MGM University

Vision

- To ensure sustainable human development which encourages self-reliant and self-content society.
- To promote activities related to community services, social welfare and also Indian heritage and culture.
- To inculcate the culture of non-violence and truthfulness through vipassanna meditation and Gandhian Philosophy.
- To develop the culture of simple living and high thinking

Mission

- To impart state of art education and technical expertise to students and give necessary training to teachers to create self-reliant society for future.
- To encourage students to participate in Indian and International activities in sports, literature, etc. so that future generation becomes base for free and liberal society
- To educate students in areas like Management, Finance, Human relations to inculcate philosophy of simple living and high thinking value of simple economic society.
- To inculcate culture of non-violence and truthfulness through Vipassana.

  To sustain activities of Indian culture (viz. classical dance, music and fine arts) through establishing institutes like Mahagami, Naturopathy, etc.

विद्यापीठ गीत

अत्त दिप भव भव प्रदिप भव,

स्वरूप रूप भव हो

ज्ञान सब्ब विज्ञान सब्ब भव,

सब्ब दिप भव हो

अत्ताहि अत्त नो नाथो,

अत्ताहि अत्त नो गति

अत्त मार्गपर अप्रमादसे है तुझे चलना

सब्ब का कल्याण हो,

वो कार्यकुशल करना

सब्ब का उत्तम मंगल, पथप्रदर्शक हो

अत्त दिप भव भव प्रदिप भव,

स्वरूप रूप भव हो

ज्ञान सब्ब विज्ञान सब्ब भव,

सब्ब दिप भव हो

बुद्धमं शरनं गच्छामि :

धम्मं शरनं गच्छामि :

संघं शरनं गच्छामि :

Jawaharlal Nehru Engineering College (JNEC) at a Glance

Jawaharlal Nehru Engineering College is a premier institute of engineering that has carved a niche for itself in the field of technical education in a very short span of time. The college has made its presence felt in the world of technical education. JNEC is a conducted college of MGM University, Chhatrapati Sambhajinagar from the academic year 2020-21.

Unique in its structure, methods and goals, the college is strongly rooted in the philosophy of training and research that enhances the relationship between knowledge and its application and seeks to promote the creation of an ideal society. The college also provides facilities for research leading to Ph. D. through its Research Center. JNEC provides a congenial atmosphere for diligent academic pursuits. This has been reflected through the results. Most of our students are among the toppers in various engineering disciplines.

Vision

To create self-reliant, continuous learner & competent technocrats imbued with human values.

Mission

- Imparting quality technical education to the students through participative teaching –learning process.
- Developing competence amongst the students through academic learning and practical experimentation.
- Inculcating social mindset and human values amongst the students.

Programs offered at JNEC

Undergraduate Programmes	Postgraduate Programmes	PhD Programmes	PG Diploma Programmes	Certificate Programmes
B. Arch. - Architecture	M. Arch. - General Architecture	Ph. D. Architecture		
B. Tech. Artificial Intelligence & Data Science	M. Arch. - Environmental Architecture	Ph. D. Chemical Engineering		
B. Tech. Chemical Engineering	M. Tech. Digital Transformation	Ph. D. Civil Engineering		
B. Tech. Civil Engineering	M. Tech. Electrical Power Systems	Ph. D. Electrical Engineering		
B. Tech. Civil Engineering with Computer Applications	M. Tech. Mechanical Engineering	Ph. D. Electronics Engineering		
B. Tech. Civil Engineering (Construction Technology)	M. Tech. Structural Engineering	Ph. D. Mechanical Engineering		
B. Tech. Computer Science & Engineering	M. Tech. VLSI & Embedded Systems	Ph. D. Computer Science & Engineering		
B. Tech. Electrical & Computer Engineering	Master of Computer Applications - MCA	Ph. D. Computer Applications		
B. Tech. Electronics & Computer Engineering				
B. Tech. Mechanical Engineering				
B. Tech. Mechanical & Mechatronics Engineering (Additive Manufacturing)				
B. Tech. Robotics & Artificial Intelligence				

Eligibility –

1. Maharashtra State Candidate.

(i) The Candidate should be an Indian National and having domicile of Maharashtra state and/or born in Maharashtra state.

(ii) Passed HSC or its equivalent examination with Physics and Mathematics as compulsory subjects along with one of the Chemistry or Biotechnology or Biology or Technical Vocational subject or Computer Science or Information Technology or Informatics Practices or Agriculture or Engineering Graphics or Business Studies, and obtained at least 45% marks (at least 40% marks, in case of Backward class categories and Persons with Disability candidates belonging to Maharashtra State only) in the above subjects taken together and the candidate should have appeared in MGMU-CET 2022/ MHT-CET 2022/ PERA CET 2022/ JEE (Main) Paper-I 2022 and should obtain non zero score in MGMU-CET 2022/ MHT-CET 2022/ PERA CET 2022/ JEE (Main) Paper-I 2022. However, preference shall be given to the candidate obtaining non-zero positive score in MGMU-CET 2022 over the candidates who obtained non-zero score in MHT-CET 2022/ PERA CET 2022.

OR

(ii)Passed Diploma in Engineering and Technology and obtained at least 45% marks (at least 40% marks, in case of Backward class categories and Persons with Disability candidates belonging to Maharashtra State only).

2. All India Candidates –

(i) The Candidate should be an Indian National.

(ii) Passed HSC or its equivalent examination with Physics and Mathematics as compulsory subjects along with one of the Chemistry or Biotechnology or Biology or Technical Vocational subject or Computer Science or Information Technology or Informatics Practices or Agriculture or Engineering Graphics or Business Studies , and obtained at least 45% marks (at least 40% marks, in case of Backward class categories and Persons with Disability candidates belonging to Maharashtra State only) in the above subjects taken together and candidate should have appeared in MGMU-CET 2022/ MHT-CET 2022/ PERA CET 2022/

JEE (Main) Paper-I 2022 and should obtain non-zero score in MGMU-CET 2022/ MHT-CET 2022/ PERA CET 2022/ JEE (Main) Paper-I 2022. However, preference shall be given to the candidate obtaining non-zero positive score in JEE Mains Paper-I over the candidates who obtained non-zero score in MGMU-CET 2022/ MHT-CET 2022/ PERA CET 2022.

OR

(ii) Passed Diploma in Engineering and Technology and obtained at least 45% marks (at least 40% marks, in case of Backward class categories and Persons with Disability candidates belonging to Maharashtra State only)

Name of Faculty: Engineering and Technology

Name of the College/Institute/Department/School: JNEC **Name of the Programme**: Engineering

Programme Type (UG/PG): UG **Duration:** 4 Years

First Year - Semester I (Group A)												
Course Category	**Course Code**	**Course Title**	**Nature of Course**	**No. of Credits**	**Teaching (Contact hrs/ week)**		**Evaluation Scheme (Marks)**			**Minimum Passing (Marks)**		
					L	**P**	**Internal**	**External**	**Total**	**Internal**	**External**	**Total**
BSC	APS21BSL 101	Single and Multivariable Calculus	Theory	4	4	-	60	40	100		16	40
BSC	APS21BSL 102	Engineering Physics	Theory	3	3	-	60	40	100		16	40
ESC	APS21ESL 101	Python Programming	Theory	2	2	-	60	40	100		16	40
ESC	APS21ESL 102	Engineering Graphics	Theory	2	2	-	60	40	100		16	40
AEC	MGM54AEL101	Communicative English	Theory	1	1	-	30	20	50		8	20
VSEC	APS21VSP 101	Engineering Exploration	Practical	2	-	4	60	40	100		16	40
BSC	APS21BSP 101	Engineering Physics Lab	Practical	1	-	2	30	20	50		8	20
ESC	APS21ESP 101	Python Programming Lab	Practical	1	-	2	30	20	50		8	20
ESC	APS21ESP 102	Engineering Graphics Studio	Practical	2	-	4	30	20	50		8	20
ESC	APS21ESP 103	Recent Trends in Integrated Technology	Practical	1	-	2	30	20	50		8	20
AEC	MGM54AEP101	Communicative English Lab	Practical	1	-	2	30	20	50		8	20
CCA	MGM82CCP101 MGM82CCP102 MGM82CCP103	NCC / Yoga / Sports	Practical	2	-	4	30	20	50		8	20
Total				22	12	20	510	340	850	0	136	340

Note:
Nature of Course : L- Lecture, P-Practical, S-Seminar, J-Project, I-Internship, D-Dissertation,

Course Category: MM-Major Mandatory, ME-Major Elective, MI-Minor, OE-Generic / Open electives, VSC-Vocational skill course, SEC-Skill Enhancement course, AEC-Ability Enhancement course, IKS-Indian

Knowledge system, VEC-Value Education course, OJT-On Job Training / Internship / Apprenticeship, FP-Field project, CEP-Community engagement and service, CC-Co – curricular course, RM-Research methodology, RP-Research project

First Year- Semester II (Group A)												
Course Category	**Course Code**	**Course Title**	**Nature of Course**	**No. of Credits**	**Teaching (Contact hrs/ week)**		**Evaluation Scheme (Marks)**			**Minimum Passing (Marks)**		
					L	**P**	**Internal**	**External**	**Total**	**Internal**	**External**	**Total**
BSC	APS21BSL103	Linear Algebra and Differential Equations	Theory	4	4	-	60	40	100	-	16	40
BSC	APS21BSL104	Engineering Chemistry	Theory	3	3	-	60	40	100	-	16	40
ESC	APS21ESL103	Engineering Mechanics	Theory	2	2	-	60	40	100	-	16	40
ESC	APS21ESL104	Building Programming logic in C	Theory	1	1	-	30	20	50	-	8	20
PCC	APS21PCL101	Basics of Electrical and Electronics Engineering	Theory	2	2	-	60	40	100	-	16	40
IKS	APS21IKL1XX	Indian Knowledge System	Theory	2	2	-	60	40	100	-	16	40
VSEC	APS21VSP102	Workshop Practices	Practical	2	-	4	60	40	100	-	16	40
BSC	APS21BSP102	Engineering Chemistry Lab	Practical	1	-	2	30	20	50	-	8	20
ESC	APS21ESP104	Engineering Mechanics Lab	Practical	1	-	2	30	20	50	-	8	20
ESC	APS21ESP105	Building Programming logic in C Lab	Practical	1	-	2	30	20	50	-	8	20
PCC	APS21PCP101	Electrical and Electronics Technology Lab	Practical	1	-	2	30	20	50	-	8	20
CCA	MGM82CCP104 MGM73CCP105 MGM73CCP106	NSS/ Fine Art/ Visual Art	Practical	2	-	4	30	20	50	-	8	20
Total				22	14	16	540	360	900	0	144	360

Note:

Nature of Course : L- Lecture, P-Practical, S-Seminar, J-Project, I-Internship, D-Dissertation,

Course Category: MM-Major Mandatory, ME-Major Elective, MI-Minor, OE-Generic / Open electives, VSC-Vocational skill course, SEC-Skill Enhancement course, AEC-Ability Enhancement course, IKS-Indian Knowledge system, VEC-Value Education course, OJT-On Job Training / Internship / Apprenticeship, FP-Field project, CEP-Community engagement and service, CC-Co – curricular course, RM-Research methodology, RP-Research project

Level 4.5 Award of UG certificate with 40 credits and an additional 4-credits core NSQF course / internship OR continue with major and minor

First Year - Semester I (Group B)												
Course Category	**Course Code**	**Course Title**	**Nature of Course**	**No. of Credits**	**Teaching (Contact hrs/ week)**		**Evaluation Scheme (Marks)**			**Minimum Passing (Marks)**		
					L	**P**	**Internal**	**External**	**Total**	**Internal**	**External**	**Total**
BSC	APS21BSL101	Single and Multivariable Calculus	Theory	4	4	-	60	40	100	-	16	40
BSC	APS21BSL104	Engineering CHEMISTRY	Theory	3	3	-	60	40	100	-	16	40
ESC	APS21ESL101	Python Programming	Theory	2	2	-	60	40	100	-	16	40
ESC	APS21ESL103	Engineering Mechanics	Theory	2	2	-	60	40	100	-	16	40
AEC	MGM54AEL101	Communicative English	Theory	1	1	-	30	20	50	-	8	20
PCC	APS21PCL101	Basics of Electrical and Electronics Engineering	Theory	2	2	-	60	40	100	-	16	40
VSEC	APS21VSP102	Workshop Practices	Practical	2	-	4	60	40	100	-	16	40
BSC	APS21BSP102	Engineering Chemistry Lab	Practical	1	-	2	30	20	50	-	8	20
ESC	APS21ESP101	Python Programming Lab	Practical	1	-	2	30	20	50	-	8	20
ESC	APS21ESP104	Engineering Mechanics Lab	Practical	1	-	2	30	20	50	-	8	20
AEC	MGM54A	Communicative	Pract	1	-	2	30	20	50	-	8	20

	EP101	English Lab	ical									
PCC	APS21PCP101	Electrical and Electronics Technology Lab	Practical	1	-	2	30	20	50	-	8	20
CCA	MGM82CCP101 MGM82CCP102 MGM82CCP103	NCC / Yoga / Sports	Practical	2	-	4	30	20	50	-	8	20
Total				23	14	18	570	380	950	0	88	64

First Year - Semester II (Group B)

Course Category	Course Code	Course Title	Nature of Course	No. of Credits	Teaching (Contact hrs/ week)		Evaluation Scheme (Marks)			Minimum Passing (Marks)		
					L	P	Internal	External	Total	Internal	External	Total
BSC	APS21BSL103	Linear Algebra and Differential Equations	Theory	4	4	-	60	40	100	-	16	40
BSC	APS21BSL102	Engineering Physics	Theory	3	3	-	60	40	100	-	16	40
ESC	APS21ESL102	Engineering Graphics	Theory	2	2	-	60	40	100	-	16	40
IKS	APS21IKL1XX	Indian Knowledge System	Theory	2	2	-	60	40	100	-	16	40
ESC	APS21ESL104	Building Programming logic in C	Theory	1	1	-	30	20	50	-	8	20
VSEC	APS21VSP101	Engineering Exploration	Practical	2	-	4	60	40	100	-	16	40
BSC	APS21BSP101	Engineering Physics Lab	Practical	1	-	2	30	20	50		8	20
ESC	APS21ESP102	Engineering Graphics Studio	Practical	2	-	4	30	20	50		8	20
ESC	APS21ESP105	Building Programming	Practical	1	-	2	30	20	50		8	20

		logic in C Lab										
ESC	APS21ESP103	Recent Trends in Integrated Technology	Practical	1	-	2	30	20	50		8	20
CCA	MGM82CCP104 MGM73CCP105 MGM73CCP106	NSS/ Fine Art/ Visual Art	Practical	2	-	4	30	20	50		8	20
Total				21	12	18	480	320	800	0	128	320

Name of the Programme: B.Tech. in Mechanical Engineering with Multidisciplinary Minor
Programme Type (UG/PG):UG
Duration: 04 Years

Second Year - Semester III

Course Category	Course Code	Course Title	Nature of Course	No. of Credits	Teaching (Contact hrs/ week)		Evaluation Scheme (Marks)			Minimum Passing (Marks)		
					L	P	Internal	External	Total	Internal	External	Total
PCC	MEN21PCL201	Engineering Thermodynamics	Lecture	2	2	-	60	40	100	-	16	40
PCC	MEN21PCL202	Strength of Material	Lecture	2	2	-	60	40	100	-	16	40
PCC	MEN21PCL203	Manufacturing Processes	Lecture	2	2	-	60	40	100	-	16	40
PCC	MEN21PCP201	Engineering Thermodynamics Lab	Practical	1	-	2	30	20	50	-	8	20
PCC	MEN21PCP202	Strength of Material Lab	Practical	1	-	2	30	20	50	-	8	20
PCC	MEN21PCP203	Machine Drawing and CAD Lab	Practical	1	-	2	30	20	50	-	8	20
PCC	MEN21PCP204	Design Thinking Lab	Practical	1	-	2	30	20	50	-	8	20
MDM		Refer MGMU MDM Basket (Annexure 5)	Lecture	2	2	-	60	40	100	-	16	40
OE		Refer MGMU Open Elective -1 Basket (Annexure 8)	Lecture	2	2	-	30	20	50	-	8	20
OE		Refer MGMU Open Elective -2 Basket (Annexure 8)	Lecture	2	2	-	30	20	50	-	8	20
VEC	MGM56VEL102	Constitution of India	Lecture	2	2	-	30	20	50	-	8	20
EEMC	MGM21HSL205	Business Management & Financial Accounting	Lecture	2	2	-	60	40	100	-	16	40
FP	MEN21FPJ206	Field Project	Project	2	-	4	30	20	50	-	8	20
Total				**22**	**16**	**12**	**540**	**360**	**900**			

Nature of Course: L- Lecture, P-Practical, J-Project

Course Category: PCC-Programme Core Course, MDM- Multidisciplinary Minor, MI-Minor, OE-Open electives, VEC-Value Education Course, FP-Field project, EEMC-Entrepreneurship Economics Management Courses

Second Year- Semester IV												
Course Category	**Course Code**	**Course Title**	**Nature of Course**	**No. of Credits**	**Teaching (Contact hrs/ week)**		**Evaluation Scheme (Marks)**			**Minimum Passing (Marks)**		
					L	**P**	**Internal**	**External**	**Total**	**Internal**	**External**	**Total**
PCC	MEN21PCL251	Engineering Materials & Metallurgy	Lecture	2	2	-	60	40	100	-	16	40
PCC	MEN21PCL252	Mechanisms of Machines	Lecture	2	2	-	60	40	100	-	16	40
PCC	MEN21PCL253	Advanced Machine Tools	Lecture	2	2	-	60	40	100	-	16	40
PCC	MEN21PCL254	Product Design-I	Lecture	2	2	-	60	40	100	-	16	40
PCC	MEN21PCP251	Engineering Materials & Metallurgy Lab	Practical	1	-	2	30	20	50	-	8	20
PCC	MEN21PCP252	Mechanisms of Machines Lab	Practical	1	-	2	30	20	50	-	8	20
VSEC	MEN21VSP251	Workshop Practice- I	Practical	2	-	4	30	20	50	-	8	20
EEMC	MEN21HSL255	Entrepreneurship Development	Lecture	2	2	-	60	40	100	-	16	40
AEC		Refer MGMU AEC Basket (Annexure 6)	Lecture	2	2	0	30	20	50	-	8	20
MDM		Refer MGMU MDM Basket (Annexure 5)	Lecture	2	2	-	60	40	100	-	16	40
OE		Refer MGMU Open Elective – 3 Basket (Annexure 8)	Lecture	2	2	-	30	20	50	-	8	20
VEC	MGM21VEL101	Environmental Studies	Lecture	2	2	-	30	20	50	-	8	20
Total				**22**	**18**	**8**	**540**	**360**	**900**			

Nature of Course: L- Lecture, P-Practical

Course Category: PCC-Programme Core Course, MDM- Multidisciplinary Minor, VSEC-Vocational and Skill Enhancement Course, MDM- Multidisciplinary Minor

EEMC-Entrepreneurship Economics Management Courses, AEC-Ability Enhancement Course, MDM- Multidisciplinary Minor, OE-Open electives, VEC-Value Education Course

Mahatma Gandhi Mission University

Jawaharlal Nehru Engineering College, Aurangabad

Proposed Teaching and Evaluation Scheme for Third Year B. Tech.
Mechanical Engineering

	Semester V									
Course Category	**Course Code**	**Subject**	**Teaching Scheme**			**Evaluation Scheme**				**Credits**
			L	**T**	**P**	**CA**	**MSE**	**ESE**	**TOTAL**	
Professional Core Courses	20UME501D	Machine Design-I	2	1	---	20	20	60	100	3
Professional Core Courses	20UME502D	Dynamics of Machines	2	1	---	20	20	60	100	3
Professional Core Courses	20UME503D	Fluid Mechanics	3	---	---	20	20	60	100	3
Professional Core Courses	20UME504D	Metrology and Mechanical Measurement	2	---	---	20	20	60	100	2
Professional Core Courses	20UME505D	IC Engine	2	---	---	10	10	30	100	2
Professional Elective Courses	20UME506E 20UME507E 20UME508E	Electives: 1. Subtractive Manufacturing 2. Energy Conservation & Management 3. Product Design-II	2	---	---	10	10	30	50	2
Professional Core Courses	20UME509L	Machine Design-I Lab.	---	---	2	30	---	20	50	1
Professional Core Courses	20UME510L	Dynamics of Machines Lab.	---	---	2	30	---	20	50	1
Professional Core Courses	20UME511L	Fluid Mechanics Lab.	---	---	2	30	---	20	50	1
Professional Core Courses	20UME512L	Metrology and Mechanical Measurement Lab.	---	---	2	30	---	20	50	1
Professional Core Courses	20UME513L	IC Engine Lab.	---	---	2	30	---	20	50	1
		Total	**13**	**2**	**10**	**250**	**100**	**400**	**750**	**20**

Note: Minimum 2 industrial visits related with the subject are mandatory.

Mahatma Gandhi Mission University

Jawaharlal Nehru Engineering College, Aurangabad

Proposed Teaching and Evaluation Scheme for Third Year B. Tech. Mechanical Engineering

	Semester VI									
Course Category	**Course Code**	**Subject**	**Teaching Scheme**			**Evaluation Scheme**				
			L	**T**	**P**	**CA**	**MSE**	**ESE**	**TOTAL**	**Credits**
Professional Core Courses	20UME601D	Machine Design-II	2	1	---	20	20	60	100	3
Professional Core Courses	20UME602D	Heat Transfer	3	---	---	20	20	60	100	3
Professional Core Courses	20UME603D	CAD/CAM	3	---	---	20	20	60	100	3
Professional Elective Courses	20UME604E 20UME605E 20UME606E	Electives: 1. Tool Design 2. Supply Chain Management (SCM) 3. Advanced Thermodynamics	2	---	---	20	20	60	100	2
Professional Core Courses	20UME607D	Smart Manufacturing	2	---	---	10	10	30	50	2
Humanities & social sciences including management courses	20UME608D	Industrial Management	2	---	---	10	10	30	50	2
Professional Core Courses	20UME609L	Machine Design-II Lab.	---	---	2	30	---	20	50	1
Professional Core Courses	20UME610L	Heat Transfer Lab.	---	---	2	30	---	20	50	1
Professional Core Courses	20UME611L	CAD/CAM Lab.	---	---	2	30	---	20	50	1
Professional Elective Courses	20UME612E 20UME613E 20UME614E	Electives: 1. Tool Design Lab. 2. SCM Lab. 3. Advanced Thermodynamics Lab.	---	---	2	30	---	20	50	1
Professional Core Courses	20UME615L	Smart Manufacturing Lab.	---	---	2	30	---	20	50	1
		Total	**14**	**1**	**10**	**250**	**100**	**400**	**750**	**20**

Note: Minimum 2 industrial visits related with the subject are mandatory.

Course Code: - 20UME501D	*Course Title*	*Total credits: 03*
Teaching Scheme	**Machine Design-I**	***Evaluation Scheme***
Theory: 3 Hrs. /week		CA – 20 Marks
Exam Duration: - 3 Hours		Mid Sem -20 Marks
		End Sem Exam: 60 Marks

Course Objectives	To introduce 1. Design considerations 2. Design process for simple components of machines Concept of Dynamic load
Course Outcomes	After completing this course, students will be able to: 1. Use Design standards 2. Design simple machine parts under satiric load
Pre-requisites	Engineering Graphics, Engineering Mechanics, Machine Drawing, Strength of Material
Course Type	***Professional Core Course***

Course Contents

Unit No.	***PO Mapping***	***PSO Mapping***	***Teaching Methodology***	***Competency***	***Performance Indicator***
Unit 1: Fundamental Aspect of Design					
1.The meaning of design, Engineering design, Phases of design, Aesthetic, Ergonomic & manufacturing design consideration, Use of standards in design, preferred series. Material properties & selection of materials, BIS designation. 2.Types of loads and stresses. Factor of safety, Direct stresses, bending stresses, Necessity of Theories of failure, Two-dimensional stress condition, Different theories of failure and combined stresses. Design of C-clamp & C-frame.	PO1-3 PO2-3 PO3-3 PO4-3 PO6-1 PO10-1 PO12-1	PSO1-3 PSO2-2	PPT/Chalk/ Video lecture/Quizzes/ MCQ	1.3 2.1 2.2 3.1 6.1 10.1 10.3	1.3.1 2.1.1 2.1.2 2.1.3 2.2.1 3.1.4 3.4.1 6.1.1 6.1.2 10.1.1 10.3.1
Unit 2: Design of Various Joints, shaft keys and Couplings					
(A) Design against static loading: Design of Cotter joint single and double cotter joint. Design of knuckle joint. Design of lever. (B) Design of shaft, keys and coupling: Shafts subjected to bending and torsion, types of keys and their design, design of rigid and flexible couplings.	PO1-3 PO2-3 PO3-3	PSO1-3 PSO2-2	PPT/Chalk/ Video lecture/Quizzes/ MCQ	1.3 1.4 2.1 2.2 3.4 6.2	1.3.1 1.4.1 2.1.1 2.1.2 2.1.3 2.2.1
Unit 3: Design of screw and fasteners					

Design of bolted and threaded joints, design of power screws, introduction to re-circulating ball screw.	PO1-3 PO2-3 PO3-3 PO4-3 PO10-1	PSO1-3 PSO2-2	PPT/Chalk/ Video lecture/Quizzes/ MCQ	1.3 1.4 2.1 2.2 3.4 6.2 10.1 10.3	1.3.1 1.4.1 2.1.1 2.1.2 2.1.3 2.2.1 2.2.2 2.2.3 3.1.4 3.4.1 6.2.1 10.1.1
Unit 4: Design against fluctuating load					
Stress concentration, fatigue failure, endurance limit, notch sensitivity, Goodman, Soderberg diagrams, and modified Goodman diagram, fatigue design under combined stresses.	PO1-3 PO2-3 PO3-3 PO4-3 PO10-1	PSO1-3 PSO2-2	PPT/Chalk/ Video lecture/Quizzes/ MCQ	1.3 1.4 2.1 2.2 3.4 6.2 10.1 10.3	1.3.1 1.4.1 2.1.1 2.1.2 2.1.3 2.2.1 2.2.2 2.2.3 3.1.4 3.4.1 6.2.1 10.1.1 10.3.1
Unit 5: Design of Welded and Riveted joint					
(A) Types of welded joints, eccentrically loaded joints, welded joints subjected to bending moment.	PO1-3 PO2-3 PO3-3 PO4-3 PO10-1 PO12-1	PSO1-3 PSO2-2	PPT/Chalk/ Video lecture/Quizzes/ MCQ	1.3 1.4 2.1 2.2 3.4 6.2 10.1 10.3	1.3.1 1.4.1 2.1.1 2.1.2 2.1.3 2.2.1 2.2.2 2.2.3 3.1.4 3.4.1 6.2.1 10.1.1 10.3.1
Unit 6: Design of Spring					
Terminology and types of spring, Design of helical spring against static loading, A.M. Wahl correction factor, Design against fluctuating load, Surging and Buckling of spring, design of multi leaf spring, Nipping.	PO1-3 PO2-3 PO3-3 PO4-3 PO10-1 PO12-1	PSO1-3 PSO2-2	PPT/Chalk/ Video lecture/Quizzes/ MCQ	1.3 1.4 2.1 2.2 3.4 6.2 10.1 10.3	1.3.1 1.4.1 2.1.1 2.1.2 2.1.3 2.2.1 2.2.2 2.2.3 3.1.4 3.4.1 6.2.1 10.1.1

					10.3.1

Text Books:

1. Bhandari V.B., “Design of Machine Elements”, Tata McGraw Hill Publ. Co. Ltd.

2. Kulkarni S. G., Machine Design, McGraw Hill.

3. Ganesh Babu K. and Srithar K., “Design of Machine Elements”, McGraw Hill.

Reference Books:

1. Shigley J.E. and Mischke C.R.,“Mechanical Engineering Design”, McGraw Hill Publications Co. Ltd.
2. Spotts M.F. and Shoup T.E., “Design of Machine Elements”, Prentice Hall International.
3. Black P.H. and O. Eugene Adams, “Machine Design”, McGraw Hill Book Co. Ltd.
4. “Design Data”, P.S.G. College of Technology, Coimbatore.
5. Juvinal R.C., “Fundamentals of Machine Components Design”, John Wiley & Sons.
6. Hall A.S., Holowenko A.R. and Laughlin H.G., “Machine Design”, Schaum’s outline series, McGraw Hill.

E-sources:

1. NPTEL Videos
2. NPTEL Lectures

Course Code: - **20UME502D**	*Course Title*	*Total credits: 03*
Teaching Scheme	**Dynamics of Machines**	***Evaluation Scheme***
Theory: 3 Hrs. /week		CA – 20 Marks
Exam Duration: - 3 Hours		Mid Sem -20 Marks
		End Sem Exam: 60 Marks

Course Objectives	To introduce 1. To understand the various types of gear applications. 2. To understand the function of Gear train for various application 3. To select Suitable Drives and Mechanisms for a particular application 4. To analyze mechanisms of control gyroscope and their applications. 5. To analyze mechanisms of governors and their applications. 6.To understand the concept of Vibration
Course Outcomes	After completing this course, students will be able to: 1.Ability to apply suitable gear drive 2. Ability to apply gear train 3. Ability to apply the Clutch, Brake and Dynamometer Mechanisms for a particular application 4. Ability to apply the principles of gyroscopic effects and stabilization on various transport vehicles and applications 5. Ability to apply the principles of governors 6. Ability to study the various principles of vibrations of different systems
Pre-requisites	Engineering drawing, Machine Drawing and Theory of Machine-I
Course Type	***Professional Core Course***

Course Contents

Unit No.	***PO Mapping***	***PSO Mapping***	***Teaching Methodology***	***Competency***	***Performance Indicator***
Unit 1: Toothed Gears					
Classification of gears, Types of gears, Spur gears - terminology, fundamental law of toothed gearing, Involute and Cycloidal profile, conjugate action, contact ratio, minimum number of teeth, interference and under cutting. Helical gears: Nomenclatures, center distance, force analysis. [8hrs]	PO1-3 PO2-2 PO3-1	PSO1-2 PSO2-2	PPT/Chalk/Video lecture/Quizzes/ MCQ	1.2 2.2 3.3 12.2	1.2.1 2.2.2 3.4.1 12.2.2
Unit 02: Theory of Gears II					
Spiral Gears, Worm and worm Gears, Bevel Gears; their terminologies, center distance, force analysis and efficiency. [6 hrs.]	PO1-3 PO2-2	PSO1-2 PSO2-2	PPT/Chalk/ Video lecture/Quizzes/ MCQ	1.2 2.2 3.3 12.2	1.2.1 2.2.2 3.4.1 12.2.2
Unit03: Clutches, Brakes and Dynamometer					
Introduction, Types of clutch, uniform wear and Uniform pressure for the clutch, Types of brakes, the braking of a vehicle, Dynamometer and its type. [6 hrs.]	PO1-3 PO2-2 PO3-1 PO12-2	PSO1-2 PSO2-2	PPT/Chalk/ Video lecture/Quizzes/ MCQ	1.2 2.2 3.3 12.2	1.2.1 2.2.2 3.4.1 12.2.2

Unit04: Gyroscope					
Introduction, Angular acceleration, gyroscopic couple, Effect of gyroscopic couple on aero plane, naval ship, Stability of vehicles. [6 hrs.]	PO1-3 PO2-2 PO3-1	PSO1-2 PSO2-2	PPT/Chalk/ Video lecture/Quizzes/ MCQ	1.2 2.2 3.3 12.2	1.2.1 2.2.2 3.4.1 12.2.2
Unit 05: Governor Mechanisms					
Introduction, Types, Governor Effort and governor power, Controlling force analysis, sensitivity, stability, isochronism's and hunting, friction, insensitiveness. [6 hrs.]	PO1-3 PO2-2 PO3-1 PO12-3	PSO1-2 PSO2-2	PPT/Chalk/ Video lecture/Quizzes/ MCQ	1.2 2.2 3.3 12.2	1.2.1 2.2.2 3.4.1 12.2.2
Unit 06: Mechanical Vibrations					
Fundamentals, undamped and damped free vibrations of single degree freedom system, Forced vibration of single degree of freedom system, Critical speed of shafts. [8 hrs.]	PO1-3 PO2-2 PO3-1 PO12-2	PSO1-2 PSO2-2	PPT/Chalk/ Video lecture/Quizzes/ MCQ	1.2 2.2 3.3 12.2	1.2.1 2.2.2 3.4.1 12.2.2

Text Books:

1. Author "Name of the Book". Publisher, Year of Publication.
2. Ballaney, P., "Theory if Machines and Mechanisms", 2005Khanna Publication.
3. Ratan S. S. "Theory of Machines", Tata McGraw Hills.

