MECHATRONICS DRAFTING**Course Code : 314015****XIII . LEARNING WEBSITES & PORTALS**

Sr.No	Link / Portal	Description
1	https://www.cadtutor.net/	Tutorials, articles, forums and downloadable resources covering various CAD software applications.
2	https://ocw.mit.edu/courses/mechanical-engineering/	Lectures, assignments and projects covering topics such as engineering design, CAD/CAM, and product development.
3	https://www.youtube.com/watch?v=cmR9cfWJRUU	Introductory tutorial for beginners to AutoCAD, covering topics such as interface navigation, basic drawing commands and setting up units and layers.
4	https://www.youtube.com/watch?v=QuR-VKis3jU	2D mechanical drawings in AutoCAD, including drawing parts, adding dimensions, annotations and creating detailed technical drawings.
5	https://www.youtube.com/watch?v=IWYKfzx-M1E	2D mechanical drawings in AutoCAD, including drawing parts, adding dimensions and annotations, and creating detailed technical drawings.
6	https://www.youtube.com/watch?v=N5VThCFG0Bs	Complete guide for learning Circuitmaker software.
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. 21/11/2024**Semester - 4, K Scheme**

ENVIRONMENTAL EDUCATION AND SUSTAINABILITY**Course Code : 314301**

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/ Fashion & Clothing Technology/ Dress Designing & Garment Manufacturing/ 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/ Hotel Management & Catering Technology/ 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./ Travel and Tourism/ Textile Manufactures
Programme Code	: AA/ AD/ AE/ AI/ AL/ AN/ AO/ AT/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CST/ CW/ DC/ DD/ DE/ DS/ EE/ EJ/ EK/ EP/ ET/ EX/ FC/ HA/ HM/ IC/ ICE/ IE/ IF/ IH/ IS/ IX/ IZ/ LE/ ME/ MK/ ML/ MRT/ MU/ MY/ PG/ PN/ PO/ SC/ SE/ TC/ TE/ TR/ TX/
Semester	: Fourth / Sixth
Course Title	: ENVIRONMENTAL EDUCATION AND SUSTAINABILITY
Course Code	: 314301

I. RATIONALE

The survival of human beings is solely depending upon the nature. Thus, threats to the environment directly impact on existence and health of humans as well as other species. Depletion of natural resources and degradation of ecosystems is accelerated due to the growth in industrial development, population growth, and overall growth in production demand. To address these environmental issues, awareness and participation of individuals as well as society is necessary. Environmental education and sustainability provide an integrated, and interdisciplinary approach to study the environmental systems and sustainability approach to the diploma engineers.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Resolve the relevant environmental issue through sustainable solutions

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 relevant Environmental issues in specified locality.

ENVIRONMENTAL EDUCATION AND SUSTAINABILITY**Course Code : 314301**

- CO2 - Provide the green solution to the relevant environmental problems.
- CO3 - Conduct SWOT analysis of biodiversity hotspot
- CO4 - Apply the relevant measures to mitigate the environmental pollution.
- CO5 - Implement the environmental policies under the relevant legal framework.

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				
				CL	TL	LL	Practical					Based on SL												
							FA-TH					SA-TH	Total		FA-PR		SA-PR		SLA					
													Max	Max	Max	Min	Max	Min	Max	Min	Max	Min		
314301	ENVIRONMENTAL EDUCATION AND SUSTAINABILITY	EES	VEC	3	-	-	1	4	2	1.5	30	70*#	100	40	-	-	-	-	25	10	125			

Total IKS Hrs for Sem. : 2 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.
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ENVIRONMENTAL EDUCATION AND SUSTAINABILITY**Course Code : 314301**

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 need of studying environment and its components. TLO 1.2 Investigate the impact of population growth and industrialization on the relevant environmental issues and suggest remedial solutions TLO 1.3 Explain the Concept of 5 R w.r.t. the given situation TLO 1.4 Elaborate the relevance of Sustainable Development Goals in managing the climate change TLO 1.5 Explain the concept of zero carbon-footprint with carbon credit	Unit - I Environment and climate change 1.1 Environment and its components, Types of Environments, Need of environmental studies 1.2 Environmental Issues- Climate change, Global warming, Acid rain, Ozone layer depletion, nuclear accidents. Effect of population growth and industrialization 1.3 Concept of 5R, Individuals' participation in i) 5R policy, ii) segregation of waste, and iii) creating manure from domestic waste 1.4 Impact of Climate change, Factors contributing to climate change, Concept of Sustainable development, Sustainable development Goals (SDGs), Action Plan on Climate Change in Indian perspectives 1.5 Zero Carbon footprint for sustainable development, (IKS-Environment conservation in vedic and pre-vedic India)	Lecture Using Chalk-Board Presentations
2	TLO 2.1 Justify the importance of natural resources in sustainable development TLO 2.2 Explain the need of optimum use of natural resources to maintain the sustainability TLO 2.3 Differentiate between renewable and non-renewable sources of energy TLO 2.4 Suggest the relevant type of energy source as a green solution to environmental issues	Unit - II Sustainability and Renewable Resources 2.1 Natural Resources: Types, importance, Causes and effects of depletion. (Forest Resources, Water Resources, Energy Resources, Land resources, Mineral resources), (IKS- Concepts of Panchmahabhuta) 2.2 Impact of overexploitation of natural resources on the environment, optimum use of natural resources 2.3 Energy forms (Renewable and non-renewable) such as Thermal energy, nuclear energy, Solar energy, Wind energy, Geothermal energy, Biomass energy, Hydropower energy, biofuel 2.4 Green Solutions in the form of New Energy Sources such as Hydrogen energy, Ocean energy & Tidal energy	Lecture Using Chalk-Board Presentations
3	TLO 3.1 Explain the characteristics and functions of ecosystem TLO 3.2 Relate the importance of biodiversity and its loss in the environmental sustainability TLO 3.3 Describe biodiversity assessment initiatives in India TLO 3.4 Conduct the SWOT analysis of the biodiversity hot spot in India TLO 3.5 Explain the need of conservation of biodiversity in the given situation	Unit - III Ecosystem and Biodiversity 3.1 Ecosystem - Definition, Aspects of ecosystem, Division of ecosystem, General characteristics of ecosystem, Functions of ecosystem 3.2 Biodiversity - Definitions, Levels, Value, and loss of biodiversity 3.3 Biodiversity Assessment Initiatives in India 3.4 SWOT analysis of biodiversity hot spot in India 3.5 Conservations of biodiversity - objects, and laws for conservation of biodiversity	Lecture Using Chalk-Board Presentations Video Demonstrations

ENVIRONMENTAL EDUCATION AND SUSTAINABILITY**Course Code : 314301**

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 Classify the pollution based on the given criteria TLO 4.2 Justify the need of preserving soil as a resource along with the preservation techniques TLO 4.3 Maintain the quality of water in the given location using relevant preventive measures TLO 4.4 State the significance of controlling the air pollution to maintain its ambient quality norms TLO 4.5 Compare the noise level from different zones of city with justification TLO 4.6 Describe the roles and responsibilities of central and state pollution control board	Unit - IV Environmental Pollution 4.1 Definition of pollution, types- Natural & Artificial (Man- made) 4.2 Soil / Land Pollution – Need of preservation of soil resource, Causes and effects on environment and lives, preventive measures, Soil conservation 4.3 Water Pollution - sources of water pollution, effects on environment and lives, preventive measures, BIS water quality standards for domestic potable water, water conservation 4.4 Air pollution - Causes, effects, prevention, CPCB norms of ambient air quality in residential area 4.5 Noise pollution - Sources, effects, prevention, noise levels at various zones of the city 4.6 Pollution Control Boards at Central and State Government level: Norms, Roles and Responsibilities	Lecture Using Chalk-Board Presentations
5	TLO 5.1 Explain Constitutional provisions related to environmental protection TLO 5.2 Explain importance of public participation (PPP) in enacting the relevant laws TLO 5.3 Use the relevant green technologies to provide sustainable solutions of an environmental problem TLO 5.4 Explain the role of information technology in environment protection	Unit - V Environmental legislation and sustainable practices 5.1 Article (48-A) and (51-A (g)) of Indian Constitution regarding environment, Environmental protection and prevention acts 5.2 Public awareness about environment. Need of public awareness and individuals' participation. Role of NGOs 5.3 Green technologies like solar desalination, green architecture, vertical farming and hydroponics, electric vehicles, plant-based packaging 5.4 Role of information technology in environment protection and human health	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)****Assignment**

