Indian Institute of Technology Indore

Curriculum and Courses of Study for Bachelor of Technology in Mechanical Engineering

May 2026

[After incorporating decisions of the 63rd meeting of the Senate held on May 19, 2026]

CONTENTS

Curriculum of 1st Year BTech (For AY 2009-10)

Semester I

Course Code	Course Title	Weekly Contact Hours (L-T-P)	Credits
CH 101	Chemistry	2-1-0	6
CS 101	Computer Programming & Utilization	2-0-2	6
MA 101	Calculus	3-1-0	8
PH 101	Physics –I	2-1-0	6
CH 151	Chemistry Lab	0-0-3	3
ME 151	Engineering Graphics & Drawing	0-1-3	5
NC 101#	National Cadet Crops (NCC)	0-0-0	P/NP
NO 101#	National Sports Organization (NSS)	0-0-0	P/NP
NS 101#	National Service Scheme (NSS)	0-0-0	P/NP
	Total	**9-4-7**	**34**

Semester II

Course Code	Course Title	Weekly Contact Hours (L-T-P)	Credits
PH 102	Physics – II	2-1-0	6
HS101/ HS 103/ HS 105	Introduction to Philosophy/ Economics/ Reading Literature	3-0-0	6
CS 102 EE 102 ME 102	Abstractions and Paradigms for Programming* Intro. to Elect. And Electronics Circuit* Engineering Mechanics*	3-0-2 2-1-0 2-1-0	8 6 6
MA 102	Linear Algebra and Ordinary Differential Equation – I	3-1-0	8
ME 152	Workshop Practice	0-1-3	5
PH 112	Physics Lab	0-0-3	3
NC 102#	National Cadet Crops (NCC)	0-0-0	P/NP
NO 102#	National Sports Organisation (NSS)	0-0-0	P/NP

NS 102#	National Service Scheme (NSS)	0-0-0	P/NP
	Total	**11/10-3/4-8/6**	**36/34**

Any one of these courses to be taken
* Department Introductory course, specific to the students of concerned Departments

2nd Year B. Tech. (Mechanical Engineering)
(For AY 2010-11)

Semester III

Course Code	Subject Name	Weekly Contact Hours (L-T-P)	Credits
HS 111 / HS 113 / HS 115	Introduction to Philosophy / * Economics / Reading Literature	3-0-0 / 3-0-0 / 3-0-0	3 /3 / 3
ME 201	Solid Mechanics	3-1-0	4
ME 203	Fluid Mechanics	3-1-0	4
ME 205	Materials Science	2-1-0	3
ME 257	Machine Drawing	1-0-3	2.5
EE 104	Basic Electrical and Electronics Engineering	2-1-0	3
EE 154	Basic Electrical and Electronics Engineering Lab	0-0-2	1
IC 211	Experimental Engineering Lab	0-0-3	1.5
	Total	**14-4-8**	**22**

Semester IV

Course Code	Subject Name	Weekly Contact Hours (L-T-P)	Credits
MA 204	Numerical Methods	3-1-0	4
ME 202	Strength of Materials	3-1-0	4
ME 204	Fluid Machinery	3-0-0	3
ME 206	Thermodynamics	3-1-0	4
ME 208	Theory of Manufacturing Processes	3-0-0	3

ME 251	Solid Mechanics Lab	0-0-3	1.5
ME 254	Fluid Mechanics and Machinery Lab	0-0-3	1.5
ME 258	Manufacturing Processes Lab	0-0-3	1.5
	Total	**15-3-9**	**22.5**

* Students have to choose an HSS course other than the one which they have taken in the 2nd Sem.

Curriculum of 1st year BTech (common to all the Departments)

Semester I

Curriculum of 1st Year B. Tech. Program (From AY 2010-11 to AY 2013-14)				**Curriculum of 1st Year B. Tech. Program** (From AY 2014-15 to AY 2018-19)			
Course Code	**Course Title**	**Weekly Contact Hours (L-T-P)**	**Credits**	**Course Code**	**Course Title**	**Weekly Contact Hours (L-T-P)**	**Credits**
CH 103	Chemistry	3-1-0	4	CH 103	Chemistry	3-1-0	4
MA 103	Mathematics-I (Calculus)	3-1-0	4	MA 105	Calculus	3-1-0	4
PH 103	Physics-I (Modern Physics)	2-1-0	3	PH 105	Physics-I	2-1-0	3
HS 107	English Language and Literature	2-0-0	2	HS 159	English Language and Communication	0-3-0	3
CS 103	Computer Programming	2-0-0	2	CS 103	Computer Programming	2-0-0	2
CH 153	Chemistry Lab	0-0-3	1.5	CH 153	Chemistry Lab	0-0-3	1.5
HS 157	English Language Lab	0-0-2	1				
CS 153	Computer Programming Lab	0-0-3	1.5	CS 153 ***(upto AY 2017-18)*** IC 151 ***(from AY 2018-19 onwards)***	Computer Programming Lab	0-0-3	1.5
ME 153	Engineering Graphics	1-0-3	2.5	IC 153	Engineering Graphics	1-0-3	2.5
NC 101/ NO 101/ NS 101	National Cadet Corps (NCC) National Sports Organization (NSO) National Service Scheme (NSS)	0-0-0 0-0-0 0-0-0	P/NP P/NP P/NP	NC 101/ NO 101/ NS 101	National Cadet Corps (NCC) National Sports Organization (NSO) National Service Scheme (NSS)	0-0-0 0-0-0 0-0-0	P/NP P/NP P/NP
	Total	**13-3-11**	**21.5**		**Total**	**11-6-9**	**21.5**

Semester II

Curriculum of 1st Year B. Tech. Program (From AY 2010-11 to AY 2013-14)				Curriculum of 1st Year B. Tech. Program (From AY 2014-15 to AY 2018-19)			
Course Code	**Course Title**	**Weekly Contact Hours (L-T-P)**	**Credits**	**Course Code**	**Course Title**	**Weekly Contact Hours (L-T-P)**	**Credits**
MA 104	Mathematics-II(Linear Algebra and Ordinary Differential Equations-I)	3-1-0	4	MA 106	Linear Algebra and Ordinary Differential Equations-I	3-1-0	4
PH 104	Physics-II (Electricity and Magnetism)	2-1-0	3	PH 106	Physics-II	2-1-0	3
				BSE 102	Bio-Sciences	2-1-0	3
HS 108	Fundamentals of Economics	3-0-0	3	HS 108	Fundamentals of Economics	3-0-0	3
EE 104	Basic Electrical and Electronics Engineering	2-1-0	3	EE 104	Basic Electrical and Electronics Engineering	2-1-0	3
ME 104	Basic Mechanical Engineering	3-0-0	3	ME 106	Basic Mechanical Engineering	2-1-0	3
PH 154	Physics Lab	0-0-3	1.5	PH 156	Physics Lab	0-0-3	1.5
EE 154	Basic Electrical and Electronics Engineering Lab	0-0-2	1	EE 154	Basic Electrical and Electronics Engineering Lab	0-0-2	1
ME 154	Basic Manufacturing Techniques	2-0-2	3	IC 156	Basic Manufacturing Techniques	0-0-3	1.5
NC 102/ NO 102/ NS 102	National Cadet Corps (NCC) National Sports Organization (NSO) National Service Scheme (NSS)	0-0-0 0-0-0 0-0-0	P/NP P/NP P/NP	NC 102 / NO 102 / NS 102	National Cadet Corps (NCC) National Sports Organization (NSO) National Service Scheme (NSS)	0-0-0 0-0-0 0-0-0	P/NP P/NP P/NP
	Total	**15-3-7**	**21.5**		**Total**	**15-4-8**	**23**