Reference Books:

1. Uicker Jr, J. J., Penock G. R. and Shigley, J. E., "Theory oif Machines and Mechanisms' Tata McGraw Hill. 2003.
2. Ramamurthy V., "Mechanisms of Machines", 3rd edition, ISBN 978-1842654569, Narosa Publishing House.
3. Bevan Thomas, "The Theory of Machines", 3rd edition, CBS publication. ·
4. Bansal, R. K., "Theory of machines", Laxmi Publications Pvt. Ltd, New Delhi

E-sources:

1. NPTEL Videos
2. NPTEL Lectures

Course Code: - 20UME503D	*Course Title*	*Total credits: 03*
Teaching Scheme	**Fluid Mechanics**	***Evaluation Scheme***
Theory: 3 Hrs. /week		CA – 20 Marks
Exam Duration: - 3 Hours		Mid Sem -20 Marks
		End Sem Exam: 60 Marks

Course Objectives	To introduce 1. To know and understanding basic laws, principles and phenomena in the area of fluid mechanics. 2. To solve problems of fluid mechanics – 3. Making students aware of different applications 4. Acquired knowledge and skills in professional courses
Course Outcomes	After completing this course, students will be able to: 1. To know fluids and its various properties 2. To calculate hydrostatic forces and explain know and decide stability of floating and submerged bodies. 3. To know various fluid dynamic laws and its applications. 4. To know and analyses fluid flowing through pipe of different sections and form 5. To understand and know boundary layer theory. 6. To get knowledge of equation building and model analysis.
Pre-requisites	Students should have good understanding and intuition on calculus and physics in general
Course Type	***Professional Core Course***

Course Contents

Unit No.	***PO Mapping***	***PSO Mapping***	***Teaching Methodology***	***Competency***	***Performance Indicator***
Unit 1: Introduction to fluids					
Definition of fluid, fluid properties such as viscosity, vapor pressure, compressibility, surface tension, capillarity, Mach number etc., pressure at a point in the static mass of fluid, variation of pressure, Pascal's law, pressure measurement by simple and differential manometers using manometric expression.	PO1 – 3 PO2 – 2 PO12 – 2	PSO1- 2 PSO2 – 1	Lecture – Chalk- Board, PPT, Video	1.3 1.2 1.4 2.1 12.2	PI 1.3.1 PI 1.2.1 PI 1.4.1 PI 2.1.2 PI 12.2.2
Unit 2: Hydrostatics					
Pressure at a point - Hydrostatic equations for incompressible and compressible fluids - Manometers - Hydrostatic force on a submerged plane and curved surfaces - Buoyancy and equilibrium of floating bodies - Metacenter - Fluid in rigid motion bodies.	PO1 – 3 PO2 – 3 PO3 – 1 PO4 – 1 PO6 – 2 PO12 – 2	PSO1-3	Lecture – Chalk- Board, PPT, Video	1.1 1.2 1.4 2.1 3.4 4.2 6.2 12.2	PI 1.1.2 PI 1.2.1 PI 1.4.1 PI 2.1.2 PI 3.4.2 PI4.2.2 PI6.2.1 PI 12.2.2
Unit 3: Fluid Dynamics					
Momentum equation, development of Euler's equation, Introduction to Navier-Stokes equation, Integration of Euler's equation to obtain Bernoulli's equation, Bernoulli's theorem, Application of Bernoulli's theorem such as venturi meter, orifice meter,	PO1 – 2 PO2 – 3	PSO1 – 1 PSO2 – 1	Lecture – Chalk- Board, PPT, Video	1.1 2.1 3.4 4.2	PI 1.1.2 PI 2.1.2 PI 3.4.2 PI4.2.2

rectangular and triangular notch, pitot tube, orifices, etc.	PO3 – 1 PO4 – 1				
Unit04: Hydraulics Power					
Types of fluid flows, Kinematics of fluid flow, Continuity equation, Euler's and Bernoulli's theorem and equation, Flow measurement, Laws of fluid friction (Laminar and turbulent), Darcy's equation and Chezy's equation for frictional losses. Minor losses in pipes Hydraulic gradient and total gradient line. Hydraulic power transmission through pipe, Energy Gradient.	PO1 – 3 PO2 – 3 PO3 – 1 PO4 – 1 PO11 – 2 PO12 – 2	PSO1 –2 PSO2 – 1	Lecture – Chalk- Board, PPT, Video	1.3 1.4 2.2 3.1 4.2 12.2	PI 1.3.1 PI 1.4.1 PI 2.2.2 PI 3.1.6 PI 4.2.1 PI 12.2.2
Unit 5: Boundary layer theory					
Fluid rotation and deformation - Stream function - Condition of irrotationality - Governing equations of potential flow - Laplace equation, Boundary layer concept - Prandtl's equation - Drag on flat plat.	PO1 – 2 PO2 – 3 PO3 – 3 PO4 – 2 PO12 – 2	PSO1-2 PSO2-2	Lecture – Chalk- Board, PPT, Video	1.3 1.4 2.2 3.1 4.2 12.2	PI 1.3.1 PI 1.4.1 PI 2.2.2 PI 3.1.6 PI 4.2.1 PI 12.2.2
Unit 6: Dimensional analysis					
Dimensional homogeneity, Raleigh's method, Buckingham's theorem, Model analysis, similarity laws and dimensionless numbers.	PO1 – 3 PO2 – 3 PO3 – 1 PO4 – 1 PO5 – 2 PO11 – 2 PO12 - 3	PSO1 – 3 PSO2 – 3	Lecture – Chalk- Board, PPT, Video	1.3 1.4 2.2 2.3 3.1 4.2 5.1 11.2 12.2	PI 1.3.1 PI 1.4.1 PI 2.2.2 PI2.3.2 PI 3.1.6 PI 4.2.1 PI 5.1.2 PI 11.2.1 PI 12.2.2

Text Books:

1. R.K.Rajput ,"Textbook of fluid Mechanics and Hydraulic Machines in SI unit".
2. R.S.Khurmi, N. Khurmi ,"Textbook of fluid Mechanics and Hydraulic Machines".
3. S.K.Som, Gautam Biswas, S.Chakoraborty,"Introduction to Fluid Mechanics and Fluid Machines".
4. Yasuki Nakayaman, "Introduction to Fluid Mechanics".
5. Engineering Fluid Mechanics by K.L. Kumar, Multicolor revised edition, S. Chand and Co, Eurasia Publishing House, New Delhi, 2014
6. Fluid Mechanics, Yunus A. Cenegal, and John M. Cimbala, second edition, Mc Graw Hill Education (India) Pvt. Ltd, 2013

Reference Books:

1. R.K.Rajput ,"Textbook of fluid Mechanics and Hydraulic Machines in SI unit".
2. R.S.Khurmi, N. Khurmi ,"Textbook of fluid Mechanics and Hydraulic Machines".
3. S.K.Som, Gautam Biswas, S.Chakoraborty,"Introduction to Fluid Mechanics and Fluid Machines".
4. Yasuki Nakayaman, "Introduction to Fluid Mechanics".

Course Code: - **20UME504D**	*Course Title*	***Total credits: 02***
Teaching Scheme	**Metrology and Mechanical Measurement**	***Evaluation Scheme***
Theory: 2 Hrs. /week		CA – 20 Marks
Exam Duration: - 3 Hours		Mid Sem -20 Marks
		End Sem Exam: 60 Marks

Course Objectives	To introduce 1. To Understand core concepts of Science of Measurement 2. To learn in depth about various measurement Tools and Techniques. 3. To be able to Calibrate the Measuring instrument with Standards 4. To be able to Analyze and Solve Complex Tasks with Modern Metrology Tools
Course Outcomes	After completing this course, students will be able to: 1. Relate engineering aspects of metrology & mechanical measurement, 2. Make use of various measuring instruments for Linear, angular measurement of length, force, torque and temperature, 3. Assess the correctness and Calibrate the measuring instrument, 4. Operate Modern Metrology Tools for given application.
Pre-requisites	None
Course Type	***Professional Core Course***

Course Contents

Unit No.	***PO Mapping***	***PSO Mapping***	***Teaching Methodology***	***Competency***	***Performance Indicator***
Unit 1: Introduction to Metrology & Mechanical Measurement					
Basics of Metrology, Accuracy and Precision, Standards of measurement, Line standards, end standards, sources of error in measurement. Need of mechanical measurement, Basic definitions: Hysteresis, Linearity, Resolution of measuring instruments, Threshold, Drift, zero stability, loading	PO –1, 2,	PSO1 PSO2	PPT/Case Studies/Role Plays/Games/Quizzes/Activity Based	1.3 1.4 2.1	1.3.1 1.4.1 2.1.1
Unit 2: Measurement and Instrumentation					
Measurement system model, methods of measurements, static and dynamic characteristics of an instrument, classification of instruments, uncertainty in measurement. Linear & Mechanical Instruments, Comparators its Functional Requirements, Classification, Mechanical Comparators, Mechanical Optical Comparators, Electrical Comparators, Pneumatic Comparators.	PO – 3	PSO1 PSO2	PPT/Case Studies/Role Plays/Games/Quizzes/Activity Based Learning(ABL)	3.1	3.1.2 3.1.4
Unit 3: Measurement of Mechanical Parameters					
Force measurement: load cells, cantilever beams, proving rings, differential transformers. Power Measurements. Measurement of torque: Torsion bar dynamometer, servo-controlled dynamometer, absorption dynamometers. Measurement of strain: Theory of strain gauges and Types of Strain measurement. Temperature Measuring Devices: Thermocouples, Resistance Temperature Detectors, Thermistor, Liquid in glass Thermometers, Pressure	PO – 2, 4	PSO1 PSO2	PPT/Case Studies/Role Plays/Games/Quizzes/Activity Based Learning(ABL)	2.1 2.4 4.1	2.1.3 2.4.1 2.4.3 2.4.4 4.1.1 4.1.4

Course Code: - **20UME505D**	*Course Title*		*Total credits: 02*		
Thermometers, Pyrometer, Bimetallic strip. Working principle of Mechanical, Electrical and Photoelectric Tachometers, Piezoelectric Accelerometer, Seismic Accelerometer					
Unit04: Modern Metrology					
Basics of Optical Interference and Interferometry, Optical Measuring Techniques: Tool Maker's Microscope, Profile Projector, Precision Instrumentation based on Laser Principals, Coordinate measuring machines.	PO – 5	PSO1 PSO2	PPT/Case Studies/Role Plays/Games/Quizzes/Activity Based Learning(ABL)	5.1 5.2 5.3	5.1.1 5.1.2 5.2.1 5.3.2

Text Books:

1. Galyer J.F.W. and Shot bolt, Metrology for Engineers, Thomson Learning

2. Bently, Engineering Metrology and Measurements, Pearson Education
3. A K Sawhney, A course in Mechanical Measurements and Instrumentation, Dhanpat Rai Publications

Reference Books:

1.Ernest Doebelin, Doebelin's Measurement Systems, McGraw-Hill.
2. N V Raghavendra, Engineering Metrology and Measurement, Oxford University Press.

E-sources:

1. NPTEL Videos
2. NPTEL Lectures

Teaching Scheme	**IC Engine**	*Evaluation Scheme*
Theory: 2 Hrs. /week		CA – 10 Marks
Exam Duration: - 2 Hours		Mid Sem -10 Marks
		End Sem Exam: 30 Marks

Course Objectives	To introduce 1. To understand the Otto and Diesel cycles and the functions of engine components. 2. To analyze fuel feed systems for S.I. and C.I. engines. 3. To explain stages of combustion in S.I. engine and control strategies for detonation. 4. To learn stages of combustion in C.I. Engines and control strategy for Diesel knock. 5. To evaluate performance parameters and efficiency of engine. 6. To apply control strategies for emission control and developments in I.C. engines.
Course Outcomes	After completing this course, students will be able to: 1. Understand the basics of I.C. Engine, air standard cycles and functions of components. 2. Learn fuel requirements for SI and CI Engines using carburetor and fuel injectors. 3. Identify the stages of combustion in S.I. Engine and factors controlling detonation. 4. Analyze the stages of combustion of C.I. Engine and factors controlling diesel knock. 5. Evaluate the performance parameters and study supercharging and turbocharging. 6. Interpret different emission control methods and developments in engine.
Pre-requisites	Engineering Thermodynamics
Course Type	***Professional Core Course***

Course Contents

Unit No.	***PO Mapping***	***PSO Mapping***	***Teaching Methodology***	***Competency***	***Performance Indicator***
Unit 1: Introduction					
Engine components, Nomenclature, Classification of Engines, working principle of I.C. Engine, Comparison of 2-Stroke and 4-Stroke Engines, air standard cycles: Otto and Diesel cycles, Spark Ignition (SI) and Compression Ignition (CI) Engines, Fuel air cycle and actual cycle, Valve timing Diagram etc.	PO1,6,12	PSO2	Lecture, PPT, Charts, Demonstration, Animation, NPTEL Videos, Practical Approach	1.1 6.1 12.1	1.1.1 6.1.1 12.1.1
Unit 2: Fuels, Carburetors and Fuel Injection					
Fossil based conventional fuels for I.C. engines, requirements of fuel, fuel additives and their importance, and alternative biofuels, Working principle and functions of Carburetor, types of carburetors, Air Fuel Mixture Requirements, Working principle and Functions of Fuel Injector and Fuel Pump assembly, Classification of Injection Systems, Working principles of Governors, Types of Nozzles fitted to Fuel Injectors etc.	PO1,6,12	PSO2	Lecture, PPT, Charts, NPTEL Videos and Animation	1.1 6.1 12.1	1.1.1 6.1.1 12.1.1
Unit 3: Combustion in Spark Ignition (S.I.) Engine					
Stages of combustion in S.I. Engine, Ignition Lag, factors influencing various stages, Normal and abnormal combustion, Detonation, Factors responsible for detonation, Effect of detonation, Octane rating of S.I. engine fuel, design considerations and types of combustion chambers for S.I. engines, factors for	PO1,3,6, 12	PSO2	Lecture,Charts, Demonstration, Animations, NPTEL Videos	1.1 3.1 6.1 12.1	1.1.1 3.1.1 3.1.2 6.1.1 12.1.1

controlling detonation in S.I. Engine etc.					
Unit04: Combustion in Compression Ignition (C.I.) Engine					
Stages of combustion in C.I. Engines, Delay Period: Physical and Chemical Delay, factor affecting delay period, Diesel knock, Cetane rating of fuel, Requirements of combustion chamber for C.I. Engines, Types of combustion chamber for C.I. Engines, Methods of generating turbulence in combustion chamber, Diesel Engine: Direct and Indirect Injection, factors controlling knocking in C.I. Engine etc.	PO1,3,6, 12	PSO2	Lecture,Charts, Animations, Demonstration, NPTEL Lectures	1.1 3.1 6.1 12.1	1.1.1 3.1.1 3.1.2 6.1.1 12.1.1
Unit 5: Performance Parameters for I.C. Engines					
Indicated Power, Brake power and Friction power, Engine Efficiencies, Performance Characteristics, Variables Affecting Performance Characteristics, Methods of Improving Engine Performance, Heat Balance Sheet, Supercharging and Turbocharging, Supercharging: Basic principles, objectives, arrangements for supercharging, merits and limitations of supercharging etc.	PO1,2,6, 12	PSO2	Lecture,Charts, Animations, Demonstration, NPTEL Lectures, Practical Approach	1.1 2.1 6.1 12.1	1.1.1 2.1.1 2.1.2 6.1.1 12.1.1
Unit 6: Emissions and control strategies in I.C. Engines					
Emissions from I.C. Engines, causes of formation, effect of emissions on human health, approaches to control pollutants, catalytic converters, Bharat stage emission standards (BSES) and European emission standards, engine advancements: multi-point fuel injection (MPFI) engines, common rail direct injection (CRDI) engines and variable compression ratio engines, control strategies for emissions: Exhaust gas recirculation (EGR) technology, homogeneous charge compression ignition (HCCI) etc.	PO1,5,6, 7,12	PSO2	Lecture,Charts, Animations, Demonstration, NPTEL Lectures, Practical Approach	1.1 5.1 6.1 7.1 12.1	1.1.1 5.1.1 6.1.1 7.1.1 12.1.1

Text Books:

1. V. Ganesan, Internal Combustion Engines, McGraw Hill Education India Private Limited, 2017.
2. R.P. Mathur, M.L. Sharma, Internal Combustion Engines, Dhanpat Rai Publications, 2014.
3. V.M. Domkundwar, A Cource in Internal Combustion Engines, Dhanpat Rai and Co., 2015.

4. G. Kaushik, S. Patil, S. Chaturvedi and A. Chel, Biofuels: Advances and Perspectives, Studium Press, 2018.
5. R.K. Rajput, A Textbook of Internal Combustion Engines: Manufacturing Processes, Laxmi Publications Pvt Ltd, Third edition, 2008.
6. P. L. Ballaney, Internal Combustion Engines (Including Gas Turbines), Khanna Publishers, 7th Edition, 2016.
7. Pulkrabek, Engineering Fundamentals of the Internal, Pearson, Second Edition, 2015.
8. R.K. Singal, IC Engines and Compressors, S.K. Kataria & Sons, 2013.

Reference Books:

1. Scott Post, I.C. Engines: Fundamental Thermodynamics of Internal Combustion Engines, Independently Published, 2018.

2. John Heywood, Internal Combustion Engine Fundamentals, McGraw-Hill Education, Second Edition, 2018.

3. V. Sajith, Shijo Thomas, Internal Combustion Engines, Oxford University Press; First edition, 2017.

4. A.Anderson R. Devaraj, S.Ramachandran, S.Ramachandran, Advanced IC Engines, First Edition, Airwalk Publications, 2017.

5. Robert Leroy Streeter, Internal Combustion Engines, Theory and Design, Franklin Classics Trade Press, 2018.

6. Alfred C. Roth, Blake J. Fisher, W. Scott Gauthier, Small Gas Engines: Fundamentals, Service, Troubleshooting, Repair, Applications, Goodheart-Willcox Pub; 11 Edition, 2015.

E-sources:

1. NPTEL Video Lectures by Prof Pranab K. Mondal, IIT Guwahati.
2. Published research papers by Elevier, Springer etc.
3. Online YouTube Videos on Referigeration Systems and their maintenance.

Course Code: - 20UME506E	*Course Title*	*Total credits: 02*
Teaching Scheme	**Electives:** **1. Subtractive Manufacturing**	***Evaluation Scheme***
Theory: 2 Hrs. /week		CA – 10 Marks
Exam Duration: - 2 Hours		Mid Sem -10 Marks
		End Sem Exam: 30 Marks

Course Objectives	To introduce 1. Understand how the Cartesian coordinate system works. 2. Write simple part programs. 3. Be introduced to SIEMENS SINUTRAIN and ArtCAM software's. 4. Calculate parameters of machines and Debug a CNC Part programming. 5. Identify cutting tools used for milling, turning operations. 6. Simulate part programs on CNC machining simulation software.
Course Outcomes	After completing this course, students will be able to: 1. Understand how the Cartesian coordinate system relates to CNC Routing, Turning and Milling operations. 2. Write simple part programs for the two axis CNC lathe and router and milling machines. 3. Be introduced to master cam's machining software program. 4. Calculate speeds and feeds for CNC machining operations and Debug a CNC Part programming. 5. Identify cutting tools used for milling, turning operations. 6. Simulate part programs on CNC machining simulation software.
Pre-requisites	None
Course Type	***Professional Elective course***

Course Contents

Unit No.	***PO Mapping***	***PSO Mapping***	***Teaching Methodology***	***Competency***	***Performance Indicator***
Unit 1: Basics of Manufacturing					
Occupational Safety, Materials, Tools and Clamping Devices, Manufacturing with machine tools, Metal Removal processes, Cutting, Drilling, Milling, Turning, Grinding, threading, Basic Terms.	PO1,2,8, 10,12	3,3	Direct Instruction, Audio-Visuals	1.5 10.5 12.4	1.5.1 10.5.1 10.5.2
Unit 2: Geometrical Dimensioning & Tolerancing					
Limits Fits and Tolerances, GD & T, Vernier Caliper, Micrometer.	PO 1,2,3,8	2,3	Direct Instruction, Audio-Visuals	1.6 5.5 10.5	1.6.1 5.5.1 10.5.1
Unit 3: CNC Technology					
Introduction to CNC, Classification of Computer numerical control (CNC) – Point to point and continuous control, CNC Fundamentals: Axis & Motion Nomenclature, CNC Milling Fundamentals, CNC Turning Fundamentals.	PO 2,9	3,2	Direct Instruction	1.6 5.5 10.5	1.6.1 5.5.1 10.5.1

Unit 4: Coordinate Systems and Interpolation Functions					
Machine Coordinate System, Work piece Coordinate System, Local Coordinate System, Plane Selection, Rapid Positioning (G00), Linear Interpolation (G01), Circular Interpolation (G02, G03), Work Offset and Tool Offset.	PO 1,5,6,10,12	3,3	Direct Instruction	1.6 5.5 10.5	1.6.1 5.5.1 10.5.1
Unit 5: FANUC Cycles - Part Programming					
Different Stock Removal Cycles namely G71, G72, G75, G76 etc. with Hand-on.	PO 3,4,5,6,7,9,10,12	2,2	Direct Instruction, Hands-on on SIEMENS SINUTRAIN and ArtCAM	1.6 1.7 2.5 4.4 5.5	1.6.1 1.7.1 2.5.2 4.4.3 5.5.1 5.5.2
Unit 6: SIEMENS - Part Programming					
Different Stock Removal Part Programs using SIEMENS SINUTRAIN Software and ArtCAM.	PO1,5,6, 7,8,12	PSO2	Direct Instruction, Hands-on on SIEMENS SINUTRAIN and ArtCAM	1.6 1.7 2.5 4.4 5.5	1.6.1 1.7.1 2.5.2 4.4.3 5.5.1 5.5.2

Text Books:

1. S. Krar, A. Gill., CNC Technology and Programming, McGraw-Hill Publishing Co., 1990.
2. P. J. Amic, Computer Numerical Control Programming, Prentice Hall, 1996.
3. K. J.Astrom, B. Wittenmark, Adaptive Control (2nd Ed.), Addison-Wesley, 1994.
4. D.Gibbs, T.Crandell, CNC: An Introduction to Machining and Part Programming, Industrial Press, 1991.

Reference Books:

1.M. Lynch, Computer Numerical Control for Machining, McGraw-Hill, 1992.

2.CNC Turning machines ACE MICROMATIC FANUC Controlled operator and programming manual.

3.CNC Milling machine SIEMENS 808D, 828D and 840Dsl manuals.

E-sources:

1. NPTEL Videos
2. NPTEL Lectures

Course Code: - 20UME507E	*Course Title*	*Total credits: 02*
Teaching Scheme	**Electives:** **2. Energy Conservation & Management**	***Evaluation Scheme***
Theory: 2 Hrs. /week		CA – 10 Marks
Exam Duration: - 2 Hours		Mid Sem -10 Marks
		End Sem Exam: 30 Marks

Course Objectives	To introduce 1. To understand energy generation scenario and road map of JNNSM. 2. To identify the energy conservation opportunities and application of cogeneration and waste heat recovery systems. 3. To explain alternative biofuels and their potential in transport sector. 4. To analyze potential developments in electric vehicles in transportation sector. 5. To recognize the importance and methods of energy audit. 6. To develop aptitude for financial analysis of investments for energy conservation and renewable energy systems.
Course Outcomes	After completing this course, students will be able to: 1. Understand the energy scenario, CDM and road map of JNNSM. 2. Identify potential ways of energy conservation in buildings, cogeneration and waste heat recovery. 3. Explain the alternative biofuels with their potential usage. 4. Analyze the advancements in electric vehicles, charging methods and battery storage technologies. 5. Apply the methods of energy audit for various establishments. 6. Evaluate investment opportunities for energy conservation and renewable energy systems.
Pre-requisites	Engineering Thermodynamics, Status and sustainable development of power sector.
Course Type	***Professional Elective course***

Course Contents

Unit No.	***PO Mapping***	***PSO Mapping***	***Teaching Methodology***	***Competency***	***Performance Indicator***
Unit 1: Introduction					
Energy scenario, Energy security for the nation, energy conservation act, star rating by BEE, road map of Jawaharlal Nehru National Solar Mission (JNNSM), Kyoto Protocol, carbon sequestration, Clean Development Mechanism (CDM) etc.	PO1, PO6, PO7, PO12	PSO2	Chalk and Board, Presentations, animations/videos on carbon sequestration and CDM.	1.1 6.1 7.1 12.1	1.1.1 6.1.1 7.1.1 12.1.1
Unit 2: Energy conservation in building, cogeneration and waste heat recovery					
Developments in low embodied energy building materials for building construction, reducing the operational energy consumption in the building using efficient heating/cooling equipment like Earth air/water heat exchangers, management of daylight and efficient artificial lights in the building, utilization of solar water heating systems and renewable energy power in the building. Energy conservation in boiler through boiler accessories, distribution of steam and compressed air systems, cogeneration in sugar factories and waste heat recovery systems, energy conservation in pumps, fans and central air conditioning units etc.	PO1, PO3, PO6, PO12	PSO2	Case Study of waste heat recovery and co-generation, working videos/animations of co-generation plants, Chalk and Board, Presentation.	1.1 3.1 6.1 12.1	1.1.1 3.1.1 3.1.2 6.1.1 12.1.1

Unit 3: Developments in alternative biofuels					
Overview of Biofuels, key policy and issues addressing the development of biofuels, International status of advances in Biodiesel, merits and demerits of bioethanol as an alternate fuel, case studies of biofuels production from sugarcane, corn, Jatropha and Karanja etc.	PO1, PO3, PO6, PO12	PSO2	Chalk and Board, Presentation, Case Study of biodiesel production.	1.1 3.1 6.1 12.1	1.1.1 3.1.1 3.1.2 6.1.1 12.1.1
Unit 4: Advances in electric vehicles					
Status of air pollution from transportation fuels for emission control, Need of E-vehicle and its merits and demerits, developments in battery for power storage, types of charging methods, requirement of infrastructure for charging stations, features of wiring harness of E-vehicle, case study on power requirement for E-vehicle, recent trends in variable speed drive and developments in regenerative braking of E-vehicle.	PO1, PO6, PO7, PO10, PO12	PSO2	Chalk and Board, Presentation, Case Study and use of animations/videos of E-vehicle/ battery/charging stations.	1.1 6.1 7.1 10.1 12.1	1.1.1 6.1.1 7.1.1 10.1.1 12.1.1
Unit 5: Energy audit					
Definition and need of energy audit, Types of energy audit, Steps/methodologies of energy audit, Instruments for energy audit, Case study on the energy audit of residential, commercial and industrial establishments like household, shopping complex, and Sugar/Glass/Paper Industries etc.	PO1, PO3, PO6, PO9, PO12	PSO2	Case Study on Energy Audit video on Nuclear power plant, construction &	1.1 3.1 6.1 9.1 12.1	1.1.1 3.1.1 3.1.2 6.1.1 9.1.1 12.1.1
Unit 6: Economic analysis for investment in energy conservation and renewable energy systems					
Case study on the energy conservation options for domestic/commercial/industrial establishments, Investment on energy efficient appliances and renewable energy system and its financial analysis using simple payback period, Return on investment, Net present value, Internal rate of return, Life cycle costs etc.	PO1, PO2, PO6, PO11, PO12	PSO2	Presentation on case study of financial analysis, Financial terms explaination	1.1 2.1 6.1 11.1 12.1	1.1.1 2.1.1 2.1.2 6.1.1 11.1.1 12.1.1

Text Books:

1. P. Venkataseshaiah K.V. Sharma, Energy Management and Conservation, Dreamtech Press, 2020.
2. G. Kaushik, S. Patil, S. Chaturvedi and A. Chel, Biofuels: Advances and Perspectives, Studium Press, 2018.
3. S.K. Shukla and J. Tirkey, Text Book on Energy Conservation and Management, Narosa Publication, 2010.
4. S.S. Thipse, Energy conservation and managment, Alpha Science, 2014.

Reference Books:

1. Barney L. Capehart, Wayne C. Turner, William J. Kennedy, Guide to Energy Management, Fairmont Press, Eighth Edition, 2016.