- Suggest the steps to implement (or improve the implementation) of the 5R policy in your home/institute stating your contribution
- Draft an article on India's Strategies to progress across the Sustainable Development Goals
- Make a chart of Renewable and non-renewable energy sources mentioning the advantages and disadvantages of each

ENVIRONMENTAL EDUCATION AND SUSTAINABILITY**Course Code : 314301**

source

Conduct the SWOT analysis of biodiversity hotspot in India

Prepare a mind-mapping for the zero carbon footprint process of your field

Prepare a chart showing sources of pollution (air/water/ soil), its effect on human beings, and remedial actions

Any other assignment on relevant topic related to the course suggested by the facilitator

UNICEF Certification(s)

- Students may complete the self-paced course launched by Youth Leadership for climate Exchange under UNICEF program on portal www.mahayouthnet.in. The course encompasses five Modules in the form of Units as given below:

Unit 1: Living with climate change

Unit 2 : Water Management and Climate Action

Unit 3: Energy Management and Climate Action

Unit 4 : Waste Management and Climate Action

Unit 5 : Bio-cultural Diversity and Climate Action

If students complete all the five Units they are not required to undertake any other assignment /Microproject/activities specified in the course. These units will suffice to their evaluations under SLA component

Micro project

- Technical analysis of nearby commercial RO plant.

Comparative study of different filters used in Household water filtration unit

Evaluate any nearby biogas plant / vermicomposting plant or any such composting unit on the basis of sustainability and cost-benefit

IKS-Study and prepare a note on Vedic and Pre-Vedic techniques of environmental conservation

Visit a local polluted water source and make a report mentioning causes of pollution

Any other activity / relevant topic related to the course suggested by the facilitator

Activities

- Prepare a report on the working and functions of the PUC Center machines and its relevance in pollution control.

Prepare and analyse a case study on any polluted city of India

Prepare a note based on the field visit to the solid waste management department of the municipal corporation / local authority

Record the biodiversity of your institute/garden in your city mentioning types of vegetation and their numbers

Visit any functional hall/cultural hall /community hall to study the disposal techniques of kitchen waste and prepare a report suggesting sustainable waste management tool

Watch a video related to air pollution in India and present the summary

Any other assignment on relevant topic related to the course suggested by the facilitator

ENVIRONMENTAL EDUCATION AND SUSTAINABILITY**Course Code : 314301****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 judicious 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 may be considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Nil	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	Environment and climate change	CO1	8	4	4	4	12
2	II	Sustainability and Renewable Resources	CO2	10	4	4	8	16
3	III	Ecosystem and Biodiversity	CO3	8	4	4	4	12
4	IV	Environmental Pollution	CO4	12	4	8	6	18
5	V	Environmental legislation and sustainable practices	CO5	7	4	4	4	12
Grand Total				45	20	24	26	70

X. ASSESSMENT METHODOLOGIES/TOOLS**Formative assessment (Assessment for Learning)**

- Two-unit tests (MCQs) of 30 marks will be conducted and average of two-unit tests considered. Formative assessment of self learning of 25 marks should be assessed based on self learning activity such as UNICEF Certification(s)/Microproject/assignment/activities. (60 % weightage to process and 40 % to product)

Summative Assessment (Assessment of Learning)

- Online MCQ type Exam

XI. SUGGESTED COS - POS MATRIX FORM

ENVIRONMENTAL EDUCATION AND SUSTAINABILITY**Course Code : 314301**

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	-	-	3	2	3			
CO2	-	2	2	-	3	2	3			
CO3	-	-	-	-	3	1	2			
CO4	1	-	-	-	3	2	2			
CO5	1	-	2	-	3	2	3			
Legends :- High:03, Medium:02,Low:01, No Mapping: - *PSOs are to be formulated at institute level										

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Y. K. Singh	Environmental Science	New Age International Publishers, 2006, ISBN: 81-224-2330-2
2	Erach Bharucha	Environmental Studies	University Grants Commission, New Delhi
3	Rajagopalan R.	Environmental Studies: From Crisis to Cure.	Oxford University Press, USA, ISBN: 9780199459759, 0199459754
4	Shashi Chawla	A text book of Environmental Science	Tata Mc Graw-Hill New Delhi
5	Arvind Kumar	A Text Book of Environmental science	APH Publishing New Delhi (ISBN 978-8176485906)

XIII. LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://sdgs.un.org/goals	United Nation's website mentioning Sustainability goals
2	http://www.greenbeltmovement.org/news-and-events/blog	Green Belt Movement Blogs on various climatic changes and other issues
3	http://www.greenbeltmovement.org/what-we-do/tree-planting-for-watersheds	Green Belt Movement's work on tree plantation, soil conservation and watershed management techniques
4	https://www.youtube.com/@ierekcompany/videos	International Experts For Research Enrichment and Knowledge Exchange –IEREK's platform to exchange the knowledge in fields such as architecture, urban planning, sustainability
5	www.mahayouthnet.in	UNICEF Initiative for youth leadership for climate action

ENVIRONMENTAL EDUCATION AND SUSTAINABILITY**Course Code : 314301**

Sr.No	Link / Portal	Description
6	https://eepmoefcc.nic.in/index1.aspx?lsid=297&lev=2&lid=1180&langid=1	GOI Website for public awareness on environmental issues
7	https://egyankosh.ac.in/handle/123456789/61136	IGNOU's Initiative for online study material on Environmental studies
8	https://egyankosh.ac.in/handle/123456789/50898	IGNOU's Initiative for online study material on sustainability
9	https://sustainabledevelopment.un.org/content/documents/11803Official-List-of-Proposed-SDG-Indicators.pdf	Final list of proposed Sustainable Development Goal indicators
10	https://sustainabledevelopment.un.org/memberstates/india	India's Strategies to progress across the SDGs.
11	https://www.un.org/en/development/desa/financial-crisis/sustainable-development.html	Challenges to Sustainable Development
12	https://nptel.ac.in/courses/109105190	NPTEL course on sustainable development
13	https://onlinecourses.swayam2.ac.in/cec19_bt03/preview	Swayam Course on Environmental studies (Natural Resources, Biodiversity and other topics)
14	https://onlinecourses.nptel.ac.in/noc23_hs155/preview	NPTEL course on environmental studies which encompasses SDGs, Pollution, Climate issues, Energy, Policies and legal framework
15	https://www.cbd.int/development/meetings/egmbped/SWOT-analysis-en.pdf	SWOT analysis of Biodiversity
16	https://www.sanskrit.nic.in/SVimarsha/V2/c17.pdf	Central Sanskrit University publication on Vedic and pre Vedic environmental conservation

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. 21/11/2024**Semester - 4 / 6, K Scheme**

CONTROL SYSTEMS**Course Code : 314337**

Programme Name/s : Mechatronics
Programme Code : MK
Semester : Fourth
Course Title : CONTROL SYSTEMS
Course Code : 314337

I. RATIONALE

Control systems aims to maintain desired outputs or conditions by adjusting inputs which ensures that a system behaves in a predictable and desired manner. As a result, the control systems are widely gaining importance in industrial automation, production, robotics, and many other fields. This course will facilitate students to understand and apply the concepts, principles, and procedures of controlling various parameters in different processes used in industry as well as day to day life.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Maintain the mechatronics control systems in 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 - Interpret the type of control system.
- CO2 - Analyse the given control system for standard test input signal.
- CO3 - Examine the stability of given control system.
- CO4 - Use different control action for controlling various processes.
- CO5 - Maintain different servo system components in 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	
314337	CONTROL SYSTEMS	CSS	DSC	3	-	2	1	6	3	3	30	70	100	40	25	10	-	-	25	10	150		