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Sections and Course structure of 1st year BTech (from AY 2019-20 to AY 2022-23)

Section-A (CSE + CE + MEMS) **Classroom No. 1B-201, Titanium POD**				**Section-B (EE + ME)** **Classroom No. 1D-105, Chromium POD**			
1st (i.e. Autumn) Semester							
Course Code	**Course Title**	**Teaching Hours (L-T-P)**	**Credits**	**Course Code**	**Course Title**	**Teaching Hours (L-T-P)**	**Credits**
CH 103	Chemistry	3-1-0	4	BSE 102	Bio-Sciences	2-1-0	3
MA 105	Calculus	3-1-0	4	MA 105	Calculus	3-1-0	4
PH 105	Physics-I	2-1-0	3	PH 106	Physics-II	2-1-0	3
CS 103	Computer Programming	2-0-0	2	EE 104	Basic Electrical and Electronics Engineering	2-1-0	3
				ME 106	Basic Mechanical Engineering	2-1-0	3
HS 159	English Language and Communication	0-3-0	3	HS 108	Fundamentals of Economics	3-0-0	3
CH 153	Chemistry Lab	0-0-3	1.5	PH 156	Physics Lab	0-0-3	1.5
IC 151	Computer Programming Lab	0-0-3	1.5	EE 154	Basic Electrical and Electronics Engineering Lab	0-0-2	1
IC 153	Engineering Graphics	1-0-3	2.5	IC 156	Basic Manufacturing Techniques	0-0-3	1.5
NO 101	National Sports Organization (NSO)	0-0-0	P/NP	NO 101	National Sports Organization (NSO)	0-0-0	P/NP
	Total	**11-6-9**	**21.5**		**Total**	**14-5-8**	**23**
2nd (i.e. Spring) Semester							
BSE 102	Bio-Sciences	2-1-0	3	CH 103	Chemistry	3-1-0	4
MA 106	Linear Algebra and Ordinary Differential Equations-I	3-1-0	4	MA 106	Linear Algebra and Ordinary Differential Equations-I	3-1-0	4
PH 106	Physics-II	2-1-0	3	PH 105	Physics-I	2-1-0	3
EE 104	Basic Electrical and Electronics Engineering	2-1-0	3	CS 103	Computer Programming	2-0-0	2
ME 106	Basic Mechanical Engineering	2-1-0	3				

HS 108	Fundamentals of Economics	3-0-0	3	HS 159	English Language and Communication	0-3-0	3
EE 154	Basic Electrical and Electronics Engineering Lab	0-0-2	1	IC 151	Computer Programming Lab	0-0-3	1.5
PH 156	Physics Lab	0-0-3	1.5	CH 153	Chemistry Lab	0-0-3	1.5
IC 156	Basic Manufacturing Techniques	0-0-3	1.5	IC 153	Engineering Graphics	1-0-3	2.5
NO 102	National Sports Organization (NSO)		P/NP	NO 102	National Sports Organization (NSO)		P/NP
	Total	**14-5-8**	**23**		**Total**	**11-6-9**	**21.5**

Sections and Course structure of 1st year BTech (from AY 2023-24 onwards)

Section-A (CSE+CE+MEMS+CH+EP)			
Semester-I	**Autumn Semester**		
Course Code	**Course Title**	**Weekly Contact Hours (L-T-P)**	**Credits**
EE 101	Basic Electrical Engineering	1-1-0	2
ME 101	Engineering Mechanics	2-0-0	2
PH 107	Basics of Physics	2-1-0	3
PH 157	Physics Lab- I	0-0-2	1
MA 101N	Calculus-I (half Semester)	3-1-0 (=4/2)	2
MA 103N	Calculus-II (half Semester)	3-1-0 (=4/2)	2
HS 109	Language and Composition	2-0-0	2
HS XXX	Flexible Elective (HSS)	1-0-0	1
IC 152	Makerspace	1-0-6	4
CS 103	Computer Programming	2-0-0	2
IC 151	Computer Programming Lab	0-0-3	1.5
NO 101	National Sports Organization (NSO)	0-0-0	P/NP
	Total	**14-3-11**	**22.5**

Section-B (EE+ME+MC+SSE)			
Semester-I	**Autumn Semester**		
Course Code	**Course Title**	**Weekly Contact Hours (L-T-P)**	**Credits**
EE 101	Basic Electrical Engineering	1-1-0	2
ME 101	Engineering Mechanics	2-0-0	2
CH 105	Chemistry	3-0-0	3
CH 155	Chemistry Lab	0-0-2	1
MA 101N	Calculus-I (half Semester)	3-1-0 (=4/2)	2
MA 103N	Calculus-II (half Semester)	3-1-0 (=4/2)	2
HS 109	Language and Composition	2-0-0	2
HS XXX	Flexible Elective (HSS)	1-0-0	1
CS 103	Computer Programming	2-0-0	2
IC 151	Computer Programming Lab	0-0-3	1.5
NO 101	National Sports Organization (NSO)	0-0-0	P/NP
	Total	**14-2-5**	**18.5**

Semester-II	Spring Semester		
Course Code	**Course Title**	**Weekly Contact Hours (L-T-P)**	**Credits**
BSE 102	Biosciences	2-1-0	3
MA 102N	Linear Algebra (half Semester)	2-1-0 (=3/2)	1.5
MA 104N	Differential Equations-I (half Semester)	2-1-0 (=3/2)	1.5
ES 102	Environmental Studies: Scientific and Engineering Aspects (half Semester)	2-1-0 (=3/2)	1.5
HS 102	Environmental Studies: Social Aspects (half Semester)	2-1-0 (=3/2)	1.5
HS 104	Fundamentals of Economics	2-0-0	2
CH 105	Chemistry	3-0-0	3
CH 155	Chemistry Lab	0-0-2	1
ZZ XXX	Flexible Elective	1-0-0	1
ZZ XXX	Flexible Elective	1-0-0	1
ZZ XXX	Flexible Elective (HSS)	1-0-0	1
NO 102	National Sports Organization (NSO)	0-0-0	P/NP

Semester-II	Spring Semester		
Course Code	**Course Title**	**Weekly Contact Hours (L-T-P)**	**Credits**
BSE 102	Biosciences	2-1-0	3
MA 102N	Linear Algebra (half Semester)	2-1-0 (=3/2)	1.5
MA 104N	Differential Equations-I (half Semester)	2-1-0 (=3/2)	1.5
ES 102	Environmental Studies: Scientific and Engineering Aspects (half Semester)	2-1-0 (=3/2)	1.5
HS 102	Environmental Studies: Social Aspects (half Semester)	2-1-0 (=3/2)	1.5
HS 104	Fundamentals of Economics	2-0-0	2
IC 152	Makerspace	1-0-6	4
PH 107	Basics of Physics	2-1-0	3
PH 157	Physics Lab- I	0-0-2	1
ZZ XXX	Flexible Elective	1-0-0	1
ZZ XXX	Flexible Elective	1-0-0	1
ZZ XXX	Flexible Elective (HSS)	1-0-0	1

Total		**14-3-2**	**18**

NO 102	National Sports Organization (NSO)	0-0-0	P/NP
Total		**14-4-8**	**22**

2nd year Curriculum for BTech (Mechanical Engineering)