2. A. Chel, Thermal Model: Adobe house, Earth Air heat exchanger, Skylight & PV, Lambert Academic Publishing, 2012.

3. K. Nagabhushan Raju, Industrial Energy Conservation Techniques: Concepts, Applications and Case Studies, Atlantic Publisher, 2007

4. Glen Swindle, Valuation and Risk Management in Energy Markets, Cambridge University Press; Reprint edition, 2015.

E-sources:

1. NPTEL SWAYAM, YouTube.

Course Code: - 20UME508E	*Course Title*	*Total credits: 02*
Teaching Scheme	**Electives:** **3. Product Design-II**	*Evaluation Scheme*
Theory: 2 Hrs. /week		CA – 10 Marks
Exam Duration: - 2 Hours		Mid Sem -10 Marks
		End Sem Exam: 30 Marks

Course Objectives	To introduce 1. To understand how to design & develop the prototype by using different advanced manufacturing techniques.
Course Outcomes	After completing this course, students will be able to: 1. To create the prototype by using different manufacturing techniques. 2. To get the knowledge of different electronic components such as controller, sensors and drives. 3. To understand different advanced manufacturing techniques such as 3D printing, CNC, etc.
Pre-requisites	PDE I, Basic knowledge of controller, sensors, electrical components such as motors & motor drivers.
Course Type	***Professional Elective course***

Course Contents

Unit No.	***PO Mapping***	***PSO Mapping***	***Teaching Methodology***	***Competency***	***Performance Indicator***
Unit 1: Testing & Analysis of New Product Development					
Prototyping, Product Architecture, Different testing methods of new product development, Testing parameters, test marketing, error analysis methods, minimizing errors.	PO 1	PSO1	PPT	1.1 1.2 1.3	1.1.2 1.2.1 1.3.1
Unit 2: Embedded systems in Product Design Engineering					
Introduction to controllers: Arduino, Raspberry Pi, Introduction to different sensors, Types of motors: DC motor, Servo Motor, Stepper motor, Motor Drivers, Algorithm & logic development, PCB & schematic layout.	PO 2	PSO1,	PPT, Case Study on different product development papers.	1.2 1.3 1.4	1.2.1 1.3.1 1.4.1
Unit 3: Advanced Manufacturing Techniques					
Introduction to manufacturing processes, Types of manufacturing processes, Additive manufacturing i.e. 3D printing, materials used for 3D printing, Introduction to CNC machining, types of CNC machining, Introduction to G codes & M codes, product specification sheet.	PO 2 & PO 3	PSO1, PSO2	PPT, Performing different activities in the class.	2.3 2.4 3.2 3.3	2.3.1 2.3.2 2.4.2 2.4.3 2.4.4 3.2.1 3.2.2 3.3.1
Unit 4: Documentation of New product development.					
Types of documentation, index page preparation, product description, product detail sheet, 2D drafting of each component, 3D modeling with proper orientation, conclusion & future scope of new product development.	PO 2 & PO 3	PSO1, PSO2	Case study	1.1 1.2	1.1.2 1.2.1

Unit 5: Environmental aspects of PDE.					
Product life cycle management, material selection criteria, disposal of materials used for new product development, disposal methods of waste formed during production.	PO 2 & PO 3	PSO1, PSO2	PPT & Video presentation	1.1 1.2 1.3	1.1.1 1.1.2 1.2.1 1.3.1

Text Books:

1. Green, W., & Jordan, P. W. (Eds.). (1999). Human factors in product design: current practice and future trends. CRC Press.
2. Sanders, M. S., & McCormick, E. J. (1993). Human factors in engineering and design. McGraw-Hill book company.

Reference Books:

1. Model Curriculum for "Product Design Engineer – Mechanical", NASSCOM (Ref. ID: SSC/Q4201, Version 1.0, NSQF Level: 7).
2. Eppinger, S., & Ulrich, K. (2015). Product design and development. McGraw-Hill Higher Education.

E-sources:

1. NPTEL SWAYAM, YouTube.
2. Elsevier Journals & Springer Journal.

Course Code: -20UME509L	*Course Title*	*Total credits: 01*
Teaching Scheme	**Machine Design-I Lab.**	***Evaluation Scheme***
Practical: 2 Hrs. /week		CA – 30 Marks
		End Sem Exam: 20 Marks
		Total: - 50 Marks

Lab outcomes	1.Apply design process to an open-ended problem. 2. Determine suitable material and decide dimensions of simple machine components. 3. Selection of design factors. 4. Design simple machine parts. 5. Demonstrate good communication skill graphically, orally and with documentation.

Course Contents

Name of Practical	*Type/ Methodology*	*PO Mapping*	*PSO Mapping*	*Competency*	*Performance Indicator*
Design of cotter joint/Knuckle Joint	Demonstration	PO1-3 PO2-3 PO3-3 PO4-3 PO6-1 PO10-1	PSO1-3	1.3 1.4 2.2 3.4 6.2 10.1	1.3.1 1.4.1 2.1.1 2.1.2 2.1.3 2.2.1
Design of Power screw	Demonstration	PO1-3 PO2-3 PO3-3 PO4-3 PO6-1 PO10-1	PSO1-3	1.3 1.4 2.2 3.4 6.2 10.1	1.3.1 1.4.1 2.1.1 2.1.2 2.1.3 2.2.1
Design of Power screw	Demonstration	PO1-3 PO2-3 PO3-3 PO4-3 PO6-1 PO10-1	PSO1-3	1.3 1.4 2.2 3.4 6.2 10.1	1.3.1 1.4.1 2.1.1 2.1.2 2.1.3 2.2.1
Study of Welded joint and Riveted joint in practice and modes of failures	Demonstration	PO1-3 PO2-3 PO3-3 PO4-3 PO6-1 PO10-1	PSO1-3	1.3 1.4 2.2 3.4 6.2 10.1	1.3.1 1.4.1 2.1.1 2.1.2 2.1.3 2.2.1
Assignment on Fluctuating loads Calculation of finite and infinite life	Demonstration	PO1-3 PO2-3 PO3-3 PO4-3 PO6-1 PO10-1	PSO1-3	1.3 1.4 2.2 3.4 6.2 10.1	1.3.1 1.4.1 2.1.1 2.1.2 2.1.3 2.2.1

References:

1. Lab Manual.
2. Design Data Book, V.B. Bhandari, McGraw Hill Education (India) Pvt Ltd.

Course Code: - 20UME510L	*Course Title*	*Total credits: 01*
Teaching Scheme	**Dynamics of Machines Lab.**	***Evaluation Scheme***
Practical: 2 Hrs. /week		CA – 30 Marks
		End Sem Exam: 20 Marks
		Total: - 50 Marks

Lab outcomes	1. Ability to apply suitable gear drive. 2. Ability to apply the Clutch, Brake and Dynamometer. 3. Ability to apply the principles of gyroscopic effects. 4. Ability to apply the principles of governors. 5. Ability to study the various principles of vibrations.

Course Contents

Sr	*Name of Practical*	*Type/ Methodology*	*PO Mapping*	*PSO Mapping*	*Competency*	*Performance Indicator*
1	To generate gear tooth profile and to study the effect of under cutting and rack shift using model	Demonstration and perform the Practical's	PO1-3 PO2-2 PO3-3 PO4-3 PO12-2	PSO1-3 PSO2-3	1.2 2.2 3.3 4.1 12.2	1.2.1 2.2.2 3.4.1 4.1.1 12.2.2
2	To study frictional properties of clutch/brake	Demonstration and perform the Practical's	PO1-3 PO3-3 PO4-3 PO12-2	PSO1-3 PSO2-3	1.2 2.2 3.3 4.1 12.2	1.2.1 2.2.2 3.4.1 4.1.1 12.2.2
3	Determination of gyroscopic couple	Demonstration and perform the Practical's	PO1-3 PO2-2 PO3-3 PO4-3 PO12-2	PSO1-3 PSO2-3	1.2 2.2 3.3 4.1 12.2	1.2.1 2.2.2 3.4.1 4.1.1 12.2.2
4	To study of different types Governor	Demonstration and perform the Practical's	PO1-3 PO3-3 PO12-2	PSO1-3 PSO2-3	1.2 2.2 3.3 4.1	1.2.1 2.2.2 3.4.1 4.1.1
5	Determine MMI of uniform rod by using Bifilar suspension	Demonstration and perform the Practical's	PO1-3 PO2-2 PO3-3 PO4-3 PO12-2	PSO1-3 PSO2-3	1.2 2.2 3.3 4.1 12.2	1.2.1 2.2.2 3.4.1 4.1.1 12.2.2
6	Determine MMI of uniform rod by using Compound Pendulum	Demonstration and perform the Practical's	PO1-3 PO2-2 PO3-3 PO4-3 PO12-2	PSO1-3 PSO2-3	1.2 2.2 3.3 4.1 12.2	1.2.1 2.2.2 3.4.1 4.1.1 12.2.2
7	Determine MMI of disc by using Compound Pendulum	Demonstration and perform the Practical's	PO1-3 PO2-2 PO3-3 PO4-3 PO12-2	PSO1-3 PSO2-3	1.2 2.2 3.3 4.1 12.2	1.2.1 2.2.2 3.4.1 4.1.1 12.2.2

8	Determination of natural frequency of transverse vibrations of a bar	Demonstration and perform the Practical's	PO1-3 PO2-2 PO3-3 PO4-3 PO12-2	PSO1-3 PSO2-3	1.2 2.2 3.3 4.1 12.2	1.2.1 2.2.2 3.4.1 4.1.1 12.2.2
9	Determination of critical speed of shaft of single rotor	Demonstration and perform the Practical's	PO1-3 PO2-2 PO3-3 PO4-3 PO12-2	PSO1-3 PSO2-3	1.2 2.2 3.3 4.1 12.2	1.2.1 2.2.2 3.4.1 4.1.1 12.2.2
10	Determination of node point of two rotor system	Demonstration and perform the Practical's	PO1-3 PO2-2 PO3-3 PO4-3 PO12-2	PSO1-3 PSO2-3	1.2 2.2 3.3 4.1 12.2	1.2.1 2.2.2 3.4.1 4.1.1 12.2.2

References:

1.Lab Manual.

Course Code: - 20UME511L	*Course Title*	*Total credits: 01*
Teaching Scheme	**Fluid Mechanics Lab.**	***Evaluation Scheme***
Practical: 2 Hrs. /week		CA – 30 Marks
		End Sem Exam: 20 Marks
		Total: - 50 Marks

Lab outcomes	1. Understand the procedure do determine viscosity of oil. 2. To understand pressure measurement. 3. Understand the procedure to determine metacentric height of floating body. 4. Study and analyze different nature of flow. 5. To study how flow patterns are developed. 6. Understand that total energy in continuously flowing fluid remains constant. 7. Understand losses in fluid flow through pipes. 8. Understand the flow measuring devices.

Course Contents

Sr	*Name of Practical*	*Type/ Methodology*	*PO Mapping*	*PSO Mapping*	*Competency*	*Performance Indicator*
1	Determine viscosity using viscometer	Trial	PO1- 1 PO4-1	PSO1- 1	1.1 1.1 1.2 4.1 4.3	PI 1.1.1 PI 1.1.2 PI 1.2.1 PI 4.1.1 PI 4.1.3 PI 4.1.4 PI4.3.1
2	To understand pressure measurement procedure and related instruments/devices.	Trial	PO1- 1 PO2-2	PSO1- 1	1.2 1.3 2.1 2.4	PI 1.2.1 PI 1.3.1 PI 2.1.2 PI2.4.2
3	Determination of Critical Reynolds number using Reynolds Apparatus	Trial	PO1- 1 PO2-2	PSO1- 1	1.2 1.3 2.1 2.4 2.4	PI 1.2.1 PI 1.3.1 PI 2.1.2 PI 2.4.1 PI2.4.2
4	Determination to determine metacentric height of floating body	Trial	PO1- 1 PO6- 1 PO12-1	PSO1- 1	1.1 1.2 1.3 6.1 12.3	1.1.2 1.2.1 1.3.1 6.1.1 12.3.2
5	Verification of Bernoulli's theorem	Trial	PO1- 1 PO2-2	PSO1- 1	1.2 1.3 2.1 2.4 2.4	PI 1.2.1 PI 1.3.1 PI 2.1.2 PI 2.4.1 PI2.4.2
6	To study different flow patterns	Study/Trail	PO1- 1 PO2-1 PO12- 1	PSO1- 1	1.2 2.3 12.3	1.2.1 2.3.2 12.3.2

7	To determine the Friction factor for the different pipes.	Problem Base Learning	PO1- 2 PO2- 2 PO3-2 PO12-1	PSO1- 1 PSO2- 1	1.1 1.2 1.3 2.1 2.4 2.4 3.3 12.4	PI 1.1.2 PI 1.2.1 PI 1.3.1 PI 2.1.2 PI 2.4.1 PI 2.4.2 PI 3.3.1 12.4.2
8	To determine the Coefficient of discharge of Orifice meter flow meters	Problem Base Learning	PO1- 1 PO2- 1 PO3- 1 PO12-1	PSO1- 1	1.1 1.2 1.3 2.1 2.4 2.4 3.3 12.4	PI 1.1.2 PI 1.2.1 PI 1.3.1 PI 2.1.2 PI 2.4.1 PI 2.4.2 PI 3.3.1 12.4.2
9	To determine the Coefficient of discharge and Venturi meter	Problem Base Learning	PO1- 1 PO2- 1 PO3- 1 PO12-1	PSO1- 1	1.1 1.2 1.3 2.1 2.4 2.4 3.3 12.4	PI 1.1.2 PI 1.2.1 PI 1.3.1 PI 2.1.2 PI 2.4.1 PI 2.4.2 PI 3.3.1 12.4.2
10	To determine discharge coefficient Cd using Pitot Tube & determine point velocity.	Problem Base Learning	PO1- 1 PO2- 1 PO3- 1 PO12-1	PSO1- 1	1.1 1.2 1.3 2.1 2.4 2.4 3.3 12.4	PI 1.1.2 PI 1.2.1 PI 1.3.1 PI 2.1.2 PI 2.4.1 PI 2.4.2 PI 3.3.1 12.42

References:

1.Lab Manual.

Course Code: - 20UME512L	*Course Title*	*Total credits: 01*
Teaching Scheme	**Metrology and Mechanical Measurement Lab.**	***Evaluation Scheme***
Practical: 2 Hrs. /week		CA – 30 Marks
		End Sem Exam: 20 Marks
		Total: - 50 Marks

Lab outcomes	1. Operate linear & angular measuring instruments. 2. Measure physical parameters like Pressure and temperature. 3. Handle mechanical, electrical and optical comparators. 4. work on modern metrological instruments.

Course Contents

Sr	*Name of Practical*	*Type/ Methodology*	*PO Mapping*	*PSO Mapping*	*Competency*	*Performance Indicator*
1	Perform linear Measurement of given component using Vernier Caliper, Micrometer, V. Height Gauge, V. Depth Gauge and Slip Gauge	Hands on practical, Activity Based Learning	PO 1, 2	PSO 1 & 2	1.1 2.1	1.1.1 1.1.2 2.1.1
2	Measure Angle of given component using Bevel Protractor, Sine bar & Sine Centre	Hands on practical, Activity Based Learning	PO 1, 2	PSO 1 & 2	1.1 2.1	1.1.1 2.2.1
3	Perform Measurement of Pressure for the given Application	Hands on practical, Activity Based Learning	PO 3	PSO 1 & 2	3.1	3.1.1 3.1.2
4	Perform Measurement of Temperature for the given Application	Hands on practical, Activity Based Learning	PO 3	PSO 1 & 2	3.1	3.1.1 3.1.2
5	Study the surface of slip gauge using Interferometer	Hands on practical, Activity Based Learning	PO 3, 5	PSO 1 & 2	3.1 5.1	3.1.1 3.1.2 5.1.1
6	Measure given component using Tool Maker's Microscope & Profile Projector	Hands on practical, Activity Based Learning	PO 3, 5	PSO 1 & 2	3.1 5.1	3.1.1 3.1.2 5.1.1
7	Measure the given object on Coordinate Measuring Machine	Hands on practical, Activity Based Learning	PO 3,4 & 5	PSO 1 & 2	3.1 4.1 5.1	3.1.1 3.1.2 4.1.1 4.1.2 5.1.1

References:

1. Lab Manual.

Course Code: - 20UME513L	*Course Title*	*Total credits: 01*
Teaching Scheme	**IC Engine Lab.**	***Evaluation Scheme***
Practical: 2 Hrs. /week		CA – 30 Marks
		End Sem Exam: 20 Marks
		Total: - 50 Marks

Lab outcomes	1. Understand basics and key objectives of fuel pump for C.I. Engine. 2. Learn the functions of Fuel Injector fitted with different types of nozzles. 3. Explain the functions of carburetor and different Air-Fuel mixture supply. 4. Analyze engine emission [both S.I. (Petrol) and C.I. (Diesel) Engines.] 5. Evaluate heat losses in the C.I. Engine (Diesel Engine). 6. Interpret advancements in alternative fuels, emission controls and engines. .

Course Contents

Sr	*Name of Practical*	*Type/ Methodology*	*PO Mapping*	*PSO Mapping*	*Competency*	*Performance Indicator*
1	Demonstrate single plunger fuel pump	Demonstration, Participatory learning method etc.	PO 1,12	PSO2	1.1 12.1	1.1.11 12.1.1
2	Demonstrate various types of fuel injectors and nozzles	Demonstration, Participatory learning method etc.	PO 1,6,12	PSO2	1.1 6.1 12.1	1.1.1 6.1.1 12.1.1
3	Demonstrate different types of carburetor	Demonstration, Participatory learning method etc.	PO 1,6,12	PSO2	1.1 6.1 12.1	1.1.1 6.1.1 12.1.1
4	Measurement of exhaust gas emission from S.I. engine	Demonstration, Participatory learning method etc.	PO 1,2,4,6,12	PSO2	1.1 2.1 6.1 12.1	1.1.1 2.1.1 6.1.1 12.1.1
5	Measurement of exhaust gas emission from C.I. engine	Demonstration, Participatory learning method etc.	PO 1,2,4,6,12	PSO2	1.1 2.1 6.1 12.1	1.1.1 2.1.1 6.1.1 12.1.1
6	Trial on Single Cylinder Diesel Engine	Demonstration, Participatory learning method etc.	PO 1,2,4,6,12	PSO2	1.1 2.1 6.1 12.1	1.1.1 2.1.1 6.1.1 12.1.1
7	Report of Learning from Case study/Industrial Visit of I.C Engine Maintenance Unit, Engine Components Production, Engine Manufacturing, Maintenance Garage, Incubation Centre for Maintenance of I.C. Engines etc.	Demonstration, Participatory learning method etc.	PO 1,2,4,6,12	PSO2	1.1 2.1 6.1 12.1	1.1.1 2.1.1 6.1.1 12.1.1

8	Study of alternative biofuels and their production	Demonstration, Participatory learning method etc.	PO 1,2,4,6,12	PSO2	1.1 2.1 6.1 12.1	1.1.1 2.1.1 6.1.1 12.1.1
9	Study on emission control: Exhaust gas recirculation, MPFI Engine, CRDI Engine, HCCI Engine etc.	Demonstration, Participatory learning method etc.	PO 1,4,6,9,12	PSO2	1.1 4.1 6.1 9.1 12.1	1.1.1 4.1.1 6.1.1 9.1.1 12.1.1
10	Trials on a multi-cylinder petrol engine for Morse Test	Demonstration, Participatory learning method etc.	PO 1,4,6,9,12	PSO2	1.1 4.1 6.1 9.1 12.1	1.1.1 4.1.1 6.1.1 9.1.1 12.1.1

References:

1. NPTEL Video Lectures by Prof Pranab K. Mondal, IIT Guwahati.

2. Published research papers by Elsevier, Springer etc.

3. Online YouTube Videos on advancement in IC Engines and Emission control methods and maintenance.

4. Laboratory Manual.

5. Alfred C. Roth, Blake J. Fisher, W. Scott Gauthier, Small Gas Engines: Fundamentals, Service, Troubleshooting, Repair, Applications, Goodheart-Willcox Pub; 11 Edition, 2015.

6. Manish Sharma, Mechanic Refrigeration and Air Conditioning Theory, Neelkanth Publishers, 2019.

Course Code: - 20UME601D	*Course Title*	*Total credits: 03*
Teaching Scheme	**Machine Design-II**	***Evaluation Scheme***
Theory: 3 Hrs. /week		CA – 20 Marks
Exam Duration: - 3 Hours		Mid Sem -20 Marks
		End Sem Exam: 60 Marks

Course Objectives	To introduce 1. Design process for different gears. 2. Design of clutches, brakes and belts. 3. Design parameters of bearings and selection of bearings using data book. 4. Working of gear trains.
Course Outcomes	After completing this course, students will be able to: 1. Design the gear. 2. Select the bearing. 3. Analyze velocity ratio of gears in simple gear trains. 4. Calculate the torque transmitted by clutch.
Pre-requisites	Machine Design I
Course Type	***Professional Core Course***

Course Contents

Unit No.	***PO Mapping***	***PSO Mapping***	***Teaching Methodology***	***Competency***	***Performance Indicator***
Unit 1: Introduction to Gears-I					
(A) Spur Gear: Gear Tooth Failure, Selection of material, Lewis Equation, Beam strength equation, dynamic tooth load, (Buckingham's equation Wear strength (B) Helical Gears: Formative number of teeth in helical gears, beam & wear strength of helical gears, effective load & design of helical gear.	PO1-3 PO2-2 PO3-3 PO4-2 PO12-3	PSO1-3 PSO2-2	PPT/Chalk/ Video lecture/Quizzes/ MCQ	1.3 2.2 3.1 6.1 10.1 10.3	1.3.1 1.4.1 2.1.1 2.1.2 2.1.3 2.2.1 3.1.4 3.4.1 6.1.1 6.1.2 10.1.1 10.3.1
Unit 2: Introduction to Gears-II					
(C) Bevel Gear: Formative number of teeth, Design of bevel gears based on beam and wear strength. (D) Worm Gears: Friction in worm gears, Selection of materials, Strength rating, wear rating, Thermal consideration AGMA Recommendation. (E) Gear train- Introduction, simple, compound, reverted and Epicyclical gear train.	PO1-3 PO2-3 PO3-3 PO4-3	PSO1-3 PSO2-2	PPT/Chalk/ Video lecture/Quizzes/ MCQ	1.3 2.2 3.1 6.1 10.1 10.3	1.3.1 1.4.1 2.1.1 2.1.2 2.1.3 2.2.1 3.1.4 3.4.1

	PO6-1 PO10-1 PO12-1				6.1.1 6.1.2 10.1.1 10.3.1
Unit 3: Design of friction clutch					
Design of bolted and threaded joints, design of power screws, introduction to re-circulating ball screw. Introduction, types & friction materials, design for uniform pressure and wear, Torque carrying capacity, Design of single & multi-plate clutch, Design of cone clutch, Design of centrifugal clutch.	PO1-3 PO2-3 PO3-3 PO4-3 PO6-1 PO10-1 PO12-1	PSO1-3 PSO2-2	PPT/Chalk/ Video lecture/Quizzes/ MCQ	1.3 2.2 3.1 6.1 10.1 10.3	1.3.1 1.4.1 2.1.1 2.1.2 2.1.3 2.2.1 3.1.4 3.4.1 6.1.1 6.1.2 10.1.1 10.3.1
Unit 4: Design of belt and brake					
Introduction to Belt drives, Design of Flat Belt drives, Design of V- Belt drives. Design of short shoe brake (single& double), design of long shoe brake (single & double), design of automotive shoe brake and design internal expanding brake.	PO1-3 PO2-3 PO3-3 PO4-3 PO6-1 PO10-1 PO12-1	PSO1-3 PSO2-2	PPT/Chalk/ Video lecture/Quizzes/ MCQ	1.3 2.2 3.1 6.1 10.1 10.3	1.3.1 1.4.1 2.1.1 2.1.2 2.1.3 2.2.1 3.1.4 3.4.1 6.1.1 6.1.2 10.1.1 10.3.1
Unit 5: Design of bearings-I					
((A) Introduction to Tribological consideration in design: Friction, Wear, Lubrication, Types of lubrication- hydro dynamic, hydro static and EHD lubrication. (B) Sliding contact bearing: Basic theory, thick and thin film lubrication, Newton's law of viscosity, Petroff's equation, Somerfield Number, Reynolds's equation, Raimondi and Boyd method relating bearing variables, Heat balance in journal bearings, Temperature rise. Introduction to hydro static bearings.	PO1-3 PO2-3 PO3-3 PO4-3 PO6-1 PO10-1 PO12-1	PSO1-3 PSO2-2	PPT/Chalk/ Video lecture/Quizzes/ MCQ	1.3 2.2 3.1 6.1 10.1 10.3	1.3.1 1.4.1 2.1.1 2.1.2 2.1.3 2.2.1 3.1.4 3.4.1 6.1.1 6.1.2 10.1.1 10.3.1
Unit 6: Design of bearings-II					
(A) Rolling Contact Bearing: Types, static and dynamic load capacities, Stribeck's equation. Equivalent bearing load, load-life relationship, bearing life, load factor, Selection of bearing from manufactures catalogue. (B) Design for variable load and speed, Bearings with probability of survival other than 90 %.	PO1-3 PO2-3 PO3-3 PO4-3 PO6-1 PO10-1	PSO1-3 PSO2-2	PPT/Chalk/ Video lecture/Quizzes/ MCQ	1.3 2.2 3.1 6.1 10.1 10.3	1.3.1 1.4.1 2.1.1 2.1.2 2.1.3 2.2.1

	PO12-1				3.1.4 3.4.1 6.1.1 6.1.2 10.1.1 10.3.1

Text Books:

1. Bhandari V.B., "Design of Machine Elements", Tata McGraw Hill Publ. Co. Ltd.

2. Kulkarni S. G., Machine Design, McGraw Hill.

3. Ganesh Babu K. and Srithar K., "Design of Machine Elements", McGraw Hill.

Reference Books:

1. Shigley J.E. and Mischke C.R.,"Mechanical Engineering Design", McGraw Hill Publications Co. Ltd.
2. Spotts M.F. and Shoup T.E., "Design of Machine Elements", Prentice Hall International.
3. Black P.H. and O. Eugene Adams, "Machine Design", McGraw Hill Book Co. Ltd.
4. "Design Data", P.S.G. College of Technology, Coimbatore.
5. Juvinal R.C., "Fundamentals of Machine Components Design", John Wiley & Sons.
6. Hall A.S., Holowenko A.R. and Laughlin H.G., "Machine Design", Schaum's outline series, McGraw Hill.

E-sources:

3. NPTEL Videos

4. NPTEL Lectures

Course Code: - 20UME602D	*Course Title*	*Total credits: 03*
Teaching Scheme	**Heat Transfer**	***Evaluation Scheme***
Theory: 3 Hrs. /week		CA – 20 Marks
Exam Duration: - 3 Hours		Mid Sem -20 Marks
		End Sem Exam: 60 Marks

Course Objectives	To introduce 1. Model basic heat transfer processes and identify modes. 2. Design and Predict heat exchanger performance. 3. Recognize basic convective heat transfer and apply appropriate methods for quantifying. 4. Determine radiation heat transfer.
Course Outcomes	After completing this course, students will be able to: 1. Students will be able to explain the laws of heat transfer and concept of thermal conductivity and its variation with temperature. 2. Understand Heat transfer through extended surfaces & able to determine Effectiveness and efficiency of a fin. 3. Understand the concept of Free and Forced Convection. 4. Students will be able to explain Condensation and Boiling. 5. Understand Radiation Heat Transfer and concept of radiation shield.
Pre-requisites	Basic thermodynamics, Mathematics
Course Type	***Professional Core Course***

Course Contents

Unit No.	***PO Mapping***	***PSO Mapping***	***Teaching Methodology***	***Competency***	***Performance Indicator***
Unit 1: Conduction [07 hrs.]					
Modes and laws of heat transfer. Thermal conductivity and its variation with temperature. Insulating materials. Generalized heat conduction equation. Fourier, Laplace and Poisson's equation. Thermal diffusivity.1D, 2D steady state heat conduction - Heat conduction through a plane wall, cylindrical and sphere. Heat conduction through a composite slab, cylinder and sphere. Effect of variable thermal conductivity. Electrical analogy in conduction. Critical radius of insulation, and thermal contact resistance. One dimensional steady state heat conduction with heat generation for plane wall, cylinder and sphere. (Descriptive and numerical treatment).	PO1, PO2, PO12	PSO1	PPT/Chalk/Video lecture/Quizzes/ MCQ	1.2 2.1 12.2	1.2.1 2.1.3 12.2.3
Unit 2: Extended Surfaces [07 hrs.]					
Types and applications of fins. Heat transfer through extended surfaces. Derivation of equations for temperature distribution and heat transfer through fins of constant cross-section area. Effectiveness and efficiency of a fins. Errors in the measurement of temperature in a thermo-well. Unsteady state heat conduction- System with negligible internal resistance, Biot and Fourier numbers. Lumped heat	PO1, PO2, PO3, PO4, PO5, PO12	PSO1	PPT/Chalk/ Video lecture/Quizzes/ MCQ	1.2 2.1 3.1 4.1 5.2 12.2	1.2.1 2.1.3 3.1.1 4.1.1 5.1.2 12.2.2

Course Code: - 20UME603D	*Course Title*	*Total credits: 03*

capacitymethod. Use of Hiesler and Grober Charts. (Descriptive and numerical treatment)					
Unit3: Convection [08 hrs.]					
Local and average convective coefficient. Hydrodynamic and thermal boundary layer. Laminar and turbulent flow over a flat plate and in a pipe. Friction factor, laminar and turbulent flow over a flat plate. Drag and drag co-efficient. Free and Forced Convection -Dimensional analysis in free and forced convection. Physical significance of the dimension less numbers related to free and forced convection. Empirical correlations for heat transfer in laminar and turbulent flow over a flat plate and in a circular pipe. (Descriptive and numerical treatment)	PO1, PO2, PO4, PO12	PSO1 & PSO2	PPT/Chalk/ Video lecture/Quizzes/ MCQ	1.2 2.1 4.1 12.2	1.2.1 2.1.3 4.1.1 12.2.2
Unit 4: Condensation and Boiling [06 hrs.]					
Modes of pool boiling, critical heat flux, burnout point, forced boiling. Film and drop wise condensation. (Descriptive and numerical treatment)	PO1, PO2, PO4, PO10, PO12	PSO1	PPT/Chalk/ Video lecture/Quizzes/ MCQ	1.2 2.1 4.1 10.3 12.2	1.2.1 2.1.3 4.1.1 10.3.2 12.2.2
Unit 5: Radiation Heat Transfer [06 hrs.]					
Introduction to radiative heat transfer, Stefan-Boltzman law, Kirchoff's law, Planck's law and Wein's displacement law. Radiation heat exchange between two parallel infinite black surfaces, between two parallel infinite gray surfaces, effect of radiation shield, intensity of radiation and solid angle, Lambert's law, radiation heat exchange between two finite surfaces-configuration factor or view factor. (Descriptive and numerical treatment)	PO1, PO2, PO3, PO4, PO10, PO12	PSO1	PPT/Chalk/ Video lecture/Quizzes/ MCQ	1.2 2.1 3.1 4.1 10.3 12.2	1.2.1 2.1.3 3.1.1 4.1.1 10.3.2 12.2.2
Unit 6: Heat Exchangers [06 hrs.]					
Heat exchangers classification, Fouling factor, overall heat transfer coefficient, heat exchanger analysis- log mean temperature difference (LMTD) for parallel and counter flow heat exchangers. LMTD correction factor, fouling factor. The effectiveness-NTU method for parallel and counter flow heat exchangers. (Descriptive and numerical treatment)	PO1, PO2, PO3, PO4, PO7, PO10, PO12	PSO1	PPT/Chalk/ Video lecture/Quizzes/ MCQ	1.2 2.1 3.1 4.1 7.2 10.3 12.2	1.2.1 2.1.3 3.1.1 4.1.1 7.2.2 10.3.2 12.2.2

Text Books:

1. Holman J. P, Heat Transfer, Tata McgrawHill. Tenth Edition.
2. Incoropera & Dewit, Fundamentals of Heat & Mass Transfer, Wiley India Pvt. Ltd. Seventh Edition.
3. Yunus Cengel, Heat Transfer: A Practical Approach, Tata Mcgraw Hill.
4. R.C. Sachdeva: Fundamentals of Engineering Heat and Mass Transfer, Wiley Eastern Ltd., India.