CONTROL SYSTEMS**Course Code : 314337****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 Identify the given control system. TLO 1.2 Distinguish between the different types of control system. TLO 1.3 Determine transfer function of given control system. TLO 1.4 Optimize the transfer function of given system using block diagram reduction rules.	Unit - I Overview of Control Systems 1.1 Control System: Definition, block diagram 1.2 Types of Control System a) Open loop system: Block diagram, working, examples b) Closed loop system: Block diagram, working, examples c) Linear and Nonlinear system: Definition, examples d) Time Variant System and Invariant system: Definition, examples 1.3 Transfer Function: Definition, Transfer function of electrical circuits (RL, RC, LC & RLC circuits) using Laplace Transform 1.4 Block diagram reduction technique: Need, block diagram reduction rules, and numericals	Demonstration Lecture using Chalk-Board
2	TLO 2.1 Interpret time response of given control system. TLO 2.2 List the standard test input along with their laplace transform. TLO 2.3 Interpret time response of first order control system. TLO 2.4 Draw a labelled time response of second order system.	Unit - II Time Domain Analysis 2.1 Time Domain Analysis: Transient and steady state response. concept of poles, zeros, characteristics equation, order of system with numericals 2.2 Standard Test Inputs: Step, ramp, parabolic and impulse input (mathematical equation, response and their transfer function) 2.3 First Order System: Analysis for unit step input and their response 2.4 Second Order System: For unit step input (no derivation) and their response, effect of damping on system stability 2.5 Time Response Specifications: Peak time, rise time, settling time, delay time, peak overshoot (no derivation) and numericals	Lecture using Chalk-Board Hands-on Collaborative learning

CONTROL SYSTEMS**Course Code : 314337**

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 List the types of system based on stability. TLO 3.2 Determine stability based on the location of poles in S-plane. TLO 3.3 Examine stability by using Routh's criterion. TLO 3.4 Determine the range of 'k' for conditionally stable system.	Unit - III Stability Analysis 3.1 Stability: Definition, types of system based on stability 3.2 Types of Stability: Absolute and Relative Stability. Stability analysis using location of poles in S-plane 3.3 Routh's Stability Criterion: Routh's array, statement, special cases. Stability analysis using Routh Array 3.4 Application of Routh's criterion: Determination of 'K' for conditional stability	Lecture using Chalk-Board Case Study Hands-on
4	TLO 4.1 Explain process control system with labelled diagram. TLO 4.2 Classify different control actions. TLO 4.3 Compare different control action modes on the basis of its different parameters.	Unit - IV Process Controllers and Control Actions 4.1 Process Control System: Block diagram, working 4.2 Control Action Mode: Definition, classifications 4.3 Discontinuous Mode: ON-OFF control action mode, output equation, operation, Neutral zone 4.4 Continuous Mode: Proportional, Integral, Derivative control actions (output equations, operation, responses and their applications only) 4.5 Composite Control Actions: a) PI Control action b) PD control action c) PID control action (output equation, operation and their responses only)	Lecture using Chalk-Board Case Study Demonstration
5	TLO 5.1 Describe the function of servo system along with its importance in control system. TLO 5.2 Describe working of different servo components for using as an error detector. TLO 5.3 Differentiate between AC servomotor, DC servomotor and stepper motor. TLO 5.4 Differentiate between AC and DC position control system.	Unit - V Servo Systems and Components 5.1 Servo System: Definition, block diagram, working 5.2 Servo Components: a) Potentiometer: construction, working, potentiometer as an error detector b) Synchro: construction, working, synchro as an error detector c) Rotary encoder: types, working, applications 5.3 Servo Motors: a) Servo motor: types, working, applications b) Stepper motor: types, working, applications 5.4 Position Control Systems: a) AC position control: block diagram and working b) DC position control: block diagram and working	Lecture using Chalk-Board Collaborative learning Demonstration

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 open loop system available in laboratory. LLO 1.2 Demonstrate the working of open loop system available in laboratory.	1	Interpretation of open loop control system using traffic light controller or any open loop system available in laboratory	2	CO1

CONTROL SYSTEMS**Course Code : 314337**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 2.1 Identify closed loop system available in laboratory. LLO 2.2 Measure the various parameters for the closed loop temperature control system available in laboratory.	2	* Interpretation of close loop control system using temperature control system	2	CO1
LLO 3.1 Identify any open source software for control system. LLO 3.2 Implement given system using identified software.	3	Determination of transfer function and order of given system by using open-source or any other software	2	CO1
LLO 4.1 Implement given system using the open source software to identify poles and zeros.	4	Determination of poles and zeros of given transfer function by using open-source or any other software	2	CO2
LLO 5.1 Identify order of given control system. LLO 5.2 Verify the time response of identified system for standard test inputs.	5	* Interpretation of response of first order R-C circuit for the different standard inputs (any relevant software may also be used for implementation)	2	CO2
LLO 6.1 Identify order of given control system. LLO 6.2 Verify the time response of identified system for standard test inputs.	6	Interpretation of response of second order R-L-C circuit for the different standard inputs (any relevant software may also be used for implementation)	2	CO2
LLO 7.1 Determine the stability of given system using Routh's stability criteria.	7	* Verification of Routh's stability criteria of given control system by using open-source or any other software	2	CO3
LLO 8.1 Find the range of 'K' for conditionally stable system using Routh's criteria.	8	Determination of range of 'K' for deciding conditional stability of given control system using Routh's criteria	2	CO3
LLO 9.1 Identify the type of controller for given experiment. LLO 9.2 Verify the response of identified controller in the laboratory.	9	* Interpretation of characteristics of P/PI/PD controller for controlling the given process. (Any relevant software may also be used for implementation)	2	CO3
LLO 10.1 Identify the type of controller for given experiment. LLO 10.2 Verify the response of the PID controller.	10	* Interpretation of characteristics of PID controller for controlling the given process. (Any relevant software may also be used for implementation)	2	CO4
LLO 11.1 Connect potentiometers for using as an error detector. LLO 11.2 Determine the differential voltage between potentiometers.	11	* Interpretation of characteristics of potentiometer as an error detector	2	CO5
LLO 12.1 Use synchro as an error detector. LLO 12.2 Calculate the error voltage between potentiometers.	12	* Interpretation of characteristics of synchro as an error detector	2	CO5

CONTROL SYSTEMS**Course Code : 314337**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 13.1 Use AC servo system for position control. LLO 13.2 Calculate the angular position control of AC servo system.	13	* Determination of angular position of AC servo system	2	CO5
LLO 14.1 Use DC servo system for position control. LLO 14.2 Calculate the angular position control of DC servo system.	14	Determination of angular position of DC servo system	2	CO5
LLO 15.1 Use Stepper motor as servo component. LLO 15.2 Count the pulses of stepper motor required to complete one rotation.	15	Using stepper motor as servo system component for position control system	2	CO5

Note : Out of above suggestive LLOs -

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

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

- Prepare a chart on comparison of different control actions in control system
- Prepare a chart of standard test inputs used in control system and steady state errors for given standard test inputs. Prepare a brief presentation along with report on it
- Prepare a chart of rules for block diagram reduction techniques and prepare a brief presentation along with report on it
- Perform market survey for availability of different servo components and prepare a report
- Perform simulation on any open source Virtual Labs on following topics and write a report on it a. Temperature control system b. Two Tank Water Level control c. Study of DC Motor d. Study and operation of the DC Speed and Position control setup e. Simulation of Control Systems