Semester III

Curriculum of 2nd Year B. Tech. (ME) (From AY 2011-12 to AY 2013-14)				**Curriculum of 2nd Year B. Tech. (ME)** [From AY 2014-15 to 2023-24]			
Course Code	**Course Title**	**Weekly L-T-P**	**Credits**	**Course Code**	**Course Title**	**Weekly L-T-P**	**Credits**
HS 201 / HS 203 / HS 205 HS 207	Understanding Philosophy / Psychology / Sociology / French Language – I	3-0-0 / 3-0-0 / 2-1-0 / 2-1-0	3 / 3 / 3 / 3	ZZ XXX	Course-I for Minor Program *	X-X-X	3
ME 201	Solid Mechanics	3-1-0	4	ME 201	Solid Mechanics	3-1-0	4
ME 203	Fluid Mechanics	3-1-0	4	ME 203	Fluid Mechanics	3-1-0	4
ME 205	Materials Science	2-1-0	3	MM 205	Materials Science	2-1-0	3
ME 251	Solid Mechanics Lab	0-0-3	1.5	ME 251	Solid Mechanics Lab	0-0-3	1.5
ME 257	Machine Drawing	1-0-3	2.5	ME 257	Machine Drawing	1-0-3	2.5
IC 211	Experimental Engineering Lab	0-0-3	1.5	IC 211	Experimental Engineering Lab	0-0-3	1.5
	Total	**12/11-3/4-9**	**19.5**		**Total**	**9-3-9**	**16.5 / 19.5**

Curriculum of 2nd Year B. Tech. (ME) [From AY 2024-25 onwards] **(Batch admitted in and after AY 2023-24)**			
Course Code	**Course Title**	**Weekly L-T-P**	**Credits**
ZZ XXX	Course-I for Minor Program	X-X-X	3
MA 205	Complex Analysis	3-1-0 (1/2 Sem)	2
MA 207	Differential Equations-II	3-1-0 (1/2 Sem)	2
ME 203N	Fluid Mechanics	2-1-0	3

ME 205N	Materials Science and Engineering	2-1-0 (1/2 Sem)	1.5
ME 207	Principles of Industrial Engineering	2-1-0	3
ME 201N	Solid Mechanics	2-1-0	3
ME 209	Thermodynamics	2-1-0	3
ME 251N	Solid Mechanics Lab	0-0-2	1
ME 2XX	Department Elective I	X-X-X	3
	Total		**21.5/23.5**

Semester IV

Curriculum of 2nd Year B. Tech. (ME) (From AY 2011-12 to AY 2013-14)				**Curriculum of 2nd Year B. Tech. (ME)** [From AY 2014-15 to 2023-24]			
Course Code	**Course Title**	**Weekly L-T-P**	**Credits**	**Course Code**	**Course Title**	**Weekly L-T-P**	**Credits**
HS 208	French Language – II +	2-1-0	3	ZZ XXX	Course-II for Minor Program	X-X-X	3
MA 204	Numerical Methods	3-1-0	4	MA 204	Numerical Methods	3-0-2	4
ME 202	Strength of Materials	3-1-0	4	ME 202	Strength of Materials	3-1-0	4
ME 204	Fluid Machinery	3-0-0	3	ME 204	Fluid Machinery	2-1-0	3
ME 206	Thermodynamics	3-1-0	4	ME 206	Thermodynamics	3-1-0	4
ME 208	Theory of Manufacturing Processes	3-0-0	3	ME 208	Theory of Manufacturing Processes	2-1-0	3
ME 254	Fluid Mechanics and Machinery Lab	0-0-3	1.5	ME 254	Fluid Mechanics and Machinery Lab	0-0-3	1.5
ME 258	Manufacturing Processes Lab	0-0-3	1.5	ME 258	Manufacturing Processes Lab	0-0-3	1.5
	Total	**15/17-3/4-6**	**21 / 24**		**Total**	**15-3-6**	**21 / 24**

+ ONLY for those students who have taken and passed HS 207 in their 3rd Semester.

Curriculum of 2nd Year B. Tech. (ME) [From AY 2024-25 onwards] **(Batch admitted in and after AY 2023-24)**			
Course Code	**Course Title**	**Weekly L-T-P**	**Credits**
ZZ xxx	Course-II for Minor Program	x-x-x	3
MA 204N	Numerical Methods	2-0-2	3
ME 204N	Fluid Machinery	2-0-0	2
ME 202N	Strength of Materials	2-1-0	3
ME 208	Theory of Manufacturing Processes	2-1-0	3
ME 214	Introduction to Additive Manufacturing	2-1-0 (1/2 Sem)	1.5
ME 256	Computer Aided Machine Drawing	1-0-2	2
ME 254N	Fluid Mechanics and Machinery Lab	0-0-2	1
ME 258N	Manufacturing Processes Lab	0-0-2	1
ME 2XX	Department Elective II	x-x-x	3
ZZ 2XX	Institute Elective I	x-x-x	3
	Total		**22.5/25.5**

3rd year Curriculum for BTech (Mechanical Engineering)

Semester V

Curriculum of 3rd Year B. Tech. (ME) (From AY 2011-12 to AY 2013-14)			
Course Code	**Course Title**	**Weekly L-T-P**	**Credits**
HS xxx	HSS Course	3-0-0	3
ME 301	Heat Transfer	3-1-0	4
ME 303	Kinematics and Dynamics of Machines	3-1-0	4
ME 305	Machining Science and Metrology	3-0-0	3

Curriculum of 3rdYear B. Tech. (ME) [From AY 2014-15 to 2024-25]			
Course Code	**Course Title**	**Weekly L-T-P**	**Credits**
ZZ XXX HS XXX	Course-III for Minor Program * HSS Elective (for 2012 batch only)	X-X-X	3 3
ME 301	Heat Transfer	3-1-0	4
ME 303	Kinematics and Dynamics of Machines	3-1-0	4
ME 305	Machining Science and Metrology	2-1-0	3

ME 307	Principles of Industrial Engineering	3-0-0	3		ME 307	Principles of Industrial Engineering	2-0-2	3
ME 351	Heat Transfer Lab	0-0-3	1.5		ME 351	Heat Transfer Lab	0-0-3	1.5
ME 353	Kinematics and Dynamics of Machines Lab	0-0-3	1.5		ME 353	Kinematics and Dynamics of Machines Lab	0-0-3	1.5
ME 355	Machining Science and Metrology Lab	0-0-2	1		ME 355	Machining Science and Metrology Lab	0-0-2	1
	Total	**15-2-8**	**21**			**Total**	**11-2-10**	**18 / 21**

Semester V

Curriculum of 3rd Year B. Tech. (ME) [From AY 2025-26 onwards] **(Batch admitted in and after AY 2023-24)**		
Course Code	**Course Title**	**L-T-P-C**
ZZ XXX	Course-III for Minor Program	X-X-X-3
ME 301N	Heat Transfer	2-1-0-3
ME 309	Instrumentation and Control Systems	2-0-0-2
ME 311	Introduction to Robotics	2-1-0-1.5 (Half-Sem)
ME 305	Machining Science and Metrology	2-1-0-3
ME 351N	Heat Transfer Lab	0-0-2-1
ME 357	Instrumentation & Control Systems Lab	0-0-3-1.5
ME 355	Machining Science and Metrology Lab	0-0-2-1
ME 313	Introduction to Finite Element Methods	2-1-0-1.5 (Half-Sem)
ME XXX	Department Elective-III	X-X-X-3
ZZ XXX	Institute Elective-II	X-X-X-3
	Total Credit	**20.5/23.5**

Department Elective - III

Course Code	Course Title	L-T-P-C
ME 315	Operations Research	2-1-0-3
ME 317	Trends and Development in Solid Mechanics	2-1-0-1.5 (Half-Sem)
ME 319	Solid-State Cooling Technologies	2-1-0-3
ME 321	Introduction to Hybrid Additive Manufacturing Techniques	2-1-0 -1.5 (Half-Sem)
ME 323	Mechanics of Sheet Metal Forming Processes	2-1-0-1.5 (Half-Sem)
ME 325	Textiles for Noise Control	2-1-0-3