Reference Books:

1. Dr.R.K.Rajput"Heat& Mass Transfer".S Chand .Publication.
2. Domkundwar, Heat and Mass Transfer, Dhanpat Rai& co.

Teaching Scheme	**CAD/CAM**	*Evaluation Scheme*
Theory: 3 Hrs. /week		CA – 20 Marks
Exam Duration: - 3 Hours		Mid Sem -20 Marks
		End Sem Exam: 60 Marks

Course Objectives	To introduce 1. To List and describe the various input and output devices for a CAD work station. 2. To Solve problems on 2-D and 3-D transformations. 3. To Describe various geometric modeling techniques & standards. 4. To Develop NC part program for the given component. 5. To Understand concepts of CIM, FMS & CAPP.
Course Outcomes	After completing this course, students will be able to: 1. List and describe the various input and output devices for a CAD work station. 2. Solve problems on 2-D and 3-D transformations. 3. Describe various geometric modeling techniques & standards. 4. Develop NC part program for the given component. 5. Understand concepts of CIM, FMS & CAPP.
Pre-requisites	Engineering Math- I & II
Course Type	***Professional Core Course***

Course Contents

Unit No.	***PO Mapping***	***PSO Mapping***	***Teaching Methodology***	***Competency***	***Performance Indicator***
Unit 1: Introduction to Computer Aided Design (CAD)					
CAD system architecture, Hardware required for CAD: Interactive input output devices, Graphics software: general requirements and Algorithms for 2-D entities like Line, Circle, etc., Geometrical transformations such as Translation, Scaling, Rotation, reflection, and shearing and Mirror in 2-D & 3-D.	PO1-2 PO2-2 PO4-1 PSO1-1	PSO1-2	Lecture delivery, PPTs, Videos Lectures, PBL, ABL, Mini Projects	1.1 2.1 4.2	1.1.1 2.1.2 4.2.1
Unit 2: Geometric Modeling					
Representation of curves, Hermite curves, Bezier curves, B-spline curves, rational curves, Equations and Applications, 3-D geometries, CSG, B-rep, wire frame, surface and solid modeling techniques and their relative advantages, limitations and applications. CAD standards- Graphical Kernel System (GKS), Open Graphics Library (OpenGL), Data exchange standards- IGES, STEP, CALS etc.	PO3-3 PO6-2 PSO2-3	PSO1-2 & PSO2-2	Lecture delivery, PPTs, Videos Lectures, PBL, ABL, Mini Projects	3.1 6.2	3.1.2 6.2.1
Unit3: Introduction to Computer Aided Manufacturing (CAM)					
CAM system architecture, CAM Concepts, Objectives & scope, Nature & Type of manufacturing system, Evolution, Benefits of CAM, Concepts of Computer Integrated Manufacturing, Impact of CIM, CIM Wheel.	PO1-2 PO2-1	PSO1-2	Lecture delivery, PPTs, Videos Lectures, PBL, ABL, Mini Projects	1.1 2.2	1.1.2 2.2.3
Unit 4: NC/CNC Part Programming					
NC and CNC Technology: Types, Classification, Specification and components, Fundamentals of Part programming, Types of format, point to point, straight line and contouring control, Manual and Computer	PO3-1 PO6-2	PSO2-2	Lecture delivery, PPTs, Videos Lectures, PBL,	3.2 6.1 12.1	3.2.1 6.1.1 12.1.2

Assisted Part Programming, Part Programming for drilling, lathe and milling machine operations.	PO12-3		ABL, Mini Projects		
Unit 5: Introduction to Computer Aided Engineering (CAE)					
Integral Systems of CAE, Introduction, components & Objectives of Flexible Manufacturing System, Types of FMS layouts, Advantages of FMS, Cellular manufacturing, Group Technology, part families, part classification and coding systems, Automated Material Handling System.	PO1-2 PO6-3	PSO2-3	Lecture delivery, PPTs, Videos Lectures, PBL, ABL, Mini Projects	1.2 6.2	1.2.1 6.2.1
Unit 6: Computer Aided Process Planning					
Basic concepts of process planning, computer aided process planning (CAPP), Retrieval and Generative approach CAPP systems, Implementation consideration of CAPP.	PO1-2 PO6-2 PO12-3	PSO2-1	Lecture delivery, PPTs, Videos Lectures, PBL, ABL, Mini Projects	1.2 6.1 12.2	1.2.1 6.1.1 12.2.1

Text Books:

1. Ibrahim Zeid, "CAD/CAM Theory and Practice", Tata McGraw Hill Publication.
2. C. McMohan and J. Browne, CAD/CAM Principles, II edition, Pearson Education, 1999.
3. W. M. Neumann and R.F. Sproul, Principles of Computer Graphics, McGraw Hill, 1989.
4. Computer Aided Manufacturing by Tien Chien Chang, Pearson Education.

Reference Books:

1. Flexible Manufacturing Cells and System -William. W. Luggen Hall, England Cliffs, Newjersy.
2. M. P. Grover, Zeemer, "CAD/CAM/CIM", Prentice Hall, India.
3. CAD/CAM, Principles and Applications –P N Rao, McGraw Hill, 2010.

E-sources:

1. NPTEL Lectures & Videos.
2. Published research papers by Elsevier, Springer etc.

Course Code: - 20UME604E	*Course Title*	*Total credits: 02*
Teaching Scheme	**Electives** **1. Tool Design**	*Evaluation Scheme*
Theory: 2 Hrs. /week		CA – 20 Marks
Exam Duration: - 3 Hours		Mid Sem -20 Marks
		End Sem Exam: 60 Marks

Course Objectives	To introduce 1. Calculate the values of various forces involved in the machining operations. 2. Design various single and multipoint cutting tools. 3. Illustrate the properties of various cutting tool materials and hence select an appropriate tool material for particular machining application. 4. Prepare working drawings and setup for economic production of sheet metal components. 5.Identify, design and draw appropriate combination of tools, jigs and fixture, suitable for a particular machining operation.
Course Outcomes	After completing this course, students will be able to: 1. Interpret and understand the theory of metal cutting, tool life and geometry of single point and multipoint cutting tools. 2. Understand principles of locating and clamping devices. 3. Design jigs for drilling and fixtures for turning and milling. 4. Select and design dies for piercing, blanking, bending and forming operations. .
Pre-requisites	Manufacturing Process, Machine Design-I
Course Type	***Professional Elective Courses***

Course Contents

Unit No.	***PO Mapping***	***PSO Mapping***	***Teaching Methodology***	***Competency***	***Performance Indicator***
Unit 1: Theory of metal Cutting (10 Hrs.)					
Introduction, Mechanics of Machining - Geometry of single point cutting tool, Single point cutting tool. Designation of cutting tools, ORS and ASA system, Importance of Tool angles, Mechanism of chip formation, Orthogonal and oblique cutting, use chip breakers, Machining, Heat Generation and Cutting Temperature in forces and Merchant's Circle Diagram. Machining, cutting fluid, Concept of machinability and its improvement, Failure of cutting tool and tool Life, Common use and advanced cutting tools materials. Study of various cutting tool inserts (carbide and CBN), their coatings and importance.	PO –1, 2, 7, 9, 11 & 12	PSO1 PSO2	Lecture delivery, PPTs, Videos Lectures, PBL, ABL	1.3	1.3.1
Unit 2: Design of cutting tools advanced cutting tools materials. (4 Hrs.)					
Introduction, types, geometry, nomenclature and design of Drills, milling cutters, Reamers, Taps and broaches.	PO – 1, 2, 7, 9, 11 & 12	PSO1 PSO2	Lecture delivery, PPTs, Videos Lectures, PBL, ABL	3.1 3.2	3.1.1 3.2.1
Unit3: Design of jigs & fixture (14 Hrs.)					
Introduction, process planning, need of fixtures, locating & clamping - principle of location, locating elements principle for clamping purposes, clamping devices, design principles common to jigs & fixtures. Drilling Jigs :- Design principles, drill bushes, design principles	PO – 1, 2, 3, 4, 7, 9, 11 & 12	PSO1 PSO2	Lecture delivery, PPTs, Videos Lectures, PBL, ABL, Mini	3.2	3.2.1 3.2.2 3.2.3

for drill bushings, Types of drilling jigs - Template jig, plate type jig, swinging leaf jig, Box type jig, channel type jig, Milling Fixtures: - Essential features of a milling fixtures, Design principles for milling fixtures, Indexing jig & fixtures, Turning fixtures, Automatic clamping devices.			Projects		
Unit 4: Press tool Design (10 Hrs.)					
Introduction of Press operations, Press working equipment - Classification, Rating of a press, Press tool equipment's, arrangement of guide posts. Press selection, press working terminology, Types of dies - Simple dies, inverted die, compound dies, combination dies, progressive dies, Transfer dies, multiple dies. Principle of metal cutting, strip layout, clearance, angular clearance, cutting forces, method of reducing cutting forces, die block, die block thickness, die opening, fastening of die block, back up plate, Punch, Methods of holding punches, Strippers. Stoppers, Stock stop, Stock guide, Knock outs, Pilots. Design of Blanking & Piercing die design Bending, Compound & progressive dies.	PO – 1,2, 3, 4, 7, 9, 11 & 12	PSO1 PSO2	Lecture delivery, PPTs, Videos Lectures, PBL, ABL, Mini Projects	3.2 3.3	3.2.2 3.2.3 3.3.1
Unit 5: Bending Forming & Drawing dies (2 Hrs.)					
Bending Terminology, V- Bending, Air bending, bottoming dies, Wiping dies, spring back & its prevention. Design Principles - Bend radius, Bend allowance. Forming Dies- Introduction, Types.	PO – 1,2, 3, 4, 7, 9, 11 & 12	PSO1 PSO2	Lecture delivery, PPTs, Videos Lectures, PBL, ABL, Mini Projects	3.2 3.3 3.4	3.2.1 3.3.1 3.4.1

Text Books:

1. Donladson, Lecain and Goold, "Tool design", Tata McGrawhill.
2. M.H.A. Kempster, "Introduction to Jigs and fixtures design".
3. P.H. Joshi, "Jigs & Fixtures".
4. Wilson, "Fundamentals of tool design", A.S.T.M.E.
5. P C Sharma, "A Textbook of Production Engineering". S. Chand publishers.
6. A. B. Chattopadhyay, "Machining and Machine Tools"

Reference Books:

1. Fundamentals of Metal Machining by Geoffery Boothroyd.
2. Hoffman, "Introduction to Jigs and fixtures".
3. Dolyle, "Manufacturing processes and material for engineers".
4. G. Kuppuswamy, "Principles of metal cutting", university press.
5. Richard Kibbe, John E.Neely, Meyer, White, "Machine tool practices".
6. Production Technology-HMT –Tata McGraw-Hill Publishing Ltd.

E-sources:

1. NPTEL Lectures & Videos.
2. Published research papers by Elsevier, Springer etc.

Course Code: - 20UME605E	*Course Title*	*Total credits: 02*
Teaching Scheme	**Electives** **2. Supply Chain Management**	***Evaluation Scheme***
Theory: 2 Hrs. /week		CA – 20 Marks
Exam Duration: - 3 Hours		Mid Sem -20 Marks
		End Sem Exam: 60 Marks

Course Objectives	To introduce 1. To introduce Supply Chain Process. 2. To acquire concept of demand forecasting from sample example. 3. To know about the foundational role of logistics with reference to transportation and warehousing. 4. To understand parameters to design an effective supply chain.
Course Outcomes	After completing this course, students will be able to: 1. Understand Supply Chain Process 2. Analyze demand forecasting from sample example 3. Understand the foundational role of logistics with reference to transportation and warehousing. 4. Apply knowledge to design a simple supply chain.
Pre-requisites	None
Course Type	***Professional Elective Courses***

Course Contents

Unit No.	***PO Mapping***	***PSO Mapping***	***Teaching Methodology***	***Competency***	***Performance Indicator***
Unit1: Introduction to Supply Chain Management [2Hrs.]					
Evolution of SCM Function, Theme and Pillars of SCM System, How Supply chain works? Participants in the Supply Chain, Supply chain drivers, Supply chain structure.	PO6-1	PSO1- 1	Lecture – Chalk- Board, PPT, Video, PBL,	6.1	6.1.1
Unit2: Forecasting [3 Hrs.]					
Demand forecasting, Pricing and Promotional Impacts on demand, CPFR Concepts, CODP Concepts, Consensus Forecasting, Demand and Pricing Optimization.	PO1-2 PO2-1 PO3-1	PSO1-1	Lecture – Chalk- Board, PPT, Video, PBL, ABL	1.1 2.1 2.2 2.4 3.1	1.1.1 2.1.1 2.1.2 2.1.3 2.2.1 2.2.2 2.2.3 2.4.1 3.1.1
Unit3: Materials Management [5 Hrs.]					
Scope, importance, classification of materials, Procurement, purchasing policies, Vendor development and evaluation, Inventory control systems of stock replenishment, Cost elements, VMI, CMI, Green Channel supply, KM Model of Supplier Partnership, Multi-tier Supplier Partnerships Use of computers for materials function.	PO1-1 PO2-1 PO3-2 PO6-2 PO7-1 PO8-1	PSO1 -11	Lecture – Chalk- Board, PPT, Video, PBL, ABL	1.1 2.1 2.2 2.4 3.1 6.1 6.2 8.1 9.1	1.1.1 2.1.1 2.1.2 2.1.3 2.2.1 2.2.2 2.2.3 2.4.1 3.1.1 6.1.1 6.2.1 8.1.1

	PO9-1				9.1.1
Unit 4: Logistics-Transportation [5 Hrs.]					
Logistics Evolution, 8 wings of Logistics, Individual Freight and passenger modes, intermodal transportation and third party transportation services, economic social, and political roles of transportation, demand, cost and service characteristics of different transport services, carrier selection and evaluation methods, contracting for transportation services, freight rate structure, Private fleet management, Claim management, International transportation, Ocean carrier management, port administration.	PO1-2 PO3-3 PO6-2 PO8-1 PO10-1	PSO1-1	Lecture – Chalk- Board, PPT, Video, PBL, ABL	1.1 3.1 6.1 8.1 10.1 10.2	1.1.1 3.1.1 6.1.1 6.2.1 8.1.1 10.1.1 10.1.2 10.1.3 10.2.2
Unit 5: Logistics-Warehousing [2Hrs.]					
Stores Management - Introduction, Functions, Types of stores, Layout, Identification of materials, Receiving & Issuing of materials.	PO3-1 PO6-1 PO10-1	PSO1-1	Lecture – Chalk- Board, PPT, Video, PBL, ABL	6.1 6.2 10.1 10.2	6.1.1 6.2.1 10.1.1 10.1.2 10.1.3 10.2.2
Unit 6: Technology and Trends [3 Hrs.]					
Use of computers at various stages, Introduction to ERP, E-Business and Systems Integrations, Out sourcing and subcontracting, Case Study	PO3-2 PO5-2 PO6-1 PO11-1	PSO1- 1 PSO2- 2	Lecture – Chalk- Board, PPT, Video, PBL,	5.1 6.1 11.2	5.1.1 6.1.1 11.2.1

Text Books:

1. Supply Chain Management Theories and Practices (Set) by R.P. Mohanty and S. G. Deshmukh, Biztantra Publication.
2. Purchasing and Inventory Management by K.S.Menon and Sarika Kulkarni, SPD Publications.
3. Purchase and Materials Management, by P. Gopalkrushnan, McGraw Hill Education.

Reference Books:

1. Logistics and Supply Chain Management, Martin Christopher, Richard Irwin.
2. Supply Chain Management: Janat Shah, Pearson Education.
3. Principles of Supply Chain Management: Joel Wisner, G. Keong, Cengage Learning.

E-sources:

1. NPTEL Lectures & Videos.
2. Published research papers by Elsevier, Springer etc.

Course Code: - 20UME606E	*Course Title*	*Total credits: 02*
Teaching Scheme	**Electives** **3. Advanced Thermodynamics**	***Evaluation Scheme***
Theory: 2 Hrs. /week		CA – 20 Marks
Exam Duration: - 3 Hours		Mid Sem -20 Marks
		End Sem Exam: 60 Marks

Course Objectives	To introduce 1. learn entropy and its use 2. learn exergy and its use 3. learn steam generators and their performance analysis 4. learn steam nozzles and their performance analysis 5. learn steam turbines and their performance analysis 6. learn condensers, and cooling towers
Course Outcomes	After completing this course, students will be able to: 1. apply increase in entropy principle to flow and non-flow systems 2. apply exergy balance principle to flow and non-flow systems 3. evaluate performance of steam generators 4. evaluate performance of steam nozzles and steam turbines 5. evaluate performance of condensers and cooling towers
Pre-requisites	Engineering Thermodynamics
Course Type	***Professional Elective Courses***

Course Contents

Unit No.	***PO Mapping***	***PSO Mapping***	***Teaching Methodology***	***Competency***	***Performance Indicator***
Unit1: Entropy [3 Hrs.]					
Introduction, Clausius theorem, T-s plot, Clausius inequality, Entropy and Irreversibility, Entropy principle and its application, combined I and II law, Entropy and direction, Entropy and disorder. Entropy generation for non-flow and flow systems. (Descriptive and Numerical Treatment)	PO1-2 PO2-1	PSO1- 1 PSO2- 1	Lecture delivery PPT	1.3 1.4 2.2	1.3.1 1.4.1 2.2.3
Unit2: Energy/Availability [3 Hrs.]					
Available energy pertaining a cycle, Quality of energy, law of degradation of energy, maximum work in a reversible process, Dead state, Availability in steady flow and non-flow processes, Second law efficiency. Kinetic theory of gases- introduction, basic assumption, molecular flux, equation of state for an ideal gas, collisions with a moving wall, principle of equipartition of energy, classical theory of specific heat capacity. Transport phenomena-intermolecular forces, The Van der Waals equation of state, collision cross section, mean free path. Maxwell equations, Joule-Thompson experiment, irreversibility and availability, exergy analysis. (Descriptive and Numerical Treatment)	PO1-2 PO2-1	PSO1- 1 PSO2- 1	Lecture – Chalk- Board, PPT, Video, PBL, ABL	1.3 1.4 2.2	1.3.1 1.4.1 2.2.3
Unit3: Steam Generators and Performance [4 Hrs.]					
Classification, constructional details of process and power boilers, equivalent evaporation, boiler efficiency, energy balance, steam generation controls, introduction to IBR laws, principle and working of high-pressure boilers. Introduction, classification, determination of	PO1-2 PO2-2 PO6-1	PSO1- 2 PSO2- 1	Lecture – Chalk- Board, PPT, Video, PBL,	1.3 1.4 2.2 6.2	1.3.1 1.4.1 2.2.3 6.2.1

height and diameter of chimney, efficiency of chimney, condition for maximum discharge, artificial, forced and induced draught, Advantages. (Descriptive and Numerical Treatment)			ABL		
Unit 4: Steam Nozzles [3 Hrs.]					
Types of nozzles, equation of continuity of nozzle, isentropic flow through nozzle, use of Mollier chart, velocity of steam leaving a nozzle, effect of friction, mass of steam discharged, nozzle efficiency, critical pressure ratio and maximum discharge, supersaturated flow through the nozzle, effect of back pressure on nozzle characteristics. (Descriptive and Numerical	PO1-2 PO2- 1	PSO1- 1 PSO2- 1	Lecture – Chalk- Board, PPT, Video, PBL, ABL	1.3 1.4 2.2	1.3.1 1.4.1 2.2.3
Unit 5: Steam Turbines [4 Hrs.]					
Advantages and classification of steam turbines, compounding of steam turbines, governing of steam turbines, velocity diagrams, work done and efficiencies, losses in turbines. (Descriptive and Numerical	PO1-2 PO2- 1	PSO1- 2 PSO2- 1	Lecture – Chalk- Board, PPT, Video, PBL,	1.3 1.4 2.2	1.3.1 1.4.1 2.2.3
Unit 6: Steam Condensers and Cooling Towers [3 Hrs.]					
Elements of steam condensing plants, Classifications, comparison between Jet and Surface condensers, vacuum, vacuum efficiency, Daltons law of partial pressure, vacuum measurement, mass of circulating water required in a condenser, air removal, capacity of air extraction pumps, Cooling Towers: Types of cooling towers, thermodynamic analysis of cooling towers, efficiencies. (Descriptive and Numerical Treatment)	PO1-2 PO2- 1	PSO1- 1 PSO2- 1	Lecture – Chalk- Board, PPT, Video, PBL, ABL	1.3 1.4 2.2	1.3.1 1.4.1 2.2.3

Text Books:

1. P.K.Nag, “Engineering Thermodynamics”, Tata McGraw Hill, New Delhi, 3rd edition,2005.
2. G. J. Van Wylen, R. E. Sonntag, “Fundamental of Thermodynamics”, John Wiley and Sons, 5 thedition, 1998.
3. M. J. Moran, H. N. Shaprio, “Fundamentals of Engineering Thermodynamics”, John Wiley and Sons, 4th edition, 2004.
4. E. Rathakrishnan, “Fundamentals of Engineering Thermodynamics” Prentice Hall of India Privite Limited New Delhi, 2000.
5. J P Howell and P O Buckius, Fundamentals of Engineering Thermodynamics, McGraw Hill, 1992.

Reference Books:

1. Y. A.Cengel, M. A. Boles, “Thermodynamics - An Engineering Approach”, Tata McGraw Hill, 5thedition, 2006.

E-sources:

1. NPTEL Lectures & Videos.
2. Published research papers by Elsevier, Springer etc.
3. www. nptel.com
4. www.ocw.mit.edu
5. www. bodhitree.com

Course Code: - 20UME607D	*Course Title*	*Total credits: 02*
Teaching Scheme	**Smart Manufacturing**	***Evaluation Scheme***
Theory: 2 Hrs. /week		CA – 10 Marks
Exam Duration: - 2 Hours		Mid Sem -10 Marks
		End Sem Exam: 30 Marks

Course Objectives	To introduce 1. The objective of the course is to provide a strong orientation to both the industry and the students on the new advancements in manufacturing in general and the relevant features of Smart Manufacturing to an Indian context, in particular.
Course Outcomes	After completing this course, students will be able to: 1. Understand the existing IoT based manufacturing systems and Cloud architectures. 2. Design and development of IoT system with cloud infrastructure. 3. Implement a prototype of the IoT/cloud system design using various factory setups. 4. understand use & application of smart industrial sensors. 5. Implementation of cloud-based applications for smart sensors.
Pre-requisites	Good Knowledge of Industrial Automation, Sensorics & Mechatronics etc.
Course Type	***Professional Core Course***

Course Contents

Unit No.	***PO Mapping***	***PSO Mapping***	***Teaching Methodology***	***Competency***	***Performance Indicator***
Unit 1: Introduction to smart manufacturing					
What is "smart manufacturing" really and how does it differ from conventional/legacy manufacturing-Smart Manufacturing techniques- Three Dimensions: Demand Driven and Integrated Supply Chains; Dynamically Optimized Manufacturing Enterprises (plant + enterprise operations); Real Time, Sustainable Resource Management (intelligent energy demand management, production energy optimization.	PO1, PO6	PSO1	PPT, Documentaries videos on history of Manufacturing & Smart Manufacturing.	1.4 6.1	1.4.1 6.1.1
Unit 2: Smart design and Development					
Smart Design/Fabrication - Introduction to Digital Tools, Product Representation and Exchange Technologies and Standards, Agile (Additive) Manufacturing Systems and Standards. Mass Customization, Smart Machine Tools, Smart Cities, Smart Logistics, Robotics, Mechatronics System and Automation (perception, manipulation, mobility, autonomy), Smart Perception – Various smart Sensor networks and Devices used in Industry.	PO1, PO6, PO3	PSO1, PSO2	PPT, Case Study video Process Chain and Classification on, construction & Working videos.	1.4 3.1 6.1	1.4.1 3.1.1 3.1.2 3.1.3 6.1.1
Unit 3: Smart Communication systems-I					
Introduction, Physical design of IoT, Logical design of IoT, IoT enabling technologies, Domain specific IoTs, IoT design methodology, logical design, IoT physical devices (such as Raspberry Pi, pcDuino, Cubieboard,) Information, Mobility, Communication Technologies, Protocols, Cyber Physical Systems – the next generation of Embedded Systems and Networks, IT and OT convergence, co-creation and collaboration enablement. Introduction to cloud computing: cloud	PO1, PO6, PO3	PSO1, PSO2	PPT, Case Study videos, web-based application of IOT.	1.4 3.1 6.1	1.4.1 3.1.1 3.1.2 3.1.3 6.1.1

models, cloud service examples, cloud-based services & applications.					
Unit 4: Industrial Sensorics					
Sensors and Transducers for: flow, temperature, force, pressure and torque sensors; Current, torque and speed measurements using digital measurement techniques. Optical sensors: Lasers. photo-detectors and optical fiber as sensors. Sensors in Robotics: Classification, Characteristics, Internal Sensors – position, velocity, acceleration sensors, Force sensors, External sensors – proximity, touch and slip sensors. Robotic vision, process of Imaging, Architecture of Robotic Vision Systems, Image Acquisition, Components of Vision System, Image Representation, Image Processing.	PO1, PO6, PO3	PSO1, PSO2	PPT, Case Study video on General Guidelines for use of Industrial sensors.	1.4 3.1 6.1	1.4.1 3.1.1 3.1.2 3.1.3 6.1.1
Unit 5: Advance Industrial Sensorics					
Introduction to Advanced Sensors: Semiconductor sensors, Hall elements. Silicon sensors for sensing radiation, mechanical, magnetic, chemical and other signals, Catalytic devices, gas sensors and acoustic sensors. Sensor based Control: Types of controllers, electrical, pneumatic and hydraulic prime movers and associated control hardware, closed loop control of microcomputer-based drives. Relay control systems and PLC systems and programming, control including sequence control. Sensor based control of various actuators, mechatronic devices and autonomous mobile robots.	PO1, PO6, PO3	PSO1, PSO2	PPT, Case Study video on Functional Models, integration of smart sensors with cloud-based platforms, etc.	1.4 3.1 6.1	1.4.1 3.1.1 3.1.2 3.1.3 6.1.1
Unit 6: Smart Manufacturing Applications					
Online Predictive Modeling, Monitoring and Intelligent Control of Machining/Manufacturing and Logistics/Supply Chain Processes of factory unit; Industry 4.0 laboratories, Smart Energy Management of manufacturing processes and facilities in smart manufacturing.	PO1, PO6, PO3, PO7	PSO1, PSO2	PPT, Videos. Application based on smart factories.	1.4 3.1 6.1 7.2	1.4.1 3.1.1 3.1.2 3.1.3 6.1.1 7.2.1 7.2.2

Text Books & Reference Books:

1. J. Vetelino and A. Reghu, Introduction to sensors, CRC Press, 2010, ISBN 9781439808528.
2. J. Fraden, Handbook of Modern Sensors: Physics, Designs and Applications, 4th edition, Springer, 2010.
3. Doebelin, Measurement systems: Applications and Design, 5th edition, McGraw Hill Book, 2004
4. C.W. de Silava, Sensors and Actuators, 2nd edition, CRC Press, 2016.

E-sources:

1. NPTEL Videos
2. NPTEL Lectures

Course Code: - 20UME608D	*Course Title*	*Total credits: 02*
Teaching Scheme	**Industrial Management**	***Evaluation Scheme***
Theory: 2 Hrs. /week		CA – 10 Marks
Exam Duration: - 2 Hours		Mid Sem -10 Marks
		End Sem Exam: 30 Marks

Course Objectives	To introduce 1. Gain knowledge of Management systems. 2. Develop perspective for motivation strategies & resolution of group conflicts. 3. Acquire knowledge about methods of financial & cost control, Personnel & Management.
Course Outcomes	After completing this course, students will be able to: 1. Understand the concepts related to Business. 2. Demonstrate the roles, skills and functions of management. 3. Analyze effective application of PPM knowledge to diagnose and solve organizational problems and develop optimal managerial decisions. 4. Understand the complexities associated with management of human resources in the organizations and integrate the learning in handling these complexities.
Pre-requisites	None
Course Type	***Humanities & social sciences including management courses***

Course Contents

Unit No.	***PO Mapping***	***PSO Mapping***	***Teaching Methodology***	***Competency***	***Performance Indicator***
Unit 1: Introduction to Management					
Functions, Role, Skills, Levels of Decision Making, Historical Perspective, Forms of Industrial Organization: Single Proprietorship, Partnership, Joint Stock companies., Cooperatives and Public Sector Undertakings (PSUs), Principles & functions of Management.	PO6-1 PO8-1 PO11-2 PO12-1	PSO1 PSO2	PPT/Case Studies/Role Plays/Games/Quizzes/Activity Based Learning (ABL)	6.1 8.2 11.1 12.1	6.1.1 8.2.2 11.1.1 12.1.1
Unit2: Human and Industrial Relations					
Industrial relations and disputes, Relations with subordinates, peers and superiors, Characteristics of group behavior and trade unionism., Grievance handling mechanisms, Labor welfare, Workers' participation in management, Case studies/Role-plays on group dynamics.	PO6-1 PO8-1 PO9-3 PO10-2 PO11-1 PO12-3	PSO1, PSO2	PPT/Case Studies/Role Plays/Games/Quizzes/Activity Based Learning (ABL)	6.2 8.1 9.2 10.1 11.2 12.1	6.2.1 8.1.1 9.2.1 10.1.2 11.2.1 12.1.2
Unit3: Motivation & Leadership					
Maslow's hierarchy of human needs, Mc Gregor's Theory of Motivation, Factors determining motivation, Characteristics of motivation, Methods for improving motivation, Incentives, pay, promotion, rewards, Job satisfaction and job enrichment. Leadership: Need for leadership, Functions of a leader, Factors for	PO8-2 PO9-3 PO10-3	PSO1, PSO2	PPT/Case Studies/Role Plays/Games/Quizzes/Activity Based Learning	8.1 9.1 10.2 12.2	8.1.1 9.1.2 10.2.1 12.2.1

accomplishing effective leadership, Case studies on Corporate Leadership Styles.	PO12-3		(ABL)		
Unit 4: Human Resource Development & Professional Ethics					
Human Resource Planning, Recruitment, selection &development. Interview methods & techniques. Training strategies and methods. Professional Ethics: Concept of ethics, Concept of professionalism, Need for professional ethics. Code of professional ethics, Ethical issues for professional engineers, Professional bodies and their role.	PO8-3 PO9-2 PO10-1 PO12-2	PSO1, PSO2	PPT/Case Studies/Role Plays/Games/Quizzes/Activity Based Learning (ABL)	8.1 9.2 10.1 12.2	8.1.1 9.2.3 10.1.2 12.2.1
Unit 5: Financial Management					
Costs- Types, Elements, Allocation of Overheads, Product and Process Costing, Time Value of Money, NPV, IRR, Payback Periods, Evaluation of Investment proposals based on capital budgeting methods.	PO10-2 PO11-3 PO12-2	PSO1, PSO2	PPT/Case Studies/Role Plays/Games/Quizzes/Activity Based Learning (ABL)	10.2 11.1 12.1	10.2.1 11.1.2 12.1.2
Unit 6: Total Quality Management (TQM)					
Definition, Understanding quality, Evolution of TQM, Framework for TQM, Formulation and implementation of TQM: Case Study.	PO11-3 PO12-1	PSO1, PSO2	PPT/Case Studies/Role Plays/Games/Quizzes/Activity Based Learning	11.2 12.1	11.2.1 12.1.2

Text Books:

1. TR Banga " Industrial Engineering and Management".
2. OP Khanna" Industrial Engineering and Management".

Reference Books:

1. Harold Koontz, Cyril O 'Donnell " Principles of Management".
2. Besterfield, D. H." Total Quality Management".
3. Eugene J.L." Finanancial Accounting".

