PUNYASHLOK AHILYADEVI HOLKAR SOLAPUR UNIVERSITY, SOLAPUR

FACULTY OF SCIENCE & TECHNOLOGY

NEP 2020 Compliant Curriculum for Mechanical Engineering with effect from 2023-24

PUNYASHLOK AHILYADEVI HOLKAR SOLAPUR UNIVERSITY, SOLAPUR

FACULTY OF SCIENCE & TECHNOLOGY

NEP 2020 Compliant Curriculum

With effect from 2023-2024

Semester I (Common for All Engineering Branches)

Course Type	*Course Code*	*Name of the Course*	*Engagement Hours*		*Credits*	*FA*	*SA*		*Total*
			L	*P*		*ESE*	*ISE*	*ICA*	
BSC	BS-01/ BS-02	Engineering Physics / Engineering Chemistry $	3	2	4	70	30	25	125
	BS-03	Engineering Mathematics-I	3	2	4	70	30	25	125
ESC	ES-01/ ES-02	Basics of Civil and Mechanical Engineering /Basic Electrical & Electronics Engineering $	3	2	4	70	30	25	125
	ES-03	Engineering Mechanics	3	2	4	70	30	25	125
AEC	AE-01	Communication Skills	1	2	2		25	25	50
CC	CC-01	Sports and Yoga or NSS/NCC/UBA (Liberal Learning Course-I)	1	2	2			25	25
SEC	SE-01	Workshop Practices		2	1			25	25
		Total	**14**	**14**	**21**	**280**	**145**	**175**	**600**
		Student Induction Program**							

Semester II (Common for All Engineering Branches)

Course Type	*Course Code*	*Name of the Course*	*Engagement Hours*		*Credits*	*FA*	*SA*		*Total*
			L	*P*		*ESE*	*ISE*	*ICA*	
BSC	BS-01/ BS-02	Engineering Physics / Engineering Chemistry $	3	2	4	70	30	25	125
	BS-04	Engineering Mathematics – II	3	2	4	70	30	25	125
ESC	ES-01/ ES-02	Basics of Civil and Mechanical Engineering / Basic Electrical & Electronics Engineering $	3	2	4	70	30	25	125
		Engineering Graphics and CAD		4	2		25	50	75
SEC	SE-02	Data Analysis and Programming Skills	1	2	2		25	25	50
CC	CC-02	Professional Personality Development (Liberal Learning Course-II)	1	2	2		25	25	50
IKS	IKS-01	Introduction to Indian Knowledge System	2		2		25	25*	50
		Total	**13**	**14**	**20**	**210**	**190**	**200**	**600**
		Democracy, Elections and Good Governance *	**1**			**50**			

***For IKS activity report should be submitted**

BSC- Basic Science Course, ESC- Engineering Science Course, PCC- Programme Core Course ,

AEC- Ability Enhancement Course, IKS- Indian Knowledge System, CC- Co-curricular Courses ,

VSEC-Vocational and Skill Enhancement Course

- Legends used–

L	Lecture	FA	Formative Assessment
T	Tutorial	SA	Summative Assessment
P	Lab Session	ESE	End Semester Examination
		ISE	In Semester Evaluation
		ICA	Internal Continuous Assessment

- **Notes-**

1. $ - Indicates approximately half of the total students at F. Y. will enroll under Group A and remaining will enroll under Group B.

   Group A will take up course of Engineering Physics (theory & laboratory) in Semester I and will take up course of Engineering Chemistry (theory & laboratory) in semester II.

   Group B will take up course of Engineering Chemistry (theory & laboratory) in Semester I and will take up course of Engineering Physics (theory & laboratory) in semester II.

2. # - For the Course (C113) Basic Electrical & Electronics Engineering, Practicals of Basic Electrical Engineering and Basic Electronics Engineering will be conducted in alternate weeks.

3. @ - For the Course (C113) Basics of Civil and Mechanical Engineering, Practicals of Basics of Civil Engineering and Basics of Mechanical Engineering will be conducted in alternate weeks.

4. In Semester Evaluation (ISE) marks shall be based upon student's performance in minimum two tests & mid-term written test conducted & evaluated at institute level.

   Internal Continuous Assessment Marks (ICA) is calculated based upon student's performance during laboratory sessions / tutorial sessions.

5. *- Democracy, Elections & Good Governance is mandatory course. The marks earned by student with this course shall not be considered for calculation of SGPA/CGPA. However, student must complete End Semester Examination (ESE) of 50 marks (as prescribed by university) for fulfillment of this course. This course is not considered as a passing head for counting passing heads for ATKT. However, student must pass this subject for award of the degree.
6. Student must complete induction program of minimum five days before commencement of the regular academic schedule at the first semester.

**** GUIDELINES FOR INDUCTION PROGRAM (C119)**

New entrants into an Engineering program come with diverse thoughts, mind set and different social, economic, regional and cultural backgrounds. It is important to help them adjust to the new environment and inculcate in them the ethos of the institution with a sense of larger purpose.

An induction program for the new UG entrant students is proposed at the commencement of the first semester. It is expected to complete this induction program before commencement of the regular academic schedule.
Its purpose is to make new entrants comfortable in their new environment, open them up, set a healthy daily routine for them, create bonding amongst the peers as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.
The Induction Program shall encompass (but not limited to) below activity –

1. Physical Activities
2. Creative Arts
3. Exposure to Universal Human Values
4. Literary Activities
5. Proficiency Modules
6. Lectures by Experts / Eminent Persons
7. Visit to Local Establishments like Hospital /Orphanage
8. Familiarization to Department

Induction Program Course do not have any marks or credits however performance of students for Induction Program is assessed at institute level using below mandatory criteria –

1. Attendance and active participation
2. Report writing

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FACULTY OF SCIENCE & TECHNOLOGY

NEP 2020 Compliant Curriculum

With effect from 2024-2025

Semester -III

Distribution	*Course Code*	*Name of the Course*	*Engagement Hours*			*Credits*	*FA*	*SA*			*Total*
			L	*T*	*P*		*ESE*	*ISE*	*ICA*	*OE/ POE*	
PCC	MECHPCC-01	Applied Thermodynamics	2	-	2	03	70	30	25	-	125
PCC	MECHPCC-02	Manufacturing Processes	2	-	2	03	70	30	-	25	125
PCC	MECHPCC-03	Mechanics of Materials	3	1		04	70	30	25		125
CEP/FP	MECHFP-01	Mini-Project on Workshop Practice	-	-	4	02	-	-	50	25	75
Entrepreneurship	EM-01	Product Development and Entrepreneurship	1	1	-	02	-	50	25	-	75
OE	OE-01	Open Elective-01	2	-	2	03	70	30	25	-	125
MDM	MDM-01	Multidisciplinary Minor-I	2	-	2	03	70	30	25	-	125
VEC	VEC-01	Universal Human Values	1	-	2	02	50*		25	-	75
		Total	**13**	**2**	**14**	**22**	**400**	**200**	**200**	**50**	**850**
		Environmental Studies	**1**								

*For VEC-01 MCQ-based examination to be conducted.

PCC- Programme Core Course, CEP/FP – Community Engagement Project/Field Project, EM-01: Entrepreneurship/Management,
OE- Open Elective, MDM-Multidisciplinary Minor, VEC- Value Education Course, MDM – Multidisciplinary Minor: It should be selected from other UG engineering minor program.

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With effect from 2024-2025

Semester -IV

Distribution	*Course Code*	*Name of the Course*	*Engagement Hours*			*Credits*	*FA*	*SA*			*Total*
			L	*T*	*P*		*ESE*	*ISE*	*ICA*	*OE/ POE*	
PCC	MECHPCC-04	Kinematics and Theory of Machine	2	-	2	03	70	30	-	25	125
PCC	MECHPCC-05	Machine Drawing	2	-	2	03	70	30	25	-	125
PCC	MECHPCC-06	Fluid mechanics and Fluid Machines	3	-	2	04	70	30	25	-	125
VSC	MECHVSC-01	Advanced Lab on CAD	1	-	2	02	-		25	25	50
Economic/ Management	EM-02	Project Management and Economics	2	-	-	02	-	25	25	-	50
OE	OE-02	Open Elective-02	2	-	2	03	70	30	25	-	125
MDM	MDM-02	Multidisciplinary Minor-II	2	-	2	03	70	30	25	-	125
VEC	VEC-02	Professional Ethics	1	-	2	02	50*	-	25	-	75
		Total	**15**	-	**14**	**22**	**400**	**175**	**175**	**50**	**800**
		Environmental Studies	**1**				**40**	**10**			**50**

*VEC-02 MCQ-based examination to be conducted.

PCC- Programme Core Course, EM-02: Entrepreneurship/Management, OE- Open Elective, MDM-Multidisciplinary Minor,

VSC-Vocational Skill Course, VEC- Value Education Course

MDM – Multidisciplinary Minor: It should be selected from other UG engineering minor program.

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NEP 2020 Compliant Curriculum

With effect from 2025-2026

Semester -V

Distribution	*Course Code*	*Name of the Course*	*Engagement Hours*			*Credits*	*FA*	*SA*			*Total*
			L	*T*	*P*		*ESE*	*ISE*	*ICA*	*OE/ POE*	
PCC	MECHPCC-07	Advance Manufacturing Technology	2	-	2	03	70	30	25	-	125
PCC	MECHPCC-08	Design of Machine Elements	3	1		04	70	30	25	-	125
PCC	MECHPCC-09	Metallurgy	3	-	2	04	70	30	-	25	125
PEC	MECHPEC-01	Programme Elective Course-I	3	-	2	04	70	30	25	-	125
AEC	AEC-02	Creativity and Design Thinking	1	-	2	02	50*	-	25	-	75
OE	OE-03	Interdisciplinary Mini Project	1	-	2	02	-	-	25	25	50
MDM	MDM-03	Multidisciplinary Minor-III	2	-	2	03	70	30	25	-	125
		Total	**15**	**1**	**12**	**22**	**400**	**150**	**150**	**50**	**750**

*AEC-02 MCQ-based examination to be conducted.

PCC- Programme Core Course, PEC: Programme Elective Courses, OE- Open Elective, AEC- Ability Enhancement Course,

MDM-Multidisciplinary Minor,

MDM – Multidisciplinary Minor: It should be selected from other UG engineering minor program.

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FACULTY OF SCIENCE & TECHNOLOGY

NEP 2020 Compliant Curriculum

With effect from 2025-2026

Semester -VI

Distribution	*Course Code*	*Name of the Course*	*Engagement Hours*			*Credits*	*FA*	*SA*			*Total*
			L	*T*	*P*		*ESE*	*ISE*	*ICA*	*OE/ POE*	
PCC	MECHPCC-10	Transmission System Design	2	1		03	70	30	25		125
PCC	MECHPCC-11	Heat Transfer	2	-	2	03	70	30	-	25	125
PCC	MECHPCC-12	Instrumentation and Control Engineering	2	-	2	03	70	30	25	-	125
PEC	MECHPEC-02	Programme Elective Course-II	3	-	2	04	70	30	25	25	150
PEC	MECHPEC-03	Programme Elective Course -III	3	-	2	04	70	30	25	-	125
SEC	MECHSEC-03	Mini project on Industrial Applications (MPIA)	1	-	2	02	-	-	25	50	75
MDM	MDM-04	Multidisciplinary Minor-IV	2	-	2	03	70	30	25	-	125
		Total	**15**	**1**	**12**	**22**	**420**	**180**	**150**	**100**	**850**

PCC- Programme Core Course, PEC: Programme Elective Courses, MDM-Multidisciplinary Minor, SEC- Skill Enhancement Course

MDM – Multidisciplinary Minor: It should be selected from other UG engineering minor program.

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NEP 2020 Compliant Curriculum

With effect from 2026-2027

Semester -VII

Distribution	*Course Code*	*Name of the Course*	*Engagement Hours*			*Credits*	*FA*	*SA*			*Total*
			L	*T*	*P*		*ESE*	*ISE*	*ICA*	*OE/ POE*	
PCC	MECHPCC-13	Automation and Robotics	3	-	-	03	70	30	-	-	100
PCC	MECHPCC-14	Refrigeration and Air Conditioning	2	-	2	03	70	30	25	-	125
PEC	MECHPEC-04	Programme Elective Course -IV or MOOCS ##	4	-	-	04	100	-	-	-	100
Project	MECHProject	Capstone project		-	8*	04	-	-	100	100	200
RM	RM	Research Methodology and IPR	3	-	2	04	70	30	25	-	125
MDM	MDM-05	Multidisciplinary Minor-V	2	-		02	70	30	-	-	100
		Total	**14**	-	**12**	**20**	**380**	**120**	**150**	**100**	**750**

Students should attend Moocs in 4 hrs.

PCC- Programme Core Course, PEC: Programme Elective Courses, RM-Research Methodology, MDM-Multidisciplinary Minor

*Load based on the project groups

MDM – Multidisciplinary Minor: It should be selected from other UG engineering minor program.