Semester VI

Curriculum of 3rd Year B. Tech. (ME) (From AY 2011-12 to AY 2013-14)				**Curriculum of 3rd Year B. Tech. (ME)** [From AY 2014-15 to AY 2024-25]			
Course Code	**Course Title**	**Weekly L-T-P**	**Credits**	**Course Code**	**Course Title**	**Weekly L-T-P**	**Credits**
HS 302	Environmental Studies: Social Aspects (Half Semester course)	3-0-0	1.5	HS 302	Environmental Studies: Social Aspects (Half Semester course)	3-0-0	1.5
ES 302	Environmental Studies: Scientific and Engineering Aspects (Half Semester course)	3-0-0	1.5	ES 302	Environmental Studies: Scientific and Engineering Aspects (Half Semester course)	3-0-0	1.5
ME 302	Applied Thermodynamics	3-0-0	3	ME 302	Applied Thermodynamics	2-1-0	3
ME 304	Instrumentation and Control Systems	3-0-0	3	ME 304	Instrumentation and Control Systems	2-1-0	3
ME 306	Machine Design-I	2-2-0	4	ME 306	Machine Design-I	2-2-0	4
ME 308	Quality Management	3-0-0	3	ME 308	Quality Management	2-1-0	3
ME 352	Applied Thermodynamics Lab	0-0-3	1.5	ME 352	Applied Thermodynamics Lab	0-0-3	1.5

ME 354	Instrumentation and Control Systems Lab	0-0-3	1.5		ME 354	Instrumentation and Control Systems Lab	0-0-3	1.5
ME 391	Summer Internship (After the completion of the 6th semester)							
	Total	**14-2-6**	**19**			**Total**	**14-2-6**	**19**

Semester VI

Curriculum of 3rd Year B. Tech. (ME) [From AY 2025-26 onwards] **(Batch admitted in and after AY 2023-24)**		
Course Code	**Course Title**	**Weekly L-T-P**
ZZ XXX	Course-IV for Minor Program*	X-X-X-3
ME 302	Applied Thermodynamics	2-1-0-3
ME 310	Design of Machine Elements	2-1-0-3
ME 312	Introduction to Computational Fluid Dynamics	2-1-0-1.5 (Half-Sem)
ME 314	Kinematics & Dynamics of Machines	2-1-0-3
ME 352N	Applied Thermodynamics Lab	0-0-2-1
ME 356	Kinematics & Dynamics of Machines Lab	0-0-2-1
ME XXX	Department Elective-IV	X-X-X-3
ME XXX	Department Elective-V	X-X-X-3
ZZ XXX	Institute Elective-III	X-X-X-3
	Total Credit	**21.5/24.5**

Department Elective - IV and V

Course Code	**Course Title**	**L-T-P-C**
ME 316	Automobile Engineering	2-1-0-3
ME 318	Mechatronics System Design	2-1-0-3
ME 320	Experimental Methods in Thermal Science	2-0-2-1.5 (Half-Sem)

ME 322	Introduction to Electric Vehicles	2-1-0-1.5 (Half-Sem)
ME 324	Applied Impact Mechanics	2-1-0 -1.5 (Half-Sem)
ME 328	Surface Modification Methods	2-0-2-1.5 (Half-Sem)

4th year Curriculum for BTech (Mechanical Engineering)

Semester VII

Curriculum of 4th Year B. Tech. (ME) (From AY 2011-12 to AY 2013-14)					**Curriculum of 4th Year B. Tech. (ME)** [From AY 2014-15 onwards]			
Course Code	**Course Title**	**Weekly L-T-P**	**Credits**		**Course Code**	**Course Title**	**Weekly L-T-P**	**Credits**
ME 401	Machine Design-II	2-2-0	4		ME 493	**B Tech Project (BTP)** 1. Student can do B Tech project either outside the institute or within the institute under a supervision of an IIT Indore Faculty. 2. Summer Internship, if any, will be part of B Tech Project. 3. The choice is to be made latest by 30th April. 4. Duration: 6-7 months during 2nd week of May to Last week of Nov. 5. Last Date of Thesis submission: 1st week of Dec 6. Last Date of Submission of Grades: 2nd week Dec.	0-0-40	20
ME xxx	Department Elective-I	3-0-0	3					
ME xxx	Department Elective-II	x-x-x	3					
XX xxx	Institute Elective-I	x-x-x	3					
ME 491	B.Tech. Project (Stage 1)	0-0-12	6					
ME 391	Evaluation of Summer Internship	0-2-0	2					
		Total	21				**Total**	**20**

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Curriculum of 4th Year B. Tech. (ME) (From AY 2026-27 onwards) (Batch admitted in and after AY 2023-24)			
Course Code	**Course Code**	**Course Code**	**Credits**
Course Code	**Course Name**	**Weekly Contact Hours L-T-P**	**Credit**
ZZ XXX	Course-V for Minor project/field study/white paper/domain comprehension (Seminar)/Lab course	x-x-x	2
ZZ 493N	B. Tech Project (BTP)	0-0-32	16
ZZ 495 ZZ XXX	Internship **OR** Professional/ Societal-Connect basket course	x-x-x	1.5
	Total		**17.5/19.5**

Semester VIII

Curriculum of 4th Year B. Tech. (ME) (From AY 2011-12 to AY 2013-14)				Curriculum of 4th Year B. Tech. (ME) [From AY 2014-15 to AY 2019-20]			
Course Code	**Course Title**	**Weekly L-T-P**	**Credits**	**Course Code**	**Course Title**	**Weekly L-T-P**	**Credits**
ME xxx	Department Elective – III	x-x-x	3	ME 401	Machine Design-II	2-2-0	4
ME xxx	Department Elective – IV	x-x-x	3	ZZ xxx	Elective-I	x-x-x	3
ME xxx	Department Elective - V	x-x-x	3	ZZ xxx	Elective-II	x-x-x	3
ME xxx	Department Elective - VI	x-x-x	3	ZZ xxx	Elective-III	x-x-x	3
XX xxx	Institute Elective – II	x-x-x	3	ZZ xxx	Elective-IV (or Course-IV for Minor Program*)	x-x-x	3

ME 492	B. Tech. Project (Stage 2)	0-0-12	6
	Total		**21**

ZZ xxx	Elective-V (or Course-V for Minor Program*)	x-x-x	3
	Total		**19**

Curriculum of 4th Year B. Tech. (ME)
[From AY 2020-21 to AY 2025-26]

ME 401	Machine Design-II	2-2-0	4
ME xxx	Department Elective-I	x-x-x	3
ME xxx	Department Elective-II	x-x-x	3
ME xxx	Department Elective-III	x-x-x	3
ZZ xxx	Open Elective-I (or Course-IV for Minor Program*)	x-x-x	3
ZZ xxx	Open Elective-II (or Course-V for Minor Program*)	x-x-x	3
		Total	**19**

From the 2013 BTech batch onwards.