E-sources:

1. NPTEL Videos
2. NPTEL Lectures

Course Code: - 20UME609L	*Course Title*	*Total credits: 01*
Teaching Scheme	**Machine Design-II Lab.**	***Evaluation Scheme***
Practical: 2 Hrs. /week		CA – 30 Marks
		End Sem Exam: 20 Marks
		Total: - 50 Marks

Lab outcomes	1.Apply design process to an open-ended problem. 2. Determine suitable material and decide dimensions of simple machine components. 3. Selection of design factors. 4. Design simple machine parts. 5. Demonstrate good communication skill graphically, orally and with documentation.

Course Contents

Sr	*Name of Practical*	*Type/ Methodology*	*PO Mapping*	*PSO Mapping*	*Competency*	*Performance Indicator*
1	Design of Gear box	Demonstration	PO1-3 PO2-3 PO3-3 PO4-3 PO6-1 PO10-1	PSO1-3 PSO2-1	1.3 2.2 3.1 6.1 10.1 10.3	1.3.1 1.4.1 2.1.1 2.1.2 2.1.3 2.2.1
2	Design of any one type of clutch	Demonstration	PO1-3 PO2-3 PO3-3 PO4-3 PO6-1 PO10-1	PSO1-3 PSO2-1	1.3 2.2 3.1 6.1 10.1 10.3	1.3.1 1.4.1 2.1.1 2.1.2 2.1.3 2.2.1
3	Design any one type of brake	Demonstration	PO1-3 PO2-3 PO3-3 PO4-3 PO6-1 PO10-1	PSO1-3 PSO2-1	1.3 2.2 3.1 6.1 10.1 10.3	1.3.1 1.4.1 2.1.1 2.1.2 2.1.3 2.2.1
4	Study of any one rolling contact bearing, sliding contact bearing and belt used in automobile/machine tool	Demonstration	PO1-3 PO2-3 PO3-3 PO4-3 PO6-1 PO10-1	PSO1-2 PSO2-1	10.1 10.3 12.3	10.1.1 10.3.1 12.3.1 12.3 .2
5	Assignment on design of one rolling contact bearing, sliding contact bearing and belt used in automobile/machine tool	Demonstration	PO1-3 PO2-3 PO3-3 PO4-3 PO6-1 PO10-1	PSO1-3 PSO2-1	1.3 2.2 3.1 6.1 10.1 10.3	1.3.1 1.4.1 2.1.1 2.1.2 2.1.3 2.2.1

References:

1. Lab Manual.
2. Design Data Book, V.B. Bhandari, McGraw Hill Education (India) Pvt Ltd.

Course Code: - 20UME610L	*Course Title*	*Total credits: 01*
Teaching Scheme	**Heat Transfer Lab.**	***Evaluation Scheme***
Practical: 2 Hrs. /week		CA – 30 Marks
		End Sem Exam: 20 Marks
		Total: - 50 Marks

Lab outcomes	1. Explain thermal conductivity and Determine the thermal conductivity of insulating powder. 2. Determine the thermal conductivity of composite slab. 3. Explain Natural convection and Determine heat transfer coefficient in Natural convection from cylinder. 4. Explain Forced convection and Determine heat transfer coefficient in Forced convection from cylinder. 5. Determine the critical heat flow.

Course Contents

Sr	*Name of Practical*	*Type/ Methodology*	*PO Mapping*	*PSO Mapping*	*Competency*	*Performance Indicator*
1	Determination of the thermal conductivity of a given rod.	Demonstration& Experimentation	PO 1,2, 3,4,10,12	PSO 1,2	1.2 2.3 3.1 4.2 10.3 12.1	1.2.1 2.3.2 3.1.1 4.2.1 10.3.1 12.1.1
2	Determination of the thermal conductivity of insulating powder.	Demonstration& Experimentation	PO 1,2, 3,4,10,12	PSO 1,2	1.2 2.3 3.1 4.2 10.3 12.1	1.2.1 2.3.2 3.1.1 4.2.1 10.3.1 12.1.1
3	Determination of the thermal conductivity of composite slab.	Demonstration& Experimentation	PO 1,2, 3,4,10,12	PSO 1,2	1.2 2.3 3.1 4.2 10.3 12.1	1.2.1 2.3.2 3.1.1 4.2.1 10.3.1 12.1.1
4	Determination of heat transfer coefficient in Natural convection from cylinder.	Demonstration& Experimentation	PO 1,2, 3,4,10,12	PSO 1,2	1.2 2.3 3.1 4.2 10.3 12.1	1.2.1 2.3.2 3.1.1 4.2.1 10.3.1 12.1.1

5	Determination of heat transfer coefficient in Forced convection from cylinder.	Demonstration& Experimentation	PO 1,2, 3,4,10,12	PSO 1,2	1.2 2.3 3.1 4.2 10.3 12.1	1.2.1 2.3.2 3.1.1 4.2.1 10.3.1 12.1.1
6	Determination of the critical heat flux.	Demonstration Experimentation	PO 1,2, 3,4,10,12	PSO 1,2	1.2 2.3 3.1 4.2 10.3 12.1	1.2.1 2.3.2 3.1.1 4.2.1 10.3.1 12.1.1
7	Experimentation on drop-wise and film-wise condensation.	Demonstration Experimentation	PO 1,2, 3,4,10,12	PSO 1,2	1.2 2.3 3.1 4.2 10.3 12.1	1.2.1 2.3.2 3.1.1 4.2.1 10.3.1 12.1.1
8	Trial on parallel and counter flow heat exchanger.	Demonstration Experimentation	PO 1,2, 3,4,10,12	PSO 1,2	1.2 2.3 3.1 4.2 10.3 12.1	1.2.1 2.3.2 3.1.1 4.2.1 10.3.1 12.1.1
9	Determination of the emissivity of the given surface.	Demonstration Experimentation	PO 1,2, 3,4,10,12	PSO 1,2	1.2 2.3 3.1 4.2 10.3 12.1	1.2.1 2.3.2 3.1.1 4.2.1 10.3.1 12.1.1
10	Determination of the Stefan-Boltzmann's constant.	Demonstration Experimentation	PO 1,2, 3,4,10,12	PSO 1,2	1.2 2.3 3.1 4.2 10.3 12.1	1.2.1 2.3.2 3.1.1 4.2.1 10.3.1 12.1.1

References:

1. Lab Manual.

Course Code: - 20UME611L	*Course Title*	*Total credits: 01*
Teaching Scheme	**CAD/CAM Lab.**	***Evaluation Scheme***
Practical: 2 Hrs. /week		CA – 30 Marks
		End Sem Exam: 20 Marks
		Total: - 50 Marks

Lab outcomes	1. Analyze 1D Element Static Structural Problems. 2. Analyze 1D Element Thermal and Heat transfer Problems. 3. Analyze 2D Element and Dynamic Analysis for Natural Frequency.

Course Contents

Sr	*Name of Practical*	*Type/ Methodology*	*PO Mapping*	*PSO Mapping*	*Competency*	*Performance Indicator*
1	Creating 04 Two Dimensional Models on any software	Analysis of Practical problem using any CAE Software (ANSYS APDL/MSC)	PO1, PO2, PO3, P04, PO5	PSO1, PSO2	1.4 2.3 3.4 4.2 5.1	1.4.1 2.3.2 3.4.2 4.2.1 5.1.2
2	Creating 04 Three Dimensional Models on any software package	Analysis of Practical problem using any CAE Software (ANSYS APDL/MSC)	PO1, PO2, PO3, P04, PO6	PSO1, PSO2	1.3 2.4 3.3 4.3 6.2	1.3.1 2.4.4 3.3.2 4.3.4 6.2.1
3	Creating part models of a 5 components Assembly	Analysis of Practical problem using any CAE Software (ANSYS APDL/MSC)	PO1, PO2, PO3, P04, PO7	PSO1, PSO2	1.2 2.2 3.4 4.3 7.1	1.21 2.2.4 3.4.1 4.3.1 7.1.2
4	Building a composite assembly using components from last lab work.	Analysis of Practical problem using any CAE Software (ANSYS APDL/MSC)	PO1, PO2, PO3, P04, PO8	PSO1, PSO2	1.3 2.3 3.2 4.3 8.2	1.3.1 2.3.2 3.2.3 4.3.2 8.2.1
5	Drafting an assembly & parts sheet with Bill of Material on any drafting package	Analysis of Practical problem using any CAE Software (ANSYS	PO1, PO2, PO3, P04, PO9	PSO1, PSO2	1.4 2.3 3.4 4.2 9.3	1.4.1 2.3.2 3.4.1 4.2.1 9.3.1

		APDL/MSC)				
6	02 NC part program for milling operations on any CAM package	Analysis of Practical problem using any CAE Software (ANSYS APDL/MSC)	PO1, PO2, PO3, P04, PO10	PSO1, PSO2	1.2 2.4 3.3 4.3 10.2	1.2.1 2.4.2 3.4.1 4.3.1 10.2.2
7	02 NC part program for Drilling operations on any CAM package	Analysis of Practical problem using any CAE Software (ANSYS APDL/MSC)	PO1, PO2, PO3, P04, PO11	PSO1, PSO2	1.4 2.3 3.3 4.1 11.3	1.4.1 2.3.1 3.3.2 4.1.3 11.3.2
8	02 NC part program for Lathe operations on any CAM package	Analysis of Practical problem using any CAE Software (ANSYS APDL/MSC)	PO1, PO2, PO3, P04, PO12	PSO1, PSO2	1.4 2.3 3.3 4.1 11.3	1.4.1 2.4.3 3.2.3 4.3.2 12.2.2
9	Assignment on Computer Aided Engineering	Assignment on CAE example	PO1, PO2, PO3, P04, PO12	PSO1	1.3 2.2 3.1	1.3.1 2.2.4 3.1.3
10	Assignment on computer aided process planning	Assignment on CAPP case study	PO1, PO2, PO3, P04, PO12	PSO1	1.2 2.1 3.3	1.2.1 2.1.3 3.3.1

References:

1. Lab Manual.

Course Code: - 20UME612E	*Course Title*	*Total credits: 01*
Teaching Scheme	**Electives:** **1. Tool Design Lab.**	***Evaluation Scheme***
Practical: 2 Hrs. /week		CA – 30 Marks
		End Sem Exam: 20 Marks
		Total: - 50 Marks

Lab outcomes	1. Demonstrate knowledge of different types of chips and mechanism of chip formation. 2. Demonstrate the various angles of single point cutting tool and their importance. 3. Develop capacities in integrating knowledge of design along with other aspects of value addition in the conceptualization and manufacturing stage of jigs and fixture. 4. Students will able to design the press tool for said problem.

Course Contents

Sr	*Name of Practical*	*Type/ Methodology*	*PO Mapping*	*PSO Mapping*	*Competency*	*Performance Indicator*
1	Sheet No.1 Drawing of nomenclature of single point cutting tool, milling cutter, drill, reamer, broach and tap	Drawing	PO1-2	PSO1-2 PSO2-3	1.3	1.3.1
2	Prepare a single point cutting tool made up of any soft material.	Demonstration	PO3-2	PSO1-3 PSO2-3	3.1 3.2	3.1.1 3.2.1
3	Demonstration of generation of various chips during machining operations.	Demonstration	PO1-2	PSO1-3 PSO2-2	1.3	1.3.1
4	Sheet 2 Detail drawings of different locating elements and detail drawings of different clamping elements.	Drawing	PO3-2	PSO1-3 PSO2-3	3.2	3.2.1 3.2.2 3.2.3
5	Sheet 3: Design and drawing of jig for given component using any CAD software	Drawing	PO3-2	PSO1-2 PSO2-3	3.2	3.2.1 3.2.2 3.2.3
6	Sheet 4: Design and drawing of milling fixture for given component or design and drawing of turning fixture for given component.	Drawing	PO3-2	PSO1-3 PSO2-3	3.2	3.2.1 3.2.2 3.2.3
7	Sheet 5: Design and drawing of any one press tool (compound die / progressive die/Drawing Die)	Drawing	PO3-3	PSO1-3 PSO2-3	3.2 3.3 3.4	3.2.2 3.2.3 3.3.1 3.2.1
8	Industrial Visit to any Tooling or fixture manufacturing Industry	Visit	PO1-3 PO3-3	PSO1-3 PSO2-3	1.3 3.2 3.4 3.3	3.2.2 3.2.3 3.3.1 3.2.1

References:

1. Lab Manual.

Course Code: - 20UME613E	*Course Title*	*Total credits: 01*
Teaching Scheme	**Electives: 2. SCM Lab.**	***Evaluation Scheme***
Practical: 2 Hrs. /week		CA – 30 Marks
		End Sem Exam: 20 Marks
		Total: - 50 Marks

Lab outcomes	1. Understand Supply Chain Process in practice 2. Select appropriate transportation option 3. Understand practice in forecasting in industry 4. Understand function of stores

Course Contents

Sr	*Name of Practical*	*Type/ Methodology*	*PO Mapping*	*PSO Mapping*	*Competency*	*Performance Indicator*
1	Assignment based on unit 1	Demonstration/ Industry Visit/PPT/Case Study	PO1 PO2	PSO1-2	1.4 2.1	1.4.1 2.1.1 2.1.2 2.1.3
2	Case study of forecasting for one local industry	Demonstration/ Industry Visit/PPT/Case Study	PO2 PO3	PSO1-3	2.4 3.1	2.4.1 3.1.1
3	Case study of purchasing policy, vendor development and vendor evaluation method of one local industry	Demonstration/ Industry Visit/PPT/Case Study	PO4 PO6	PSO1-3	4.3 6.1	4.3.1 4.3.2 6.1.1
4	Comparative study of transportation considering different aspects for given sample product and with defined parameters	Demonstration/ Industry Visit/PPT/Case Study	PSO9 PO10	PSO1-3	9.2 10.1	9.2.1 9.2.2 9.2.3 10.1.1 10.1.2
5	Visit to store of any one organization study and analysis of functions	Demonstration/ Industry Visit/PPT/Case Study	PO11 PO12	PSO1-3	11.1 12.1	11.1.1 11.1.2 12.1.1 12.1.2
6	Assignment based on ERP	Demonstration/ Industry Visit/PPT/Case Study	PO2 PO5	PSO1-3	2.1 5.1	2.1.1 2.1.2 2.1.3 5.1.1 5.1.2

References:

1. Lab Manual
2. ISO procedures/SOPs of respective organizations for particular study is being conducted

Course Code: - BTTEAT604L	*Course Title*	*Total credits: 01*
Teaching Scheme	**Electives:** **3. Advanced Thermodynamics Lab**	***Evaluation Scheme***
Practical: 2 Hrs. /week		CA – 30 Marks
		End Sem Exam: 20 Marks
		Total: - 50 Marks

Lab outcomes	1. Evaluate performance of boiler 2. Evaluate performance of steam nozzle 3. Evaluate performance of steam turbine 4. Evaluate performance of cooling tower 5. Apply the increase in entropy principle and exergy balance for mechanical systems

Course Contents

Sr	*Name of Practical*	*Type/ Methodology*	*PO Mapping*	*PSO Mapping*	*Competency*	*Performance Indicator*
1	Trial on boiler	Trial	PO1- 1 PO6- 1	PSO1- 1	1.4 6.1 6.2	1.4.1 6.1.1 6.2.1
2	Trial on steam nozzle	Trial	PO1- 1	PSO1- 1	1.4	1.4.1
3	Trial on steam turbine	Trial	PO1- 1	PSO1- 1	1.4	1.4.1
4	Trial on steam condenser	Trial	PO1- 1	PSO1- 1	1.4	1.4.1
5	Trial on cooling tower	Trial	PO1- 1	PSO1- 1	1.4	1.4.1
6	Field visit	Study/Demonstration	PO1- 1 PO2-1 PO12- 1	PSO1- 1 PSO2- 1	1.4 2.1 12.1 12.2 12.3	1.4.1 2.1.1 2.1.2 12.1.1 12.1.2 12.2.1 12.2.2 12.3.1 12.3.2
7	Assignment on unit1: Solve open ended problems on Entropy	Problem Base Learning	PO1- 1 PO2- 1	PSO1- 1 PSO2- 1	1.3 1.4 2.2 2.3 2.4	1.3.1 1.4.1 2.2.3 2.2.4 2.4.4
8	Assignment based on unit 2: Solve open ended problems on Exergy	Problem Base Learning	PO1- 1 PO2- 1	PSO1- 1 PSO2- 1	1.3 1.4 2.2 2.3 2.4	1.3.1 1.4.1 2.2.3 2.2.4 2.4.4

References:

1. Lab Manual.

Course Code: - 20UME615L	*Course Title*	*Total credits: 01*
Teaching Scheme	**Smart Manufacturing Lab**	***Evaluation Scheme***
Practical: 2 Hrs. /week		CA – 30 Marks
		End Sem Exam: 20 Marks
		Total: - 50 Marks

Lab outcomes	1.Explain thermal conductivity and Determine the thermal conductivity of insulating powder. 2.Determine the thermal conductivity of composite slab. 3. Explain Natural convection and Determine heat transfer coefficient in Natural convection from cylinder. 4. Explain Forced convection and Determine heat transfer coefficient in Forced convection from cylinder.

Course Contents

Sr	*Name of Practical*	*Type/ Methodology*	*PO Mapping*	*PSO Mapping*	*Competency*	*Performance Indicator*
1	Using IoT devices small systems like classroom automation	Demonstration, PBL, etc.	PO1, PO6	PSO 2	1.4 6.1	1.4.1 6.1.1
2	Demonstration Using IoT devices small systems like Smart Assembly Factory	Demonstration, PBL, etc.	PO1, PO6	PSO 2	1.4 6.1	1.4.1 6.1.1
3	Demonstration Using IoT devices small systems like Smart Manufacturing Factory	Demonstration, PBL, etc.	PO1, PO6, PO3	PSO 2	1.4 3.1 6.1	1.4.1 3.1.1 3.1.2 3.1.3 6.1.1
4	Using IoT devices small systems for smart parking,	Demonstration, PBL, etc.	PO1, PO6, PO3	PSO 1 PSO2	1.4 3.1 6.1	1.4.1 3.1.1 3.1.2 3.1.3 6.1.
5	Environment monitoring using Smart IOT Devices	Demonstration, PBL, etc.	PO1, PO6, PO3	PSO 2	1.4 3.1 6.1	1.4.1 3.1.1 3.1.2 3.1.3 6.1.
6	Integration of Smart Sensors in Agile (Additive) Manufacturing Systems	Demonstration, PBL, etc.	PO1, PO6, PO3	PSO 2	1.4 3.1 6.1	1.4.1 3.1.1 3.1.2 3.1.3 6.1.
7	Study & Integration of Industrial Sensors: Identification System: other Sensors	Demonstration, PBL, etc.	PO1, PO6, PO3	PSO 1 PSO2	1.4 3.1 6.1	1.4.1 3.1.1 3.1.2 3.1.3 6.1.

8	Study & Integration of Industrial Sensors: Industry 4.0 Sensors	Demonstration, PBL, etc.	PO1, PO6, PO3	PSO 2	1.4 3.1 6.1	1.4.1 3.1.1 3.1.2 3.1.3 6.1.
9	Trials on IOT Based manufacturing System	Demonstration, PBL, etc.	PO1, PO6, PO3	PSO 2	1.4 3.1 6.1	1.4.1 3.1.1 3.1.2 3.1.3 6.1.
10	Smart Energy Management of manufacturing processes	Demonstration, PBL, etc.	PO1, PO6, PO3	PSO 2	1.4 3.1 6.1	1.4.1 3.1.1 3.1.2 3.1.3 6.1.
11	Demonstration based on Sensor based Control systems	Demonstration, PBL, etc.	PO1,PO6, PO3	PSO 2	1.4 3.1 6.1	1.4.1 3.1.1 3.1.2 3.1.3 6.1.1
12	Report of Learning from Case study/Industrial Visit	Demonstration, PBL, etc.	PO1,PO6, PO3	PSO 2	1.4 3.1 6.1	1.4.1 3.1.1 3.1.2 3.1.3 6.1.1

References:

1. Lab Manual.

MAHATMA GANDHI MISSION`S

JAWAHARLAL NEHRU ENGINEERING COLLEGE

AURANGABAD.

DEPARTMENT OF MECHANICAL ENGINEERING

Curriculum for

B.Tech. in MECHANICAL ENGINEERING

w.e.f.

Academic Year 2021-22

VISION, MISSION, PROGRAM EDUCATIONAL OBJECTIVES and PROGRAM

SPECIFIC OUTCOMES OF MECHANICAL DEPARTMENT

Vision of Mechanical Department

To establish the state of the art learning center in Mechanical Engineering which will impart global competence, enterprising skills, professional attitude and human values in the student.

Mission of Mechanical Department

1. To impart quality technical education to the students.
2. To develop comprehensive competence in the students through various modes of learning.
3. To enable students for higher studies and competitive examinations.
4. To facilitate students and industry professionals for continuous improvement and innovation.

Program Educational Objectives:

[1] Use core competence acquired in various areas of Mechanical Engineering to solve techno-managerial issues for creating innovative products that lead to better livelihoods & economy of resources.

[2] To establish themselves as effective collaborators and innovators to address technical, managerial and social challenges.

[3]To equip students for their professional development through lifelong learning and career advancement along with organizational growth.

[4] Serve as a driving force for proactive change in industry, society and nation.

PROGRAM SPECIFIC OUTCOMES

Student should have

1) An ability to work professionally in mechanical systems including design, analysis, production, measurement and quality control.

2) An ability to work on diverse disciplinary tasks including manufacturing, materials, thermal, automobile, robotics, mechatronics, engineering software tools, automation and computational fluid dynamics.

PO No.	Program Outcome Description
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problemanalysis:**Identify,formulate,reviewresearchliterature,andanalyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineeringsciences.
PO 3	**Design / Development of solution:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO 4	**Conduct investigation of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Moderntoolusage:**Create,select,andapplyappropriatetechniques,resources,and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of thelimitations.
PO 6	**Theengineer&society**:Applyreasoninginformedbythecontextualknowledgeto assesssocietal,health,safety,legalandculturalissuesandtheconsequent responsibilities relevant to the professional engineering practice
PO 7	**Environment&sustainability:**Understandtheimpactoftheprofessionalengineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual & team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinarysettings.
PO 10	**Communication:**Communicateeffectivelyoncomplexengineeringactivitieswith the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clearinstructions.
PO 11	**Project management & finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work,as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Lifelong learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Appendix A

MGM University
Aurangabad – 431003
Approved Program Structure

Name of the College/Institute- **Jawaharlal Nehru Engineering College** Faculty of - **Engineering & Technology**
Name of the Program:- Mechanical Engineering
Approved by the Board of Studies on-22nd February 2020
Program Approved vide Academic Council Meeting dt-29th June 2020 Item No. MGMU:AC-1:2020:22
Program Type: **UG** Duration: 08 Semesters
Curriculum Code: ---------- (this code will change when you change the Curriculum)

Semester VII																		
Course Code	**Course Title**	**Type**	**Teaching Scheme**			**Evaluation Scheme (Marks)**						**Minimum Passing (Marks)**						**Credit**
						Internal			**External**		**Total**	**Internal**			**External**		**Total**	
			L	**T**	**P**	**CA**	**MSE**	**TW**	**ESE**	**PR**		**CA**	**MSE**	**TW**	**ESE**	**PR**		
20UME701D	Industry 4.0	Theory	3	1	-	20	20	-	60	-	100	-	-	-	24	-	40	4
20UME702D	Refrigeration & Air Conditioning	Theory	2	-	-	20	20	-	60	-	100	-	-	-	24	-	40	2
20UME703D	Industrial Hydraulics and Pneumatics	Theory	3	-	-	20	20	-	60	-	100	-	-	-	24	-	40	3
20UME704D	Production Planning & Control	Theory	2	-	-	20	20	-	60	-	100	-	-	-	24	-	40	2
20UME705E 20UME706E 20UME707E	Electives: 1.Costing & Financial Management 2. Modern management techniques 3. Power Plant Engineering	Theory	2	-	-	10	10	-	30	-	50	-	-	-	12	-	20	2
20UME708E 20UME709E 20UME710E	Electives: 1. Machine Tool Design 2. Industrial Product Design 3. Mobility Engineering	Theory	2	-	-	10	10	-	30	-	50	-	-	-	12	-	20	2
20UME711L	Industry 4.0 Lab.	Practical	-	-	2	-	-	30	-	20	50	-	-	12	-	8	20	1
20UME712L	Refrigeration & Air Conditioning Lab.	Practical	-	-	2	-	-	30	-	20	50	-	-	12	-	8	20	1
20UME713L	Industrial Hydraulics and Pneumatics Lab.	Practical	-	-	2	-	-	30	-	20	50	-	-	12	-	8	20	1
20UME714P	Project-I	Practical	-	-	2	-	-	30	-	20	50	-	-	12	-	8	20	1
20UME715S	Seminar (Industrial Case Study)	Practical	-	-	2	-	-	-	-	50	50	-	-	-	-	20	20	1
	Total		**12**	**1**	**10**	**100**	**100**	**120**	**300**	**130**	**750**	**-**	**-**	**48**	**120**	**52**	**300**	**20**

Semester VIII																		
Course Code	**Course Title**	**Type**	**Teaching Scheme**			**Evaluation Scheme (Marks)**						**Minimum Passing (Marks)**						**Credit**
						Internal			**External**		**Total**	**Internal**			**External**		**Total**	
			L	**T**	**P**	**CA**	**MSE**	**TW**	**ESE**	**PR**		**CA**	**MSE**	**TW**	**ESE**	**PR**		
20UME801D	Quality Engineering	Theory	3	-	-	20	20	-	60	-	100	-	-	-	24	-	40	3
20UME802D	Reverse Engg. & Additive Manufacturing	Theory	3	-	-	20	20	-	60	-	100	-	-	-	24	-	40	3
20UME803E 20UME804E 20UME805E	Electives: 1. Research Methodology 2. Industrial Engineering 3. Autonomous Vehicle	Theory	3	-	-	20	20	-	60	-	100	-	-	-	24	-	40	3
20UME806E 20UME807E 20UME808E	Electives: 1. Tribology 2. Casting & Welding Technology 3. Reliability & Maintenance Engineering	Theory	2	-	-	20	20	-	60	-	100	-	-	-	24	-	40	2
20UME809D	Operation Research	Theory	3	-	-	20	20	-	60	-	100	-	-	-	24	-	40	3
20UME810L	Reverse Engg. & Additive Manufacturing Lab.	Practical	-	-	2	-	-	-	-	50	50	-	-	-	-	20	20	1
20UME811L 20UME812L 20UME813L	Electives: 1. Research Methodology Lab. 2. Industrial Engineering Lab. 3. Autonomous Vehicle Lab.	Practical	-	-	2	-	-	-	-	50	50	-	-	-	-	20	20	1
20UME814P	Project-II	Practical	-	-	8	-	-	50	-	100	150	-	-	-	-	60	60	4
	Total		**14**	**-**	**12**	**100**	**100**	**50**	**300**	**200**	**750**	**-**	**-**	**-**	**120**	**100**	**300**	**20**

OR

Semester VIII																		
Course Code	**Course Title**	**Type**	**Teaching Scheme**			**Evaluation Scheme (Marks)**						**Minimum Passing (Marks)**						**Credit**
						Internal			**External**		**Total**	**Internal**			**External**		**Total**	
			L	**T**	**P**	**CA**	**MSE**	**TW**	**ESE**	**PR**		**CA**	**MSE**	**TW**	**ESE**	**PR**		
20UME815L 20UME816L 20UME817L	Internship and Self Learning of any one subject for which assignment work to be given 1) Modern Management Tools 2) Industrial Engineering 3) Quality Engineering	Practical	-	-	8	-	-	100	-	50	150	-	-	40	-	20	60	4
20UME818P	Internship	Practical	-	-	32	-	-	200	-	400	600	-	-	80	-	160	240	16
	Total		**-**	**-**	**40**	**-**	**-**	**300**	**-**	**450**	**750**	**-**	**-**	**120**	**-**	**180**	**300**	**20**

Signature of the Principal/Director_____

Date _____

Abbreviations:

L-Lecture, T-Tutorial, P-Practical, CA-Continuous Assessment, MSE-Mid Semester Examination, ESE-End Semester Examination,PR-Practical,
TW- Term Work, Note: * and # to indicate anyone elective subject to be selected by the students. Please note the following:
Audit courses. Whether to be counted for SGPA calculation or not. Whether their credits to be counted or not. Please ensure that the spelling of names are correct, weightage of marks are correct as per credit structure and Names of courses are written in full.