List of Moocs courses related to MECHPEC04 will be provided by BOS time to time

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NEP 2020 Compliant Curriculum

With effect from 2026-2027

Semester -VIII

Distribution	*Course Code*	*Name of the Course*	*Engagement Hours*			*Credits*	*FA*	*SA*			*Total*
			L	*T*	*P*		*ESE*	*ISE*	*ICA*	*OE/ POE*	
PCC	MECHPCC-15	Energy Engineering	4#	-	-	04	100	-	-	-	100
PEC	MECHPEC-05	Programme Elective Course-V or MOOCS	4#	-	-	04	100	-	-	-	100
OJT	MECHOJT	On-Job Training	-	-	24	12	-	-	200	100	300
		Total	**8**	**-**	**24**	**20**	**200**	**-**	**200**	**100**	**500**

PCC- Programme Core Course, PEC: Programme Elective Courses, OJT-On job Training

#PCC-15-Students will practice or attend in Self-Learning mode

#PEC-05: - Students will practice or attend in Self-Learning mode or MOOCS.

List of Moocs courses related to MECHPEC05 will be provided by BOS time to time

Basket of Programme Elective Course (PEC)

PEC/Sem	Course code and name
MECHPEC - 01/V	MECHPEC – 01A:Metrology and Quality control MECHPEC – 01B:Internal Combustion Engines MECHPEC – 01C:Product Life cycle Management MECHPEC – 01D:Mechatronics systems
MECHPEC –02/VI	MECHPEC – 02A:Plastic Engineering MECHPEC – 02B: Tool engineering MECHPEC – 02C: Automobile Engineering MECHPEC – 02D: CAD-CAM-CAE
MECHPEC – 03/VI	MECHPEC – 03A:Finite Element Method MECHPEC – 03B: Industrial Engineering MECHPEC – 03C: Power plant and Energy Engineering MECHPEC – 03D: Railway Transportation
MECHPEC – 04/VII **OR**	MECHPEC – 04A: Production and Operation Management MECHPEC – 04B: Supply chain Management MECHPEC – 04C: Industrial Hydraulics and Pneumatics MECHPEC – 04D: Railway systems and Management
MECHPEC – 04/VII	MOOC Courses MECHPEC – 04E: <As per the list provided by BoS>
MECHPEC – 05/VIII **OR**	MECHPEC – 05A: Marketing Management MECHPEC – 05B: Industrial Safety and hazards MECHPEC – 05C: Material Handling System MECHPEC – 05D: Business Economics
MECHPEC – 05/VIII	MOOC Courses MECHPEC – 05E: <As per the list provided by BoS>

A. Multidisciplinary Minor in "Material Science and Energy Engineering"

Semester	Course Code	Course Title
III	MECHMDM-01A	**Fundamentals of Material Science and Engineering**
IV	MECHMDM-02A	**Materials for Technology Development**
V	MECHMDM-03A	**Advanced Materials and Manufacturing Process**
VI	MECHMDM-04A	**Renewable Energy Resources**
VII	MECHMDM-05A	**Energy Conversion Systems**

B. Multidisciplinary Minor in "Industrial and Project Management"

Semester	Course Code	Course Title
III	MECHMDM-01B	**Industrial Management**
IV	MECHMDM-02B	**Production and Operation Management**
V	MECHMDM-03B	**Operation Research**
VI	MECHMDM-04B	**Project Management**
VII	MECHMDM-05B	**Marketing Management**

A. Honors in Robotics Engineering

Semester	*Course Code*	*Name of the Course*	*Engagement Hours*			*Credits*	*FA*	*SA*			*Total*
			L	*T*	*P*		*ESE*	*ISE*	*ICA*	*OE/ POE*	
III	MechHon-01A	Industrial Robotics	3	-	2	4	70	30	25	-	125
IV	MechHon - 02A	Machine Vision	3	-	2	4	70	30	25	-	125
V	MechHon - 03A	Industrial Networks and Controllers	2	-	2	3	70	30	25	-	125
VI	MechHon - 04A	Advanced topics in Robotics	3	-	2	4	70	30	25	-	125
VII	MechHon - 05A	Mini Project	1	-	4	3	-	-	50	-	50
		Total				**18**	**280**	**120**	**150**		**550**

Honors Course will be for the students of same Program

B. Honors in Electric Vehicle Engineering

Semester	*Course Code*	*Name of the Course*	*Engagement Hours*			*Credits*	*FA*	*SA*			*Total*
			L	*T*	*P*		*ESE*	*ISE*	*ICA*	*OE/ POE*	
III	MechHon - 01B	Introduction to Automobile Engineering	3	-	2	4	70	30	25	-	125
IV	MechHon - 02B	Introduction to Electric and Hybrid Vehicles	3	-	2	4	70	30	25	-	125
V	MechHon - 03B	Battery Technology and Charging Infrastructure	2	-	2	3	70	30	25	-	125
VI	MechHon - 04B	Advanced topics in Electric Vehicles	3	-	2	4	70	30	25	-	125
VII	MechHon - 05B	Mini project	1	-	4	3	-	-	50	-	50
		Total				**18**	**280**	120	150		550

Honors Course will be for the students of same Program

Honors with Research

Semester	*Course Code*	*Name of the Course*	*Engagement Hours*	*Credits*	*SA*		*Total*
			P		*ICA*	*OE*	
VII	MECHRES-01	Research Project Phase-01	9 #	9	100	100	200
VIII	MECHRES-02	Research Project Phase-02	9 ##	9	100	100	200
		Total	18	18	200	200	400

Along with 9 hours of engagement hours, 4.5 Hrs. activities for preparation for community engagement and service, preparation of reports, etc.

Along with 9 hours of engagement hours 4.5 Hrs. activities for preparation for community engagement and service, preparation of reports, etc. and independent reading during Project Phase 2 and preferably related to Project Phase 2 activities.

These Courses are open for students of all the UG Engineering Program.

Semester: III List of Open Elective - I

Sr. No.	List of Open Electives
1.	OE-01A: Advanced Mathematics and Statistics
2.	OE-01B Digital Marketing and E- Commerce
3.	OE-01C Humanities and Social Sciences
4.	OE-01D Industrial and Quality Management
5.	OE-01E Mathematics for Software and Hardware
6.	OE-01F Soft Skills and Personality Development

Semester: IV List of Open Elective – II

Sr. No.	List of Open Electives
1.	OE-02A Entrepreneurship and Innovation
2.	OE-02B Environmental Sustainability
3.	OE-02C Renewable Energy
4.	OE-02 D Measurement, Instrumentation and Sensors
5.	OE-02E Operation Research
6..	OE-02F Computational Mathematics
7.	OE-02 G Professional Business Communication

Semester: V Open Elective – III

Sr. No.	List of Open Electives
1.	Interdisciplinary Mini Project

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

NAAC Accredited-2022

'B++'Grade(CGPA2.96)

Name of the Faculty: Science and Technology

CHOICE BASED CREDIT SYSTEM

Structure: Mechanical Engineering

Name of the Course: S. Y. B. Tech.

Semester-III

(Syllabus to be implemented w.e.f. 2024-25)

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Second Year B.TECH. (Mechanical Engineering)

Semester-III

MECHPCC- 01:Applied Thermodynamics

***Teaching Scheme**

Lectures:02 Hours/week, 02 Credits

Practical:02Hours/week, 01Credit

***Examination Scheme**

ESE:70Marks

ISE: 30Marks

ICA:25Marks

Course Introduction: Applied Thermodynamics is one of the core courses in the Mechanical Engineering curriculum and one of the traditional courses, dating back from the last many centuries. In Applied Thermodynamics the significance moves from studying general concepts with illustrative examples to develop methods and performing analyses of real-life problems. The objective of this subject is to apply knowledge of basic thermodynamic concepts to understand and evaluate the working of various thermodynamic cycles and devices used in thermal power plants and reciprocating air compressors.

Course Objectives:

During this course, the student is expected to:

1. Learn about of laws of thermodynamics and apply them to thermodynamic systems.
2. Study steam properties and calculate the performance of steam boilers
3. Learn about vapour power cycles and their analysis
4. Study steam nozzles and evaluate the performance of steam turbines
5. Study steam condensers
6. Study reciprocating air compressors and calculate their performance

Course Outcomes:

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

1. Apply mathematics and laws of thermodynamics to solve engineering problems.
2. Evaluate steam properties and analyze the performance of steam generators using the steam table.
3. Apply knowledge of basic thermodynamic concepts for the analysis of vapour power cycles
4. Describe the thermodynamics of steam nozzles and analysis of steam turbine
5. Explain steam condensers for various applications.
6. Calculate various performance parameters of reciprocating air compressors & determine lubricant properties.

Section I

Unit-1: Basic Laws of Thermodynamics **No. of lectures-06**

Unit content: Review of basic concepts of thermodynamics, application of First law of Thermodynamics to chemically reacting system: the standard enthalpy (heat) of reaction, the standard enthalpy of formation **(Numerical Treatment).**

Second Law of Thermodynamics: Limitations of the first law of thermodynamics, heat engine, refrigerator and heat pump, Kelvin-Plank and Clausius statements and their equivalence. Reversibility and Irreversibility, Clausius Inequality **(Numerical Treatment)** Introduction to Energy, Entropy, entropy change for: i) Phase change of pure substance ii) Change of state of an ideal gas iii) adiabatic mixing.**(Theoretical Treatment)**

Unit-2: Steam Generators **No. of lectures-06**

Unit content: Formation of steam**,** Properties of Steam, Steam tables, Temperature-entropy, Temperature-enthalpy diagrams and Mollier diagram, Classification of Boilers, Evaporative capacity, equivalent evaporation, factor of evaporation Boiler efficiency **(Numerical treatment)** Heat losses in boiler plant & heat balance sheet, Introduction to waste recovery ***(Theoretical Treatment)***

Unit-3: Vapour Power Cycles **No. of lectures-03**

Unit content: Classification of thermodynamic cycles, vapour power cycles, Carnot vapour power cycle, simple Rankine cycle, actual Rankine cycle, Performance Parameters, Effect of operating conditions on Rankine cycle efficiency.**(Numerical Treatment)**

Section II

Unit-4: Steam Nozzles and Turbines **No. of lectures- 06**

Unit content: Types of Nozzles, flow of steam through nozzles **(Theoretical Treatment) Steam Turbines**: -Advantages and classification of steam turbines, simple impulse turbine, compounding of steam turbines, Parson's reaction turbine, Velocity diagrams, work done and efficiencies **(Numerical Treatment)**

Unit-5: Steam Condensers **No. of lectures-03**

Unit content: Elements of steam condensing plants, advantages of using condensers, types of condensers, vacuum efficiency, Condenser efficiency**. (Theoretical Treatment)**

Unit-6: Reciprocating Air Compressors **No. of lectures-06**

Unit content: Classification of compressors, constructional detail of single & multistage compressors, computation of work (Polytropic, Isentropic and isothermal compression),the effect of clearance, Efficiencies of Compressor, FAD **(Numerical Treatment)**

Introduction to multistage compression (Need &Construction), **Lubrication**-Properties of Lubricants. **(Theoretical Treatment)**

Internal Continuous Assessment (ICA):

List of Experiments/Assignments/Case Studies, etc. Any six of the following:

1. Study of Boilers
2. Study of Boilers Mountings and Accessories.
3. Study/trial on steam calorimeter
4. Two problems using Steam table software for finding steam properties.
5. Study/trial on reciprocating air compressor
6. Study of different types of condensers
7. To determine the Flash and Fire point of lubricating oil
8. Trial on Redwood viscometer
9. Study/trial on Bomb Calorimeter.
10. Industrial visit to any process/power industry

Text Books:

1. A Course inThermal Engineering-S. Domukundwar,Kothandraman,DhanpatRai & Co.Delhi.
2. Thermal Engineering -R. K. Rajput – Laxmi Publication – New Delhi (Sixth Edition)
3. Basic &Applied Thermodynamics-P.K.NagTataMcGrawHillPublication
4. An Introduction to Thermodynamics-Y.V.C.Rao–UniversitiesPress

Reference Books

1. Thermodynamics by C.P. Arora TMH New Delhi 1998 edition.
2. Thermodynamics & Heat Engine – Vol. 1 &2 – R. Yadav Central Book Depot.
3. Thermodynamics- Cengel Boles, Tata McGraw Hill New Delhi.
4. Steam & Gas Turbines- R. Yadav, CPH Allahabad

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Second Year B.TECH. (Mechanical Engineering)
Semester-III
MECHPCC-02 : Manufacturing Processes

***Teaching Scheme**
Lectures:02Hours/week, 02 Credits
Practical :02Hours/week, 01Credit

***Examination Scheme**
ESE:70Marks
ISE: 30Marks
OE:25 Marks

Course Introduction:

This course covers all primary manufacturing processes like casting, forging, rolling, extrusion and drawing along with Fabrication. These processes are basics of Mechanical Engineering Programme. These basic processes along with applications and techniques are covered in brief.