Curriculum of 4th Year B. Tech. (ME)
(From AY 2026-27 onwards) (Batch admitted in and after AY 2023-24)

Course Code	Course Code	Course Code	Credits
ME 4XX	Department Elective VI	X – X - X	3
ME 4XX	Department Elective VII	X – X - X	3
ZZ 4XX	Institute Elective IV	X – X - X	3
ZZ 4XX	Institute Elective V	X – X - X	3
ZZ 4XX	Institute Elective VI	X – X - X	3
	Total		**15**

Curriculum of **5-Year Degree Program with BTech (ME) and MTech (PIE) and B Tech + PhD (from AY 2014-15 onwards)**
Semester VII

Course Code	Subject Name	Weekly L-T-P	Credits
ME 655	Advanced Manufacturing Processes	2-1-0	3
ME 657	Mechatronics and Metrology	3-0-2	4
ME 659 / ME 459	Micro and Precision Manufacturing	2-0-2	3
MM 661	Materials Science and Engineering	2-1-0	3
ME 675 / MA 675	Probability and Statistical Methods	2-0-2	3
ZZ XXX	Elective-I	X-X-X	3
		Total	**19**

Semester VIII

Course Code	Subject Name	Weekly L-T-P	Credits
ME 401	Machine Design II *	2-2-0	4
ME 672/ ME 472	Reliability Engineering	2-0-2	3
ME 650	Materials Characterization Techniques	2-0-2	3
ME 660/ ME 460	Technology of Surface Coatings	2-1-0	3
ME 698	PG seminar course	0-2-0	2
ZZ XXX	Elective-II	X-X-X	3
ZZ XXX	Elective-III	X-X-X	3
		Total	**21**

Semester IX

Course Code	Course Name	Weekly L-T-P	Credits (Grade)
ME 799 (ZZ 899+)	M. Tech. Research Project (Stage-I) (PhD Thesis)	0-0-36	18 (SS/US)

Semester X

Course Code	Course Name	Weekly L-T-P	Credits (Grade)
ME 800 (ZZ 899 +)	M. Tech. Research Project (Stage-II) (PhD Thesis)	0-0-36	18 (SS/US)
Total minimum credits to be earned during the program			**163.5/ 166.5**

*** Only** for BTech students of IITI admitted to this program**.**

+ A student will have choice to convert his/her MTech program to the PhD program during its 2nd semester of MTech or 8th semester of BTech + MTech program.

Mechanical Engineering Courses for Elective-I @

ME 653/ ME 453	Computer Aided Manufacturing	2-0-2	3
ME 663	Theory of Conventional Machining	2-1-0	3
ME 671/ ME 471 / MA 671	Operations Research	2-0-2	3
ME 751/ ME 451	Theory of Advanced Machining Processes	2-0-2	3

Mechanical Engineering Courses for Elective-II, III @

ME 640/ ME 440	Smart Materials and Structures	2-1-0	3
ME 644/ ME 444	Robotics	2-0-2	3
ME 646/ ME 446	Dynamics and Control Systems	2-1-0	3
ME 648/ ME 448	MEMS and Micro System Design	2-1-0	3
ME 654/ ME454	Rapid Product Manufacturing	2-0-2	3
ME 658/ ME 458	Laser based Measurements and Micro-Manufacturing	2-1-0	3
ME 468/ ME 668	Propulsion System	2-1-0	3
ME 470/ ME 670	Machine Component Design	2-1-0	3
ME 730	Theory of Elasticity	2-1-0	3
ME 736/ ME 436	Finite Element Analysis	2-0-2	3
ME 738/ ME 438	Composite Materials	2-1-0	3

ME 756/ ME 456	Industrial Automation	2-0-2	3
ME 482/682	Heat and Mass Transfer in Textiles	2-1-0	3
ME 484/ 684	Transport Phenomena in Porous Textiles	2-1-0	3
ME 486/686	Technical Textiles for Ballistic Protection	2-1-0	3

@ In addition to this course list, a student can also opt from the PG courses being offered by any other Department.

Department Elective - I From AY 2024-25 onwards			
Course Code	**Course Title**	**Weekly L-T-P**	**Credits**
ME 217	Industrial Data Analytics	2-1-0	3
ME 219	Energy Storage Systems	2-1-0 (Half-Sem)	1.5
ME 221	Optical Measurement Techniques in Fluid Mechanics	2-1-0 (Half-Sem)	1.5
ME 223	Design Thinking	2-1-0 (Half-Sem)	1.5
ME 225	Fundamentals of Vibrations	2-1-0 (Half-Sem)	1.5
ME 227	Plastic Parts Manufacturing	2-0-2 (Half-Sem)	1.5

Department Elective - II From AY 2024-25 onwards			
Course Code	**Course Title**	**Weekly L-T-P**	**Credits**
ME 216	Thermal Systems and Applications	2-1-0 (Half-Sem)	1.5
ME 218	Quality Management	2-1-0 (Half-Sem)	1.5
ME 220	Fundamentals of Acoustics	2-1-0 (Half-Sem)	1.5
ME 222	Introduction to Experimental Aerodynamics	2-1-0 (Half-Sem)	1.5
ME 224	Fundamentals of Microscale Flows	2-1-0 (Half-Sem)	1.5
ME 228	High Strain rate Forming Process	2-1-0 (Half-Sem)	1.5
ME 230	Introduction to Smart Materials	2-1-0 (Half-Sem)	1.5

Curriculum of 5-Year Degree Program with B.Tech. (ME) and M.Tech. (MSD) and B.Tech. + Ph.D. (from AY 2021-22 onwards)

Semester VII

Course Code	Subject Code	Weekly L-T-P	Credits
ME 646/ ME 446	Dynamics and Control Systems	2-1-0	3
ME 647	Dynamics and Control Systems Lab	0-0-3	1.5
ME 730	Theory of Elasticity	2-1-0	3
ME 736/ ME 436	Finite Element Methods	2-0-2	3
ME 738/ ME 438	Composite Materials	2-1-0	3
ZZ XXX	Elective – I	X-X-X	3
Total minimum credits earned during the semester			**16.5**

Semester VIII

Course Code	Subject Code	Weekly L-T-P	Credits
ME 401	Machine Design II*	2-2-0	4
ME 632/ 432	Vibrations and Noise Control	2-1-0	3
ME 634/ 434	Principle of Product Design	2-1-0	3
ME 637/ 437	Fracture Mechanics	2-1-0	3
ME 656	Vibrations and Noise Control Lab	0-0-3	1.5
ZZ XXX	Elective – II	X-X-X	3
ZZ XXX	Elective – III	X-X-X	3
ME 698	PG seminar course	0-2-0	2
Total minimum credits earned during the semester			**22.5**

Semester IX

Course Code	Subject Code	Weekly L-T-P	Credits (Grades)
ME 799 (ZZ 899+)	M.Tech. Research Project (Stage-I) (PhD Thesis)	0-0-36	18 (SS/US)

Semester X

Course Code	Subject Code	Weekly L-T-P	Credits (Grades)

ME 800 (ZZ 899+)	M.Tech. Research Project (Stage-II) (PhD Thesis)	0-0-36	18 (SS/US)

Mechanical Engineering Courses for Elective I, II and III @			
Course Code	**Subject Code**	**Weekly L-T-P**	**Credits**
ME 607/ ME 407	Biofluid Mechanics	2-1-0	3
ME 608/ ME 408	Hybrid Electric Vehicles	2-1-0	3
ME 630	Robotic Control Systems	2-1-2	4
ME 639/ 439	Mechanical Behavior of Materials	2-1-0	3
ME 640/ ME 440	Smart Materials and Structures	2-1-0	3
ME 641/ 441	Design of Laminated Composite Structures	2-1-0	3
ME 643/ 443	Micromechanics and Nanomechanics	2-1-0	3
ME 644/ ME 444	Robotics	2-0-2	3
ME 648/ ME 448	MEM.S. and Micro-System Design	2-1-0	3
ME 756/ ME 456	Industrial Automation	2-0-2	3

@ In addition to this course list, a student can also opt from the PG courses being offered by the other Departments.
***Only for B.Tech. students of IITI admitted to this program.**
+A student will have choice to convert his/her M.Tech. program to the Ph.D. program during its 2nd semester of M.Tech. or 8th semester of B.Tech. + M.Tech. program.