MGM University
Aurangabad – 431003
Approved Program Curriculum

Appendix B

Name of the College/Institute-**Jawaharlal Nehru Engineering College** Faculty of **Engineering & Technology**
Name of the Program-**Mechanical Engineering**
Approved by the Board of Studies on - 22nd February 2020
Program Approved vide Academic Council Meeting dt-29th June 2020 Item No. MGMU:AC-1:2020:2
Program Type: **UG**/PG/Integrated Masters Program/Diploma/Certificate Duration: 08 Semesters
Curriculum Code:---------- (this code will change when you change the Curriculum)

Course Name: Industry 4.0
Course Code: 20UME701D
Semester: VII
Course Outcomes: After completing this course, students will be able to:

1. Understand basic of industry 4.0 concept
2. Design solution for industry 4.0 problem
3. Able to demonstrate the practical implementation

Curriculum

Unit No.	Title and Contents	Teaching Hours	Marks	Remarks
1	***Introduction to Industry 4.0*** The origins of Industries 4.0, Industry 4.0 definition – the digital transformation of Industry and the fourth industrial revolution, The Various Industrial revolutions, The Journey so far: Developments in USA, Europe, China and other countries, Comparison of Industry 4.0 Factory and Today's Factory, Digitalization and the Networked Economy Drivers Enablers, Benefits of Industry 4.0			
2	***Technology Roadmap for Industry 4.0*** (A) Design against static loading: Design of Cotter jointsingle and double cotter joint. Design of knuckle joint. Design of lever. (B) Design of shaft, keys and coupling:Shafts subjected to bending and torsion, types of keys and their design, design of rigid and flexible couplings.			
3	***The Building Blocks of Industry 4.0*** Cyber-physical Systems (CPS) in the Industry 4.0 vision, Cyber-physical systems before Industry 4.0, Robotic Automation and Collaborative Robots, SupportSystem for Industry 4.0, Mobile Computing, Artificial Intelligence, Additive Manufacturing (3D Printing), Augmented reality and virtual reality in			

	Industry 4.0			
4	***Role of Data, Information, Knowledge and Collaboration in Future Organizations*** Resource-based view of a firm, Trends of Industrial BigData, Data Mining, Data Analytics & Data as a new resource for organizations, Harnessing and sharing knowledge in organizations, Cloud Computing and Industry 4.0			
5	***Applications and Case Studies, Opportunities and Challenges of Industry 4.0*** Industry 4.0 laboratories, IoT case studies, Changes forCompanies, Entrepreneurs, SMEs and start-ups, Sustainability and circular economy, Infrastructure in Developing Countries, Jobs, Skills and Education in Developed and Developing Countries, Ethical Implications of Industry 4.0 technologies.			
6	***Business Issues in Industry 4.0 and Impacts on Various Sectors*** Future of Works and Skills for Workers in the Industry 4.0 Era, Impact on Automotive industry, Agriculture 4.0, Retail and Consumer Goods, Healthcare Industry, E-commerce for Manufacturing, Strategies for competing in an Industry 4.0 world.			

Text Books:

1. The concept Industry 4.0 - Springer

Reference Books:

1. Industry 4.0_ the Industrial Internet of Things Alasdair Gilchrist Apress
2. Industry 4.0_ Managing The Digital Transformation Alp Ustundag, EmreCevikcan Springer
3. Industry 4.0_Opportunities Behind The Challenge Dr. Mirjana Stankovic, Ravi Gupta and Dr. Juan E. FigueroaUNIDO General Conference 2017

E-sources:

1. NPTEL SWAYAM, YouTube
2. Elsevier Journals
3. Springer Journals
4. ndl.iitkgp.ac.in
5. www.sciencedirect.com

MGM University
Aurangabad – 431003
Approved Program Curriculum

Appendix B

Name of the College/Institute-**Jawaharlal Nehru Engineering College** Faculty of **Engineering & Technology**
Name of the Program-**Mechanical Engineering**
Approved by the Board of Studies on - 22nd February 2020
Program Approved vide Academic Council Meeting dt-29th June 2020 Item No. MGMU:AC-1:2020:2
Program Type: **UG**/PG/Integrated Masters Program/Diploma/Certificate Duration: 08 Semesters
Curriculum Code:---------- (this code will change when you change the Curriculum)

Course Name: Refrigeration and Air Conditioning
Course Code: 20UME702D
Semester: VII
Course Outcomes: After completing this course, students will be able to:

1. Define basic terminology used in refrigeration and air conditioning systems
2. Evaluate simple and advanced Vapor Compression Refrigeration Cycle (VCRC)
3. Identify the requirements of multistage VCRC and Gas Cycle Refrigeration
4. Analyze & study simple and modified Vapor Absorption Refrigeration Cycle (VARC)
5. Represent various air conditioning processes on the refrigerant Psychrometric Chart
6. Interpret different types of refrigerants and their applications in refrigeration system

Curriculum

Unit No.	Title and Contents	Teaching Hours	Marks	Remarks
1	***Simple Vapor Compression Refrigeration Cycle*** Definition of refrigeration, unit of refrigeration, refrigerator, heat pump, coefficient of performance, modification ofreversed Carnot cycle, vapor compression cycle (VCC) components and its representation on T-s and P-h planes, effect ofoperating conditions on performance of VCC,superheating and subcooling of refrigerant,COP of VCC and methods for improvement, actual VCC.			
2	***Multistage Vapor Compression Refrigeration Cycle*** Limitations of simple VCC for achieving low temperatures, intercooling with multicompression, multi evaporator system, compound Compression, cascade systems etc.			
3	***Air Cycle Refrigeration Systems*** Comparison of air refrigeration with VCC, components, Bell Coleman cycle, Necessity ofaircraft refrigeration; Merits and demerits of aircraft refrigeration, classification of aircraft refrigeration system and their analysis, Dry airrated temperature (DART).			
4	***Vapor Absorption Refrigeration System*** Principle of absorption system; common refrigerant absorbent pairs; comparison between absorption and			

	compression system; simple absorption system; modification to simple vapor absorption system; Use of temperature concentration diagram (T - C) andenthalpy concentration diagram (h-c) Lithium-Bromide water vapor absorption system.			
5	***Psychrometry and Air conditioning processes*** Psychrometry and Air composition, psychometric properties, psychometricrelations, Adiabatic saturation and thermodynamic wet bulb temperature; psychomotor. Psychrometric processes: itsrepresentation psychrometric chart; Adiabatic mixing of air streams; coil bypass factor, Human Comfort Chart, Air conditioning			
6	***Refrigerants and Application of Refrigeration and Air Conditioning*** Properties of refrigerants; classification of refrigerants, Designation of refrigerants; Selection of refrigerants; ODP and GWP of Chlorofluorocarbon (CFC) refrigerants;substitutes for CFC refrigerants, Azeotropicmixtures, Secondary refrigerants. Application:Domestic refrigerator, water cooler, Ice plant, cold storage, Steam jet refrigeration system, defrosting in refrigerators, Mine air conditioning and ventilation.			

Text Books:

1. S.C. Arora and S. Domkundwar, A Cource in Refrigeration and Air- Conditioning, Dhanpat Rai, 2018.
2. C. P. Arora, Refrigeration and Airconditioning, Mc Graw Hill India, Third Edition, 2017.
3. R.K. Rajput, A Textbook of Refrigeration and Air-Conditioning, S.K. Kataria & Sons, 2013.
4. R.S. Khurmi and J. K. Gupta, Textbook of Refrigeration and Air-conditioning, S.Chand, 2006.
5. P. L. Ballaney, Refrigeration and Air Conditioning, Khanna, Sixteenth Edition, 2015.
6. Dr. G..S. Sawhney, Refrigerator and Air conditioner, Vayu Education of India, 2015.
7. Manohar Prasad, Refrigeration and Air Conditioning, New Age International Pvt Ltd; Third Edition, 2015.

Reference Books:

1. G.F. Hundy, A.R. Trott, T C Welch, Refrigeration, Air Conditioning and Heat Pumps, Butterworth-Heinemann;Fifth edition, 2016.
2. Dr.A. Anderson Dr.S. Ramachandran, Refrigeration and Air Conditioning, Airwalk Publications; First Edition, 2018.
3. William C. Whitman and William M. Johnson, Refrigeration and Air Conditioning Technology: Concepts, Procedures and Troubleshooting Techniques, Delmar Cengage Learning; Third Edition, 1994.
4. Inc. American Society of Heating, Refrigerating and Air-Conditioning Engineers, ASHRAE Handbook, 2016
5. Herbert W. Stanford III, Adam F. Spach, Analysis and Design of HVAC, CRC Press, Second Edition, 2019.

E-sources:

1. NPTEL Video Lectures by Prof Ravi Kumar, IIT Roorkee
2. Published research papers by Elsevier, Springer etc
3. Online YouTube Videos on Refrigeration Systems and their maintenance

MGM University
Aurangabad – 431003
Approved Program Curriculum

Appendix B

Name of the College/Institute-**Jawaharlal Nehru Engineering College** Faculty of **Engineering & Technology**
Name of the Program-**Mechanical Engineering**
Approved by the Board of Studies on - 22nd February 2020
Program Approved vide Academic Council Meeting dt-29th June 2020 Item No. MGMU:AC-1:2020:2
Program Type: **UG**/PG/Integrated Masters Program/Diploma/Certificate Duration: 08 Semesters
Curriculum Code:---------- (this code will change when you change the Curriculum)

Course Name: Industrial Hydraulics and Pneumatics
Course Code: 20UME703D
Semester: VII

Course Outcomes:

1. Students will understand the basics of hydraulics and pneumatics.
2. Students will Identify standard Symbols of Hydraulics and Pneumatics
3. Students will able to draw the different circuit diagrams of hydraulics and pneumatics.
4. Students will understand the working and construction of automation system.
5. Students will understand the design of the mechanical systems.
6. Students will understand the different uses of Electro-Hydraulics/Pneumatics systems.

Unit No.	Title and Contents	Teaching Hours	Marks	Remarks
1	***Fluid Power Principles and Hydraulic Pumps*** **Fluid power Introduction**: Classification of fluid power systems, Merits & Demerits of fluid power system, Fluid power Applications, Fluid Types, Fluid Properties, fluids selection criteria, Basics ofHydraulics, Pascal's Law, Bramah press principle,Principles of flow, Friction loss, Work, Power andTorque Problems, ISO & ANSI Standard symbols. **Hydraulic power source:** Theory of Pumping, Classification of pumps, Pump Construction, PumpWorking, Pump Design, Merits & Demerits, Pump performance, Pump Selection criteria among Linear pumps & Rotary pumps, Fixed & Variable displacement pumps.			
2	***Hydraulic Actuators and Control Components*** **Hydraulic Actuators:** Linear Actuators, Cylinder types, Cylinder construction, Application, Cushioning of cylinders, Rotary Actuators, Hydraulic motors Types, construction & application. **Control Components:** Direction control valve,(DCV), Flow control valve, Pressure control valve - Types, Construction & Operation, Servo valves & Proportional valves, Applications. **Accessories:** Reservoirs, Pressure Switches, Applications, Fluid Power ISO & ANSI Symbols.			

3	***Hydraulic Circuits and Systems*** Industrial hydraulic circuits – Regenerative, PumpUnloading, Sequencing circuit, Synchronization circuit, Reciprocation circuit, Counterbalancing circuit, Fail-Safe circuit, Speed Control circuits, Hydrostatic transmission, Accumulators types &circuits, Pressure Intensifier types & circuits, Basic electro hydraulic circuits, Elements, Ladder diagram.			
4	***Pneumatic and Electro Pneumatic Systems*** Air Properties, Perfect Gas Laws , Air preparation, Installation layout of pipelines, Compressor types,construction & operation, Filter types, construction &operation , Regulator, Lubricator, FRL unit, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit, Air supply Cascade method, Electro Pneumatic System, Elements , Ladder diagram, Introduction to fluidics and pneumatic logic circuits.			
5	***Trouble Shooting and Applications*** Standard operating procedure for Installation in hydraulics & Pneumatics, Selection criteria, Maintenance methods, Trouble Shooting of Hydraulicand Pneumatic systems, Design of hydraulic circuits for various industrial applications such as Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Low cost Automation, Pick and Place applications and tool handling in CNC Machine tools, Hydraulic and Pneumatic power packs.			

Text Books:

1. Anthony Esposito, “Fluid Power with Applications”, Pearson Education 2005.
2. Majumdar S.R., “Oil Hydraulics Systems- Principles and Maintenance”, Tata McGraw- Hill, 2001. Volume I & II.

Reference Books:

1. Pneumatics and Hydraulics” by Andrew Parr
2. Hydraulics and Pneumatics” by Jagadeesha T
3. “Fluid Power: Hydraulics and Pneumatics” by James R Daines
4. Essential Hydraulics: Fluid Power – Basic” by M Winston
5. Pneumatics and Hydraulics” by Harry L Stewart

E-sources:

1. https://www.hydraulicspneumatics.com/learning-resources
2. https://nptel.ac.in/courses/112105046/
3. https://nptel.ac.in/courses/112105047/
4. https://nptel.ac.in/courses/112106175/

MGM University
Aurangabad – 431003
Approved Program Curriculum

Appendix B

Name of the College/Institute-**Jawaharlal Nehru Engineering College** Faculty of **Engineering & Technology**
Name of the Program-**Mechanical Engineering**
Approved by the Board of Studies on - 22nd February 2020
Program Approved vide Academic Council Meeting dt-29th June 2020 Item No. MGMU:AC-1:2020:2
Program Type: **UG**/PG/Integrated Masters Program/Diploma/Certificate Duration: 08 Semesters
Curriculum Code:---------- (this code will change when you change the Curriculum)

Course Name: Production Planning and Control
Course Code: 20UME704D
Semester: VII
Course Outcomes: After completing this course, students will be able to:

1. To understand the various components and functions of production planning and control
2. To know the recent trends like MRP and ERP
3. To know the importance of selection of material, machines, methods and manpower.

Curriculum

Unit No.	Title and Contents	Teaching Hours	Marks	Remarks
1	***Introduction*** Definition – Objectives of production Planningand Control – Functions of production planning and control – Types of production – Organization of production planning and control department – Internal organization of department – Information required for Production Planning.			
2	***Forecasting*** Importance of forecasting – Types of forecasting, their uses – General principles offorecasting – Forecasting techniques – qualitative methods and quantitive methods.			
3	***Inventory Management*** Functions of inventories – relevant inventory costs – ABC analysis – VED analysis – EOQ model – Inventory control systems – P– Systems and Q-Systems – Introduction to MRP & ERP, LOB (Line of Balance).			
4	***Routing*** Definition – Routing procedure –Route sheets– Bill of material – Factors affecting routing procedure. Schedule –definition – Difference with loading. Introduction to computerintegrated production planning systems – elements of JUST IN TIME SYSTEMS Fundamentals of MRP II and ERP.			
5	***Scheduling Policies*** Techniques, Standard scheduling methods,Line Balancing, Aggregate planning, Chase planning,			

	Expediting, controlling aspects. Dispatching – Activities of dispatcher –Dispatching procedure – follow up – definition– Reason for existence of functions – types of follow up – applications of computer in production planning and control.			

Text Books:

1. Modern Production/ operation managements / Baffa & Rakesh Sarin/Wiley & Sons.
2. Elements of Production Planning and Control / Samuel Eilon/ Collier Macmillan Ltd.
3. Manufacturing Planning and control/ Partik Jonsson & Stig-Arne Mattsson/ TATA Mc Graw Hill Edition.
4. Production Planning & Control / M. Mahajan / Dhanpat Rai & Co.
5. Production Control A Quantitative Approach / John E. Biegel/ Prentice-Hall.

Reference Books:

1. Production Control / Franklin G. Moore, Ronald Jablonski/ McGraw-Hill.
2. Inventory Control Theory and Practice / Martin K. Starr and David W. Miller/ Prentice-Hall

E-sources:

1. NPTEL Videos
2. NPTEL Lectures

MGM University
Aurangabad – 431003
Approved Program Curriculum

Appendix B

Name of the College/Institute-**Jawaharlal Nehru Engineering College** Faculty of **Engineering & Technology**
Name of the Program-**Mechanical Engineering**
Approved by the Board of Studies on - 22nd February 2020
Program Approved vide Academic Council Meeting dt-29th June 2020 Item No. MGMU:AC-1:2020:2
Program Type: **UG**/PG/Integrated Masters Program/Diploma/Certificate Duration: 08 Semesters
Curriculum Code:---------- (this code will change when you change the Curriculum)

Course Name: Electives : 1.Costing and Financial Management
Course Code: 20UME705E
Semester: VII
Course Outcomes: After completing this course, students will be able to:

1. Describe how cost accounting is used for decision making and performance evaluation.
2. Explain the basic concept of cost and how costs are presented in financial statements.
3. Demonstrate how materials, labor and overhead costs are added to a product at each stage of theproduction cycle.
4. Use Break even analysis as a planning and decision-making aid.
5. Prepare a budget and use budgets for performance evaluation after fixing the budget.
6. Identify and apply the concepts of Financial Management.

Curriculum

Unit No.	Title and Contents	Teaching Hours	Marks	Remarks
1	***Costing Accounting & Overheads*** Objectives of cost accounting, types of cost accounting, costing & its types, elements of cost, selling price, cost unit & cost centers, Overheads, types of overheads, allocation of overheads, depreciation and methods ofdepreciations calculations of machine hour rates. (Numerical treatment)			
2	***Cost Estimate & Cost Control*** Cost estimate, types of cost estimates, making an initial cost estimate, cost estimate sheet, part explosion diagram, cost control, cost reduction, capital cost control, elements of cost control program, operating cost control, cost reporting.			
3	***Break Even Analysis*** Break Even point, economic productionchart, nonlinear break-even chart, fixed and variable costs, contribution sales ratio, profitpath chart, margin of safety. (Numerical treatment)			
4	***Budgeting*** Budget, importance of budget, types of budget such as fixed, variable, sales, production, material, direct labor and master budget, Introduction to budge importance ofbudgetary control			

5	***Financial Management*** Introduction, Importance of financial management, Investment capital, types, sources of finance, financial accounting, Introduction to profit loss account, balance sheet, financial ratios.			

Text Books:

1. "Cost & Management Accounting" - S.N.Inamdar, Everest Publishing House
2. "Industrial Engineering and Management" – O.P.Khanna, Dhanpat Rai Publications
3. "Essentials of Financial Management" – I.M.Pandey, Vikas Publication

Reference Books:

1. "Cost and Optimization Engineering" – F.C. Jelen (McGraw Hill Publication)
2. "Management Accounting" – M.Y Khan, P.K.Jain (McGraw Hill Publication)

E-sources:

1. NPTEL – Fundamentals of Managerial Accounting.
2. NPTEL – Cost Accounting.
3. NPTEL – Financial Management for Managers.

MGM University
Aurangabad – 431003
Approved Program Curriculum

Appendix B

Name of the College/Institute-**Jawaharlal Nehru Engineering College** Faculty of **Engineering & Technology**
Name of the Program-**Mechanical Engineering**
Approved by the Board of Studies on - 22nd February 2020
Program Approved vide Academic Council Meeting dt-29th June 2020 Item No. MGMU:AC-1:2020:2
Program Type: **UG**/PG/Integrated Masters Program/Diploma/Certificate Duration: 08 Semesters
Curriculum Code:---------- (this code will change when you change the Curriculum)

Course Name: Electives : 2.Modern Management Techniques
Course Code: 20UME706E
Semester: VII
Course Outcomes: After completing this course, students will be able to:

1. To comprehend quality management techniques and its practices
2. To get acquainted with the new dimensions or concepts in modern management theory and practices
3. To develop managerial skills/techniques for practicing new management techniques

Curriculum

Unit No.	Title and Contents	Teaching Hours	Marks	Remarks
1	***Introduction to Management*** Management principles and characteristics, Importance of management, Functions of management, Management as a decision-making process. Introduction to Total Quality Management, Basic approach for TQM, Dimensions of Quality, New and Old Quality Cultures. Problem solving Tools-Seven Old and New Quality tools.			
2	***Methods of Engineering*** Methods Engineering: KAIZEN, POKAYOKE, Workplace layout & Work station design, Single Minute Exchange of Dies (SMED). Just in Time: Basic Elements of JIT, Role of set-up time and lot size in JIT, Benefits of JIT, JIT implementation issues. KANBAN: Definition and principles, Types of Kanban systems – Withdrawal Kanban, Production ordering Kanban, One and two card Kanban, implementation steps.			
3	***Lean Manufacturing*** Lean Manufacturing: Basic definitions of terms -lean production, value, waste, value steam, Toyota production system (TPS) and 4P model (Philosophy, process people and problem solving), lean principles, eight Muda (wastes). Value Stream Mapping: Definitions of the basic terms, Phases of the value stream analysis implementation, Creation of the value streammap (steps).			

4	***Principles of Management*** 5S: Definition, Principles and description of 5S, Implementation of 5S using PDCA cycle. Six Sigma: Evolution of Six Sigma, Sigma levels, DMAIC process, Process capability, Phases of Six Sigma. Quality Function Deployment (QFD):- Introduction, Voice of Customer, House of Quality, QFD Process, Merits and Demerits.			
5	***Total Productive Maintenance*** Total Productive Maintenance: Introduction, Definition, Types of maintenance, Reliability centered maintenance (RCM), eight TPM Pillars, Measure of TPM efficiency – overall equipment efficiency (OEE), six big losses, thefive TPM development activities, the twelve steps of TPM.			
6	***Creativity and Innovation*** Creativity and Innovation: Definition, Characteristics, Significance, Role of management. Types of thinking: Vertical Thinking, Parallel Thinking, Practical Thinking Techniques, Six thinking hats, Concept of Lateral Thinking. Quality of Work Life (QWL): Definition, Features, Elements/Factors, PositiveEffect/Outcomes, Managerial role for improvingQWL, Relationship between QWL and Work Life Balance (WLB)			

Text Books:

1. Total Quality Management by Dr. Gunmala Suri and Dr. Puja Sharma, Wiley Pub.
2. Industrial Engineering & Production Management by Maratand Telsang, S.Chand Pub.
3. Competitive Manufacturing Management by John M.Nicholas, Tata McGraw Hill.
4. Just-In Time by M G Korgaonkar, Macmillan Publishers India.
5. Six Thinking Hats by Edward De Bono.

Reference Books:

1. Total Quality Management by Dale Besterfield, Carol Besterfield-Michna, Glen Besterfield, and MaryBesterfield-Sacre, Prentice Hall
2. Lean Manufacturing: Tools, Techniques, and How to Use Them by William M Feld, CRC Press.

E-sources:

1. NPTEL Videos
2. NPTEL Lectures

MGM University
Aurangabad – 431003
Approved Program Curriculum

Appendix B

Name of the College/Institute-**Jawaharlal Nehru Engineering College** Faculty of **Engineering & Technology**
Name of the Program-**Mechanical Engineering**
Approved by the Board of Studies on - 22nd February 2020
Program Approved vide Academic Council Meeting dt-29th June 2020 Item No. MGMU:AC-1:2020:2
Program Type: **UG**/PG/Integrated Masters Program/Diploma/Certificate Duration: 08 Semesters
Curriculum Code:---------- (this code will change when you change the Curriculum)

Course Name: Electives : 3.Power Plant Engineering
Course Code: 20UME707E
Semester: VII
Course Outcomes: After completing this course, students will be able to:

1. Understand the basics and functions of power plant components
2. Identify site and environmental issues of the power plants
3. Explain the basic operation principles of power plants
4. Analyze the contribution of various energy sources to mitigate power demand
5. Compare merits and demerits of power plants
6. Evaluate load, key factors and tariff of power plants

Curriculum

Unit No.	Title and Contents	Teaching Hours	Marks	Remarks
1	***Introduction*** Principal of generation of electricity, sources of energy, classification of power plants, present scenario of power industry, site selection criteria for different power plants, selection of the number and size of units.			
2	***Steam Power Plant*** Detailed layout of steam power plant (SPP) showing various components, thermodynamic rankine cycle, working principle of SPP, high pressure boilers, performance of boilers and steam turbines, steam circuit, fuel handling circuit, ash handling circuit, water supply system, air supply through natural and forced draught, merits and demerits of steam power plants, merits of Electrostatic precipitators (ESP)and water desalination units, environmental concerns with SPP.			
3	***Diesel and Gas Turbine Power Plant*** General Layout of Diesel Generator (DG) and Gas Turbine power plants, Thermodynamic working cycles: Diesel Cycle and Brayton Cycle,Components of diesel and gas turbine powerplants,			

	supercharging of diesel engines, merits and demerits of both Diesel Generator (DG) andGas Turbine power plants, Environmental issuesassociated with DG sets and Gas Turbine powerplants.			
4	***Hydro Power Plant and Renewable Energy Sources Power Plants*** Layout of the Hydroelectric Power Plant (HPP), working principle and components of HPP, hydrograph and effect of water hammering, Construction and working of Renewable EnergySources (RES) power plants like Solar Photovoltaic, Solar Thermal, Wind power plants, merits and demerits of RES power plants.			
5	***Nuclear Power Plant*** Nuclear power plant layout, working principle of different types of nuclear reactors: Pressurized Water Reactor (PWR), Boiling Water Reactor (BWR), CANDU heavy water reactor etc, radiation hazards and safety measures for nuclear power plants,Environmental concerns with radioactive waste disposal, merits and demerits of Nuclear powerplants.			
6	***Economic Analysis & Environmental Issues of Power Plant*** Numericals on Load estimation, load duration curve, load factor, capacity factor, use factor, diversity factor, demand factor, the effect of variable load on power plant, cost of energy generation, performance and operatingcharacteristics of power plants, types of tariffs, environmental aspects of power generation.			

Text Books:

1. R.K.Hegde, Power Plant Engineering, Pearson Education India, 2015.
2. Domkundwar and Arora, Power Plant Engineering, Dhanpat Rai & Co., 2016.
3. P.K. Nag, Power Plant Engineering, TATA McGraw-Hill Publication, 2017.
4. Amiya Ranjan Mallick, Practical Boiler operation engineering and power plant,Fourth Edition, PHI Learning, 2015.
5. P.K. Das and A.K. Das, An Introduction to Thermal Power Plant Engineering and Operation:For power plant professionals, Notion Press, Chennai, 2018.
6. Black & Veatch, Power plant Engineering, CBS Publisher, 2005.

Reference Books:

1. John Oakey, Power Plant Life Management and Performance Improvement,Woodhead Publishing, Elsevier, 2011.
2. Bahman Zohuri, Thermal-Hydraulic Analysis of Nuclear Reactors, Second Edition, Springer, 2017.
3. P. M.Reynolds, Modern Power Station Practice: Incorporating Modern Power System Practice,Pergamon Publisher, 1992.
4. J.H. Rust, Nuclear Power Plant Engineering, Haralson Pub. Co., 1999.
5. M.M. El-Wakil, Power plant technology, McGraw-Hill Book Co, 2002.
6. Miguel Mendonca, Feed-in Tariffs: Accelerating the Deployment of Renewable Energy,World Future Council, Earthscan, 2007.

E-sources:

1. NPTEL SWAYAM, YouTube
2. Elsevier Journals
3. Springer Journals

MGM University
Aurangabad – 431003
Approved Program Curriculum

Appendix B

Name of the College/Institute-**Jawaharlal Nehru Engineering College** Faculty of **Engineering & Technology**
Name of the Program-**Mechanical Engineering**
Approved by the Board of Studies on - 22nd February 2020
Program Approved vide Academic Council Meeting dt-29th June 2020 Item No. MGMU:AC-1:2020:2
Program Type: **UG**/PG/Integrated Masters Program/Diploma/Certificate Duration: 08 Semesters
Curriculum Code:---------- (this code will change when you change the Curriculum)

Course Name: Electives : 1.Machine Tool Design
Course Code: 20UME708E
Semester: VII
Course Outcomes: After completing this course, students will be able to:

1 Students understand the fundamentals of Machine Tool Design
2 Students are analyze the fundamentals of Machine Tool Design
3 Students understand the gear box design.

Curriculum

Unit No.	Title and Contents	Teaching Hours	Marks	Remarks
1	***Introduction*** General requirements to machine tools, Machine tool design recommendations, Classification of motions to shape surface, Machine tool drives for rectilinear motion, Periodic motion, reversing motion etc.			
2	***Kinematics of Machine Tools and Design of Kinematics Scheme*** Kinematics or gearing diagram of Lathe, drilling Machine, Milling Machine etc. Main drive and feed drive, principles specification of Machine tool. Methods to determine transmission ratios for drives. Development of Kinematics scheme, minimum of transmission groups, Determination of number of teeth on gears.			
3	***Speed and Feed Boxes, Spindle Design and Spindle Bearings*** General requirement Design of gear trains, speed boxes types, speed changing devices Feed boxes characteristics of feed mechanism, types of Rapid traverse mechanisms, variable devices. Main requirement of spindle design and bearing, Materialsand details of spindle design, Spindle bearings, bearings, types of bearings and their selections, Bearing Materials BED			
4	***Columns, Tables and Ways*** Materials, typical constructions and design.			

5	***Machine Tools Control Systems and Machine Tool Dynamics*** Requirement of control system selection and construction of control systems Mechanical control system, predilection control, remote control safety devices. Dynamic performance of machine tool, dynamic and elastic system of Machine, tools. Dynamics of cutting forces, tool chatter.			
6	***Recent Trends*** A review of recent practices used in Machine Tool Technology effect of development on manufacturing process, modular design concept.			

Text Books:

1. Machine Tools Design by Sen and Bhattacharya, CBS Publishers
2. Machine Tool Design by N.K. Mehta, Tata Mc Graw Hill.3.Machine Tool Design by N. Acherkan Mir Publishers
4. Design of machine tools by S.K. Basu and D.K. Pal, Oxford and IBH, 2005
5. Principles of Machine Tool by Bhattacharya and S. G. Sen, New central book agency Calcutta 6.Design Principles of Metal Cutting Machine Tools by F. Koenigsberger The Macmillan Company NewYork

Reference Books:

1. Numerical control and computer Aided Manufacturing by T. kundra, Rao, Tiwari N.K. Tata Mc Graw Hill
2. NC Machine Tools by Martin S.J., ELBS.

E-sources:

1. NPTEL Videos
2. NPTEL Lectures

MGM University
Aurangabad – 431003
Approved Program Curriculum

Appendix B

Name of the College/Institute-**Jawaharlal Nehru Engineering College** Faculty of **Engineering & Technology**
Name of the Program-**Mechanical Engineering**
Approved by the Board of Studies on - 22nd February 2020
Program Approved vide Academic Council Meeting dt-29th June 2020 Item No. MGMU:AC-1:2020:2
Program Type: **UG**/PG/Integrated Masters Program/Diploma/Certificate Duration: 08 Semesters
Curriculum Code:---------- (this code will change when you change the Curriculum)

Course Name: Electives : 2.Industrial Product Design
Course Code: 20UME709E
Semester: VII
Course Outcomes: After completing this course, students will be able to:

1. Students will be able to understand the basics of product design.
2. Students will be able to understand the product development process.
3. Students will understand the different steps in new product development like marketsurvey, finding out customers need etc.