Micro project

- Simulate On-Off temperature and flow control loop system using process control simulator
- Build/ Test Potentiometer as an error detector
- Survey or Visit automation industry using PLC/SCADA/DCS/HMI system and prepare detailed report on it
- Build/ Test an automatic feedback temperature control system
- Build/ Test an automatic feedback water level control system
- Build/ Test an RC circuit and check its output response
- Build/ Test an RLC circuit and check its output response
- Prepare a report of Simulation on PI -control action on a given system for given step input and set point. Obtain the effect on output varying K_p , K_i , K_d of the system
- Prepare a report of Simulation on PD-control action on a given system for given step input and set point. Obtain the effect on output varying K_p , K_i , K_d of the system

Assignment

CONTROL SYSTEMS**Course Code : 314337**

- Identify and classify the control systems available in control system laboratory
- Prepare a report and presentation on stability analysis based on special cases

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 judicious 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	Traffic Light control system setup with red, yellow and green lights	1
2	Potentiometer as an error detector trainer kit	11
3	Characteristics of synchro Transmitter	12
4	AC Position control system	13
5	DC Position control system	14
6	Stepper motor trainer kit	15
7	ON-OFF controller: Heater, Temperature sensor and Relay	2
8	Softwares like SCILAB or MATLAB or MULTISIM or NI	3,4,5,6,7,8,9,10
9	Standard test signal generator kit : Step, Ramp and Parabolic signals. 1) First Order trainer 2) Second order trainer	5,6
10	Proportional PI, PD, PID controller and control system setup with ON-OFF Temperature control using PID Trainer	9,10
11	Cathode ray oscilloscope: Dual trace 50MHz	All
12	Multimeter 3 1/2 Digit: AC/DC, 0-200 V	All

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

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Overview of Control Systems	CO1	10	4	4	6	14
2	II	Time Domain Analysis	CO2	11	4	4	8	16
3	III	Stability Analysis	CO3	10	4	4	6	14
4	IV	Process Controllers and Control Actions	CO4	6	2	4	4	10
5	V	Servo Systems and Components	CO5	8	4	6	6	16
Grand Total				45	18	22	30	70

X. ASSESSMENT METHODOLOGIES/TOOLS

CONTROL SYSTEMS**Course Code : 314337****Formative assessment (Assessment for Learning)**

- Continuous assessment based on process and product related performance indicators. Each practical will be assessed considering: -60% weightage to process -40% weightage to product

Summative Assessment (Assessment of Learning)

- End of Term Examination (Theory)

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	3	3	-	-	2			
CO2	3	3	3	3	-	-	2			
CO3	3	3	3	-	-	-	2			
CO4	3	-	-	3	2	2	3			
CO5	3	2	2	3	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	I. J. Nagrath & M. Gopal	Control System Engineering	New Age International Publishers, 2021, ISBN: 978-8195175581
2	K. Ogata	Modern Control Engineering	PHI, New Delhi (5th Edition), 2008, ISBN: 978-8131703118
3	C. D. Johnson	Process Control Instrumentation Technology	PHI Learning, 2015, ISBN: 978-9332549456
4	A. Anand Kumar	Control Systems	PHI (2nd Edition), 2014, ISBN: 978-8120349391
5	K.P. Ramchandran	Control Engineering	Willey India, Delhi, 2011 , ISBN: 978-8126522880,
6	Rajeev Gupta	Control System Engineering	NISE's, Willey India, 2018 ISBN: 8126571837
7	S.P. Eugene Xavier, Joseph Cyril Babu, J.	Principles of Control System	S. Chand, New Delhi, 2004, ISBN: 978-8121917780

CONTROL SYSTEMS**Course Code : 314337****XIII . LEARNING WEBSITES & PORTALS**

Sr.No	Link / Portal	Description
1	https://www.tutorialspoint.com/control_systems/control_systems_introduction.htm	Control Systems - Introduction
2	https://www.tutorialspoint.com/control_systems/control_systems_quick_guide.htm	Control Systems - Quick Guide
3	https://www.tutorialspoint.com/control_systems/control_systems_feedback.htm	Control Systems - Feedback
4	https://www.tutorialspoint.com/control_systems/control_systems_mathematical_models.htm	Control Systems - Mathematical Models
5	https://www.tutorialspoint.com/control_systems/control_systems_block_diagrams.htm	Control Systems - Block Diagrams
6	https://www.tutorialspoint.com/control_systems/control_systems_time_domain_specifications.htm	Time Domain Specifications
7	https://electronicscoach.com/time-domain-analysis-of-control-system.html	Time Domain Analysis of Control System
8	https://www.tutorialspoint.com/control_systems/control_systems_stability.htm	Control Systems - Stability
9	https://www.tutorialspoint.com/control_systems/control_systems_controllers.htm	Control Systems - Controllers
10	https://www.electrical4u.com/types-of-controllers-proportional-integral-derivative-controllers/	Types of controllers
11	https://en.wikipedia.org/wiki/Servomechanism	Servo Systems
12	https://www.utmel.com/blog/categories/motors/introduction-to-servo-system	Servo Systems
13	https://www.scilab.org	SCILAB Software
14	https://www.mathworks.com/products/matlab.html	MATLAB Software
15	https://www.multisim.com	Multisim Software
16	https://www.youtube.com/watch?v=ApMz1-MK9IQ	MATLAB Practice
17	http://vlabs.iitkgp.ac.in/gps/ctrl/index.html	Virtual Labs
18	https://www.ni.com/en/support/downloads/software-products/download.multisim.html	NI MULTISIM Software

Note :

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MSBTE Approval Dt. 21/11/2024**Semester - 4, K Scheme**

EMBEDDED SYSTEM USING 'C'**Course Code : 314338**

Programme Name/s : Mechatronics
Programme Code : MK
Semester : Fourth
Course Title : EMBEDDED SYSTEM USING 'C'
Course Code : 314338

I. RATIONALE

Embedded system has become an integral part of various mechatronics systems such as robotics, industrial automation, smart appliances etc. This course will make students proficient and enable them to develop and maintain various embedded systems.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Develop various embedded system applications in mechatronics.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Classify the different types of embedded systems.
- CO2 - Use embedded 'C' language for programming 8051 microcontroller.
- CO3 - Interpret the communication protocols of embedded systems.
- CO4 - Develop embedded 'C' programs for Input/Output devices.
- CO5 - Develop basic embedded system applications.

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	Min	Max	Min	Max	Min	Max	Min			
314338	EMBEDDED SYSTEM USING 'C'	ESC	AEC	3	-	4	1	8	4	3	30	70	100	40	25	10	-	-	25	10	150		

EMBEDDED SYSTEM USING 'C'**Course Code : 314338****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 block diagram of embedded system with it's characteristics. TLO 1.2 Classify the Embedded Systems. TLO 1.3 Distinguish between Von-Neumann and Harvard architecture. TLO 1.4 Explain the features and pin configuration of 8051 microcontroller. TLO 1.5 Explain power-saving options of 8051.	Unit - I Overview of Embedded System 1.1 Block diagram of embedded system with hardware components 1.2 Characteristics of Embedded System: Processor power, memory, operating system, reliability, performance, power consumption, NRE cost, unit cost, size, flexibility, time-to prototype, time-to-market, maintainability, correctness and safety 1.3 Classification of Embedded System: Small scale, medium scale, sophisticated, stand-alone, reactive /real time (soft and hard real time) 1.4 Von-Neumann and Harvard architecture 1.5 8051 microcontroller: Features, pin configuration 1.6 8051 as a Boolean processor, Power-saving options- Idle and power down mode	Lecture using Chalk-Board Presentations Video Demonstrations
2	TLO 2.1 List the various datatypes in Embedded 'C'. TLO 2.2 Develop embedded 'C' program for arithmetic, logical and data transfer operations. TLO 2.3 Develop embedded 'C' program using timer. TLO 2.4 Develop embedded 'C' program for serial transmission and reception. TLO 2.5 Explain the 8051 interrupts.	Unit - II 8051 Programming using Embedded 'C' 2.1 Embedded C: Data types, decision control and looping 2.2 8051 Microcontroller programming in embedded C: Arithmetic and logical operations, data transfer on Input/ Output ports 2.3 Timer/Counters: TMOD, TCON, Timer/Counter modes and 'C' programs for Timer/Counter 2.4 Serial communication: SCON, SBUF, modes of serial communication, 'C' programs for serial communication 2.5 Interrupts: 8051 interrupts, IE and IP SFRs	Lecture using Chalk-Board Presentations Video Demonstrations