ME Courses available for the Elective Course in the 8th Semester of BTech in ME (From AY 2014-15 onwards)

Structure of the Minor programs [from AY 2014-15 to AY 2020-21]

A student has to register and pass at least FIVE courses (three core courses and two elective courses) as prescribed for a minor program in order to get a minor degree in that specialization along with the regular BTech degree in his/her engineering Department. A minor program will run only when at least TEN students register for it. Following minor programs are available from AY 2014-15 onwards.

1. Minor program in Biosciences and Biomedical Engineering (BSBE): To get a minor degree in BSBE, a student needs to register and pass **at least FIVE prescribed** courses ***excluding the core course*** BSE 101 Bio-Sciences for successful minor degree in BSBE.

2. MINOR PROGRAM IN CHEMISTRY: To get a minor degree in Chemistry, a student needs to register and pass **at least FIVE prescribed** courses ***excluding the core course CH 103.*** Following are courses for successful minor degree in Chemistry.

3. Minor Program in HSS: A student needs to register and pass **at least FIVE prescribed courses of Humanities and Social Sciences** ***excluding the core courses*** HS 159 and HS 108 for successful minor degree in Humanities or Social Sciences.

4. **Minor Program in Astronomy (from AY 2016-17):** To get a minor degree in Astronomy, a student needs to register and pass **at least FIVE prescribed** courses***.*** Following are courses for successful minor degree in Astronomy.

Course structures of various Minor programs

Semester: Minor course	**Minor Program in BSBE**	**Minor Program in Chemistry**	**Minor Program in Humanities and Social Sciences**	**Minor Program in Astronomy (from AY 2016-17 onwards)**
3rd : Minor1	BSE 201: Biophysics	CH 201: Molecules that Change the World	HS 201: Understanding Philosophy HS 203: Psychology HS 205: Sociology HS 207: French Language-I	AA 201: Introduction to Astronomy
4th : Minor 2	BSE 202: Biomedical Technologies	CH 202: Chemistry of Transition Metals and Lanthanides &	HS 206: Paradigms and Turning Points # HS 208: French Language-II HS 210: Indian Economy HS 211: German Literature and Culture Studies HS 214: History of Indian Culture and Civilization HS 216: Introduction to Hindi Cinema	AA 202N: Astronomical Techniques
5th : Minor 3	BSE 301: Introduction to Molecular Biology	CH 301: Functional Materials	HS 311: Life and Thought of Gandhi HS 313: History of Early Cinema HS 315: Sociology of Science and Technology HS 323: International Economics HS 341: Appreciating Indian English Literature	AA 301: High Energy Astronomy
8th : Two elective	BSE 402: Cancer Diagnosis and Therapy	CH 402: Chemistry in Industry	IHS 402: Twentieth Century World History: Critical Perspectives	AA 404/ AA 604: Spacecraft and Payload Attitude

courses as Minor 4 and Minor 5	BSE 404/ BSE 604: Biomedical Imaging BSE 405/ BSE 605: Molecular Biophysics BSE 413/ BSE 613: Omics Technologies BSE 417/ BSE 617: Biomolecular Modeling EE 419/ EE 619: Biomedical Optics ME 407/ME 607: Bio-fluid Mechanics	CH 404: Chemical Physics CH 406: Nuclear Science	HS 412/ 612: Contemporary Indian Thought HS 418/ 618: Sustainability Studies HS 424/ HS 624: Econometrics-I IHS 422 / HS 622: Development Economics IHS 425: Money and Banking HS 426: Economics of Innovation HS 442/ HS 642: Language and Mind IHS 443/ HS 643: Contemporary Short Fiction IHS 444: Literature of the Twentieth Century IHS 482: Introduction to International Development and Area Studies	Dynamics, Control and Pointing AA 471N/ AA 671N: Relativity and Cosmology AA 472N/ AA 672N: Galactic and Extragalactic Astronomy AA 474 / AA 674: Basics of Radio Astronomy AA 476/ AA 676: Satellite Based Navigation Systems AA 478/ AA 678: Space Weather

[&] *A student who takes CH 202 will not be allowed to take ME 416/616 in his/her 8th Semester*

Structure of the Minor programs [For AY 2021-22]

A student has to register and pass at least FIVE courses (three core courses and two elective courses) as prescribed for a minor program in order to get a minor degree in that specialization along with the regular BTech degree in his/her engineering Department. A minor program will run only when at least TEN students register for it. Following minor programs are available from AY 2014-15 onwards.

1. Minor program in Biosciences and Biomedical Engineering (BSBE): To get a minor degree in BSBE, a student needs to register and pass **at least FIVE prescribed** courses ***excluding the core course*** BSE 101 Bio-Sciences for successful minor degree in BSBE.

2. MINOR PROGRAM IN CHEMISTRY: To get a minor degree in Chemistry, a student needs to register and pass **at least FIVE prescribed** courses ***excluding the core course CH 103.*** Following are courses for successful minor degree in Chemistry.

3. Minor Program in HSS: A student needs to register and pass **at least FIVE prescribed courses of Humanities and Social Sciences** ***excluding the core courses*** HS 159 and HS 108 for successful minor degree in Humanities or Social Sciences.

4. **Minor Program in Astronomy (from AY 2016-17):** To get a minor degree in Astronomy, a student needs to register and pass **at least FIVE prescribed** courses***.*** Following are courses for successful minor degree in Astronomy.

Course structures of various Minor programs

Semester: Minor course	**Minor Program in BSBE**	**Minor Program in Chemistry**	**Minor Program in Humanities and Social Sciences**	**Minor Program in Astronomy (from AY 2016-17 to AY 2021-22)**
3rd : Minor1	BSE 201: Biophysics	CH 201: Molecules that Change the World	HS 201: Understanding Philosophy HS 203: Psychology HS 205: Sociology HS 207: French Language-I	AA 201: Introduction to Astronomy
4th : Minor 2	BSE 202: Biomedical Technologies	CH 202: Chemistry of Transition Metals and Lanthanides &	HS 206: Paradigms and Turning Points # HS 208: French Language-II HS 210: Indian Economy HS 211: German Literature and Culture Studies HS 214: History of Indian Culture and Civilization HS 216: Introduction to Hindi Cinema	AA 202N: Astronomical Techniques AA 204: Introduction to Space Exploration
5th : Minor 3	BSE 301: Introduction to	CH 301: Functional	HS 311: Life and Thought of Gandhi	AA 301: High Energy

	Molecular Biology	Materials	HS 313: History of Early Cinema HS 315: Sociology of Science and Technology HS 323: International Economics HS 341: Appreciating Indian English Literature	Astronomy AA 303: IoT for Space Applications
8th : Two elective courses as Minor 4 and Minor 5	BSE 402: Cancer Diagnosis and Therapy BSE 404/ BSE 604: Biomedical Imaging BSE 405/ BSE 605: Molecular Biophysics BSE 413/ BSE 613: Omics Technologies BSE 417/ BSE 617: Biomolecular Modeling BSE 419/ BSE 619: Renewable Energy Technologies EE 419/ EE 619: Biomedical Optics ME 407/ME 607: Bio-fluid Mechanics	CH 402: Chemistry in Industry CH 404: Chemical Physics CH 406: Nuclear Science	IHS 402: Twentieth Century World History: Critical Perspectives HS 412/ 612: Contemporary Indian Thought HS 418/ 618: Sustainability Studies HS 424/ HS 624: Econometrics-I IHS 422 / HS 622: Development Economics IHS 425: Money and Banking HS 426: Economics of Innovation HS 442/ HS 642: Language and Mind IHS 443/ HS 643: Contemporary Short Fiction IHS 444: Literature of the Twentieth Century IHS 482: Introduction to International Development and Area Studies	AA 404/ AA 604: Spacecraft and Payload Attitude Dynamics, Control and Pointing AA 471N/ AA 671N: Relativity and Cosmology AA 472N/ AA 672N: Galactic and Extragalactic Astronomy AA 474 / AA 674: Basics of Radio Astronomy AA 476/ AA 676: Satellite Based Navigation Systems AA 478/ AA 678: Space Weather

& A student who takes CH 202 will not be allowed to take ME 416/616 in his/her 8th Semester

Structure of the Minor programs [from AY 2022-23 onwards]

A student has to register and pass at least FIVE courses (three core courses and two elective courses) as prescribed for a minor program in order to get a minor degree in that specialization along with the regular BTech degree in his/her engineering Department. A minor program will run only when at least TEN students register for it. Following minor programs are available from AY 2014-15 onwards.