Curriculum

Unit No.	Title and Contents	Teaching Hours	Marks	Remarks
1	***Introduction*** Characteristics of successful product development, who designs and develops products? Duration and cost of Product development.			
2	***Development Process*** The Product Development Process, Concept development- The front-end process, Adapting the Generic Product development process, Product development process flow, The Tyco Product Development process.			
3	***Opportunity Identification*** What is an opportunity? Opportunity identification process, five steps of product Planning, Identifying customer needs			
4	***Product Specifications*** What are specifications? When are specifications established? Establishing Product Specifications, Setting the final specifications, Concept generation- The activity of concept generation-steps 1 to 5, Concept Selection: Concept selection, Methods for choosing concept, Benefits, Concept Screening, Concept Testing.			

5	***Product Architecture*** What is Product Architecture? Implications of the Architecture, Establishing the architecture, Delayed differentiation, Platform planning, Related system Level Design Issues			
6	***Industrial Design*** What is Industrial design? Assessing the need for Industrial Design, the impact of industrial design, the industrial design process, Management of the industrial design process, Assessing the quality of industrial design.			

Text Books:

1. Model Curriculum for "Product Design Engineer – Mechanical", NASSCOM (Ref. ID: SSC/Q4201, Version 1.0,NSQF Level: 7)

2. Eppinger, S., & Ulrich, K.(2015). Product design and development. McGraw-Hill Higher Education.

Reference Books:

1. Green, W., & Jordan, P. W. (Eds.).(1999).Human factors in product design: current practice and future trends.CRC Press.

2. Sanders, M. S., & McCormick, E. J. (1993). Human factors in engineering and design. McGraw-Hill bookcompany.

E-sources:

1. NPTEL Videos
2. NPTEL Lectures

MGM University
Aurangabad – 431003
Approved Program Curriculum

Appendix B

Name of the College/Institute-**Jawaharlal Nehru Engineering College** Faculty of **Engineering & Technology**
Name of the Program-**Mechanical Engineering**
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Program Approved vide Academic Council Meeting dt-29th June 2020 Item No. MGMU:AC-1:2020:2
Program Type: **UG**/PG/Integrated Masters Program/Diploma/Certificate Duration: 08 Semesters
Curriculum Code:---------- (this code will change when you change the Curriculum)

Course Name: Electives : 3. Mobility Engineering
Course Code: 20UME710E
Semester: VII
Course Outcomes: After completing this course, students will be able to:

1. Understand the developments in the mobility of vehicle and emission standards
2. Identify modern developments in the engine-based vehicles and alternative biofuels
3. Explain working of hybrid electric vehicles
4. Analyze the electric vehicle components, traction batteries and their charging methods
5. Interpret the types of electric motor drives and application of regenerative braking systems
6. Evaluate the potential of fuel cell vehicle and storage requirements of hydrogen

Curriculum

Unit No.	Title and Contents	Teaching Hours	Marks	Remarks
1	***Introduction*** Fundamentals developments in mobility vehicles: Human powered bicycle, animal power cart, Enginepowered vehicle, Hybrid power from electric motor and engine in vehicles, electric vehicle, fuel cell vehicle etc., Comparison between European, US, and Bharat stage (Indian) emission standards for diesel passenger cars.			
2	***S.I. and C.I. engines for vehicles*** Historical development of conventional engine based vehicles, Components of engines and their functions, thermodynamic Otto and Diesel cycles, combustion phenomenon in both SI and CI Engines, IC Engines Recent trends: Microprocessor based engines, multi- point fuel injection (MPFI) engines, common rail direct injections (CRDI) engines, variable valve timing engines and homogeneous charge compression ignition (HCCI) engines, Enlist with functions of fundamental automobile components in the existing I.C. Engine based vehicles, advancements for emission control, developments in alternative fuels such as biofuels from sugarcane, corn, Jatropha and Karanja etc.			

3	***Developments in Hybrid Vehicles*** History of Hybrid Electric Vehicles, Arrangements of drive train in hybrid vehicle, Series and parallel Hybrid Electric Drive Trains, Torque-Coupling and Speed- Coupling for Parallel Hybrid Electric Drive Trains, case study on hybrid electric vehicles.			
4	***Electric vehicles*** Evolution of electric vehicle (E-vehicle), Merits and demerits of electric vehicle (E-vehicle), components of electric vehicle, role of solar photovoltaic power systemas skin of electric vehicle for charging of energy storage devices, types of traction batteries, emission and cost comparison with conventional fossil fuel vehicles, methods and economics of fast and slow charging, key features of wiring harness of E-vehicle, full chargepower requirements, speed control of E-vehicle.			
5	***Electric propulsion systems and energy storage devices*** DC Motor Drives, Induction Motor Drives, PermanentMagnetic Brush-Less DC Motor Drives, Motor drive with generating mode of operation (or regenerativebraking), developments in the regenerative brakingsystem of E-vehicle. Power Rating Design of the Traction Motor and design of gear ratio etc. Electrochemical Batteries: Lead acid battery, Nickel- based batteries, Lithium-based batteries, Ultracapacitors, Ultrahigh-Speed Flywheels etc.			
6	***Fuel cell vehicles*** Historical developments of fuel cell vehicle, operating principles of fuel cells, Fuel cell system characteristics, types of fuel cell technologies: Proton Exchange Membrane Fuel Cells, Hydrogen Storage, Hydrogen Production, Design of Fuel Cell Hybrid Electric Drive Train, case study on fuel cell electric vehicle.			

Text Books:

1. Kambiz E M Ehsani, Yimin Gao, Stefano Longo, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles,Press; Third edition, 2019.
2. A.K.Babu, Electric & Hybrid Vehicles, Khanna Book Publishing, 2019.
3. V Ganesan, Internal Combustion Engines, McGraw Hill Education; 4 edition, 2017.
4. G. Kaushik, S. Patil, S. Chaturvedi and A. Chel, Biofuels: Advances and Perspectives, Studium Press, 2018.
5. Mark Warner, The Electric Vehicle Conversion Handbook: How to Convert Cars, Trucks, Motorcycles,Vehicles, HP Books, 2011.
6. Eric Forsta Thacher, A Solar Car Primer: A Guide to the Design and Construction of Solar-PoweredVehicles, Springer, 2016.
7. Larry E. Erickson, Jessica Robinson, Gary Brase, Jackson Cutsor, Solar Powered Charging InfrastructureElectric Vehicles: A Sustainable Development, 2017.
8. Tony Seba, Clean Disruption of Energy and Transportation: How Silicon Valley Will Make Oil, Nuclear,Coal, Electric Utilities and Conventional Cars, Lightning Source, 2014.
9. Jack Erjavec and Jeff Arias, Hybrid, Electric, and Fuel-Cell Vehicles (Go Green with Renewable EnergyCengage Learning, Second Revised edition, 2012.
10. C.S.Solanki, Solar Photovoltaics - Fundamentals, Technologies and Applications, PHI, 2015
11. Seth Leitman, Bob Brant, Build Your Own Electric Vehicle, Third Edition, McGraw-Hill Education, 2013.

Reference Books:

1. John G. Hayes, Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, ElectricCell Vehicles, Wiley-Blackwell, 2018.
2. Adrian Newey, How to Build a Car: The Autobiography of the World's Greatest Formula 1 Designer,Harper Collins, 2017.
3. W. Liu, Introduction to Hybrid Vehicle System Modeling and Control, Wiley, 2015.
4. Pasquale Corbo, Fortunato Migliardini, Ottorino Veneri, Hydrogen Fuel Cells for Road VehiclesEnergy and Technology), Springer,

2013.
5. David Wood, Impacting Rapid Hydrogen Fuel Cell Electric Vehicle Commercialization: System CostSubcomponent Performance Enhancement, SAE International, 2016.
6. Raphael Edinger and Sanjay Kaul, Sustainable Mobility: Renewable Energies for Powering Fuel CellVehicles, Praeger Publishers, 2003.
7. Seth Leitman, Build Your Own Plug-In Hybrid Electric Vehicle (Tab Green Guru Guides), McGraw-HillEducation, 2009.
8. Ronald K. Jurgen, Electric and Hybrid-Electric Vehicles: Fuel Cell Hybrid Evs, SAE International, 2011.
9. Sheldon S. Williamson, Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles,Springer, 2016.
10. Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design (Power Electronics and Applications Series), CRC Press, 2004.

E-sources:

1. NPTEL SWAYAM Lectures/Videos, YouTube Videos
2. Elsevier Journals
3. Springer Journals

MGM University
Aurangabad – 431003
Approved Program Curriculum

Appendix B

Name of the College/Institute-**Jawaharlal Nehru Engineering College** Faculty of **Engineering & Technology**
Name of the Program-**Mechanical Engineering**
Approved by the Board of Studies on - 22nd February 2020
Program Approved vide Academic Council Meeting dt-29th June 2020 Item No. MGMU:AC-1:2020:2
Program Type: **UG**/PG/Integrated Masters Program/Diploma/Certificate Duration: 08 Semesters
Curriculum Code:---------- (this code will change when you change the Curriculum)

Course Name: Industry 4.0 Lab
Course Code: 20UME711L
Semester: VII
Course Outcomes: After completing this course, students will be able to:

1.To understand the basic concept of Industry 4.0

2 To perform logic operation on TIA portal.

3.To select accurate sensor used for any industrial application.4 To design & demonstrate mechatronic application.

Curriculum

Practical No.	Name of Practical	Teaching Hours	Marks	Remarks
1	Explanation of Industry 4.O concepts forvarious sector from the industry 4.O	**02**		
2	Overview of technologies with demonstrationof PLC	**02**		
3	Basic of PLC programming	**02**		
4	Perform Logical & Arithmetic operation onTIA software.	**02**		
5	To study basic concept of various sensor usedin Industry 4.O	**02**		
6	Overview of technologies used inMechatronics factory	**02**		
7	Demonstration of Mechatronics factory.	**02**		
8	Demonstration of Mechatronics factory.	**02**		

References:

1. Lab Manual.

2. Industry 4.0_ the Industrial Internet of Things Alasdair Gilchrist Apress
3. Industry 4.0_ Managing The Digital Transformation Alp Ustundag, Emre Cevikcan Springer
4. Industry 4.0_Opportunities Behind The Challenge Dr. Mirjana Stankovic, Ravi Gupta and Dr. Juan E. FigueroaUNIDO General Conference 2017
5. The concept Industry 4.0 – Springer

E-Source:

1. NPTEL SWAYAM, YouTube
2. Elsevier Journals
3. Springer Journals
4. ndl.iitkgp.ac.in
5. www.sciencedirect.com

MGM University
Aurangabad – 431003
Approved Program Curriculum

Appendix B

Name of the College/Institute-**Jawaharlal Nehru Engineering College** Faculty of **Engineering & Technology**
Name of the Program-**Mechanical Engineering**
Approved by the Board of Studies on - 22nd February 2020
Program Approved vide Academic Council Meeting dt-29th June 2020 Item No. MGMU:AC-1:2020:2
Program Type: **UG**/PG/Integrated Masters Program/Diploma/Certificate Duration: 08 Semesters
Curriculum Code:---------- (this code will change when you change the Curriculum)

Course Name: Refrigeration and Air Conditioning Lab
Course Code: 20UME712L
Semester: VII
Course Outcomes: After completing this course, students will be able to:

1. Ability to apply suitable gear drive.
2. Ability to apply the Clutch, Brake and Dynamometer.
3. Ability to apply the principles of gyroscopic effects.
4. Ability to apply the principles of governors.
5. Ability to study the various principles of vibrations.

Curriculum

Practical No.	Name of Practical	Teaching Hours	Marks	Remarks
1	Study the functions and practical demonstration of tools used in refrigeration and air conditioning	**02**		
2	Study the function of control units usedin refrigeration and air conditioning	**02**		
3	Demonstration of components of domestic refrigerator	**02**		
4	Trials on Heat Pump Test Rigs	**02**		
5	Trial on Ice Plant Test Rig	**02**		
6	Trial on Air-conditioning (AC) Test Rigand demonstrate various processes	**02**		
7	Report of Learning from Casestudy/Industrial Visit of refrigeration and air-conditioning establishments: Central AC Chillers, Milk Plant, Storage Plant, Malls, Hospitals etc.	**02**		
8	Study of Refrigerants and its chargingmethods	**02**		
9	Trial on Vapor Absorption Test Rig	**02**		
10	Study of Leak detection methods forrefrigerants	**02**		

References:

1. NPTEL Video Lectures by Prof Ravi Kumar, IIT Roorkee
2. Published research papers by Elsevier, Springer etc
3. Online YouTube Videos on Refrigeration Systems and their maintenance
4. Laboratory Manual, R134a Refrigeration p-h Charts and Psychrometric Charts
5. Manish Sharma, Mechanic Refrigeration and Air Conditioning Theory, Neelkanth Publishers, 2019.

MGM University
Aurangabad – 431003
Approved Program Curriculum

Appendix B

Name of the College/Institute-**Jawaharlal Nehru Engineering College** Faculty of **Engineering & Technology**
Name of the Program-**Mechanical Engineering**
Approved by the Board of Studies on - 22nd February 2020
Program Approved vide Academic Council Meeting dt-29th June 2020 Item No. MGMU:AC-1:2020:2
Program Type: **UG**/PG/Integrated Masters Program/Diploma/Certificate Duration: 08 Semesters
Curriculum Code:---------- (this code will change when you change the Curriculum)

Course Name: Industrial Hydraulics and Pneumatics Lab
Course Code: 20UME713L
Semester: VII
Course Outcomes: After completing this course, students will be able to:

1. Create the basic hydraulic circuit for the working of double acting cylinder andthe same on hydraulic trainer.
2. Create the basic pneumatic circuit for the working of single and double actingon fluidsim software & build the same on pneumatic trainer.
3. Create the circuits for the use of different direction control valves (DCV) andactuation in single and double acting cylinder, and multi actuation circuit fluidsim software & build the same on hydraulic/pneumatic trainer.
4. Create the different speed control circuits, including Metering methods of Inletflow control on fluidsim software & build the same on hydraulic/pneumatic
5. Create the counterbalancing circuit & unloading circuit on fluidsim softwarethe same on hydraulic trainer.
6. Create the circuit using cam operated pilot valves operating a pilot operateddirection control valve or proximity/ limit switches, solenoid operated 4way control valve for auto reversing circuit on fluidsim software & build hydraulic/pneumatic trainer.
7. Create the circuit for operating the Double Acting Cylinder with AND Logic &Logic on fluidsim software & build the same on pneumatic trainer.
8. Create two hand safety circuit on fluidsim software & build the same on hydraulicpneumatic trainer.
9. Create the basic Electo-Hydraulics circuit & Electro-Pneumatics circuit for workingdouble acting cylinder & single acting cylinder on fluidsim software & build the on hydraulic & pneumatic trainer.
10. Design the circuit for the given problem statement.
11. Understand the industrial application of Hydraulics and Pneumatics.

Curriculum

Practical No.	Name of Practical	Teaching Hours	Marks	Remarks
1	Creating the basic hydraulic circuit for theworking of double acting cylinder and a hydraulic motor (Unidirectional & Bidirectional) on fluidsim software & building the same on hydraulic trainer.	**02**		
2	Creating the basic pneumatic circuit for the working of single and double actingcylinder on fluidsim software & building the same on pneumatic trainer.	**02**		
3	Creating the circuits for the use of differentdirection control valves (DCV) and valve actuation in single and double acting cylinder, and multi actuation circuit onfluidsim software & building the same on hydraulic/pneumatic trainer. (PilotOperation, Sequencing & Synchronizationcircuits)	**02**		
4	Creating the different speed control circuits, including Metering methods ofInlet & outlet flow control (meter-in & meter-out circuit) on fluidsim software & building the same on hydraulic/pneumatictrainer. (Bleed-off, By-pass and Regenerative circuits etc.)	**02**		
5	Creating the counterbalancing circuit &unloading circuit on fluidsim software & building the same on hydraulic trainer.	**02**		
6	Creating the counterbalancing circuit &unloading circuit on fluidsim software & building the same on hydraulic trainer.	**02**		
7	Creating the circuit for operating the Double Acting Cylinder with AND Logic & OR Logic on fluidsim software & building the same on pneumatic trainer.	**02**		
8	Creating two hand safety circuit on fluidsim software & building the same on hydraulic & pneumatic trainer.	**02**		
9	Creating the basic Electo-Hydraulicscircuit & Electro-Pneumatics circuit forworking of double acting cylinder & single acting cylinder on fluidsim software & building the same on hydraulic & pneumatic trainer.	**02**		
10	Designing the circuit for the given problemstatement (any two of the following) Wheel braking, Car wheels steering, drilling machine, planning machine, shaping machine, Surface grindingmachine, Press and Forklift applications.	**02**		
11	Study of Hydraulics and Pneumatics circuit, based on the industrial application.(at least one in each)			

References:

1. Lab Manual.

MGM University
Aurangabad – 431003
Approved Program Curriculum

Appendix B

Name of the College/Institute-**Jawaharlal Nehru Engineering College** Faculty of **Engineering & Technology**
Name of the Program-**Mechanical Engineering**
Approved by the Board of Studies on - 22nd February 2020
Program Approved vide Academic Council Meeting dt-29th June 2020 Item No. MGMU:AC-1:2020:2
Program Type: **UG**/PG/Integrated Masters Program/Diploma/Certificate Duration: 08 Semesters
Curriculum Code:---------- (this code will change when you change the Curriculum)

Course Name: Project-I
Course Code: 20UME714P
Semester: VII
Course Outcomes: After completing this course, students will be able to:

1. State the exact title of the project and problem definition.
2. Explain the motivation, objectives and scope of the project
3. Review the literature related to the selected topic of the project.
4. Design the mechanism, components of the system and prepare detailed drawings.

Curriculum

Practical No.	Name of Practical	Teaching Hours	Marks	Remarks
1	The students in a group of not more than FOUR will work under the guidance of the faculty member on the project workundertaken by them. The completion of work, the submission of the report and assessment should be done at the end of VII Semester. ***The project work should consist of any of the following or appropriate combination:*** 1. A comprehensive and up-to-date survey of literature related to study of a phenomenon or product. 2. Design of any equipment and / or its fabrication and testing. 3. Critical Analysis of any design or process for optimizing the same. 4. Experimental verification of principles used in applications related to various specializations related to MechanicalEngineering. 5. Software development for particular applications. A combination of the above.	**02**		

MGM University
Aurangabad – 431003
Approved Program Curriculum

Appendix B

Name of the College/Institute-**Jawaharlal Nehru Engineering College** Faculty of **Engineering & Technology**
Name of the Program-**Mechanical Engineering**
Approved by the Board of Studies on - 22nd February 2020
Program Approved vide Academic Council Meeting dt-29th June 2020 Item No. MGMU:AC-1:2020:2
Program Type: **UG**/PG/Integrated Masters Program/Diploma/Certificate Duration: 08 Semesters
Curriculum Code:---------- (this code will change when you change the Curriculum)

Course Name: Seminar
Course Code: 20UME715S
Semester: VII
Course Outcomes: After completing this course, students will be able to:

1. To find out the ideas
2. To do the detail study of particular topic by collecting data from different mediums
3. Industrial visit to analyze & study the topic
4. To give effective presentation of the topic

Curriculum

Practical No.	Name of Practical	Teaching Hours	Marks	Remarks
1	The role of seminar on live industry case study is to get knowledge of particular area to the student. In this subject student should choose a particular area from any industry and collect the data related to the topic from different mediums for example internet, research papers, books, industrial experts. In this subject individual student will be allotted a faculty guide from the department and the student should report the work done on weekly basis to the guide. Student should follow all the instructionsgiven by the guide. At the end of the semester a seminar on the topic is to be given to the internal & external examiner by the student in which a live industrial case study should be included.	**02**		

MGM University
Aurangabad – 431003
Approved Program Curriculum

Appendix B

Name of the College/Institute-**Jawaharlal Nehru Engineering College** Faculty of **Engineering & Technology**
Name of the Program-**Mechanical Engineering**
Approved by the Board of Studies on - 22nd February 2020
Program Approved vide Academic Council Meeting dt-29th June 2020 Item No. MGMU:AC-1:2020:2
Program Type: **UG**/PG/Integrated Masters Program/Diploma/Certificate Duration: 08 Semesters
Curriculum Code:---------- (this code will change when you change the Curriculum)

Course Name: Quality Engineering
Course Code: 20UME801D
Semester: VIII
Course Outcomes: After completing this course, students will be able to:

1. Relate engineering aspects of quality
2. Make use of various quality tools
3. Understand the various quality tools and its industrial applications.
4. Identify suitable quality control tool for given application.

Curriculum

Unit No.	Title and Contents	Teaching Hours	Marks	Remarks
1	***Introduction to Quality Engineering*** Historical perspective, definition of quality, quality ofdesign, quality of conformance, cost of quality, cost quality relationship, quality assurance.			
2	***Statistical quality control*** Satirical quality control-seven tools of SQC, Conceptof variance analysis, control charts for variables and attributes, process capability, acceptance sampling, inspection methods-C curve.			
3	***Total Quality Management*** Total quality management-quality function deployment,5S, kaizen, Kanban, poke yoke, ZD, PPM, JIT, FMECA.			
4	***Total Productivity Maintenance*** Total Productivity Maintenance concept, need, objective, Pillars of TPM, Predictive maintenance, and six sigma.			

5	***Quality system standards*** Quality management system, quality management principles, ISO 9001, ISO 14000, structure, quality audits, ISO registration, requirements, ISO audit, lead auditor, MR role and responsibilities, TS certification.			
6	***Employee involvement and team building*** Importance of employee involvement, empowerment, motivation, recognition and reward, suggestion schemes, teams in organization, quality awards, Malcoim Baldrige National Quality Award, Deming prize, IMC Ramakrishna Bajaj National quality award, Quality Bodies in India.			

Text Books:

1. Juran J.M. and Gryna Frank M, Quality planning and analysis, Tata McGraw Hill Education.
2. Mitra Amitava., Fundamentals of Quality Control and Improvement, John Wiley & Sons.
3. Grant E.L., Statistical Quality Control, McGraw-Hill Education.

Reference Books:

1. Kaoru Ishikawa, Introduction to Quality Control, Modern Productivity and Quality Publishing Pvt. Ltd.

E-sources:

1. NPTEL Videos and YouTube
2. NPTEL Lectures

MGM University
Aurangabad – 431003
Approved Program Curriculum

Appendix B

Name of the College/Institute-**Jawaharlal Nehru Engineering College** Faculty of **Engineering & Technology**
Name of the Program-**Mechanical Engineering**
Approved by the Board of Studies on - 22nd February 2020
Program Approved vide Academic Council Meeting dt-29th June 2020 Item No. MGMU:AC-1:2020:2
Program Type: **UG**/PG/Integrated Masters Program/Diploma/Certificate Duration: 08 Semesters
Curriculum Code:---------- (this code will change when you change the Curriculum)

Course Name: Reverse and Additive Manufacturing
Course Code: 20UME802D
Semester: VIII
Course Outcomes: After completing this course, students will be able to:

1. Understand the role of additive manufacturing in the design process and the implications for design.
2. Exploit AM technology to reduce tooling cost at low volume production environments.
3. Understand the principles behind the design of the product, ways to redesign and improve theperformance of the system.

Curriculum

Unit No.	Title and Contents	Teaching Hours	Marks	Remarks
1	***Introduction*** Introduction to Additive Manufacturing: Introduction to AM, AM evolution, Distinction between AM & CNC machining, Advantages of AM, Need of reverse engineering, Methodologies for Reverse Engineering, Phases of Reverse Engineering, Levels of abstraction: Application level, Functional level, Structural level.			
2	***Additive Manufacturing Process Chain and Classification of AM Processes*** Conceptualization, CAD, conversion to STL, Transferto AM, STL file manipulation, Machine setup, build, removal and clean up, post processing, Liquid polymer system, discrete particle system, molten material systems, solid sheet system.			
3	***Design for Additive Manufacturing*** Motivation, DFMA concepts and objectives, AM unique capabilities, Exploring design freedoms, Design tools for AM, Part Orientation, Removal of Supports, Hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an			

	Assembly, Identification of markings/ numbers etc.			
4	***Applications of Additive Manufacturing*** Functional models, Pattern for investment and vacuum casting, Medical models, art models, Engineering analysis models, Rapid tooling, new materials development, Bi-metallic parts, Re-manufacturing. Application examples for Aerospace, defense, automobile, Bio-medical and general engineering industries			
5	***Post Processing and Future Directions of Additive Manufacturing*** Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques, Introduction to Future Directions of AM, new types of products and employment and digiproneurship.			
6	***Methodology of Reverse Engineering*** Forward Engineering Design, Design Steps, RE Methodology, RE Steps and Examples, Product Development, Product Functions, Engineering Specifications, Product Architecture, Mechanical RE, Computer-Aided RE, Reverse Engineering in Computer Applications.			

Text Books:

1. Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: Rapid Prototyping toDirect Digital Manufacturing", Springer, 2010.
2. Ali K. Kamrani, Emand Abouel Nasr, "Rapid Prototyping: Theory & Practice", Springer, 2006.
3. Product Design: Techniques in Reverse Engineering and New Product Development by K.Otto and K. WoodPrentice Hall, 2001.

Reference Books:

1. Chua Chee Kai, Leong Kah Fai, "Rapid Prototyping: Principles & Applications", World Scientific, 2003.

E-sources:

1. NPTEL SWAYAM, YouTube
2. Elsevier Journals
3. Springer Journals

MGM University
Aurangabad – 431003
Approved Program Curriculum

Appendix B

Name of the College/Institute-**Jawaharlal Nehru Engineering College** Faculty of **Engineering & Technology**
Name of the Program-**Mechanical Engineering**
Approved by the Board of Studies on - 22nd February 2020
Program Approved vide Academic Council Meeting dt-29th June 2020 Item No. MGMU:AC-1:2020:2
Program Type: **UG**/PG/Integrated Masters Program/Diploma/Certificate Duration: 08 Semesters
Curriculum Code:---------- (this code will change when you change the Curriculum)

Course Name: Elective: Research Methodology
Course Code: 20UME803E
Semester: VIII
Course Outcomes: After completing this course, students will be able to:

1. Understand Research and Types of Research Perform Mathematical Modeling and Simulation
2. Understand single factor experiments, guidelines for designing experiments Understand Different Approaches to Parameter Design
3. Understand types of data, Methods and techniques of data collection
4. Understand Types of report, layout of research report

Curriculum

Unit No.	Title and Contents	Teaching Hours	Marks	Remarks
1	***Research Concept & Formulation of Research Task*** Concept, meaning, objectives. motivation: Types of research, approaches (descriptive research, conceptual, theoretical, applied and experimental research), Literature Review: importance &methods, sources, field study, laboratory experiments, critical analysis of already generated facts, hypothetical proposal for future development and testing, selection of research task. Prioritization of research, introduction to hypothesis testing.			
2	***Mathematical Modeling and Simulation*** Concept of modelling, classification ofmathematical models, modeling with ordinarydifferential equations, differential equations, partialdifferential equations, graphs. Simulation concept, types			

	(quantitative, experimental, computer, statistical), process of formulation of model based on simulation.			
3	***Experimental Modeling and General Model of Process*** Definition of experimental design. examples, singlefactor experiments, guidelines for designing experiments, Input factors/variables. Outputparameters/variables, controllable/ uncontrollable variables, dependent/ independent variables. compounding variables, extraneous variables andexperimental validity.			
4	***Process optimization and designed experiments*** Methods for study of response surface, First order design. Determining optimum combination of factors, determination of steepest ascent, Taguchi approach to parameter design.			
5	***Analysis of Results*** (Parametric and Non parametric. Descriptive and Inferential Data): types of data, Methods and techniques of data collection. sampling and sample design, Non parametric test, error analysis, analysis of variance, significance of ' variance, analysis of co- variance, multiple regression, Introduction to Analytical hierarchical process, Factor analysis, Cluster analysis, Fuzzy logic, testing linearity/ non linearity of model, testing adequacy of model.			
6	***Computer Aided Process Planning*** Types of report, layout of research report, interpretation of results, layout and format, style of writing, typing, references, pagination, tables. figures, conclusions, appendices.			

Text Books:

1. Research Methodology, C Kothari, Wiley Eastern publishers. New Delhi, 10th edition, 2006
2. Research in Education, John W Besr & James V Kahn, Prentice Hall of India, New Delhi
3. Theories of Engineering Experiments, Schank Fr, Tata McGraw Hill Publishing Ltd., New Delhi

Reference Books:

1.Experimental design by Cochran & Cocks, John Willy & sons. New Delhi, 20052.Design of Experiments, Douglas Montgomery, 1995

3.Formulation of Hypothesis, Wilkinson K, P L Bhandarkar. Himalaya Publishing House, Mumbai, 2005.

E-sources:

1. NPTEL Lectures & Videos.
2. Published research papers by Elsevier, Springer etc.

MGM University
Aurangabad – 431003
Approved Program Curriculum

Appendix B

Name of the College/Institute-**Jawaharlal Nehru Engineering College** Faculty of **Engineering & Technology**
Name of the Program-**Mechanical Engineering**
Approved by the Board of Studies on - 22nd February 2020
Program Approved vide Academic Council Meeting dt-29th June 2020 Item No. MGMU:AC-1:2020:2
Program Type: **UG**/PG/Integrated Masters Program/Diploma/Certificate Duration: 08 Semesters
Curriculum Code:---------- (this code will change when you change the Curriculum)

Course Name: Elective: Industrial Engineering
Course Code: 20UME804E
Semester: VIII
Course Outcomes: After completing this course, students will be able to:

1. Construct operations process charts, models and diagrams for manufacturing and operations planning.
2. Use flow process charts, time study and occurrence sampling for methods improvement and workmeasurement applications
3. Perform job evaluation and merit rating, Kaizen and SMED.
4. Evaluate and apply the techniques used in Industrial and Systems where productivity stems fromefficient technology, and demonstrate this in labs and projects.