Course Objectives:

During this course, student is expected:

1. To introduce the casting technique and its significance in Manufacturing.
2. To introduce the various solidification process and inspection methods.
3. To introduce various fabrication techniques and their significance in industry.
4. To introduce the forming technique and its significance in Manufacturing.
5. To introduce the modern forming technique and its significance in industry.
6. To introduce the modern manufacturing technique and its significance in industry

Course Outcomes:

At the end of this course, student will be able to:

1. Demonstrate the different types of pattern and explain detailed casting process.
2. Identify appropriate melting and molding technique with classification of different defects in casting.
3. Select and explain in brief about fabrication process for engineering problems.
4. Illustrate and compare the different types of forming processes.
5. Make suitable use of various advanced forming process.
6. Illustrate different rapid prototyping techniques.

Section I

Unit-1: Basics of Casting Processes **No. of lectures-05**

Definition of casting, Basic steps in casting processes, Introduction to patterns, Types of patterns, materials used, Allowances, types of cores, Gating system, types of risers, Function of riser, method to improve efficiency of risers. Riser design (simple numerical problems).

Unit-2: Melting, Molding and Inspection processes **No. of lectures-06**

Construction and working in brief of melting furnaces such as Cupola, Arc furnaces, Induction furnaces. Green sand Molding (hand and machine molding), Shell molding, Investment casting, centrifugal casting, gravity and pressure die casting processes. Stages in Fettling, Common important defects in castings. Inspection procedure, Computer applications in foundry processes, foundry Mechanization.

Unit-3: Introduction to Joining processes **No. of lectures-04**

Welding processes, classification of welding process, arc welding, welding rod selection, TIG welding & MIG welding, submerged arc welding, gas welding, resistance welding, Brazing and soldering.

Section II

Unit-4: Conventional Forming Processes **No. of lectures-06**

Introduction to forming process, Classification of forming processes, forging, types of forging, simple numerical problem on upset forging. Extrusion, Types – direct extrusion, indirect extrusion, impact extrusion, hydrostatic extrusion, Wire drawing process, Methods of tube drawing, hot rolling, cold rolling of sheets, classification of Rolling mills, theory of rolling, simple numerical problems on rolling.

Unit-5: Advanced Forming Processes **No. of lectures-04**

Introduction to advanced forming process, High energy rate forming process- explosive, Electro-hydraulic, magnetic pulse forming. Forming with hydrostatic pressure- hydro mechanical and hydro forming process

Unit-6: Advanced Manufacturing Processes **No. of lectures-05**

Introduction to Rapid prototyping (RP), Basic principles, Classification, Steps in RP, Advantages, disadvantages and applications of RP, Stereo lithography - Selective Laser Sintering (SLS), Selective Powder Binding (SBP), Fused Deposition Modelling (FDM), Direct Metal Laser Sintering (DMLS), Advantages, disadvantages and applications

List of Experiments/Assignments/Case Studies, etc.

1. Design of pattern and core for a simple component.
2. Testing of silica sand for grain fineness and clay content.
3. Testing of green sand for green compression strength, permeability.
4. Study of mould for moisture content and core hardness tester.
5. Study of VI characteristic of welding process.
6. Study of manufacturing sequence of upset forging with example.
7. Demonstration of any one rapid prototyping technique.
8. Visit to Foundry and Forging unit.

Text Books:

1. TV Ramana Rao, METAL CASTING Principles and Practice, NEWAGEINTERNATIONAL
2. N.D. Titov, Foundry Practice.
3. P.L. Jain, Principles of Foundry Technology.
4. P. N. Rao, Manufacturing Technology: Foundry, Forming and Welding.

Reference Books

1. Metal Casting Principles and Techniques, 1st Edition, Publisher: American Foundry Society Editor: Ian Kay
2. Fundamentals of Modern Manufacturing, M. P. Groover, John Wiley & Sons.
3. Heine, Lopar, Rosenthal, Principles of Metal Casting.
4. Metal Forming: Technology and process modelling, McGraw-Hill Education
5. Rapid Prototyping: Principles and Applications, Chee Kai Chua, World Scientific.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Second Year B.TECH. (Mechanical Engineering)
Semester-III
MECHPCC- 03 : Mechanics of Materials

***Teaching Scheme**
Lectures: 03Hours/week, 03 Credits
Tutorial :01Hours/week, 01Credit

***Examination Scheme**
ESE:70Marks
ISE: 30Marks
ICA: 25 Marks

Course Introduction:

Mechanics of materials introduces the four concept-force, stress, strain and deformation of deformable bodies. As the engineering design of different components, structures etc. used in practice are carried using different kinds of materials, it is essential to understand the basic behavior of such materials. The present course is to make students acquainted with force and displacement relation of structural elements subjected to uniaxial stress, bending, twisting and impact is studied. This course emphasizes the fundamentals of material strength necessary while designing and analysis of mechanical components This course improves problem solving skill of the students. In particular, course require prerequisite knowledge of engineering mechanics and basics calculus.

Course Objectives:

During this course, student is expected:

1. To study different types of stresses, strains and deformation induced in mechanical components due to external load
2. To study distribution of different stresses in mechanical elements such as beams and shafts etc.
3. To study effect of component dimensions and shape stress and deformation

Course Outcomes:

At the end of this course, student will be able to:

1. Demonstrate fundamental knowledge of different types stress and loading condition
2. Compute the stresses in basic mechanical components under axial, torsional and flexural loading.
3. Draw and interpret SFD and BMD for different types of loads and support conditions
4. Develop shear force and bending moment diagrams to analyze bending and shear stress offered by beam
5. Determine slope and deflection of beam under concentrated and uniformly distributed load
6. Compute the principal stress and position planes in a member subjected to different types of stress system

Section I

Unit-1: Simple stress and strains **No. of lectures-06**

Concept and types of stresses and strains, Poisson's ratio, stresses and deformation in homogeneous and compound bars under axial loads, stress-Strain diagrams, Hooke's law, elastic constants and their relationships, temperature stress & strain in simple bars under axial loading.

Unit-2: **No. of lectures-08**

a) Torsion of Circular Shafts: Theory of torsion and assumptions, torsion of solid and hollow circular shafts, derivation of torsion equation, determination of torsional shear stress and angular twist for solid and hollow shafts used in power transmission applications.

b) Strain Energy and Impact Load: Concept of strain energy, proof resilience and modulus of resilience, determination of strain energy in tension and compression for axially loaded members due to gradual, sudden and impact loads.

Unit-3: Shear force and bending moment **No. of lectures-06**

Concept and definitions of shear force and bending moment in determinate beams, SF and BM diagrams for cantilever, simply supported beams with or without overhang, calculations of maximum shear force and bending moment and point of contra flexure under i) concentrated load ii) Uniformly distributed load iii) Combination of concentrated and uniformly distributed load iv) uniformly varying load iv) Couple. Relation between the rate of loading, shear force and the bending moment.

Section II

Unit-4: Bending and shear stresses in beams **No. of lectures-08**

Concept of theory of pure bending of beams, assumptions and sign conventions, bending stresses in beams with derivation and application to commonly used beam cross sections as circular rectangular, I-sections and T-sections. Concept of shear stresses and shear stress distribution in beam, determination of shear stresses for rectangular, I and T sections of beams

Unit-5: Slope and Deflection of Beams **No. of lectures-06**

Concept and definitions of slope and deflection, relationship between bending moment, slope and deflection by moment area method, determination of slope and deflections of i) cantilever beam ii) simply supported beam under concentrated and uniformly distributed load

Unit-6: Principal stresses and strains **No. of lectures-06**

Concept of normal and shear stresses on oblique planes, principal stresses and strains and principal planes, two dimensional stress system, determination of principal stresses and maximum shear stresses using analytical and Mohr's circle method (2-D cases only).

Internal Continuous Assessment (ICA):

List of Experiments/Assignments/Case Studies, etc.

1. Assignment on simple stresses and strains.
2. Assignment on torsion of circular shafts.
3. Assignment on strain energy and impact loads.
4. Assignment on shear force and bending moment diagrams.
5. Assignment on bending stresses in beams.
6. Assignment on shear stresses in beams.
7. Assignment on slope and deflection of beams.
8. Assignment on principal stresses and strains.

Text Books:

1. Rajput R. K., Strength of materials, S. Chand & Co. Ltd., New Delhi.
2. Bansal R.K., Strength of materials, Laxmi publications (P) Ltd., New Delhi.
3. Subramanyam, Strength of Materials, Oxford University Press, Edition 200
4. Rajput R. K., Strength of materials, S. Chand & Co. Ltd., New Delhi.

Reference Books:

1. Timoshenko & Young, Elements of Strength of Materials, CSB Publishers
2. Ramamrutham S. Strength of Materials DhanpatRaiand Co.(p) Pvt. Ltd. Delhi
3. S. S. Rattan Mechanics of Materials, TMH Pvt. Ltd
4. Basu A. R., Strength of materials, Dhanpat Rai & Co. (P) Ltd., Delhi.
5. Beer and Johnson, Strength of materials, Mc-Graw Hill International student series.
6. Khurmi R. S. & Gupta J. K., Strength of materials, S. Chand &Co.Ltd., New Delhi
7. Basavarajaiah and Mahadevappa, Strength of Materials, Khanna Publishers, New Delhi.
8. W. Nash, Strength of Materials, Schaum's Outline Series, McGraw Hill Publication.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Second Year B.TECH. (Mechanical Engineering)

Semester-III

MECHFP-01:Mini-Project on Workshop Practice

***Teaching Scheme**

Practical :04Hours/week, 02Credit

***Examination Scheme**

ICA: 50 Marks

OE: 25Marks

Course Introduction: The mini project is designed to help students develop practical ability and knowledge about practical tools/techniques in order to solve real life problems related to the industry, academic institutions and society. This course will also develop investigative, research and report writing skills and will provide an opportunity to investigate in considerable depth. Mini Project provides the opportunity for students to demonstrate the application of their research skills, and to apply their knowledge to complex computing problems. A mini project is an assignment that strengthens the understanding of fundamental knowledge through effective application of theoretical concepts.

Course Objectives:

The course aims to:

1) Details about mechanical workshop tools and equipments
2) Clarify safety awareness in work shop
3) Operating principle of various machines
4) Construct engineering drawing
5) Prepare process sheet
6) Estimation of time and cost of manufacturing

Course Outcomes:

At the end of this course, student will be able to:

1) Demonstrate practical knowledge
2) Develop manufacturing skills
3) Enhance drawing understanding skills
4) Cost and time estimation
5) Enhance skills of PPC
6) Do material requirement and planning

Mini project based on:

1) Design and development of jig and fixtures
2) Design and development of press tool/Draw tool
3) Miniature of wind turbine
4) Automatic conveyor belt
5) Pneumatic arm manipulator
6) Hydraulic lift system
7) Solar water heater
8) Miniature of EV
9) Automatic plant watering
10) Design and development of any power pack unit

Internal Continuous Assessment (ICA)-

Guidelines for Mini-Project content & Mark Distribution

1. A group of maximum 04 students be formed for Mini-Project work.

2. Work diary and reporting to guide as per prescribed contact hours.

3. The contents of work diary shall reflect the efforts taken by project group for

   i. Searching suitable mini-project work

   ii. Brief report preferably on journals/ research or conference papers/ books or literature surveyed to select and bring out the mini-project area.

   iii. Brief report of feasibility studies carried to implement the conclusion.

   iv. Rough Sketches/ Design Calculations, etc.

4. The mini-project may be based on above mentioned topics.

5. It will be preferable if student will work on the area of mini project in line with their proposed final year project.

6. The group has to give a power point presentation in front of the faculty members / panel of department at the end of semester along with the spiral bound report (Limited to 25 Pages).

A. Multidisciplinary Minor in "Material Science and Energy Engineering"

Semester	Course Code	Course Title
III	MECHMDM-01A	Fundamentals of Material Science and Engineering

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Second Year B.TECH. (Mechanical Engineering)

Semester-III

Multidisciplinary Minor in "Material Science and Energy Engineering"

MECHMDM-01A: Fundamentals of Material Science and Engineering

(Multidisciplinary Minor-I)

***Teaching Scheme**
Lectures: 02 Hours/week, 02 Credits
Practical : 02 Hours/week, 01Credit

***Examination Scheme**
ESE:70 Marks
ISE: 30 Marks
ICA: 25 Marks

Course Introduction:

This course focuses on the fundamental aspects of materials science which every material scientist is supposed to be familiar with. The course discusses the basic structure of solids, classification of materials based on the structure and the correlation between the structure and properties. The evolution of properties based on the structure and its alteration is also dealt with. The course provides a broad and general knowledge of various types of materials like Ferrous materials, Non-ferrous materials, Polymers, Ceramics, Composite materials, Nano-materials, Electronic materials, Magnetic materials, Nuclear material, etc. which are widely used in development of new technologies along with properties and applications of these materials in various sectors like Aerospace, Automobile, Healthcare, Electronics, Energy storage devices, etc. The course aims to give an understanding of how different materials are and what these differences mean for their properties and application.