EMBEDDED SYSTEM USING 'C'**Course Code : 314338**

Sr.No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Compare serial vs. parallel communication and synchronous vs. asynchronous communication. TLO 3.2 Explain the serial communication protocol. TLO 3.3 Describe the important features of advanced serial protocols.	Unit - III Communication Standards and Protocols 3.1 Modes of data communication: Serial, parallel, synchronous and asynchronous communication 3.2 Serial communication standard RS232 (DB9) 3.3 Serial communication protocols: I2C, CAN, Serial Peripheral Interface (SPI) 3.4 Features of advanced serial protocols: IrDA, Bluetooth, Zigbee	Lecture using Chalk-Board Presentations Video Demonstrations
4	TLO 4.1 Develop 'C' program for interfacing switch and LED. TLO 4.2 Develop 'C' program for interfacing a relay. TLO 4.3 Develop 'C' program for interfacing 7-segment LED display. TLO 4.4 Explain interfacing of 16X2 LCD with 8051. TLO 4.5 Explain interfacing of ADC 0808 with 8051. TLO 4.6 Develop 'C' program for generating square wave and triangular wave.	Unit - IV Interfacing of Input and Output Devices with 8051 4.1 Interfacing of switch, LED and it's programming in 'C' 4.2 Interfacing of relay and it's programming in 'C' 4.3 Interfacing and 'C' programming of single 7-segment LED display 4.4 16 x 2 LCD interfacing with 8051 and it's programming in 'C' 4.5 Interfacing of ADC 0808. 'C' program to convert analog signal into digital 4.6 Interfacing of DAC 0808 and 'C' program to generate square wave and triangular wave	Lecture using Chalk-Board Presentations Video Demonstrations Demonstration
5	TLO 5.1 Develop 'C' program for rotating DC motor and servo motor interfaced with 8051. TLO 5.2 Develop 'C' program for rotating stepper motor in clockwise and anticlockwise direction. TLO 5.3 Develop 'C' program for obstacle detection using IR sensor. TLO 5.4 Develop 'C' program for motion detection using PIR sensor.	Unit - V Applications of 8051 Microcontroller 5.1 Interfacing of DC motor and servo motor, it's programming in 'C' 5.2 Interfacing of stepper motor and 'C' program to rotate the stepper motor 5.3 Interfacing of IR sensor and simple 'C' program for obstacle detection 5.4 Interfacing of PIR sensor and simple 'C' program for motion detection	Lecture using Chalk-Board Presentations Video Demonstrations Demonstration

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 blocks of 8051 microcontroller development board. LLO 1.2 Connect the development board to PC.	1	*Identification of various blocks of 8051 microcontroller development board	2	CO1

EMBEDDED SYSTEM USING 'C'**Course Code : 314338**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 2.1 Install Integrated Development Environment (IDE) tool for 8051 microcontroller. LLO 2.2 Use IDE tool.	2	*Integrated Development Environment tool for 8051 microcontroller	2	CO2
LLO 3.1 Develop C program for input/output operation over port pins. LLO 3.2 Simulate the program.	3	*Development of embedded 'C' program to accept data from P1 pins and send it out on P2 pins	2	CO2
LLO 4.1 Develop C program for various arithmetic operations. LLO 4.2 Simulate the program for arithmetic operations.	4	*Development of embedded 'C' program for various arithmetic operations	2	CO2
LLO 5.1 Develop 'C' program for various logical operations. LLO 5.2 Simulate the program for logical operations.	5	Development of embedded 'C' program for various logical operations	2	CO2
LLO 6.1 Develop 'C' program for port operations. LLO 6.2 Simulate the program port operations.	6	Development of embedded 'C' program to accept number from P1 and P2 pins and send out greater number on P3 pins	2	CO2
LLO 7.1 Develop 'C' program for block transfer. LLO 7.2 Simulate the program for block transfer.	7	*Development of embedded 'C' program for block transfer	2	CO2
LLO 8.1 Develop 'C' program for generation of square wave without using timer over port pin. LLO 8.2 Simulate the program for square wave generation.	8	Development of embedded 'C' program for generation of square wave over port pin without using timer	2	CO2
LLO 9.1 Develop 'C' program for generation of square wave using timer over port pin. LLO 9.2 Simulate the program for square wave generation.	9	*Development of embedded 'C' program for square wave generation over port pin using 8051 timer	2	CO2
LLO 10.1 Develop 'C' program to transmit a character 'Y' on Tx pin. LLO 10.2 Simulate the program for transmitting a character.	10	Development of C program to transmit a character 'Y' on Tx pin	2	CO2
LLO 11.1 Develop 'C' program for transmitting the message. LLO 11.2 Simulate the program for transmitting the message.	11	*Development of 'C' program for transmitting the message "WELCOME" on serial port	2	CO2
LLO 12.1 Identify the pins of DB9 connector. LLO 12.2 Connect DB9 connector to PC using MAX232 IC.	12	*Interfacing of RS232 (DB9) connector to PC using MAX232 IC	2	CO3

EMBEDDED SYSTEM USING 'C'**Course Code : 314338**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 13.1 Develop 'C' program for LED blinking. LLO 13.2 Execute the above program to demonstrate on hardware.	13	Interfacing of LED with 8051 and development of 'C' program for LED blinking	2	CO4
LLO 14.1 Develop 'C' program to turn ON the LED by pressing a switch. LLO 14.2 Execute the above program to demonstrate on hardware.	14	*Development of 'C' program for turning ON the LED by pressing a switch	2	CO4
LLO 15.1 Develop 'C' program for toggling 8 LEDs. LLO 15.2 Execute the above program to demonstrate on hardware.	15	Interfacing of eight LEDs with 8051 and development of 'C' program for toggling them continuously	2	CO4
LLO 16.1 Develop 'C' program for controlling a lamp interfaced with 8051 microcontroller through a relay. LLO 16.2 Execute the above program to demonstrate on hardware.	16	*Development of 'C' program for controlling a lamp interfaced with 8051 microcontroller through a relay	2	CO4
LLO 17.1 Develop 'C' program for 7-segment LED display. LLO 17.2 Execute the above program to demonstrate on hardware.	17	*Development of 'C' program for single digit up- counter (0-9) using 7-segment LED display	2	CO4
LLO 18.1 Develop 'C' program for 7-segment LED display. LLO 18.2 Execute the above program to demonstrate on hardware.	18	Development of 'C' program to display characters 'A','B','C','D','E','F' on 7-segment LED display	2	CO4
LLO 19.1 Develop 'C' program for displaying a message on the 16 x 2 LCD. LLO 19.2 Execute the above program to demonstrate on hardware.	19	*Development of 'C' program for displaying a message "Welcome" on the 16 x 2 LCD	2	CO4
LLO 20.1 Develop 'C' program to check the occurrence of an external interrupt 0. LLO 20.2 Execute the above program to demonstrate on hardware.	20	Development of 'C' program to turn 'ON' the LED when an external interrupt 0 occurs	2	CO4
LLO 21.1 Develop 'C' program for square waveform generation using DAC. LLO 21.2 Execute the above program to demonstrate on hardware.	21	*Development of 'C' program for generation of square waveform using DAC	2	CO4
LLO 22.1 Develop 'C' program for triangular waveform generation using DAC. LLO 22.2 Execute the above program to demonstrate on hardware.	22	Development of 'C' program for generation of triangular waveform using DAC	2	CO4