1. Minor program in Biosciences and Biomedical Engineering (BSBE): To get a minor degree in BSBE, a student needs to register and pass **at least FIVE prescribed** courses ***excluding the core course*** BSE 101 Bio-Sciences for successful minor degree in BSBE.

2. MINOR PROGRAM IN CHEMISTRY: To get a minor degree in Chemistry, a student needs to register and pass **at least FIVE prescribed** courses ***excluding the core course CH 103.*** Following are courses for successful minor degree in Chemistry.

3. Minor Program in Economics: A student needs to register and pass **at least FIVE prescribed courses of Humanities and Social Sciences** ***excluding the core courses*** HS 159 and HS 108 for successful minor degree in Humanities or Social Sciences.

4. **Minor Program in Liberal Arts**

5. **Minor Program in Astronomy and Space Engineering (from AY 2022-23):** To get a minor degree in Astronomy, a student needs to register and pass **at least FIVE prescribed** courses**.** Following are courses for successful minor degree in Astronomy.

Course structures of various Minor programs

Semester: Minor course	**Minor Program in BSBE**	**Minor Program in Chemistry**	**Minor Program in Economics (from AY 2022-23 onwards with BTech batch admitted in AY 2021-22)**	**Minor Program in Liberal Arts (from AY 2022-23 onwards with BTech batch admitted in AY 2021-22)**	**Minor Program in Astronomy (from AY 2016-17 to AY 2021-22)** **Minor Program in Astronomy and Space Engineering (from AY 2022-23 onwards with BTech batch admitted in AY 2021-22)**
3rd : Minor1	BSE 201: Biophysics	CH 201: Molecules that Change the World	HS 209: Intermediate Microeconomics	HS 201: Understanding Philosophy HS 203: Psychology HS 205: Sociology HS 207: French Language-I	AA 201: Introduction to Astronomy

4th : Minor 2	BSE 202: Biomedical Technologies	CH 202: Chemistry of Transition Metals and Lanthanides &	HS 210: Indian Economy	HS 206: Paradigms and Turning Points HS 208: French Language-II HS 211: German Literature and Culture Studies HS 212: History of India after Independence, 1947-2000 HS 213: Cognitive Psychology HS 214: History of Indian Culture and Civilization HS 216: Introduction to Hindi Cinema	AA 202N: Astronomical Techniques AA 204: Introduction to Space Exploration
5th : Minor 3	BSE 301: Introduction to Molecular Biology	CH 301: Functional Materials	HS 323: International Economics HS 325: Industrial Organization	HS 311: Life and Thought of Gandhi HS 313: History of Early Cinema HS 315: Sociology of Science and Technology HS 321: History of Modern Indian Business HS 327: Mind, Action, and Technology HS 341: Appreciating Indian English Literature	AA 301: High Energy Astronomy AA 303: IoT for Space Applications

8th : Two elective courses as Minor 4 and Minor 5	BSE 402: Cancer Diagnosis and Therapy BSE 404/ BSE 604: Biomedical Imaging BSE 405/ BSE 605: Molecular Biophysics BSE 413/ BSE 613: Omics Technologies BSE 417/ BSE 617: Biomolecular Modeling BSE 419/ BSE 619: Renewable Energy Technologies EE 419/ EE 619: Biomedical Optics ME 407/ME 607: Bio-fluid Mechanics	CH 402: Chemistry in Industry CH 404: Chemical Physics CH 406: Nuclear Science	HS 418/ 618: Sustainability Studies IHS 422 / HS 622: Development Economics IHS 425: Money and Banking HS 426: Economics of Innovation HS 424/ HS 624 Econometrics-I HS 431: Innovation and Intellectual Property Rights	IHS 402: Twentieth Century World History: Critical Perspectives HS 412/ 612: Contemporary Indian Thought HS 442/ HS 642: Language and Mind IHS 443/ HS 643: Contemporary Short Fiction IHS 444: Literature of the Twentieth Century IHS 482: Introduction to International Development and Area Studies HS 446: Music and Literary Modernism HS 481/ HS 681: Language, Mind and Society	AA 404/ AA 604: Spacecraft and Payload Attitude Dynamics, Control and Pointing AA 410/ AA 410: Spatial Informatics AA 412/ AA 612: Microwave Remote Sensing AA 471N/ AA 671N: Relativity and Cosmology AA 472N/ AA 672N: Galactic and Extragalactic Astronomy AA 474 / AA 674: Basics of Radio Astronomy AA 476/ AA 676: Satellite Based Navigation Systems AA 478/ AA 678: Space Weather

Structure of the Minor programs for AY 2024-25 onwards (For all UG batches admitted in and after AY 2023-24)

A student has to register and pass at least FIVE courses (three core courses and two elective courses) as prescribed for a minor program in order to get a minor degree in that specialization along with the regular BTech degree in his/her engineering Department. A minor program will run only when at least TEN students register for it. Following minor programs are available from AY 2014-15 onwards.

1. Minor program in Biosciences and Biomedical Engineering (BSBE): To get a minor degree in BSBE, a student needs to register and pass **at least FIVE prescribed** courses ***excluding the core course*** BSE 101 Bio-Sciences for successful minor degree in BSBE.

2. MINOR PROGRAM IN CHEMISTRY: To get a minor degree in Chemistry, a student needs to register and pass **at least FIVE prescribed** courses ***excluding the core course CH 103.*** Following are courses for successful minor degree in Chemistry.

3. Minor Program in Economics: A student needs to register and pass **at least FIVE prescribed courses of Humanities and Social Sciences** ***excluding the core courses*** HS 159 and HS 108 for successful minor degree in Humanities or Social Sciences.

4. **Minor Program in Liberal Arts**

5. **Minor Program in Astronomy and Space Engineering (from AY 2022-23):** To get a minor degree in Astronomy, a student needs to register and pass **at least FIVE prescribed** courses**.** Following are courses for successful minor degree in Astronomy.