Course Objectives:

During this course, student is expected :

1. To know the different types of engineering materials with their structure.
2. To understand concept of Ferrous alloys with their composition, types, properties and applications.
3. To understand different types of Non-ferrous alloys with their composition, types, properties and applications.
4. To know the Polymer materials with their properties, classification and applications.
5. To understand the different types of Ceramic Materials with their properties and applications.
6. To know the different types new materials with their applications in various sectors.

Course Outcomes:

At the end of this course, student will be able to:

1. Describe and distinguish between different engineering materials on the basis of their structure.
2. Select suitable Ferrous material for various Engineering applications.
3. Select suitable Non-ferrous material for various Engineering applications.
4. Classify and select different types of Polymer materials for various Engineering applications.
5. Explain classification, properties and applications of Ceramics materials.
6. Describe the advantages and limitations of New materials over conventional materials

Section I

Unit-1: Basics of Materials Science **No. of lectures- 05**

Introduction to engineering materials and its classification, Structure - description of unit cell and space lattices, Coordination number, APF for cubic and hexagonal close packed structures, Miller indices, Gibbs phase rule, Cooling curves, Phase diagram, Isomorphous system, Lever rule.

Unit-2: Study of Ferrous materials and its alloys **No. of lectures- 05**

Classification of Metallic materials, Fe-Fe3C equilibrium diagram, Critical temperature lines with significance, Eutectic, Eutectoid and Peritectic transformations, Plain carbon steels: classification, composition, applications & properties, Effect of alloying elements on steels, Alloys steels: Silicon steels, Spring steels, Invar Steels, HSLA Steels.

Unit-3: Study of Non-ferrous materials and its alloys **No. of lectures- 05**

Non-ferrous alloys: Copper alloys: brasses, bronzes. Cu-Zn Equilibrium diagram, Aluminum alloys: Al-Si alloy, Al-Cu alloy. Steps in precipitation hardening (Steps only), Study of White metal alloys or Babbitts. Introduction to Ni alloys, Fusible alloys.

Section II

Unit-4: Polymers **No. of lectures- 05**

Introduction of polymers with classification: Thermoplastic polymer & Thermosetting polymer, Polymerization mechanisms with types: Addition polymerization and Condensation polymerization, Degree of polymerization (D.P.) with numerical on molecular weight and DP calculations, Crystallization of polymers, Deformation of polymers, Vulcanization of rubber.

Unit-5:Ceramics **No. of lectures- 05**

Introduction to ceramic materials; Classification of ceramics, Crystal structure and bonding of common advanced ceramic materials; Mechanical behavior of ceramics, Glass and glass ceramics, Preparation and characterization of ceramics powders; Characterization of ceramic materials; Applications of ceramics in advanced technologies

Unit-6: Introduction to New Materials **No. of lectures- 05**

Concept of Composite materials, Classification of Composites, Applications of Composite materials, Classification of Nanomaterials, Applications of Nano-materials, Properties and applications of Nuclear materials, Magnetic materials and Electronic Materials.

Internal Continuous Assessment (ICA):

List of Experiments/Assignments/Case Studies, etc.

Minimum 6 Experiments/assignments from the following areas are required to be completed.

1. Study of Metallurgical Microscope
2. Study of Specimen Preparation for microstructure observations.
3. Study of microstructures of different Plain Carbon Steels.
4. Study of microstructures of Brasses and Bronzes.
5. Assignment on Ferrous materials and Non-ferrous materials with their applications.
6. Assignment on Study of various Polymer materials with their properties, classification, Polymerization types and applications of polymers.
7. Assignment on Study of Ceramic materials.
8. Assignment on New materials with their classification, types, properties and applications.

Text Books:

1. Material Science and Metallurgy – Dr. Kodgire (Everest, Pune).
2. Introduction to Engg. Materials – B. K. Agarwal (TMH).
3. Rajendra Kumar Goyal," Nanomaterials and nanocomposites: Synthesis, Properties,Characterization Techniques and Applications" CRC Press, 2017, ISBN: 978-14987616662017.
4. William F. Smith, JavedHashemi, Ravi Prakash, " Foundation of Materials Scienceand Engineering", TATA Mc Graw-Hill International Edition,4th Edition, 2008.

Reference Books:

1. Introduction to Physical metallurgy – S.H.Avner, TMH.
2. W.D. Callister, D.G. Rethwisch, *Materials science and Engineering: An Introduction*, 8th ed., Wiley, 2010.
3. Electronic Materials Handbook, ASM International, Materials Park, 1989.
4. Buschow K.H.J.," Handbook of Magnetic Materials", Amsterdam: Elsevier, Volume 15, First Edition December 2003.

B. Multidisciplinary Minor in "Industrial and Project Management"

Semester	Course Code	Course Title
III	MECHMDM-01B	Industrial Management

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Second Year B.TECH. (Mechanical Engineering)

Semester-III

Multidisciplinary Minor in "Industrial and Project Management"

MECHMDM-01B: Industrial Management

(Multidisciplinary Minor-I)

Teaching Scheme

Lectures:02 Hours/week, 02 Credits

Practical:02Hours/week, 01Credit

Examination Scheme

ESE:70Marks

ISE: 30Marks

ICA:25Marks

Course Introduction:

Industrial management involves studying structure and organization of industrial organizations. The knowledge of Industrial management comprises of those fields of business administration that are necessary for the success of companies within manufacturing sector and the encompassing services (primarily operations management, marketing and financial management). This subject is having two sections wherein, Section I is about general functions of Management applicable to industrial & other organizations whereas Section II contains Materials Management, Quality management and Human Resource management.

Course Prerequisite:

1. Knowledge of various manufacturing process.
2. Knowledge of industrial working environment through industrial training and Industrial visits.

Course Objectives:

During this course, student is expected:

1. To give the students an overview of the general functions of Management applicable to Industrial& other organizations.
2. To give insight to the philosophy & techniques of quality management applicable to industry
3. To make students aware about different motivational techniques and leadership styles
4. To give the students overview of working of various departments
5. To introduce various statistical process controls to students

Course Outcomes:

At the end of this course, student will be able to:

1. Understand basics of Industrial Management and their functions.
2. Discuss and demonstrate management functions.
3. Demonstrate various leadership and communication types.
4. Apply various material management technique for real life problems.
5. Discuss and demonstrate quality functions
6. Demonstrate various techniques of human resource management used in industry.

Section I

Unit-1: Introduction to Management and its Functions **No. of lectures- 05**

Nature, purpose & scope of Management. System's approach to Management, Functions of Managers, Social responsibility & Ethics in Managing.

Unit-2: Planning and Organizing **No. of lectures- 06**

Planning: Meaning, Types of plans, steps in planning, planning process, decision making. Organizing: Nature & purpose of organizing, Organization structure, Departmentation

Unit-3: Leading and Communication **No. of lectures- 04**

Factors in managing, Motivation, 'Carrot & Stick' theory, Maslow's theory of Hierarchy of needs, leadership styles, communication: process. Types- oral, written & nonverbal.

Section II

Unit-4: Material Management **No. of lectures- 06**

Material requirement - operation- Planning-Production-definition-Job, Batch & Mass production with their advantages and disadvantages-Productivity-definition factors to improve productivity- Production planning and Control (PPC)-definition-Functions of PPC-planning, routing, scheduling, dispatching.

Unit-5: Quality Management **No. of lectures- 04**

Definition of Quality, Elements of quality, quality specifications. Factors affecting quality of design & quality of conformance, quality control, quality costs. Benchmarking, Quality Management Systems.

Unit-6: Human Resource Development **No. of lectures- 05**

Definition, Performance appraisal, Training & development. Strategic importance HRM; objectives of HRM; challenges to HR professionals; role, Responsibilities and competencies of HR professionals; HR department operations; Human Resource Planning - objectives and process.

Internal Continuous Assessment (ICA):
List of Experiments/Assignments/Case Studies, etc.

Minimum 6 assignments based on above topic out of which 2 case studies related to industry /organization.

Text Books:

1. Essentials of Management – Koontz WeihrichBy TMH
2. Principles of Management & Administration – D. Chandra Bose. PHI
3. Statistical Quality Control – M. Mahajan By Dhanpat Rai & Co.
4. Total Quality Management – Besterfield& Others PHI

Reference Books

1. Principles of Management – Tripathy, Reddy by TMH
2. Management- James A.F. Stoner, R. Edward Freeman, Dainel R. Gilbert, JR. Peason Education Inc. and Dorling Kindersley Publishing Inc. ISBN 978-81317-0704-3

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

NAAC Accredited-2022

'B++'Grade(CGPA2.96)

Name of the Faculty: Science and Technology

CHOICE BASED CREDIT SYSTEM

Structure: Mechanical Engineering

Name of the Course: S. Y. B. Tech.

Semester-IV

(Syllabus to be implemented w.e.f. 2024-25)

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Second Year B.TECH. (Mechanical Engineering)
Semester-IV
MECHPCC-04:KINEMATICS AND THEORY OF MACHINE

Teaching Scheme:
Lectures:02 Hours/week, 02Credits
Practical :02Hours/week, 01Credit

Examination Scheme:
ESE:70Marks
ISE: 30Marks
OE:25Marks

Course Introduction:

This course helps design engineers for selecting the mechanism efficiently. It emphasizes on basic study of concept of theory of machines, and analysis of bar mechanism, Cams, gears and gear trains. Cams, gear, and gear train integral part of Mechanical Systems. In addition to this, they are primary elements of modern day automation industry. Further, the course helps to understand the mechanical control system through study of governors and their characteristics. The course also focuses on balancing of masses in rotation and reciprocation. Thus, this course lays down the foundation required for 'Selecting, Analyzing and Designing Mechanisms for Developing Machines', one of the core activities of Mechanical Engineers.

Course Objectives:

During this course, student is expected to:

1. Study Fundamentals of Kinematics of Machines.
2. Apply Graphical methods to determine motion parameter of mechanism
3. Follow procedure to generate cam profile for different motions of follower
4. Study basics of toothed gearing and procedure for gear train analysis
5. Understand relations for governor characteristics
6. Study need and method for balancing of rotary masses and reciprocating masses

Course Outcomes:

At the end of this course, student will be able to:

1. Select Mechanism for different applications
2. Perform velocity and acceleration analysis of mechanisms
3. Develop cam profile for given set of motion inputs.
4. Select gears and design gear trains for given application
5. Explain types of governors and their characteristics
6. Do balancing of rotary and reciprocating masses

Section I

Unit-1:Simple Mechanisms **No. of lectures-05**

Kinematic links, Kinematic pairs, Classification of pairs, Kinematic chain, Degrees of freedom, Types of constrained motion, Kutzbach's and Grubler's criteria for plane mechanisms, Structure, Mechanism, Machine, Grashoff's law for four bar mechanism, Inversion, Inversions of four bar chain, single slider crank chain and double slider crank chain.`

Unit-2:Velocity and Acceleration in Mechanisms **No. of lectures-05**

Velocity and acceleration analysis of mechanisms using following graphical methods :Instantaneous Centre Method (for velocity only), Relative velocity and relative acceleration method (for velocity and acceleration), Klein's construction (for velocity and acceleration)

Unit-3:Cams **No. of lectures-05**

Applications of cams in industrial automation, Types of cams and followers, cam nomenclature, displacement, velocity and acceleration diagrams motions of the follower (Uniform velocity, Simple harmonic motion, Uniform acceleration &uniform retardation, Cycloidal motion), Construction of cam profile for radial cams with different types of followers (reciprocating followers), Construction of cam profile for oscillating roller follower.

Section II

Unit-4: Gear & Gear trains **No. of lectures-05**

Gear: - Geometry of motion, Gear geometry, Types of gear profile- involute & cycloidal, Theory of Spur gears, Interference in gears with involute tooth profile and methods for its prevention, Contact ratio, Path of contact (No numerical treatment for gears) Gear Trains: - Types of Gear trains (Simple, Compound, Epicyclic, Reverted), Tabular method for finding the speeds of elements in simple and compound epicyclic gear trains.

Unit-5:Governor **No. of lectures-05**

Need of governors, Types of governors (Watt, Porter & Hartnell governors), Derivations related to speed of spindle in Porter governor and Stiffness of Spring in Hartnell governor, Sensitivity, Stability, Isochronism and Hunting of governor, Governor effort, Power and Controlling force diagram of governors.

Unit-6:Balancing **No. of lectures-05**

Need for balancing of rotating masses, Graphical method for balancing of rotating masses (masses rotating in same plane and different planes), Balancing of reciprocating masses

List of Experiments/Assignments/Case Studies, etc.