EMBEDDED SYSTEM USING 'C'**Course Code : 314338**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 23.1 Develop 'C' program for ADC. LLO 23.2 Execute the above program to demonstrate on hardware.	23	Development of 'C' program for converting the analog signal into digital form using an ADC	2	CO4
LLO 24.1 Develop 'C' program for DC motor to rotate the motor in clockwise direction. LLO 24.2 Execute the above program to demonstrate on hardware.	24	*Development of 'C' program to rotate the DC motor in clockwise direction	2	CO5
LLO 25.1 Develop 'C' program for DC motor to rotate in anticlockwise direction. LLO 25.2 Execute the above program to demonstrate on hardware.	25	Development of 'C' program to rotate the DC motor in anticlockwise direction	2	CO5
LLO 26.1 Develop 'C' program for stepper motor to rotate in clockwise and anticlockwise direction. LLO 26.2 Execute the above program to demonstrate on hardware.	26	Development of 'C' program to rotate the stepper motor in clockwise and anticlockwise direction	2	CO5
LLO 27.1 Develop 'C' program to rotate the stepper motor by 180 degrees. LLO 27.2 Execute the above program to demonstrate on hardware.	27	*Development of 'C' program to rotate the stepper motor by 180 degrees	2	CO5
LLO 28.1 Develop 'C' program to rotate servo motor by specified angle. LLO 28.2 Execute the above program to demonstrate on hardware.	28	Development of 'C' program for rotating the servo motor by specified angle	2	CO5
LLO 29.1 Develop 'C' program for IR sensor. LLO 29.2 Execute the above program to demonstrate on hardware.	29	*Development of 'C' program to turn on the LED when an obstacle is detected by IR sensor	2	CO5
LLO 30.1 Develop 'C' program for PIR sensor. LLO 30.2 Execute the above program to demonstrate on hardware.	30	Development of 'C' program to turn on the LED when motion is detected by PIR sensor	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**

- Build a circuit to blink LEDs in different patterns.
- Build 8051 based system for speed control of DC motor.

EMBEDDED SYSTEM USING 'C'**Course Code : 314338**

- Build a circuit using LCD to display name in rolling fashion.
- Build 8051 based product counter.
- Build an automated door controlled system.
- Build a countdown timer using LED 7-segment display.

Activities

- Prepare a report on different sensors used in mechatronics industry.
- Write a report on different types of robots.
- Conduct an internet survey on different Arduino boards and prepare a report on it.
- Prepare a report on different motors used in mechatronics industry.
- Prepare a chart on applications of embedded system in mechatronics.

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 judicious 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	8051 Microcontroller Development Board- single board system with 8K RAM, ROM/Flash memory with battery backup, 16x2 LCD display, RS-232/USB interfacing facility with built in power supply	1,12,13,14,15,17,18,19,20,21,22,23,24,25,26,27,28,29,30
2	LED	13,14,15,20,29,30
3	Switch	14,20
4	+5V Relay	16
5	7-Segment LED display	17,18
6	16 x 2 LCD Module	19
7	DAC 0808/0809 Module, CRO- Bandwidth AC 10Hz ~20MHz, DC ~20MHz	21,22
8	ADC 0808/0809 Module	23
9	+5V DC motor with driver	24,25
10	+5V stepper motor with driver	26,27
11	Servo motor: +5V, Torque: 2.5kg/cm, Rotation : 0°-180°	28
12	IR sensor Module	29
13	PIR sensor Module	30
14	PC with IDE and program uploading software for 8051	All

EMBEDDED SYSTEM USING 'C'**Course Code : 314338****IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)**

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Overview of Embedded System	CO1	8	4	4	6	14
2	II	8051 Programming using Embedded 'C'	CO2	14	4	6	8	18
3	III	Communication Standards and Protocols	CO3	6	2	4	4	10
4	IV	Interfacing of Input and Output Devices with 8051	CO4	11	4	6	6	16
5	V	Applications of 8051 Microcontroller	CO5	6	2	4	6	12
Grand Total				45	16	24	30	70

X. ASSESSMENT METHODOLOGIES/TOOLS**Formative assessment (Assessment for Learning)**

- FA-TH represents average of two class tests of 30 marks each. FA-PR represents continuous assessment based on process and product related performance indicators. Each practical will be assessed considering 60% weightage to process 40% weightage to product.

Summative Assessment (Assessment of Learning)

- End semester theory examination 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	2	2	1	-	1	1	2			
CO2	2	3	2	2	1	1	2			
CO3	2	1	1	1	1	1	2			
CO4	3	3	3	2	2	2	2			
CO5	3	3	3	2	2	3	2			
Legends :- High:03, Medium:02,Low:01, No Mapping: - *PSOs are to be formulated at institute level										

XII. SUGGESTED LEARNING MATERIALS / BOOKS

EMBEDDED SYSTEM USING 'C'**Course Code : 314338**

Sr.No	Author	Title	Publisher with ISBN Number
1	Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay	The 8051 Microcontroller and Embedded Systems using Assembly and 'C'	Pearson, 2007 ISBN -13: 978-0199681273
2	Kenneth J. Ayala	The 8051 Microcontroller: Architecture, Programming and Applications	Penram International Publishing, 1996 ISBN -13: 978-0314201881
3	Raj Kamal	Embedded Systems	McGraw Hill, 4th Edition, 2020 ISBN -13: 978-9353168025
4	Ajit Pal	Microcontrollers: Principles and Applications	PHI Learning Pvt. Ltd., 2011 ISBN -13: 978-8120343924
5	Ajay V. Deshmukh	Microcontrollers: Theory and Applications	McGraw-Hill Education (India) Pvt. Ltd., 2005 ISBN - 13: 978-0070585959

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.keil.com/demo/eval/c51.htm	Keil IDE download
2	https://www.engineersgarage.com/timers-8051-timer-programming/	8051 timer programming
3	https://www.tutorialspoint.com/embedded_systems/es_io_programming.htm	8051 I/O programming
4	https://electrosome.com/interfacing-relay-8051-keil-c/	Relay interfacing and programming
5	https://www.javatpoint.com/embedded-system-7-segment-display	7-segment-display interfacing and programming
6	https://www.javatpoint.com/embedded-system-lcd-programming	LCD interfacing and programming
7	https://www.elprocus.com/embedded-system-programming-using-keil-c-language/	Embedded 'C' programming
8	https://www.electronicwings.com/8051/dc-motor-interfacing-with-8051	DC-motor-interfacing-with-8051
9	https://electrosome.com/interfacing-stepper-motor-8051-keil-c-at89c51/	stepper motor interfacing and programming
10	https://circuitdigest.com/microcontroller-projects/servo-motor-interfacing-with-8051	Servo motor interfacing and programming
11	https://embetronicx.com/tutorials/microcontrollers/8051/ir-sensor-interfacing-with-8051/	IR sensor interfacing and programming
12	https://www.electronicwings.com/8051/pir-motion-sensor-interface-with-8051	PIR sensor interfacing and programming
13	http://vlabs.iitkgp.ac.in/rtes/index.html	Virtual Lab. for embedded system

EMBEDDED SYSTEM USING 'C'**Course Code : 314338**

Sr.No	Link / Portal	Description
Note : Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students		

MSBTE Approval Dt. 21/11/2024**Semester - 4, K Scheme**

FLUID POWER AND INDUSTRIAL AUTOMATION**Course Code : 314339**

Programme Name/s : Mechatronics
Programme Code : MK
Semester : Fourth
Course Title : FLUID POWER AND INDUSTRIAL AUTOMATION
Course Code : 314339