Curriculum

Unit No.	Title and Contents	Teaching Hours	Marks	Remarks
1	***Introduction*** Productivity, definitions of work study, scope, applications, relationship, between productivity & standard of living, basic work content, excess work content, Management, techniques to reduce excess work content due to product process and ineffective time in control of workers and Management. (Numerical and Cases on Productivity)			
2	***Work Study and Method Study*** Definition, concept, and relation with Productivity, human factors, work study versus Management, supervisor, and work study man, qualities of work studyman, working conditions, prevention accidents and hazards. Method Study: Definition, objectives, procedureof method study, selection of job, recording techniques, micro-memo motion study, developing new layout materials handling its principles and equipment, movement of workers and materials in working area, string diagram and its significance, multiple activity chart and their significance, two handed process chart, principles, therbligs, SIMO chart, cycle graph in methodstudy. Critical examination, installation and maintain of proposed method.			
3	***Motion Economy and Ergonomics Practices***			

	Motion Economy principles. Introduction to ergonomics, man/machine/environment systems concept. Design approach: A new design, modification of existing design, assessment of a design, limitations of man and machine with respect to each other, Posture – standing at work, seated at work, work station heights and seat geometry. Human anthropometry and its use in work place layout. (Work Efficiency and Ergonomics, Effect of Light, Noise, Temperature on Human Performance)			
4	***Time Study*** Technique, Purpose, use and basic procedure time study equipment selection of jobs for time study, approach to workers, and steps in time study, data collection about jobs, operator & surroundings breaking down jobs into elements, types of elements, selection and measurement of each element. Time study rating and allowances			
5	***Works Measurement Techniques*** Work sampling - need, establishing confidence levels, determination of sample size, random observation, and conduct of study. General study of standard data, PMTS and MTM. Methods of Improving Materials Productivity, factors affecting materials productivity. Measuring workby physiological methods – heart rate measurement – measuring oxygen consumption– establishing time standards by physiology methods.(Comparison between Time Study, Work Sampling & MTM)			
6	***Job Evaluation and Merit Rating, Kaizen*** Different techniques of job evaluation and Merit rating. Merits, Demerits, Significance of Job evaluation / meritrating with work measurement.			
7	***Kaizen*** Kaizen concept, Kaizen umbrella for quality improvement. Kaizen and management, implications of QC for Kaizen, kaizen and TQC, Kaizen and suggestion systems, Kaizen and competition, Kaizen and innovation, measurement, PDCA cycle. (Review of Cases in Kaizen)			
8	***Just In Time*** Concept, scope, objectives, push & pull system, reduced inventories and improved set up times, TOYOTAproduction system, basic assumptions of TOYOTA production system, leveling, smoothing out the productionsystem, JIT and automation. Introduction to BusinessProcess Reengineering, MOST. (Review of Cases in JIT)			
9	***Single Minute Exchange of Dies (SMED)*** Aspects of setup activities, internal and external setup. Setup improvement, conceptual stages. Techniques for, streamlining the aspect of set up, effects of SMED.			

Text Books:

1. Work Measurement and Methods Improvement, Lawrence S. Aft, John Wiley and Sons,York, 2000
2. Work Design and Industrial Ergonomics, Konz & Johnson, Holcomb Hathaway, 2000
3. Motion and Time Study – Design and Measurement of Work, Barnes, Raeph.m. John Wiley &sons, New York, 1990.
4. Human Factors in Engineering and Design, Mc.Cormick, E.J., Mc.Graw Hill.
5. Introduction to Work study, ILO, Geneva.
6. Human Factors Engineering and Design, M. S. Sanders and Ernest J. McCormick, McGraw-Hill Inc.
7. Hand Book of Industrial Engineering by Irson & Grant
8. Just In Time by David Hukins.

Reference Books:

1. Kaizen (Ky'zen), the key to Japan's competitive success, Masaaki Imai, McGraw-Hill, 1986
2. A Revolution in manufacturing: The SMED system, Shino Shingo, productivity council.
3. Industrial Engineering and Production Management by Martand Telsang, S. Chand

E-sources:

1. NPTEL Lectures & Videos.
2. Published research papers by Elsevier, Springer etc.

MGM University
Aurangabad – 431003
Approved Program Curriculum

Appendix B

Name of the College/Institute-**Jawaharlal Nehru Engineering College** Faculty of **Engineering & Technology**
Name of the Program-**Mechanical Engineering**
Approved by the Board of Studies on - 22nd February 2020
Program Approved vide Academic Council Meeting dt-29th June 2020 Item No. MGMU:AC-1:2020:2
Program Type: **UG**/PG/Integrated Masters Program/Diploma/Certificate Duration: 08 Semesters
Curriculum Code:---------- (this code will change when you change the Curriculum)

Course Name: Elective: Autonomous Vehicle
Course Code: 20UME805E
Semester: VIII
Course Outcomes: After completing this course, students will be able to:

1. Understand the Construction, working and other details about Internal Combustion Engines used inautomobiles
2. Identify Construction, working, preventive maintenance, trouble shooting and diagnosis of variousAutomobile transmission system
3. Identify Construction, working, preventive maintenance, trouble shooting and diagnosis of variousAutomobile control systems braking and Steering system
4. Identify Construction, working, preventive maintenance, trouble shooting and diagnosis of variousAutomobile suspension system
5. Identify Construction, working, preventive maintenance, trouble shooting and diagnosis of variousAutomobile Electrical Systems
6. Identify Modern technology and safety measures used in Vehicles

Curriculum

Unit No.	Title and Contents	Teaching Hours	Marks	Remarks
1	***Introduction*** Introduction: Classification of automobiles, main components of automobile. Layout of with different engine positions and drive arrangements. Types of engines and other power plants used in Automobile. Recent developments in engines. Engine selection criteria. Chassis and Super structure (Body).			
2	***Transmission System*** Clutches: Purpose of clutch, classification, single plate clutch coil spring, diaphragm spring and semi centrifugal clutch, clutch plates. Multiple plate clutches,centrifugal clutch. Gearbox: Function, various resistances, tractive effort, performance curves. Slidingmesh gear arrangement, constant mesh gear arrangement and synchromesh arrangement, epicyclic gears, layout of gear arrangement in a gearbox for forward and reverse gears, over drive. Gear selector mechanisms. Automatic transmission- types, torque converter. Differential and their types. Propeller shaft, universal joints.			
3	***Steering System and Tyres***			

	Front axle types, final drive, rear axle arrangements. Steering geometry, caster, camber, toe-in toe-out, included angle, scrub radius, turning radius, thrust angle. Effects of these angles. Wheel alignment and wheel balancing. Under steer, over steer. Steering system, steering columns, steering effort, components of steering system (one with gear box and tie rods and another with rack and pinion), Various types of steering gearboxes. Power steering- hydraulic and electronic. Wheels: Wheel rims. Tyres – function, construction, types of tyres, tubeless tyres.			
4	***Braking Systems*** Purpose, classification. Drum and disc brake systems, brake shoes, leading- trailing drum brake. Mechanical brakes, hydraulic brake system- layout, tandem master cylinder, slave cylinders. Air brake systems. ABS			
5	***Suspension System*** Objectives, various types of springs and shock absorbers used in suspension. Rigid axle suspension system, H frame twist-beam rear suspension (used in recent cars), independent suspension systems- Wish bone parallel link, Mac-Pherson strut and trailing arm suspension. Air suspension. Telescopic suspension in two wheelers. Stabilizer or anti roll bar. Introduction to electronic suspension, ride control and active suspensions.			
6	***Automotive Electricals and Additional Systems*** Ignition system, starting systems, charging system, dashboard instruments. Electrical and electronics in thedoors. (window, central locking, etc) Automobile air- conditioning systems. Safety systems in automobile. Pollution control norms and pollution control devices.			

Text Books:

1.R.K.Rajput, "Automobile Engineering," Laxmi Publications

2. Dr. Kirpal Singh, "Automobile Engineering by (Vol. I & II)," Standard Publishers 1999

3. G.B.S. Narang, "Automobile Engineering," 1999

Reference Books:

1. Crouse & Anglin, Automotive Mechanics by Tata McGraw Hill. 2005
2. Joseph Heitner Automotive Mechanics 2nd Ed., Affiliated Eastern Law house, 1967
3. K.K.Jain ,R.B.Asthana Automobile Engineering, Vol.I & II by, McGraw Hill Education
4. A H.M. Sethi Automotive Technology ,1990.
5. Banga & Singh, Automobile Engineering ,1990.

E-sources:

1. NPTEL Lectures & Videos.
2. Published research papers by Elsevier, Springer etc.

MGM University
Aurangabad – 431003
Approved Program Curriculum

Appendix B

Name of the College/Institute-**Jawaharlal Nehru Engineering College** Faculty of **Engineering & Technology**
Name of the Program-**Mechanical Engineering**
Approved by the Board of Studies on - 22nd February 2020
Program Approved vide Academic Council Meeting dt-29th June 2020 Item No. MGMU:AC-1:2020:2
Program Type: **UG**/PG/Integrated Masters Program/Diploma/Certificate Duration: 08 Semesters
Curriculum Code:---------- (this code will change when you change the Curriculum)

Course Name: Elective: Tribology
Course Code: 20UME806E
Semester: VIII
Course Outcomes: After completing this course, students will be able to:

1. Understand the fundamentals of tribology and associated parameters.
2. Apply concepts of tribology for the performance analysis and design of components experiencingrelative motion.
3. Analyze the requirements and design hydrodynamic journal and plane slider bearings for a givenapplication.
4. Select proper bearing materials and lubricants for a given tribological application.
5. Apply the principles of surface engineering for different applications of tribology.
6. The student can identify different areas of Industrial Tribology.

Curriculum

Unit No.	Title and Contents	Teaching Hours	Marks	Remarks
1	***Introduction*** Tribology in design, tribology in industry Viscosity, flow of fluids, viscosity and its variation absolute and kinematic viscosity, temperature variation, viscosity index determination of viscosity, different viscometers, Tribological considerations Nature of surfaces and their contact; Physic mechanical properties of surface layer, Geometrical properties of surfaces, methods of studying surfaces; Study of contact of smoothly and rough surfaces.			
2	***Friction and wear*** Role of friction and laws of static friction, causes of friction, theories of friction, Laws of rolling friction; Friction of metals and non-metals; Friction measurements. Definition of wear, mechanism of wear, types and measurement of wear, friction affecting wear, Theories of wear; Wear of metals and non-metals			
3	***Hydrostatic lubrication*** Principle of hydrostatic lubrication, General requirements of bearing materials, types of bearing materials., Hydrostatic step bearing, application to pivoted pad thrust bearing and other applications,			

	Hydrostatic lifts, hydrostatic squeeze films and its application to journal bearing, optimum design of hydrostatic step bearing.			
4	***Hydrodynamic theory of lubrication*** Principle of hydrodynamic lubrication, Various theories of lubrication, Petroff's equation, Reynold's equation in two dimensions -Effects of side leakage -Reynolds equation in three dimensions, Friction in sliding bearing, hydro dynamic theory applied tojournal bearing, minimum oil film thickness, oil whip and whirl, anti –friction bearing, hydrodynamic thrustbearing.			
5	***Air/gas lubricated bearing*** Advantages and disadvantages application to Hydrodynamic journal bearings, hydrodynamic thrust bearings. Hydrostatic thrust bearings. Hydrostatic bearing Analysis including compressibility effect.			
6	***Lubrication and lubricants*** Introduction, dry friction; Boundary lubrication; classic hydrodynamics, hydrostatic and elasto hydrodynamic lubrication, Functions of lubricants, Types of lubricants and their industrial uses; SAE classification, recycling, disposal of oils, propertiesof liquid and grease lubricants; lubricant additives, general properties and selection. 7. Special Topics: Selection of bearing and lubricant; bearing maintenance, diagnostic maintenance ofTribological components and considerations in IC engines and automobile parts, roller chains and wire rope, lubrication systems; Filters and filtration.			

Text Books:

1. Tribology H.G. Phakatkar and R.R. Ghorpade Nirali Publications

Reference Books:

1. Basu, Sen Gupta and Ahuja Fundamentals of Tribology, /PHI
2. Sushil Kumar Srivatsava, S. Tribology in Industry: Chand &Co.
3. O'Conner and Royle Standard Hand Book of Lubrication Engg., , McGraw Hills C
4. O'Conner and Royle, Lubrication, Raymono O. Gunther; Bailey Bros & Swinfan Ltd

E-sources:

1. NPTEL Lectures & Videos.
2. Published research papers by Elsevier, Springer etc.
3. www. nptel.com

MGM University
Aurangabad – 431003
Approved Program Curriculum

Appendix B

Name of the College/Institute-**Jawaharlal Nehru Engineering College** Faculty of **Engineering & Technology**
Name of the Program-**Mechanical Engineering**
Approved by the Board of Studies on - 22nd February 2020
Program Approved vide Academic Council Meeting dt-29th June 2020 Item No. MGMU:AC-1:2020:2
Program Type: **UG**/PG/Integrated Masters Program/Diploma/Certificate Duration: 08 Semesters
Curriculum Code:---------- (this code will change when you change the Curriculum)

Course Name: Elective: Casting and Welding Technology
Course Code: 20UME807E
Semester: VIII

Course Outcomes: After completing this course, students will be able to:

1. Describe the casting process, preparation of Green, Core, dry sand molds and Sweep, Shell, Investmentand plaster molds.
2. Explain the Pattern, Core, Gating, Riser system and Jolt, Squeeze, Sand Slinger Molding Machines.
3. Compare the Gas fired pit, Resistance, Coreless, Electrical and Cupola Metal Furnaces.
4. Compare the Gravity, Pressure die, Centrifugal, Squeeze, slush and Continuous Metal mold castings.
5. Explain the Solidification process and Casting of Non-Ferrous Metals.
6. Describe the Metal Arc, TIG, MIG, Submerged and Atomic Hydrogen Welding processes used inmanufacturing.
7. Explain the Resistance spot, Seam, Butt, Projection, Friction, Explosive, Thermite, Laser and ElectronBeam Special type of welding process used in manufacturing
8. Describe the inspection methods for the quality assurance of components made of casting and joiningprocess

Curriculum

Unit No.	Title and Contents	Teaching Hours	Marks	Remarks
1	***Introduction & Basic Materials used in Foundry*** Classification of manufacturing processes. Metals cast in the foundry-classification, factors that determine the selection of a casting alloy. Introduction to casting process & steps involved. Patterns: Definition, classification, materials used for pattern, various pattern allowances andtheir importance. Sand molding: Types of base sand,requirement of base sand. Binder, Additives definition, need and			

	types Preparation of sand molds: Molding machines- Jolt type, squeeze type and Sand slinger. Studyof important molding process: Green sand, core sand, dry sand, sweep mold, CO2 mold, shell mold, investment mold, plaster mold, cement bonded mold. Cores: Definition, need, types. Method of making cores, concept of gating (top, bottom, parting line, horn gate).			
2	***Melting & Metal Mold Casting Methods*** Melting furnaces Classification of furnaces, Gas fired pitfurnace, Resistance furnace, Coreless induction furnace, electric arc furnace, constructional features & working principle of cupola furnace. Casting using metal molds: Gravity die casting, pressure die casting, centrifugal casting, squeeze casting, slush casting, and continuous casting processes.			
3	***Solidification & Nonferrous Foundry Practice*** Solidification, Nucleation, solidification variables, Directional solidification-need and methods. Degasification in liquid metals-Sources of gas, degasification methods. Fettling and cleaning of castings: Basic steps involved. Sand Casting defects- causes, features and remedies. Advantages & limitations of casting process nonferrous foundry practice: Aluminum castings - Advantages, limitations, melting of aluminum using lift-out type crucible furnace. Hardeners used, drossing, gas absorption, fluxing and flushing, grain refining, pouring temperature. Stir casting set up, procedure, uses, advantages and limitations.			
4	***Welding Process*** Welding process: Definition, Principles, Classification, Application, Advantages & limitations of welding. Arc welding: Principle, Metal arc welding (MAW), Flux Shielded Metal Arc Welding (FSMAW), Inert Gas Welding (TIG & MIG) Submerged Arc Welding (SAW) and Atomic Hydrogen Welding (AHW). Special type of welding: Resistance welding principles, Seam welding, Butt welding, Spot welding and Projection welding. Friction welding, Explosive welding, Thermite welding, Laser welding and electron beam welding.			
5	***Soldering, Brazing and Metallurgical aspects in welding*** Structure of welds, Formation of different zones during welding, Heat Affected Zone (HAZ), Parameters affecting HAZ. Effect of carbon content on structure and properties of steel, Shrinkage in welds& Residual stresses, Concept of electrodes, filler rod and fluxes. Welding defects- Detection, causes & remedy. Soldering, brazing, gas welding: Soldering, Brazing, Gas Welding: Principle, oxy-Acetylene welding, oxy- hydrogen welding, air-acetylene welding, Gas cutting, powder cutting.			
6	***Inspection methods*** Methods used for inspection of casting and welding. Visual, magnetic particle, fluorescent particle, ultrasonic. Radiography, eddy current, holography methods of inspection.			

Text Books:

1. "Manufacturing Process-I", Dr.K. Radhakrishna, Sapna Book House,5th Revised Edition 2009.
2. "Manufacturing & Technology": Foundry Forming and Welding, P.N.Rao, 3rd Ed., Tata McGraw Hill, 2003.

Reference Books:

1. Process and Materials of Manufacturing", Roy A Lindberg, 4th Ed.Pearson Edu. 2006
2. "Manufacturing Technology", SeropeKalpakjian, Steuen. R. Sechmid,Pearson Education Asia, 5th Ed. 2006.
3. "Principles of metal casting", Rechard W. Heine, Carl R. LoperJr., Philip C. Rosenthal, Tata McGraw HillEducation Private Limited Ed.1976.
4. Foundary Technology by O.P.Khanna, Dhanpatrai Publications.
5. Welding Technology by O.P.Khanna, Dhanpatrai Publication.

E-sources:

1. NPTEL – Fundamentals of Managerial Accounting.
2. NPTEL – Cost Accounting.
3. NPTEL – Financial Management for Managers.

MGM University
Aurangabad – 431003
Approved Program Curriculum

Appendix B

Name of the College/Institute-**Jawaharlal Nehru Engineering College** Faculty of **Engineering & Technology**
Name of the Program-**Mechanical Engineering**
Approved by the Board of Studies on - 22nd February 2020
Program Approved vide Academic Council Meeting dt-29th June 2020 Item No. MGMU:AC-1:2020:2
Program Type: **UG**/PG/Integrated Masters Program/Diploma/Certificate Duration: 08 Semesters
Curriculum Code:---------- (this code will change when you change the Curriculum)

Course Name: Elective: Reliability and Maintenance Engineering
Course Code: 20UME808E
Semester: VIII
Course Outcomes: After completing this course, students will be able to:

1. To know the relationship of key concepts in reliability engineering and application
2. Analyze failure data using various reliability techniques
3. Analysis of system reliability of repairable and non-repairable system
4. To comprehend the various maintenance indices.
5. To establish maintenance strategies according to system characteristics
6. To identify the maintenance models for various systems

Curriculum

Unit No.	Title and Contents	Teaching Hours	Marks	Remarks
1	***Basic Probability Theory Basic concepts*** Rules for combining Probabilities of events – Failure Density and Distribution functions – Bernoulli's trials – Binomial distribution – Expected value and standard deviation for binomial distribution – Examples			
2	**Network Modeling and Reliability Evaluation Basic concepts** Evaluation of network Reliability / Unreliability – Series systems, Parallel systems, Series – Parallel systems, partially redundant systems – Types of redundancies - Evaluation of network Reliability / Unreliability using conditional probability method – Paths based and Cutset based approach – complete event tree and reduced event tree methods - Examples.			
3	***Time Dependent Probability Basic concepts*** Reliability functions f(t), F(t), R(t), h(t) – Relationship between these functions – Baths tubs curve – Exponential failure density and distribution functions - Expected value and standard deviation of Exponential distribution – Measures of reliability – MTTF, MTTR, MTBF – Evaluation of network reliability / Unreliability of simple Series, Parallel, Series-Parallel systems -Partially redundant			

	systems - Evaluation of reliability measure – MTTF for series and parallel systems –Examples			
4	***Maintenance Engineering*** Basic principles and approaches-Types of maintenance Specifications and functions-Systems approach-performance indices-planning and control-Strategy.			
5	***Maintenance management and control*** Functions and organization-critical maintenance- effective elements-project control methods-control indices - Maintainability-Concepts-tasks-modeling and allocation-prediction-FMECA-reliability and maintainability trade off-Design for maintainability design methods.			
6	***Preventive maintenance*** Principle-measures-mathematical models-Advantages and disadvantages - Corrective maintenance - types- measures-mathematical models-effective failure rate equations - Reliability Centered Maintenance-goals and principles -components-predictive testing			

Text Books:

1. L.S Shrinath., "Reliability Engineering", Khanna Publications

Reference Books:

1. Reliability Evaluation of Engineering Systems by Roy Billinton and Ronald N. Allan Reprinted in India B. S.Publications, 2007.
2. Reliability Engineering by E. Balagurusamy, Tata McGraw Hill, 2003.
3. Reliability and Maintainability Engineering by Charles E. Ebeling, Tata McGraw Hill, 2000.
4. Engineering Maintenance A Modern Approach, B. S. Dhillon CRC Press.

E-sources:

1. NPTEL Videos
2. NPTEL Lectures

MGM University
Aurangabad – 431003
Approved Program Curriculum

Appendix B

Name of the College/Institute-**Jawaharlal Nehru Engineering College** Faculty of **Engineering & Technology**
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Program Type: **UG**/PG/Integrated Masters Program/Diploma/Certificate Duration: 08 Semesters
Curriculum Code:---------- (this code will change when you change the Curriculum)

Course Name: Operations Research
Course Code: 20UME809D
Semester: VIII

Course Outcomes: After completing this course, students will be able to:

1. Identify different optimization models, their characteristics and limitations.
2. Understand different types of models and their applications.
3. Explain various types of models/problems.
4. Apply theory of different models/problems practicing industrial application.
5. Understand different types of assumptions, theories and their applications.
6. Explain various Sequencing, Inventory, Queuing, Network, Replacement Linear Models.

Curriculum

Unit No.	Title and Contents	Teaching Hours	Marks	Remarks
1	***Introduction and Linear Models*** Operations research development, history, definitions, objectives, characteristics, limitations, phases and applications. Formation of an L.P model, graphical solution, simplex algorithm, artificial variables technique– Big-M method, two phase method, Duality in LPP.			
2	***Transportation Models*** Introduction, Methods for finding initial solution, Test of optimality, Maximization and Minimization Transportation problems, Transshipment problems,Degeneracy.			
3	***Assignment and Replacement Models*** Introduction, Solution methods, Variations of the assignment problem, Traveling salesman problem. Replacement of items that deteriorates with time, Valueof money changing with time and not changing with time, Optimum replacement policy, Individual and group replacement.			
4	***Queuing and Sequencing Models*** Queuing models, queuing systems and structures, notation, parameter, single server and multiserver models, Poisson input, exponential service, constant rate service, infinite population.			

	Scheduling and sequencing, assumptions in sequencingmodels, processing 'n' jobs on 'm' machines, processingof two jobs on machines with each having different processing order.			
5	***Game Theory and Inventory Models*** Introduction, Two-person zero-sum game, Minimum and Maximum principle, Saddle point, Methods for solving game problems with pure and mixed strategies. Types of Inventory, EOQ, ERL, Deterministic inventory problems, Price breaks, stochastic inventory problems andSelective inventory control techniques.			
6	***Network Models*** Introduction to PERT/CPM & its importance in project management, Concept & construction of network diagrams, Critical path & project duration, floats, networkcrashing, optimum project duration & cost, PERT activity, time estimate, probability of completion of a project on or before specified time.			

Text Books:

1. Operation Research/H.A. Taha/TMH
2. Optimization in operations research/R.L Rardin
3. Optimization Techniques/Benugundu & Chandraputla/Pearson Asia

Reference Books:

1. Optimization theory & Applications/ S.S Rao/ New Age International
2. Introductory to operation research/Kasan & Kumar/Springar
3. Optimization Techniques theory and practice / M.C Joshi, K.M Moudgalya/ Narosa Publications.

E-sources:

1. NPTEL Videos
2. NPTEL Lectures

MGM University
Aurangabad – 431003
Approved Program Curriculum

Appendix B

Name of the College/Institute-**Jawaharlal Nehru Engineering College** Faculty of **Engineering & Technology**
Name of the Program-**Mechanical Engineering**
Approved by the Board of Studies on - 22nd February 2020
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Program Type: **UG**/PG/Integrated Masters Program/Diploma/Certificate Duration: 08 Semesters
Curriculum Code:---------- (this code will change when you change the Curriculum)

Course Name: Reverse Engineering and Additive Manufacturing Lab
Course Code: 20UME810L
Semester: VIII
Course Outcomes: After completing this course, students will be able to:

1. Apply engineering knowledge, techniques, skills and modern tools to analyze problems in AM.
2. Identify different industrial sectors, relevant AM processes and measurement techniques to reduce cost and time from design to manufacture.
3. Understand process of reconstructing/ reformation of an already existing object.

Curriculum

Practical No.	Name of Practical	Teaching Hours	Marks	Remarks
1	Design & Generation of STL file of an CAD Model (Mechanical Part) Using CAD Software	**02**		
2	3D Printing of CAD Model	**02**		
3	Design & Generation of STL file of an CAD Model (Bio-Medical/ Industrial)	**02**		
4	3D Printing of Bio-Medical/Industrial	**02**		
5	3D Scanning of Any Automobile Part	**02**		
6	Reformation of 3D Scan Part into CAD Model	**02**		

References:

2. Lab Manual.

MGM University
Aurangabad – 431003
Approved Program Curriculum

Appendix B

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Name of the Program-**Mechanical Engineering**
Approved by the Board of Studies on - 22nd February 2020
Program Approved vide Academic Council Meeting dt-29th June 2020 Item No. MGMU:AC-1:2020:2
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Curriculum Code:---------- (this code will change when you change the Curriculum)

Course Name: Research Methodology Lab
Course Code: 20UME811L
Semester: VIII
Course Outcomes: After completing this course, students will be able to:

1. Understand Research and Types of Research
2. Perform Mathematical Modeling and Simulation
3. Understand single factor experiments, guidelines for designing experiments
4. Understand Different Approaches to Parameter Design
5. Understand types of data, Methods and techniques of data collection

Curriculum

Practical No.	Name of Practical	Teaching Hours	Marks	Remarks
1	Assignment Based on Unit 01	**02**		
2	Assignment Based on Unit 02	**02**		
3	Assignment Based on Unit 03	**02**		
4	Assignment Based on Unit 04	**02**		
5	Assignment Based on Unit 05	**02**		
6	Assignment Based on Unit 06	**02**		

References:

1. Lab Manual.

MGM University
Aurangabad – 431003
Approved Program Curriculum

Appendix B

Name of the College/Institute-**Jawaharlal Nehru Engineering College** Faculty of **Engineering & Technology**
Name of the Program-**Mechanical Engineering**
Approved by the Board of Studies on - 22nd February 2020
Program Approved vide Academic Council Meeting dt-29th June 2020 Item No. MGMU:AC-1:2020:2
Program Type: **UG**/PG/Integrated Masters Program/Diploma/Certificate Duration: 08 Semesters
Curriculum Code:---------- (this code will change when you change the Curriculum)

Course Name: Industrial Engineering Lab
Course Code: 20UME812L
Semester: VIII
Course Outcomes: After completing this course, students will be able to:

1.Understand different concepts regarding Organization and Productivity in industries.
2.Implement different concepts involved in work and method study and understanding of work contents in different situations.
3.Undertake small case study-based project works regarding work measurement and time study.
4. Develop capacities in integrating knowledge of design along with other aspects of value addition in the conceptualization and manufacturing stage of various products.

Curriculum

Practical No.	Name of Practical	Teaching Hours	Marks	Remarks
1	Case study/numerical on productivity.	**02**		
2	Prepare operation process chart (OPC)for given assembly	**02**		
3	Prepare flow process chart and flowdiagram for given task.	**02**		
4	Prepare man and machine chart/SIMOchart for given situation.	**02**		
5	Calculate co-efficient of co-relation for time study person using performancerating technique	**02**		
6	Case study on Kaizen	**02**		
7	Demonstrate the difference betweenmaximum and minimum working area by assembly of 4-5 components.	**02**		

References:

1. Lab Manual.

MGM University
Aurangabad – 431003
Approved Program Curriculum

Appendix B

Name of the College/Institute-**Jawaharlal Nehru Engineering College** Faculty of **Engineering & Technology**
Name of the Program-**Mechanical Engineering**
Approved by the Board of Studies on - 22nd February 2020
Program Approved vide Academic Council Meeting dt-29th June 2020 Item No. MGMU:AC-1:2020:2
Program Type: **UG**/PG/Integrated Masters Program/Diploma/Certificate Duration: 08 Semesters
Curriculum Code:---------- (this code will change when you change the Curriculum)

Course Name: Autonomous Vehicle Lab
Course Code: 20UME813L
Semester: VIII
Course Outcomes: After completing this course, students will be able to:

1. Understand the various layouts of automobile
2. Identify Construction, working, preventive maintenance, trouble shooting and diagnosis of variousAutomobile transmission system
3. Identify Construction, working, preventive maintenance, trouble shooting and diagnosis of variousAutomobile Steering system
4. Identify Construction, working, preventive maintenance, trouble shooting and diagnosis of variousAutomobile braking system
5. Identify Construction, working, preventive maintenance, trouble shooting and diagnosis of variousAutomobile suspension system
6. Identify Construction, working, preventive maintenance, trouble shooting and diagnosis of variousAutomobile Electricals system

Curriculum

Practical No.	Name of Practical	Teaching Hours	Marks	Remarks
1	Layout of the automobiles, front,rear engine, 2W and 4W drives.	**02**		
2	Study of conventional Petrol & Diesel Engine and MPFI and CRDI systems.	**02**		
3	Study of Automobile clutches (single plate, multiple plate and centrifugal)	**02**		
4	Study of Automobile Gear box (Sliding mesh, constant Mesh andSynchromesh)	**02**		
5	Study of Automobile differential	**02**		
6	Study Automobile SuspensionSystems	**02**		
7	Study Automobile steeringSystem	**02**		
8	Study of Automobile brakingsystems.	**02**		
9	Study of Automobile Electricsystems (starting, ignition and charging system)	**02**		
10	Study of air conditioningsystem in a car.	**02**		

References:

1. Lab Manual.

MGM University
Aurangabad – 431003
Approved Program Curriculum

Appendix B

Name of the College/Institute-**Jawaharlal Nehru Engineering College** Faculty of **Engineering & Technology**
Name of the Program-**Mechanical Engineering**
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Program Approved vide Academic Council Meeting dt-29th June 2020 Item No. MGMU:AC-1:2020:2
Program Type: **UG**/PG/Integrated Masters Program/Diploma/Certificate Duration: 08 Semesters
Curriculum Code:---------- (this code will change when you change the Curriculum)

Course Name: Project-II
Course Code: 20UME814P
Semester: VIII
Course Outcomes: After completing this course, students will be able to:

1. Construct and conduct the tests on the system/product
2. Analyze the results of the tests
3. Discuss the findings, draw conclusions, and modify the system/product, if necessary
4. Evaluate the cost considering different materials/manufacturing processes

Curriculum

Practical No.	Name of Practical	Teaching Hours	Marks	Remarks
1	Since Project Stage II is in continuation to Project Stage I, the students are expected to complete the total project by the end ofsemester VIII. After completion of project work, they are expected to submit the consolidated report including the work donein Project stage I and Project stage II. The report shall be comprehensive and presented typed on A4 size sheets and bound. The number of copies to be submitted is number of students plus two. The assessment would be carried out by the panel of examiners for both, term work and oralexaminations. ***The project evaluation should include any of the following or appropriate combination:*** 1. Report, 2. Project Reviews, 3. Technical Content, 4. Product/Process Modifications, 5. Usefulness/Savings etc, 6. Feasibility, 7. Presentation, 8. Project Costing, 9. Merits and demerits, 10. Sustainable Solution	**02**		

References:

1. Lab Manual.