Internal Continuous Assessment (ICA): All the sheets (*) are compulsory, Opt any four from remaining

1. Study of Grashof's Law
2. Sheet based on Instantaneous Centre Method& Relative Velocity-Acceleration Method*
3. Sheet based on Klein's Construction*
4. Sheet based on generating cam profile for different followers and follower motions*
5. Assignment based solving gear train problems
6. Study of governor characteristics
7. Study of balancing of masses using balancing apparatus
8. Sheet based on graphical method for balancing of rotary masses*
9. Study of gyroscopic effect
10. Study of brakes

Text Books:

1. Ballaney P. L., Theory of Machines, Khanna Publications, New Delhi
2. Khurmi R. S. & Gupta J. K., Theory of Machines, S. Chand publications, New Delhi.
3. Bansal R. K., Theory of Machines, Laxmi publications, New Delhi.
   V.P. Singh, Theory of Machines, Dhanpat Rai & Sons Co. Pvt. Ltd., Delhi.

Reference Books

1. Rattan S. S., Theory of Machines, Tata McGraw Hill publication, New Delhi.
2. Shigley J., Theory of Machines & Mechanisms, McGraw Hill International Students' Edition.
3. Thomas Bevan, Theory of Machines, CBS publication, New Delhi

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Second Year B.TECH. (Mechanical Engineering)

Semester-IV

MECHPCC- 05 :Machine Drawing

***Teaching Scheme**

Lectures: 02 Hours/week, 02 Credits

Practical : 02 Hours/week, 01Credit

***Examination Scheme**

ESE:70Marks

ISE: 30Marks

ICA: 25Marks

Course Introduction: Drawing is called as language of engineers. Drawing, as an art, is the picture is action of the imagination of the scene in its totality by an individual. Machine drawing on the other hand is the scientific representation of an object, according to certain national and international standards of practice. This course consists of selected topics from the subject Machine Drawing and Engineering Graphics which are helpful for mechanical engineers. It contains BIS convention, free hand sketching & Production drawing which are vital in Design engineering. It covers the topics of BIS conventions, free hand sketching, Production drawing, isometric projections along with assembly and details drawing. It also includes 2D and 3D drawing using drafting software. This course emphasizes the fundamentals of various topics under machine drawing necessary for practicing mechanical engineers and inculcates problem solving skill amongst the students

Course Objectives:

During this course, student is expected:

1. To Understand & Use the Principles of Drawing
2. To Understand and apply drawing practices as per BIS Standard.
3. To Draw Machine Components by Using Principles of Freehand Sketches.
4. To Interpret and apply, Limit, Fits, and Tolerances to the Various Machine Element.
5. To Interpret and apply techniques to draw assembly drawing from given details drawing and to draw detail drawing from given assembly drawing.
6. To operate the Drafting Software.

Course Outcomes:

At the end of this course, student will be able to:

1. Apply BIS Convention in drawing mechanical components and assembly drawings
2. Use geometrical, dimensions, tolerances and symbols in part and assembly drawing.
3. Draw assembly, details drawing and identify applications of same

Section I

Unit-1:Basics of Machine Drawing **No. of lectures-03**

Unit-1:Basics of Machine Drawing & B.I.S. Conventions Types of drawing, Dimensioning :- Placing of dimensions, Functional and Non-functional dimensions, Dimensioning common features like: Circular Arcs, Diameters, Holes, Angles, Chamfers, Tapers, Undercut, Repetitive features, Countersunk, Square, Sphere, Across Flat, Threads, etc.

Unit-02: Study of B.I.S. (Bureau of Indian Standards) Conventions- **No. of lectures-05**

Significance and importance of BIS Conventions, Drawings sheet sizes and layout recommended by BIS. Conventional representation of engineering Materials, spur helical and bevel gears, worm and worm wheel, rack and pinion, gear assemblies, type of helical, disc and leaf springs. Internal and external threads, square head, spline shaft, diamond knurling BIS conventions for sectioning, type of sections, exceptional cases. BIS' methods of linear- and angular dimensioning. Symbolic representation of welds as per BIS.

Unit-3:Free Hand sketching of machine component. **No. of lectures-07**

Importance of sketching and entering proportionate dimensions on sketches. Free hand sketches of various types of threads, nut, bolts (square and hexagonal flanged nuts, lock nuts, dome nut, capstan nut, wing nut, castle nut, split pin, square headed bolt, cup headed bolt, T-headed bolt, Rag foundation bolt, stud, washer. Various types of rivets and riveted joints, Various types of keys, Socket and spigot (Cotter joint) , Knuckle (pin) joint, Muff coupling, Protected and unprotected Flanged, coupling, universal coupling, solid and bush bearing. Plummer block (pedestal bearing), foot step bearing. Flat and V-belt pulleys, Fast and loose pulleys, speed cone pulleys, Pipe joint for C.I. Flanged, socket and spigot type pipe joint. Union pipe joint and standard pipe-fitting. The applications of above machine components.

Section II

Unit-4: Production Drawing: Limits, Fits, & Tolerances **No. of lectures-07**

Dimensional Tolerances: Introduction to system of limits and fits. Basic concepts. Terminology, Tolerances, various types. Necessity of Limit system, Unilateral and Bilateral Tolerances, Relation between Tolerances and Manufacturing Processes, Methods of indicating tolerances on drawings, IT grades, Types of fits, Grades of tolerances, types of Holes & shafts based on fundamental deviations, designation of fit, Systems of fits, Selection of fits, Selection of tolerances based on fits

Geometrical Tolerances: - Need of Geometrical Tolerances, Terminology, Tolerances for Single Features such as Straightness, Flatness, Circularity, and Cylindricity. Tolerances for Related Features such as Parallelism, Perpendicularity, Angularity, Concentricity, Tolerance Symbol and Value, Indicating Geometrical Tolerances on drawings.

Surface Finish:- Surface Texture, Surface Roughness Number, Roughness Symbols, Range of Roughness obtainable with different manufacturing processes.

(Note : Numerals /calculations/problems/tasks/examples/theoretical questions on UNIT NO.3)

Unit-5: Details and Assembly Drawing **No. of lectures-05**

To prepare detail drawings from given assembly drawing. To prepare assembly drawing from Given drawing of details. Preparation of Assembly drawing from the given details such as: Tools post of center lathe, Tail stock, Cross head Assembly, Screw jack, Drill Jig, connecting rod and piston of I.C. Engines, Gland and stuffing box and many more suitable/considerations with moderate difficulty level, etc. Selection and showing of all the symbols & surface finish symbols, fits, tolerances for dimensions to details and assembly drawings

Unit-6:Isometric Projection **No. of lectures - 03**

Isometric Drawing: Isometric scale, Isometric projection, Isometric drawing, Circles in isometric view, Isometric views of simple object from given orthographic views

Internal Continuous Assessment (ICA):

List of Experiments/Assignments/Case Studies, etc.

1. Sheet no. 1. Based on Basic of drawing & dimensioning along with BIS conventions mentioned in Unit No.1and 2
2. Sheet no. 2: Based on Free hand sketches, drawing of various machine components mentioned in Unit No. 3
3. Sheet no. 3. Based on Production Drawing. (Dimensional and Geometrical Tolerances).unit-04
4. Sheet no. 4. Draw details drawing from given assembly & assembly drawing from the given details drawing (With limits, fits, tolerances)
5. Sheet no.5. Based on Isometric Drawing
6. Sheet no. 6 simple component on Isometric Drawing

Text Books:

1. P.S. Gill, Machine Drawing. S.K. Kataria and Sons, Delhi.
2. N. D. Bhatt, Machine Drawing. Charotor Publication House, Bombay.
3. N. Sidheshwar . P. Kannaiah and V.V. S. Sastry. Machine Drawing, Tata McGraw Hill, New Delhi
4. George Omura.,Mastering Auto CAD, BPB Publications
5. K.L.Narayana, P.Kanniah, & K.V. Reddy,"Machine Drawing" SciTech Publications (India Pvt. Ltd.) Chennai

Reference Books:

1. IS: SP46- Engineering drawing practice for schools and colleges, B.I.S. 15 Publications.
2. IS: 696- Code of practice for general engineering drawings B.I.S. Publications
3. IS : 2709-Guide for selection of fits, B.I.S. Publications
4. IS:919-Recommendation for limits and fits for Engineering, B.I.S. Publications

University Theory Paper Exam. Scheme:

- Question paper will contain one compulsory question – objective question for 14 Marks (On Unit-1 to 5)
- Question paper will contain one compulsory question on Unit No. 5 for 22-24 Marks.
- **Question paper will NOT contain any question on Unit No. 6.**

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Second Year B.TECH. (Mechanical Engineering)

Semester-IV

MECHPCC-06 :Fluid Mechanics and Fluid Machines

***Teaching Scheme**
Lectures:03Hours/week, 03 Credits
Practical :02Hours/week, 01Credit

***Examination Scheme**
ESE:70Marks
ISE: 30Marks
ICA:25Marks

Course Introduction:

Fluid Mechanics is the core subject in Mechanical Engineering. Conversion of fluid energy into mechanical energy and vice versa, is the scope for Fluid Mechanics & Fluid Machines. As far as applications are concerned, areas like industrial hydraulics & pneumatics, tribology, process equipment design, piping engineering; irrigation engineering requires knowledge of fluid mechanics. The contents of fluid mechanics & fluid machine subject, encourages students to become involved in learning principles of fluid flow systems.

Course Objectives:

During this course, student is expected to:

1.Various properties of fluids & related principles
2.Understand fundamentals of Fluid Statics, Kinematics & Dynamics
3.Evaluate Energy Losses in Pipes
4.Apply dimensional analysis and Buckingham's Π theorem to understand the dimensions of fluid properties, and use these principles to analyze forces on immersed bodies
5.Examine Water Turbines
6.Understand Centrifugal Pumps

Course Outcomes:

At the end of this course, student will be able to:

1. Explain and apply principles of fluid statics to analyze the equilibrium and stability of submerged and floating bodies.
2. Apply mathematical models to describe fluid motion, enabling the analysis of streamlines, potential flow, and velocity components.
3.Illustrate major and minor energy losses in pipe systems using empirical equation
4. Apply dimensional analysis to predict forces on immersed bodies, deriving dimensionless parameters for a comprehensive understanding of fluid properties.
5. Analyze impulse and reaction water turbines.
6. Calculate various parameters of centrifugal Pumps.

Section I

Unit-1: Fluid statics **No. of lectures-05**

Center of pressure, Total pressure on immersed surfaces – horizontal, vertical & inclined, Principle of buoyancy, Archimedes' principle, conditions of equilibrium for submerged & floating bodies, Meta-center & meta centric height. (No numerical treatment to Meta-centric height)

Unit-2: Fluid kinematics and dynamics **No. of lectures-08**

Fluid kinematics: Types of flow with examples, Streamlines, path lines & streak lines, velocity & acceleration components (Numerical treatment), velocity potential function, equi-potential lines, Laplace equation governing potential flow, stream function, continuity equation in Cartesian co-ordinates.

Fluid dynamics: Euler's equation along a stream line & Bernoulli's equation (Numerical Treatment), applications of Bernoulli's Theorem: Venturi meter (Numerical Treatment), Pitot tube , Orifice meter (construction and working only)

Unit-3: Flow through pipes **No. of lectures-07**

Major & minor Energy losses, Darcy-Welsbach equation, loss of head in pipe connections& fittings, (Numerical treatment on only major Losses), equivalent pipe, Hydraulic Gradient Line (HGL) & Total Energy Line (TEL),Concept of flow through pipes in series & parallel (Numerical treatment), efficiency of power transmission& Condition for maximum transmission of power through a given pipe. (No numerical treatment on HGL, TEL& Power Transmission through Pipe)

Section II

Unit-4: Dimensional Analysis and Forces on Immersed Bodies. **No. of lectures-04**

Dimensions of Commonly Encountered Fluid Properties, Dimensional Analysis, Buckingham's Π theorem (Numerical Treatment), Drag & Lift on immersed bodies

Unit-5: Water Turbines **No. of lectures-09**

Impulse Water Turbine: Euler's equation for rotodynamic machines, Classification of water turbines, Pelton wheel, Work done and efficiencies of Pelton wheel, Design of Pelton Turbine runner.(Numerical Treatment on Pelton Wheel Turbine)

Reaction Water Turbine: Construction and Working of Francis & Kaplan turbine. Work done and efficiencies of Francis, Draft tube (Theoretical treatment only for draft tube), governing of turbine.

Unit-6: Centrifugal Pumps **No. of lectures-07**

Working principle, construction, types, various Heads, multistage pumps, Velocity triangles, Minimum starting speed, Maximum Suction Height & Net Positive Suction head, Calculations of efficiencies, Discharge, blade angles, Heads, Power required, specific speed of pumps. (No Numerical Treatment on Centrifugal pump)

Internal Continuous Assessment (ICA):
List of Experiments/Assignments/Case Studies, etc.