I. RATIONALE

The diploma engineer has to use various fluid power operated machines and equipment in different industries. This course will impart knowledge and skills to select appropriate hydraulic and pneumatic system components in the context of industrial automation.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Apply knowledge and skills of hydraulics and pneumatics system for industrial automation and other applications.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Use fundamentals of fluid power in hydraulic and pneumatic systems.
- CO2 - Select pump/compressor and accessories for given fluid operated system.
- CO3 - Select valves and actuators for given fluid operated system.
- CO4 - Develop various hydraulic / pneumatic circuits for specified application
- CO5 - Construct simple automated hydraulic / pneumatic circuits.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												Total Marks
				Actual Contact Hrs./Week			SL	H		NL	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	Min	Max	Min	Max	Min	Max	Min			
314339	FLUID POWER AND INDUSTRIAL AUTOMATION	IAU	DSC	3	-	2	1	6	3	3	30	70	100	40	25	10	25#	10	25	10	175	

FLUID POWER AND INDUSTRIAL AUTOMATION**Course Code : 314339****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 State properties of fluids TLO 1.2 Describe Pascals Law, Continuity equation and Bernoulli's theorem TLO 1.3 Use suitable grade of hydraulic oil for given application TLO 1.4 Classify fluid operated systems	Unit - I Fundamental of fluid power 1.1 Fluid Properties: Density, Viscosity, Specific gravity, Lubricity, Demusibility, Neutralization number, Low foam tendency 1.2 Pascals Law, Continuity equation, Bernoulli's theorem (No numerical) 1.3 ISO grades of hydraulic oil 1.4 Types of fluid operated systems - Oil hydraulic and Pneumatic system, Advantages and limitations and applications and comparison.	Fluid samples for Demonstration Display charts
2	TLO 2.1 Classify hydraulic pump/ Air compressor TLO 2.2 Select the Pump /Compressor relevant for given application. TLO 2.3 State function of Hydraulics/Pneumatics accessories.	Unit - II Pumps, Compressor, Accessories in Hydraulics/ Pneumatics 2.1 Classification of Hydraulic Pumps, Construction and working of Gear pump, Vane pump, Lobe pump and axial piston pump. Selection criterion for pump 2.2 Classification of Compressors, Construction and working of Reciprocating compressor (Single/Multistage), Vane, Screw compressor, Selection criterion for compressor 2.3 Accessories in Hydraulics/Pneumatics: Oil and Air filter, Accumulator, Pressure intensifier, FRL unit, Muffler, pressure gauges, oil reservoir and air receiver	Models/Display charts Animation videos PPT

FLUID POWER AND INDUSTRIAL AUTOMATION**Course Code : 314339**

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 Classify control valves TLO 3.2 Describe construction and working of Control valves in Hydraulics/ Pneumatics TLO 3.3 Explain construction and working of actuators in Hydraulics/Pneumatics	Unit - III Control valves and Actuators in Hydraulics/ Pneumatics 3.1 Control valves: Classification of control valves, Hydraulic system control valves- Construction and working of - Pressure control valve, Pressure relief valve, Pressure reducing Valve, Sequence Valve, Flow control valve - Fixed and Variable type, Direction control valve- 2/2, 3/2,4/2,4/3,5/2 DCV , Actuating methods- Lever operated, Push button, Solenoid operated. 3.2 Pneumatic system control valves - Construction and working of Pilot control valve, Shuttle valve, Twin pressure Valve, Time delay valve. 3.3 Hydraulic/Pneumatics Actuators: Construction and working of linear actuator (Single, Double acting cylinder) and rotary actuator (Gear motor, Vane motor, Turbine air motor)	Models/ Display charts Animation videos PPT
4	TLO 4.1 Draw symbols of various components used in hydraulic and pneumatics TLO 4.2 Construct oil hydraulic circuit for given application TLO 4.3 Construct Pneumatic circuit for given application TLO 4.4 List safety precautions in Hydraulic/pneumatics systems	Unit - IV Oil Hydraulic and Pneumatic circuits 4.1 ISO symbols for Oil hydraulics and Pneumatics system components 4.2 Oil Hydraulic circuits: General layout of Oil Hydraulic system - Actuation of Single acting, Double acting cylinder, Actuation of Unidirectional and Bi-directional Hydro-motor, Speed control (Meter-in, Meter out), Sequencing circuits for simple operations 4.3 Pneumatic circuits: General layout of Pneumatic system , Actuation of Single acting, Double acting cylinder, Actuation of Unidirectional and Bi-directional Air -motor, Speed control of Double acting cylinder and bi directional motor, Sequencing circuits for simple operations 4.4 Hazards and safety in hydraulic/pneumatics systems	Display chart for ISO symbols Demonstration of trainer/set up Display Charts of fluid power circuits Animation of fluid power circuits
5	TLO 5.1 List function of automation devices TLO 5.2 Explain simple automation circuit using solenoid operated DC valve with diagram. TLO 5.3 Draw impulse or pilot control automation circuits TLO 5.4 Explain automation circuits using special control valves with diagram. TLO 5.5 Describe simple electropneumatic circuits with diagram.	Unit - V Oil Hydraulic and Pneumatic circuits for automation 5.1 Devices for automation: Push button switches, Limit switches, Proximity sensors, Solenoid, relays, Timers, 5.2 Automation circuit of SAC (Single Acting Cylinder) and DAC (Double Acting Cylinder) using solenoid operated DCV 5.3 Automation circuit of SAC and DAC using Single / double pilot operated DCV (impulse operation) 5.4 Automation circuits using logic gates valves (Shuttle valve - OR gate, Twin pressure valve- AND Gate), Time delay valve 5.5 Basic electropneumatic circuits for SAC and DAC	Display Charts of Automation circuits. Demonstration of trainer/set up Animation of fluid power circuits

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

FLUID POWER AND INDUSTRIAL AUTOMATION**Course Code : 314339**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Measure parameters of Total energy (Potential, Kinetic and Pressure energy) LLO 1.2 Calculate parameters of Total energy (Potential, Kinetic and Pressure energy)	1	*Verification of Bernoulli's theorem	2	CO1
LLO 2.1 Identify components of hydraulic and pneumatic system	2	Hydraulic and pneumatic system components.	2	CO1
LLO 3.1 Interpret specifications of pump and compressor mounted on trainer kit. LLO 3.2 Operate pump and compressor to measure pressure and flow rate.	3	*Functional parameters of Oil hydraulic pump and compressor.	2	CO2
LLO 4.1 Identify components of control valves LLO 4.2 Set/Operate Control valves for given application	4	*Pressure relief valve, direction control valve and flow control valve.	2	CO3
LLO 5.1 Identify functional components of actuators. LLO 5.2 Operate and measure speed of actuators	5	*SA, DA cylinders and motors in fluid power system.	2	CO3
LLO 6.1 Identify components of Shuttle valve, Twin pressure valve. LLO 6.2 Set/Operate Shuttle valve, Twin pressure valve.	6	Shuttle valve, Twin pressure valve used in pneumatic system.	2	CO3
LLO 7.1 Select components for given speed control circuit LLO 7.2 Construct hydraulic circuit LLO 7.3 Test speed variation of an actuators	7	Hydraulic circuit for SAC and DAC, Hydro-motor.	2	CO4
LLO 8.1 Select components for given speed control circuit. LLO 8.2 Construct and actuate hydraulic speed control circuit.	8	*Speed control circuits: Meter-in and Meter out hydraulic circuit.	2	CO4
LLO 9.1 Select components for given circuit. LLO 9.2 Construct pneumatic circuit. LLO 9.3 Operate given actuators	9	*Pneumatic circuits for SAC and DAC, Air motor.	2	CO4
LLO 10.1 Select components for given speed control circuit LLO 10.2 Construct and actuate pneumatic speed control circuit	10	Speed control circuits for pneumatic system	2	CO3 CO4
LLO 11.1 Select components for given sequencing hydraulic circuit. LLO 11.2 Connect and test given sequencing hydraulic circuit.	11	Sequencing hydraulic circuit.	2	CO3 CO4