Assignments (Compulsory)

1. Numerical & theoretical assignments on basics of fluid mechanics (Properties of fluids & related laws)
2. Numerical & theoretical assignments on study of manometer

List of Experiments (Any Seven out of following)

1. Determination of meta centric height for a ship
2. Verification of Bernoulli's theorem.
3. Calibration of Venturi meter/ Orifice meter.
4. Determination of hydraulic coefficients of an orifice.
5. Determination of Coefficient of friction for Parallel Pipes/Series Pipes (any one)
6. Study & Demonstration of Pelton wheel Turbine.
7. Study & Demonstration of Francis/ Kaplan turbine.
8. Study & Demonstration of centrifugal pump.
9. Two problems using CFD software

Text Books:

1. Dr. P.N. Modi and Dr. S.M. Seth - Hydraulics and Fluid Mechanics including Hydraulic Machines, Standard Book House.
2. Dr. R.K. Bansal - Fluid Mechanics and Hydraulic Machines, Laxmi Publication Pvt. Ltd., New Delhi.
3. Dr. D. S. Kumar - Fluid Mechanics & Fluid Power Engineering, Kotaria& Sons
4. Domkundwar & Domkundwar - Fluid Mechanics and Hydraulic Machines, Dhanpatrai & Co.
5. Streeter, Wylie, Bedford - Fluid Mechanics, McGraw Hill Publication.

Reference Books

1. Frank M. White , Fluid Mechanics, McGraw Hill Publication
2. Irving Shames - Mechanics of Fluid, McGraw Hill Publication.
3. Murlidhar - Advanced Fluid Engineering, Narosa Publication.
4. S. K. Som, G. Biswas- Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw Hill publications

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Second Year B.TECH. (Mechanical Engineering)

Semester-IV

MECHVSC- 01 :Advanced Lab on CAD

***Teaching Scheme**
Lectures: 01 Hours/week, 01 Credits
Practical : 02 Hours/week, 01Credit

***Examination Scheme**
ICA: 25Marks
POE: 25Marks

Course Introduction:

Computer Aided Design (CAD) & Computer Aided Manufacturing (CAM) has become a vital tool in modern day manufacturing industry. Basically, it deals with using computer systems (or workstations) for creating component models, analyzing component as per working conditions, optimizing the component designs and for generating programs which Are input to CNC Machines that carry out the machining of the machine components. Individual parts manufactured, are further assembled to form a machine. A very basic step in the process is to model the machine component accurately in the CAD/CAM software Packages available. This course introduces the preliminary commands, procedures, programming used in such software's. Use of software's in the engineering design & manufacturing increases the productivity of the designer, improves the quality of design, improves communications through documentation, and creates a database for Manufacturing. The course helps in skill development as per the need of the modern day Industry & thus, enhances the employability.

Course Objectives:

During this course, student is expected:

1.To develop the ability of using a software for drafting purpose
2. To provide introduction of different drafting and modeling techniques
3. To develop a pre-requisite for higher courses like CAD/CAM & FEM

Course Outcomes:

At the end of this course, student will be able to:

1. Classify the drafting & modeling techniques.
2. Use software package for different drafting & modeling requirements of industry.
3.Perform preliminary steps required while working on high-end CAD/CAM software's.
4. Develop logical programs required for parametric modeling.

Section I

Unit-1:Basics of Computer Aided Drafting **No. of lectures-04**

Introduction to Computer Aided Drafting – Introduction, Significance, Packages, Applications, User interface of the drafting package, status bar, different toolbars, viewing options, zoom, pan, layers & properties, etc, Draw commands (2D) : line, polyline, circle, arc, ellipse, polygon, hatch, region, etc, Edit & Modify commands (2D) : erase, scale, rotate, copy, move, trim, fillet, chamfer, extend, mirror, etc, Text commands, dimensioning: dimension style, Dimensioning common features.

Unit-2:Computer Aided Drafting (2D) **No. of lectures-03**

Drafting 2D machine components, Isometric Drawing : Snap Settings, Isoplane, Isocircle, Isometric drawings of machine components, Plotting options available in the drafting package

Section II

Unit-3:Details and assembly drawing (2D) **No. of lectures-03**

To prepare detailed part drawings of an assembly, To prepare assembly drawing from the prepared part drawings, Plotting of Part & assembly drawings including fits & tolerances

Content Delivering Methods: Demonstration on suitable software package.

Unit-4: Computer aided drafting (3D) **No. of lectures-04**

Introduction to modeling: Wireframe, Solid, Surface Modeling, Three dimensional drawing: UCS & three dimensional co-ordinates, Viewing in three dimensions, Solid modeling commands: primitive solids, extrude, revolve, sweep, loft, press pull, etc, Solid editing commands: 3D-rotate, 3D-Move. 3D-Scale, Boolean operations, Slice, Sections, etc

Internal Continuous Assessment (ICA):

List of Experiments/Assignments/Case Studies, etc.

Any Six out of Following

1. Introduction to Computer aided drafting
2. Computer aided drafting (2D) of simple components and print out
3. Computer aided drafting (2D) of isometric drawing and print out
4. Computer aided drafting (2D) of Simple Machine Components and print out.
5. Computer aided drafting (2D) of Simple Assembly Drawing and print out
6. Computer aided drafting (3D) of simple components and print out
7. Computer aided drafting (3D) of Machine components and print out
8. Computer aided drafting (3D) Assembly of Machine components and print out

Text Books:

1. Ajeet Singh, “Working with AutoCAD 2000”, Tata McGraw Hill..
2. George Omura, “ABC of Autolisp ” BPB Publications, New Del. P.S. Gill, Machine Drawing.,S.K. Kataria and Sons , Delhi.
3. N. D. Bhatt,. Machine Drawing. Charotor Publication House, Bombay.
4. N. Sidheshwsr .P. Kannaiah& V.V.S. Sastry. Machine Drawing, Tata McGraw Hill, NewDelhi.
5. K. L. Narayana, P. Kanniah, & K.V. Reddy, “Machine Drawing”.SciTech Publications (IndiaPvt. Ltd.) Chennai.

Reference Books

1. IS: SP46- Engineering drawing practice for schools and colleges, B.I.S. Publications.
2. IS: 696- Code of practice for general engineering drawings B.I.S. Publications.
3. IS: 2709-Guide for selection of fits, B.I.S. Publications.
4. IS: 919- Recommendation for limits and fits for Engineering, B.I.S. Publications.
5. IS: 8000- Part I, II. III. TV, geometrical tolerancing of technical drawings, B.I.S. Publications.

A. Multidisciplinary Minor in "Material Science and Energy Engineering"

Semester	Course Code	Course Title
IV	MECHMDM-02A	Materials for Technology Development

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Second Year B.TECH. (Mechanical Engineering)

Semester-IV

A. Multidisciplinary Minor in "Material Science and Energy Engineering"

MECHMDM- 02A: Materials for Technology Development

(Multidisciplinary Minor-II)

***Teaching Scheme**

Lectures: 02 Hours/week, 02 Credits

Practical : 02 Hours/week, 01Credit

***Examination Scheme**

ESE:70 Marks

ISE: 30 Marks

ICA: 25 Marks

Course Introduction:

The course provides a broad and general knowledge of various types of materials like Composite materials, Nano-materials, Electronic materials, Magnetic materials, Nuclear material, etc. which are widely used in development of new technologies along with properties of these materials, manufacturing methods, testing methods and applications of these materials in various sectors like Aerospace, Automobile, Healthcare, Electronics, Energy storage devices, etc. The course aims to give an understanding of how different materials are and what these differences mean for their properties and application.

Course Objectives:

During this course, student is expected:

1. To know the different types of composite materials with their properties and applications.
2. To introduce the students to the world of nanoscience and provide knowledge of various synthesized/developed and natural nanomaterials and their possibilities.
3. To equip the students with the knowledge of available methods to synthesize nanostructures and materials and make them aware, the huge potential of nanomaterials/structures in engineering/technologies.
4. To know the different types of Electronic materials with their properties and applications.
5. To know the different types of Magnetic materials with their properties and applications.
6. To know the different types of Nuclear materials with their properties and applications.

Course Outcomes:

At the end of this course, student will be able to:

1. Explain the advantages and limitations of composite materials over conventional materials.
2. Describe the effect of particles or grains size on mechanical, thermal, optical and electrical properties of nanomaterials and synthesis the nanomaterials by top-down and bottom-up approaches.
3. Explain the theoretical concepts of about the applications of nanomaterials in structural, electronics, optical, magnetic, and bio-medical fields, nanocomposites etc.
4. Identify and explain the basic principles of various electronic materials.
5. Identify and explain the basic principles of various Magnetic materials.
6. Identify and explain the basic principles of various Nuclear materials.

Section I

Unit-1: Introduction to Composites **No. of lectures- 06**

Concept of Composite materials, Classification of Composites, Various types of composites, Classification-based on Matrix Material: Organic Matrix Composites (Polymer matrix composites (PMC) / Carbon Matrix Composites or Carbon-Carbon Composites, Advantages of Composites materials. Reinforcements and Matrices for various types of composites Fibers / Reinforcement Materials, Role and Selection of reinforcement materials, Types of fibers, Mechanical properties of fibers. Manufacturing processes. Testing of Composites: Mechanical testing of composites, Tensile testing, Compressive testing. Applications of Composites.

Unit-2: Introduction to Nanomaterials and Nanotechnology **No. of lectures- 05**

Length scales, surface area/volume ratio of micron to nanoscale materials, Importance of Nanoscale and Technology, Top down and bottom-up approaches, Classification of nanomaterials, effect of particle size on thermal properties, electrical properties, phase transformation, mechanical properties, magnetic properties, optical properties, wear resistance and chemical sensitivity. Examples of inspiration from the Nature and ancient history. Top-down approaches-lithography, mechanical alloying, severe plastic deformation, Bottom-up approaches-physical vapour deposition, chemical vapour deposition, molecular beam epitaxy, colloidal or wet chemical route, green chemistry route, sol-gel method, atomic layer deposition, combustion method.

Unit-3: Applications of Nanomaterials: **No. of lectures- 04**

Applications of nanomaterials: nanofluids, hydrogen storage, solar energy, antibacterial coating, self-cleaning coating, nanotextiles, biomedical field, water treatment, automotive sector, catalysts, nanopore filters, nano diamond.

Section II

Unit-4: Electronic Materials **No. of lectures- 06**

Electrical and Thermal Conduction In Solid metal and conduction by electrons, Resistivity and its Temperature dependence, Thermal Conductivity, Thermal Resistance Temperature coefficient of Resistivity, Impurity Effect, Resistivity Mixture Rule, Skin Effect. Electrical Conductivity of Non -Metals: Ionic Crystals and Glasses, Semiconductors, Solar Radiation Fundamentals.

Semiconductors, Extrinsic, Intrinsic, Recombination and Generation in Semiconductors, Semiconductor Devices, Compound Semiconductor, Metal Semiconductor contacts, Microelectronic Devices Such as LED, CMOS, MOSFETS, BPT etc, Manufacturing Methods and Applications, Si wafer Manufacturing, Solar Cell Device and Quantum Efficiency Calculations.

Unit-5: Magnetic Materials **No. of lectures- 05**

Magnetic Properties: Magnetic Field and Quantities, Classification of Magnetic Materials, Ferromagnetism Origin, Exchange Interaction, Saturation Magnetization, Curie Temperature, Ferromagnetic Domains, Magnetostriction, Demagnetization, Magnetic Alloys: Soft and Hard Magnetic materials, Ferrites, Magnetic Recording Materials, Magnetoelectric materials

No. of lectures- 04

Unit-6:Nuclear Materials

Materials Specifications for fuel, cladding, moderator, coolant, shield, pressure vessel; Materials selection influenced by the need for a low capture cross-section for neutrons. Nuclear metallurgy; Structures and properties of materials with special relevance for nuclear power generation: uranium and other actinides, beryllium, zirconium, graphite. Recycle and waste management and disposal. environmental impact; safety.

Internal Continuous Assessment (ICA):

List of Experiments/Assignments/Case Studies, etc.

Minimum 6 assignments from the following areas are required to be completed.

1. Assignment on types of Composite material and its applications.
2. Assignment on Manufacturing processes and testing methods used for Composite materials.
3. Assignment on types of Nanomaterials with their properties and applications.
4. Assignment on Topdown and bottom-up approaches used in Nanotechnology.
5. Assignment on Electronic materials and their properties.
6. Assignment on Electronic devices Such as LED, CMOS, MOSFETS, BPT etc.
7. Assignment on Magnetic materials with their properties and applications.
8. Assignment on Introduction to Nuclear materials with its applications.

Text Books:

1. Jones R. M., “Mechanics of Composite Materials”, Hemisphere Publishing Corporation, New York.
2. Rajendra Kumar Goyal," Nanomaterials and nanocomposites: Synthesis, Properties, Characterization Techniques and Applications" CRC Press, 2017, ISBN: 978- 14987616662017.
3. William F. Smith , JavedHashemi, Ravi Prakash, " Foundation of Materials Science and Engineering", TATA Mc Graw-Hill International Edition,4th Edition, 2008.
4. S. O. Kasap," Principles of Electronic Materials and Devices", Tata Mc Graw-Hill Publication, 2nd Edition, 2002.
5. C.K.Gupta," Materials in Nuclear Energy Applications", CRC Press, 1st Edition 1989

Reference Books:

1. Chawla, Krishan K (2012), Composite Materials, Science and Engineering, ISBN: 978-0-387- 74365, Springer.
2. Dieter Vollath, "Nanomaterials: An introduction to synthesis, properties and applications", 2nd Edition, Aug 2013, Wiley-CVH (ISBN: 978-3-527-33379-0)
3. Electronic Materials Handbook, ASM International, Materials Park, 1989.
4. Buschow K.H.J.," Handbook of Magnetic Materials", Amsterdam: Elsevier, Volume15, First Edition December 2003.

B. Multidisciplinary Minor in "Industrial and Project Management"

Semester	Course Code	Course Title
IV	MECHMDM-02B	Production and Operations Management

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Second Year B.TECH. (Mechanical Engineering)

Semester-IV

C. Multidisciplinary Minor in "Industrial and Project Management"

MECHMDM 02B: Production and Operations Management

(Multidisciplinary Minor-II)

*Teaching Scheme	*Examination Scheme
Lectures:02Hours/week, 02Credits	ESE:70Marks
Practical :02 Hours/week, 01Credit	ISE:30Marks
	ICA:25Marks

Course Introduction:

Strategic growth & competiveness of organizations are depending upon the effective utilization of the critical production resources of the organization. Production/operations function is concerned with design & control systems responsible for the productive use of raw materials, human resources, equipment and facilities in the development of a product or services. The syllabus is divided into two sections, each section contains three chapters. Section I focuses on the introduction to Production and Operations Management, the forecasting and its significance and capacity planning. Inventory Management, Plant maintenance, Value Engineering and the Advanced Manufacturing concepts are included in Section-II.

Course Objectives:

During this course, student is expected to:

1. Develop knowledge about the principles of production and operations management.
2. Solve organizational problems related to production as well as operations management.
3. Empower students to handle case studies related to industrial problems.

Course Outcomes:

At the end of this course, student will be able to:

1. Explain the scope and need of production and operation management
2. Evaluate the future demands using different forecasting methods and apply the concept of capacity planning and aggregate planning to various types of manufacturing systems
3. Explain the importance and functions of production planning and control
4. Apply the inventory control models in production processes
5. Apply the concept of plant maintenance.
6. Explain various advanced techniques such as Lean manufacturing, value engineering, six sigma, Kanban, Supply chain management.

Section- I

Unit-1: Introduction to Production and Operation Management **No. of lectures-04**

Introduction to POM- Definitions, objectives, Scope and History of Production Management, Manufacturing system and their types

Unit-2:Forecasting and Capacity Planning **No. of lectures-07**

Forecasting- Need, types of Forecasting, Statistical method, Moving average method, exponential smoothing method, Least square method, Regression and Co-relation method. (Numerical Treatment)

Capacity Planning- Concept, measurement and measures of capacity, factor affecting, capacity planning procedure, Aggregate planning, Investment decision and replacement analysis. (Numerical Treatment)

Unit-3:Production Planning and Control **No. of lectures-04**

Objectives, Functions, Co-ordination of PPC with other Department, Routing Scheduling, Loading and Sequencing, Line balancing, Production Control – Dispatching, Function and documents, Follow up, Evolution

Section II

Unit-4:Inventory Management **No. of lectures- 05**

Inventory concepts, objectives, types of Inventory, different costs of Inventory, EOQ model, Economic batch quantity (EBQ) model, Inventory control techniques, ABC analysis, MRP, Fixed period and fixed quantity system. (Numerical Treatment)

Unit-5:Plant Maintenance **No. of lectures-04**

Definition, Need, Importance, Functions, scope and organization of maintenance department Types of maintenance- preventive, break down, Identification of break down using fishbone diagram, and TPM, Reliability and life testing

Unit-6:Value Engineering and Value Analysis and Advanced manufacturing System **No. of lectures-06**

Value Engineering and Value Analysis -Definition, objectives and use of value analysis, reason of unnecessary cost, value analysis procedure.

Advanced manufacturing System - Lean Manufacturing Basics , Just- in Time (JIT), Kanban System, KAIZAN, Zero defect, six sigma , Supply chain Management.

Internal Continuous Assessment (ICA):

List of Experiments/Assignments/Case Studies, etc.

(**1 mandatory and any 5 out of remaining 7**)

1. A micro project on categorization of industries based on production type and production system
   (Categorize any (minimum) six industries by type of production and production system and justify the categorization. This micro project is based on the Industry, products of the industry and further their categorization)
2. Numerical treatment on different forecasting techniques by using Microsoft Excel spreadsheet
3. Numerical treatment on capacity planning by using Microsoft Excel spreadsheet
4. Numerical treatment on inventory management
5. A Case study on plant maintenance or TPM preferably from the research paper from reputed peer reviewed journal
6. A Case study on value analysis
7. A Case study on Six Sigma
8. A Case study/online course (minimum 2 hrs.) on Supply chain Management

Text Books:

1. Industrial engineering and Production management by Martand Telsang. (S. Chand)
2. Elements of Production Planning and Control by Samuel. (Universal Pub.)
3. Modern Production/Operation Management by Buffa Sarin. (Wiley)
4. Industrial Engineering and Management by O. P. Khanna

Reference Books

1. Production and Operation Management by M. E. ThukaramRao. (New Age International Pub)
2. Sunil Chopra and Peter Meindl “Supply Chain Management – Stratergy, Planning, and Operation “,6thEditiom ,Peason Education Asia , 2016.

A. Honors in Robotics Engineering

Semester	*Course Code*	*Name of the Course*	*Engagement Hours*			*Credits*	*FA*	*SA*			*Total*
			L	*T*	*P*		*ESE*	*ISE*	*ICA*	*OE/ POE*	
III	MechHon - 01A	Industrial Robotics	3	-	2	4	70	30	25	-	125
IV	MechHon - 02A	Machine Vision	3	-	2	4	70	30	25	-	125
V	MechHon - 03A	Industrial Networks and Controllers	2	-	2	3	70	30	25	-	125
VI	MechHon - 04A	Advanced topics in Robotics	3	-	2	4	70	30	25	-	125
VII	MechHon - 05A	Mini Project	1	-	4	3			50	-	50
		Total		-		**18**	**280**	**120**	**150**	-	**550**

Honors Course will be for the students of same Program

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Second Year B.TECH. (Honors) (Mechanical Engineering)

Semester-III

A. Honors in Robotics Engineering

MechHon-01A: Industrial Robotics

***Teaching Scheme**
Lectures: 03 Hours/week, 03 Credits
Practical: 02Hours/week, 01Credit

***Examination Scheme**
ESE:70Marks
ISE: 30Marks
ICA:25Marks

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Course Introduction:

This course is designed to give the student an in depth understanding of manipulative robotics and its uses. It covers the topics such as automation types, introduction to industrial robotics, Anatomy of an industrial robot, robot history, configurations, sensors and actuators, end effectors and AGVs Kinematics of multi-degree-of-freedom systems, Jacobean matrices, kinematics, and dynamics. Robot trajectories. Design of installations, The Work cell —concepts and design, etc. This course requires the students to take part in site visits and case study presentations. Students are also required to complete a simulation and image processing in any suitable Simulation Software.

Course Objectives:

During this course, the student is expected to:

1. Understand the basic construction of an industrial robot.
2. Acquaint with existing market distribution and future trends.
3. Understand the technology behind a modern robot such as sensors, actuators, grippers, controllers, machine vision etc.
4. Understand and bridge the gap (regarding industrial robots) between textbooks to industry.

Course Outcomes:

At the end of this course, student will be able to:

1. Explain types of robots including Cobots.
2. Solve simple kinematics and dynamics problems on robot motion.
3. Select appropriate robot specifications for industrial applications.
4. Use any robot simulation software to simulate a robot and its Work cell.
5. Explain sensors and actuators used in robot
6. Solve simple kinematics and dynamics problems on robot motion.

Section I

Unit-1: Introduction, types of robots definitions **No. of lectures - 8**

History and fundamentals of Industrial Robots, Definition as per ISO & IFR, Technology Evolution, components of industrial robots, configuration, typical specifications, current market scenario, "Collaborative Robots", Service Robots. AGVs, classification, navigation techniques, applications. Mobile robots: Classification, wheeled and tracked robots, autonomous navigation and control methods and applications, Humanoid robots, Bio-mimetics.

Unit-2: Sensors and Actuators **No. of lectures - 8**

Sensors: Sensor classification, joint angle sensors, rotary encoders, proximity sensors & switches, range sensors, GPS, INU, Actuators: Compare Hydraulic, Pneumatic and Electric drives, Review of DC motors and stepper motors, AC motors, speed control of AC motors, VFD drives, and drive selection criteria.

Unit-3: Grippers and End Effectors **No. of lectures - 4**

End Effectors: End effectors & grippers, classification, applications, design, and selection criteria.

Section II

Unit-4: Kinematics & Dynamics **No. of lectures - 8**

Forward kinematics: Coordinate frames, transformations, arm equations, forward kinematics of 2 DOF and 3 DOF planar manipulator.

Inverse Kinematics: Tool Configuration, inverse kinematics of 2 DOF and 3 DOF planar manipulator. Dynamics: Velocity Jacobian, singularities, induced torque and forces, Lagrange's Equation, Dynamic models of two-axis planar robots.

(Derivations and Numerical Exercises on simple 2DOFmanipulators only.)

Unit-5: Control and Path Planning **No. of lectures - 6**

Control architecture of robots, Overview of advanced control techniques such as force control, PID control adaptive control, PWM control. Trajectory planning, joint space schemes, Cartesian space schemes, issues in trajectory planning.

Unit-6: Applications of Industrial Robots **No. of lectures - 6**

General considerations for selecting robots (including layout and work cell) for material handling and machine tending, spot welding, continuous welding, sealant application, spray painting, assembly, inspection, electronics assembly.

Internal Continuous Assessment (ICA):

List of Experiments/Assignments/Case Studies, etc. (Any Six)

1. Survey assignment on robots industry and manufacturers and applications
2. Assignment on robot sensors and actuators.
3. Assignment on EOAT.
4. Assignment on forward and inverse kinematics on software supported by hand calculations
5. Assignment on DH notations using software supported by hand calculations.
6. Assignment on manipulator dynamics using software supported by hand calculations
7. Assignment on robot control using software.
8. One software based assignment on path planning and programming techniques.
9. One assignment on various applications in industry.
10. One assignment which involves building a workcell and offline programming using software.

Text Books:

1. S.K Saha, Introduction to Robotics, McGraw-Hill
2. Mikell Groover et.al, Industrial Robotics, McGraw Hill.
3. James, Keramas, Robot Technology Fundamentals, Delmar Cengage Learning.
4. Gunter Ulrich, Automated Guided Vehicle Systems, Springer.

Reference Books

1. Asitava Ghosal, Robotics: Fundamental Concepts and Analysis, Oxford Press
2. Siegwart et.al, Autonomous Mobile Robots, Prentice Hall India.
3. Shimon Nof, Handbook of Industrial Robotics, Wiley.
4. Schilling, Fundamentals of Robotics, Prentice Hall India.
5. International Federation of Robotics - https://www/ifr.org

Note: *Students are expected to go through websites of top industrial robot manufacturers. In addition to the IFR website for up to date and real world information including statistical data. Content in textbooks is too generic and may not be up to date.*

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Second Year B.TECH. (Honors) (Mechanical Engineering)

Semester-IV

A. Honors in Robotics Engineering

MechHon-02A: Machine Vision

***Teaching Scheme**
Lectures: 03 Hours/week, 03 Credits
Practical: 02Hours/week, 01Credit

***Examination Scheme**
ESE:70Marks
ISE: 30Marks
ICA:25Marks

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Course Introduction:

This course is designed to give the student an in depth understanding of Machine Vision using in suitable software package. This course requires the students to take part in site visits and case study presentations. This course covers the fundamentals of Machine Vision such as segmentation, template matching, edge detection, camera calibration, shape analysis, object identification, Cameras (CCD, CMOS, Area Scan, and Line Scan), camera specification and selection, Image Processing using suitable software package, etc.

Course Objectives:

During this course, student is expected to:

1. Understand components of a machine vision system and its working.
2. Acquaint with existing market distribution and future trends
3. Understand the fundamentals of image processing and analysis
4. Understand fundamentals of Cameras (CCD, CMOS, Area Scan, and Line Scan)
5. Understand the scope and applications of modern machine vision systems.
6. Understand the technology behind a modern robot machine vision

Course Outcomes:

At the end of this course, student will be able to:

1. Use the Image Processing toolbox available in suitable software package.
2. Use Image Analysis toolbox in in suitable software package.
3. Use Computer Vision toolbox in in suitable software package.
4. Explain components of machine vision and image processing fundamentals.
5. Explain construction and applications of different types of robots.
6. Define segmentation and explain concept such as template matching, edge detection, shapeanalysis etc.