FLUID POWER AND INDUSTRIAL AUTOMATION**Course Code : 314339**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 12.1 Select components for given sequencing pneumatic circuit. LLO 12.2 Connect given sequencing pneumatic circuit LLO 12.3 Test the sequencing circuit.	12	*Sequencing pneumatic circuit.	2	CO3 CO4
LLO 13.1 Select components for given Automation circuit. LLO 13.2 Construct and actuate given automation circuit.	13	Automation circuit for SAC and DAC using solenoid operated DCV	2	CO3 CO5
LLO 14.1 Select components for given impulse automation circuit LLO 14.2 Connect and test given impulse automation circuit.	14	Impulse automation circuit for SAC and DAC using Single / double pilot operated DCV (use trainer or Fluid SIM free software)	2	CO3 CO5
LLO 15.1 Select components for given automation circuit. LLO 15.2 Connect and test given automation circuit.	15	*Automation circuits using logic gates valves (OR/AND gate) (use trainer or Fluid SIM free software)	2	CO3 CO5
LLO 16.1 Select components for given circuit. LLO 16.2 Connect pneumatic circuit. LLO 16.3 Test given circuit.	16	Electro-pneumatic circuits for SAC and DAC	2	CO3 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 of applications of hydraulic system in universal testing machine with the help of Laboratory visit - study of type of pump used, oil pressure, type of actuator used, auto cut off mechanism after specimen test.
- Prepare report of Market Survey of various grades of hydraulic oil. - manufacturer, specify viscosity, working temperature range, cost/liter, packaging type and capacity
- Prepare display chart for different hydraulic and pneumatic equipment used at service station (Type of equipment, Function and photograph of actual use)
- Prepare PPT on application of Hydraulic equipment used at construction site. Student may visit nearby site to collect information related to type, function, images of actual operations, etc
- Prepare a display chart of different ISO symbols of hydraulic/pneumatic components. (Use colour sketch pens and drawing sheet)

Micro project

- Prepare report on different actuators for mechatronic applications as per following parameters. - stroke length, bore, diameter of cylinder, working pressure, Bursting pressure, torque, speed, types of mountings using internet

FLUID POWER AND INDUSTRIAL AUTOMATION**Course Code : 314339**

- Prepare report on specification of hydraulic pumps using internet by visiting website of suppliers. Prepare a table with following specification: make/ manufacturer, Pressure range, Type of pump, type of prime mover required, compatibility with different grades of oil.
- Prepare working models of any hydraulic system using disposable syringe. e.g. Robot arm movement
- Prepare a display chart on different types of actuators used for earthmoving equipment like tractor trolley, JCB, Crane (Type of Actuator , Function and photograph of actual use)
- Prepare a model of any type of pump size 60 cm X 60 cm using card board. Use various colours to show casing ports and constructional elements.

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 judicious 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	Bernoulli's theorem apparatus With Pipe of varying cross sectional area, Pump of Max Head 21 Meter, Water flow 1.35 Lit/Sec, Motor rating -0.37KW, Sump Tank Capacity:250 Liter	1
2	Festo Fluid SIM free software/ any other suitable software	14,15
3	Limit switches (Operating pressure range : 3 to 70 kgf/cm ² , Operating speed range : 8 -100mm/sec, Operating temperature range : -10 to 80 Deg.Celsius), Solenoid operated valves (12/24VDC), proximity switches (range of 0 - 40 mm), roller operated valves (maximum working pressure 210 bar, Flowrate 60 l/min)	15,16
4	Charts, cut section models, actual samples of different components of fluid power system	2,3,4
5	Hydraulic Trainer kit with various components like Hydraulic power pack, Set of Pressure relief, Pressure reducing and Sequence valve , 3/2 , 4/2,4/3 DCV, Flow control valve with built in check valve, pipes and hoses, SA Cylinder, DA Cylinder	2,3,4,7,8,11,13
6	Pneumatic trainer kit with portable compressor pressure up to 12 Bar, FRL Unit, 3/2, 5/2,5/3 DCV, Solenoid operated valves, Flow control valve with check valve, Twin pressure valve, Shuttle valve, pipes and low pressure hoses, SA Cylinder, DA Cylinder	5,6,9,10,12,14,15

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 fluid power	CO1	5	2	4	2	8
2	II	Pumps, Compressor, Accessories in Hydraulics/ Pneumatics	CO2	10	2	8	4	14

FLUID POWER AND INDUSTRIAL AUTOMATION**Course Code : 314339**

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
3	III	Control valves and Actuators in Hydraulics/ Pneumatics	CO3	10	4	4	8	16
4	IV	Oil Hydraulic and Pneumatic circuits	CO4	10	4	4	8	16
5	V	Oil Hydraulic and Pneumatic circuits for automation	CO5	10	2	4	10	16
Grand Total				45	14	24	32	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 term work -25 Marks · For Self Learning 25 Marks

Summative Assessment (Assessment of 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	2	3			
CO2	3	-	-	2	-	2	2			
CO3	3	-	-	2	-	2	2			
CO4	3	-	2	2	3	2	3			
CO5	3	-	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	Dr. P. N. Modi, Dr. S. M. Seth	Hydraulics and Fluid mechanics including hydraulics machines	Standard Book House, Rajsons Publication Pvt. Ltd., New Delhi, ISBN 978-81-89401-26-9, Year: 2017
2	C. P. Kothandaraman, R. Rudramoorthy	Fluid Mechanics and Machinery	New Age International (P) Limited, New Delhi, ISBN : 978-81-224-3398-2, Year : 2012

FLUID POWER AND INDUSTRIAL AUTOMATION**Course Code : 314339**

Sr.No	Author	Title	Publisher with ISBN Number
3	Majumdar S.R.	Oil Hydraulic system- Principles and maintenance	Tata McGraw Hill, ISBN: 978-0-07-463748-7, Year : 2013
4	Majumdar S.R.	Pneumatics Systems Principles and Maintenance	Tata McGraw Hill, ISBN: 978-0-07-463748-7, Year : 2013
5	Shanmuga Sundaram	Hydraulic and Pneumatic Controls	S. Chand Publishing, New Delhi, ISBN: 978-8-12-192635-5, Year:2013
6	Andrew Parr	Hydraulics & Pneumatics A Technicians & Engineers Guide	Butterworth-Heinemann Publisher, New Delhi ISBN: 978-0-08-096675-5, Year: 2006

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://en.wikipedia.org/wiki/Hydraulic_pump	Hydraulic Pumps (all types)
2	https://www.youtube.com/watch?v=Qy1iV6EzNHg	Animation of Hydraulic pumps (all types)
3	https://www.youtube.com/watch?v=pWuxYnqYDnk	Animation of Hydraulic pumps
4	https://www.youtube.com/watch?v=sEVTIRYHoGg	Eaton Pump assembly
5	https://www.youtube.com/watch?v=XAItnsUcES0	Pneumatic control valves animation
6	https://www.youtube.com/watch?v=yIot4shcOkE	Control valve symbol generation
7	https://www.youtube.com/watch?v=jsMJbJQkGTs	Animation of D.C. Valve
8	https://www.youtube.com/watch?v=CQPwvWXbV3w	Animation of 4/2,4/3 D.C Valves
9	https://www.youtube.com/watch?v=bovfDsAYSbc	Animation of Hydraulic cylinder
10	https://www.youtube.com/watch?v=icaqvAtccY	Telescopic cylinder animation
11	https://www.youtube.com/watch?v=MmYpzgh6Gok	Pneumatic cylinder
12	https://www.youtube.com/watch?v=WRCj5Tnopo0	Pilot control pneumatic circuits
13	https://www.youtube.com/watch?v=4eCuPVxezzY	Speed control hydraulic circuit
14	https://www.youtube.com/watch?v=2HNkIldunyY	Material Handling Automated System
15	https://www.youtube.com/watch?v=355XnDsAkDw	Pneumatic components automation line
16	https://www.youtube.com/watch?v=PvYu200BVy4	Introduction to Festo FluidSIM 6

Note :

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