Section I

Unit 1 – Introduction to Machine Vision **No. of lectures - 06**

Machine Vision definition, Machine vision system components, block diagram of machine vision system, lighting techniques, front light source and back light source, application of machine vision system, Analog to digital converter (A/D Converter), image storage frame grabber

Unit 2 – Image processing fundamentals **No. of lectures -08**

Image processing fundamentals: Image representation, Image processing and analysis, image data reduction, Segmentation, Thresholding, region growing, Edge detection, corner point detection, shape analysis

Unit 3- Image Analysis **No. of lectures - 06**

Object identification, template matching, object recognition, lead through programming method, textual robot programming method

Section II

Unit 4 – Cameras **No. of lectures - 06**

Cameras: image devices Charge couple device (CCD), Complementary metal oxide semiconductor (CMOS), Area Scan, Line Scan, camera specification and Camera selection, camera calibration. difference between CCD and CMOS, Needof CCD and CMOS cameras

Unit 5 – Machine vision system **No. of lectures - 08**

Sensing and digitizing function in machine Vision, Feature extraction- basic features and measures for 2D object, numerical on finding area, minimum aspect ratio, diameter, centroid, thinness measures of image, training the vision system.

Unit 6 – Application of Machine vision system **No. of lectures - 06**

Robotic applications i.e. inspection, identification, visual surveying and navigation, Agricultural applications of Machine vision system, application of machine vision for control of AGVs

Internal Continuous Assessment (ICA):
List of Experiments/Assignments/Case Studies, etc. (any six)

1. Survey assignment on robots, AGVs, control by using machine vision.
2. Theory assignment on Machine vision system.
3. One assignment on Image Processing using suitable software package.
4. One assignment on Image Analysis using suitable software package.
5. Survey assignment on robots industry and manufacturers and applications.
6. One assignment on CCD & CMOS Cameras
7. One assignment on Segmentation
8. One assignment on Problem Solving
9. One theory assignment on Illumination techniques.
10. One assignment on shape analysis.

Text Books:

1. S.K Saha, Introduction to Robotics, McGraw-Hill.
2. Mikell Groover et.al, Industrial Robotics, McGraw Hill.
3. Stuart Russel & Peter Norvig, Artificial Intelligence a Modern Approach.
4. E. Rich and K. Knight, "Artificial intelligence", TMH.
5. N.J. Nilsson, "Principles of AI", Narosa Publ. House, 2000.

Reference Books

1. Asitava Ghosal, Robotics: Fundamental Concepts and Analysis, Oxford Press.
2. Siegwart et.al, Autonomous Mobile Robots, Prentice Hall India.
3. Robin R Murphy, Introduction to AI Robotics, PHI Publication, 2000.
4. Bishop et.al, Handbook of Mechatronics, CRC Press.
5. Schilling, Fundamentals of Robotics, Prentice Hall India.
6. Robert Babuška, Fuzzy Modeling for Control, Springer.
7. Dan Patterson, Introduction to Artificial Intelligence and Expert Systems, Prentice-Hall.
8. International Federation of Robotics - https://www/ifr.org

B. Honors in Electric Vehicle Engineering

Semester	*Course Code*	*Name of the Course*	*Engagement Hours*			*Credits*	*FA*	*SA*			*Total*
			L	*T*	*P*		*ESE*	*ISE*	*ICA*	*OE/ POE*	
III	MechHon - 01B	Introduction to Automobile Engineering	3	-	2	4	70	30	25	-	125
IV	MechHo n - 02B	Introduction to Electric and Hybrid Vehicles	3	-	2	4	70	30	25	-	125
V	MechHo n - 03B	Battery Technology and Charging Infrastructur e	2	-	2	3	70	30	25	-	125
VI	MechHo n - 04B	Advanced topics in Electric Vehicles	3	-	2	4	70	30	25	-	125
VII	MechHo n - 05B	Mini project	1	-	4	3	-	-	50	-	50
		Total				**18**	**280**	120	150		550

Honors Course will be for the students of same Program

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Second Year B.TECH. (Honors) (Mechanical Engineering)

Semester-III

B. Honors in Electric Vehicle Engineering

MechHon-01B: Introduction to Automobile Engineering

***Teaching Scheme**

Lectures: 03 Hours/week, 03 Credits

Practical: 02Hours/week, 01Credit

***Examination Scheme**

ESE:70Marks

ISE: 30Marks

ICA:25Marks

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Course Introduction:

The objective of this course is to provide a fundamental understanding of the various systems of a typical automobile. The systems that are covered are IC engines, their types, components and applications, the clutch and gearbox, calculation of gear ratios, driveline and differential, steering system, types of steering, brakes, ABS, suspension, wheels and tyres and electronics and electrical systems.

Course Objectives:

During this course, the student is expected to:

1. Understand different automobile layouts
2. Understand automobile ICE and their applications
3. Understand the construction and working of different automobile subsystems.
4. Understand how the automobile is serviced and maintained.
5. Understand how an automobile is built.
6. Understand components of electricals & electronics.

Course Outcomes:

At the end of this course, student will be able to:

1. Identify automobile body types accurately
2. Explain construction and working of different automobile subsystems
3. Calculate gear ratios, steering angle, steering forces, brake forces etc. using standard formulae.
4. Locate and identify automobile subsystems and components on an actual vehicle.
5. Explain different electrical and electronics systems in an automobile and their functions.
6. Explain automotive electricals & electronics components.

Section I

Unit -1: Automobile body type and powertrain **No. of lectures - 8**

Automobile layout, automobile body styles, chassis construction, Automotive powertrain, Classification of Internal Combustion Engines, Engine Components, Operation of Four Stroke Engines, Two-Stroke Engines, Engine Cycles, Engine Performance, Supercharging, engine subsystems and engine selection. EVs, HEVs

Unit -2: Automotive Clutch, Transmission, Powertrain Analysis **No. of lectures - 6**

Automobile Clutch, Types, basic calculations, automobile transmissions and its types, power train calculation and analysis, transmission matching.

Unit - 3: Brake System **No. of lectures - 6**

Fundamentals of Braking, braking requirements, drum brakes, disc brakes, hydraulic brakes, air brakes, brake selection for 2W, 3W, 4W and commercial vehicles, ABS.

Section II

Unit - 4: Steering System **No. of lectures - 6**

Automotive Steering, components of the steering system, type of steering (R&P, recirculating ball, etc), Ackerman steering, simple calculations for steering ratio and steering angle, power assisted steering.

Unit - 5: Wheels, Tyres and Suspension System **No. of lectures - 8**

Wheel alignment, wheel types, tyres and its tyres, radial tyres, types of suspension for front and rear, requirements of suspension system, independent and dependant suspension, shock
absorbers and suspension analysis.

Unit - 6: Automotive Electricals and Electronics **No. of lectures - 6**

Automotive sensors and actuators, microcontrollers in automobiles, electric and electronic components in an automobile, automobile battery and its types, starter, spark plugs etc.

Internal Continuous Assessment (ICA):

List of Experiments/Assignments/Case Studies, etc.

1. Survey assignment on 2W, 3W, 4W and CVs.
2. Study of ICEs for 2W, 3W, 4W and CVs
3. Braking calculations and brake selection 2W, 3W, 4W and CVs
4. Study of Clutch and transmission systems for 2W, 4W, CVs
5. Study of steering for 2W, 4W, CVs
6. Study of Suspension System for 2W, 4W, CVs
7. Study of wheels and tyres for 2W, 4W, CVs
8. Study of automotive electrical and electronics.
9. Field visit to a service station.
10. Field visit to an automobile manufacturing plant.

Text Books:

1. D. Crolla, "Automotive Engineering: Powertrain, Chassis System and Vehicle Body", Elsevier
2. R. Stone and J. K. Ball, "Automotive Engineering Fundamentals", SAE International, 2004
3. T. K. Garrett, K. Newton, and W. Steeds, The Motor Vehicle, 13th Edition, SAE International, 2001
4. Julian Happian-Smith, "An Introduction to Modern Vehicle Design", BH
5. William B. Ribbens, "Understanding Automotive Electronics", Newnes

Reference Books

1. D. Crolla, D. E. Foster, T. Kobayashi and N. Vaughan (Editors-in-Chief), "Encyclopedia of Automotive Engineering, Parts 1-6", Wiley, 2015
2. D. B. Astow, G. Howard and J. P. Whitehead, Car Suspension and Handling, 4th Edition, SAE International, 2004.
3. R. Limpert, Brake Design and Safety, SAE International, 1992.
4. Bosch, Automotive Handbook, 2004
5 The Automotive Chassis, SAE

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Second Year B.TECH. (Honors) (Mechanical Engineering)

Semester-IV

B. Honors in Electric Vehicle Engineering

MechHon-02B: Introduction to Electric and Hybrid Vehicles

***Teaching Scheme**
Lectures: 03 Hours/week, 03 Credits
Practical: 02Hours/week, 01Credit

***Examination Scheme**
ESE:70Marks
ISE: 30Marks
ICA:25Marks

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Course Introduction:

The objective of this course is to provide a fundamental understanding of the various systems of typical electric and hybrid electric vehicles. The covered systems are battery electric vehicles their types, components and applications, hybrid electric vehicles (HEVS), types of HEVs, batteries for EVs and HEVs, charging techniques and connectors, and the future of EVs and HEVs.

Course Objectives:

The Course aims to:

1. Understand the construction and working of EVs
2. Understand the construction and working of HEVs
3. Understand the types of electric motors and drives for EVs
4. Understand the types of control methods for electric motors

Course Outcomes:

At the end of this course, the student will be able to:

1. Define all nomenclature associated with EVs and HEVs.
2. Explain construction and working of EVs and HEVs.
3. Perform basic calculations about EV performance.
4. Explain the construction, operation and selection of motors for different EV and HEVapplications.
5. Explain different types of EV drive cycles.
6. Explain different types of EV motor Controller

Section I

Unit-1: EV history and fundamentals **No. of lectures - 8**

History of the electric vehicle, Electric vehicle components, Vehicle mass and performance, electric motor and engine ratings, fuel economy, Electric vehicle market. Electric Vehicles, Overview of Electric Vehicles in India, Gravitational Energy Density, Volumetric Energy Density, Energy Efficiency, Capital Cost of EV Battery, Operational Cost of EV Battery, Battery cost reduction strategy, Swapped battery, Vehicle Weight, Range Anxiety, Fast charge, Slow charge, Range-Extender batteries.

Unit-2: EVs **No. of lectures - 6**

Electric vehicle configurations, electric motor characteristics, tractive effort and transmission requirements, tractive effort in normal driving, energy consumption and vehicle performance.

Unit-3: HEVs **No. of lectures - 6**

Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains, Plug-In Hybrid Electric Vehicle, Powertrain Component Sizing, Mass Analysis and Packaging.

Section II

Unit-4: Electric Motors for EVs **No. of lectures - 6**

Basic construction working and control principles of DC motors, BLDC motors, AC induction and synchronous motors, SRM motors.

Unit-5: Motor Controllers **No. of lectures - 6**

Choppers, Inverters, VFDs, torque control of DC motors, speed control of DC motors, torque and speed control of AC motors.

Unit-6: Drive Cycle **No. of lectures - 8**

Drive cycle, Energy Efficiency, Speed, Acceleration, Idling, Deceleration, Standard Drive Cycle, India Drive Cycle, Regeneration Efficiency, Modified Indian Drive Cycle, Electric Compact Sedan, Compact Sedan Energy Efficiency, Low-End Electric Trucks, Delivery Truck Specifications, Truck MIDC, Traction Energy for Drive Cycle, Summary of the impact of various parameters.

Internal Continuous Assessment (ICA):
List of Experiments/Assignments/Case Studies, etc. (Any six)

1. History and development of EVs and HEVs
2. EV types and components
3. HEV types and components
4. Basic performance calculations for EVs
5. DC motors for EVs.
6. AC motors for EVs.
7. DC motor modelling and control.
8. AC motor modelling and control.
9. Motor controllers and power electronics.
10. Drive Cycles

Text Books:

1. Iqbal Husain, *Electric and Hybrid Vehicles Design Fundamentals*, Taylor and Francis,2021
2. Ehsani, et al, *Modern Electric, Hybrid Electric, and Fuel Cell Vehicles,* CRC press
3. R.Krishnan, "Electric Motor Drives – Modeling, Analysis and Control", Prentice-Hallof India, Pvt. Ltd., New Delhi, 2003.

Reference Books:

1. Austin Hughes, "Electric Motors and Drives – Fundamentals, Types and Applications", Elsevier – a division of Reed Elsevier India Private Limited, New Delhi, 2006.
2. Vedam Subramanyam, "Electric Drives – Concepts and Applications", Tata McGraw Hill,2000.