Course structures of various Minor programs

Semester: Minor course	**Minor Program in BSBE**	**Minor Program in Chemistry**	**Minor Program in Economics From AY 2024-25 (Batch Admitted in and after AY 2023-24)**	**Minor Program in Liberal Arts From AY 2024-25 (Batch Admitted in and after AY 2023-24)**	**Minor Program in Astronomy and Space Engineering From AY 2024-25 (Batch Admitted in and after AY 2023-24)**
3rd : Minor1	BSE 201: Biophysics	CH 201: Molecules that Change the World	HS 209: Intermediate Microeconomics	HS 211: German Literature and Culture Studies HS 212: History of India after Independence, 1947-2000 HS 203: Psychology	AA 201: Introduction to Astronomy

				HS 205: Sociology HS 221 Fundamentals of Linguistics HS 223 Language Variation: Culture and Society	
4th : Minor 2	BSE 202: Biomedical Technologies	CH 202: Chemistry of Transition Metals and Lanthanides &	HS 210: Indian Economy	HS 206: Paradigms and Turning Points HS 214: History of Indian Culture and Civilization HS 213: Cognitive Psychology HS 224 Contemporary Short Fiction HS 226 Sociology of Cinema	AA 202N: Astronomical Techniques AA 204: Introduction to Space Exploration
5th : Minor 3	BSE 301: Introduction to Molecular Biology	CH 301: Functional Materials	HS 323: International Economics HS 321: History of Modern Indian Business	HS 311: Life and Thought of Gandhi HS 327: Mind, Action, and Technology HS 341: Appreciating Indian English Literature	AA 301: High Energy Astronomy AA 303: IoT for Space Applications
6TH : Minor 4			HS 325: Industrial Organization	HS 315: Sociology of Science and Technology HS 328 Philosophy and Film HS 330 Graphic Literature	

7th : (minor project/field study/white paper/domain comprehension (Seminar)/Lab course)	(0-0-4-2) (minor project/field study/white paper/domain comprehension (Seminar)/Lab course)	(0-0-4-2) (minor project/field study/white paper/domain comprehension (Seminar)/Lab course)	(0-0-4-2) (minor project/field study/white paper/domain comprehension (Seminar)/Lab course)	(0-0-4-2) (minor project/field study/white paper/domain comprehension (Seminar)/Lab course)	(0-0-4-2) (minor project/field study/white paper/domain comprehension (Seminar)/Lab course)

Syllabi
of
Mechanical Engineering Courses

Course Code	**ME 104** [from AY 2010-11 to AY 2013-14]
Title of the Course	**Basic Mechanical Engineering**
Credit Structure	L-T-P-Credits 3-0-0-3
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	None
Scope of the course	
Course Syllabus	**Thermodynamics:** Definition and scope of thermodynamics, fundamentals and laws of thermodynamics, vapour compression and absorption refrigeration cycles, psychometry and its uses. **Heat Transfer:** Various modes of heat transfer: conduction, convection and radiation, black body, heat exchangers. **Energy Conversion:** Various types of power plants, steam power plants and accessories, renewable energy. **Internal Combustion (IC) Engines:** Otto and diesel cycle, 2-stroke and 4- stroke engines, alternative fuels **Fluid Mechanics:** Fundamental Concepts, Flow through Pipes, Laminar Boundary Layers, Introduction and classification of Turbo machines **Power and Motion Transmission Devices**: Belt drive, Chain drive and Gear drive. Introduction to Flywheels, Governors, Clutches and Brakes.
Suggested Books	1. Y.A. Cengel and M.A. Boles, **Thermodynamics: An Engineering Approach** (6th Edition), Tata McGraw Hill, New Delhi, 2008. 2. P.K. Nag, **Engineering Thermodynamics** (2nd edition), Tata McGraw Hill, New Delhi, 2003. (ISBN: 0-07-460275-6). 3. S.K. Som and G. Biswas, **Introduction to Fluid Mechanics and Fluid Machines** (2nd Edition), Tata McGraw-Hill Publishing Company, New Delhi, 2008. 4. S.S. Rattan, **Theory of Machines**, (2nd Edition) Tata McGraw Hill, New Delhi, 2005.

Course Code	**ME 106** [from AY 2014-15 onward]
Title of the Course	**Basic Mechanical Engineering**
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	None
Scope of the course	Introduces all the basic concepts of Mechanical Engineering
Course Syllabus	**Introduction to Manufacturing:** Relating manufacturing, design, assembly, metrology, quality control and service to each other. Selection of manufacturing processes. **Introduction to metal casting processes:** Sand molding and casting process. Outline of popular casting methods with easy examples of products being manufactured by them. Basic idea of steel solidification. **Introduction to joining methods:** Concept of temporary semi-permanent and permanent joints. Shielded metal arc welding and oxy-fuel gas welding processes. Outline of different fusion and non-fusion welding processes and their applications. Idea of weldability. **Introduction to machine tools:** Preliminary idea of basic machine tools, hand tools and their operations. Ways of specifying tools and operations. Composition of cutting tool materials. Introduction to CNC machine tools. **Introduction to metal forming operations:** Fundamentals of mechanical behavior of materials. Basic requirements for bulk deformation of metals. Cold and hot working processes. Application of various forming processes. **Thermal Engineering:** Definition and scope of thermodynamics, fundamentals and laws of thermodynamics, vapour compression and absorption refrigeration cycles, psychometry and its uses. Otto and diesel cycle, 2- stroke and 4- stroke engines, alternative fuels Various types of power plants, steam power plants and accessories, renewable energy. **Power and Motion Transmission Devices**: Belt drive, Chain drive and Gear drive. Introduction to Flywheels, Governors, Clutches and Brakes.
Suggested Books	1. E.P. DeGarmo, J.T. Black, and R. A. Kohser, **Materials and Processes in Manufacturing** (8th edition), Prentice Hall of India Pvt. Limited, New Delhi, 2006. 2. P.N. Rao, **Manufacturing Technology: Volume-1 and**

	Volume-2 (3rd edition), Tata McGraw Hill, New Delhi, 2009. 3. S.K. Hajra Choudhury, S.K. Bose, and A.K. Hajra Choudhury, **Elements of Workshop Technology: Vol. I and Vol. II** (14th Edition) Media Promoters and Publishers, Mumbai, 2007. 4. M.P. Groover, **Fundamentals of Modern Manufacturing,** John Wiley & Sons Inc (Indian student edition), 2002. 5. Y.A. Cengel and M.A. Boles, **Thermodynamics: An Engineering Approach** (6th Edition), Tata McGraw Hill, New Delhi, 2008. 6. S.S. Rattan, **Theory of Machines**, (2nd Edition) Tata McGraw Hill, New Delhi, 2005.

Course Code	**ME 153** [from AY 2009-10 to AY 2015-16] **IC 153** [from AY 2016-17 onwards]
Title of the Course	**Engineering Graphics**
Credit Structure	L-T- P-Credits 1-0-3-2.5
Name of the Concerned Department	All the Engineering Departments
Pre–requisite, if any	None
Scope of the course	
Course Syllabus	Introduction to engineering drawing and orthographic projections; Projection of points and straight line; Projection of planes and solids; Projection of simple machine elements; Development of surfaces, Intersection of surfaces; Construction of isometric views from orthographic projections.
Suggested Books	1. N.D. Bhatt and V.M. Panchal, **Engineering Drawing**, Charotar Publishers, Anand, 2007. 2. W.J. Luzadder and J. M. Duff, **Fundamentals of Engineering Drawing**, Prentice Hall of India, 2001. 3. T. E. French, C.J., Vierck, and R.J. Foster, **Engineering Drawing and Graphic Technology** (14th Edition) McGraw Hill Science/Engg, 1993. 4. A. D. Jolhe, **Engineering Drawing**, Tata McGraw Hill, New Delhi, 2007. 5. M.B. Shah and B.C. Rana, **Engineering Drawing**, Dorling Kindersley (India) Pvt. Ltd, Pearson Education,

Course Code	**ME 154** [from AY 2010-11 to AY 2013-14]
Title of the Course	**Basic Manufacturing Techniques**
Credit Structure	L-T- P-Credits 2-0-2-3
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	Nil
Scope of the course	
Course Syllabus	**Engineering Materials:** Introduction of engineering materials their types, applications, and manufacturability. **Introduction to Pattern Making and Casting**: Pattern materials, pattern types, hand tools used in the wood working, pattern allowances, colour coding, molding sand composition and properties, sand casting, casting defects and their remedies. **Plastic Parts Manufacturing:** Introduction and typical applications of the commonly used plastic parts manufacturing processes such as extrusion, injection molding, blow molding, rotational molding, compression molding, transfer molding, structural foam molding, thermoforming, etc. **Introduction to Machining:** Machining fundamentals, Types of machining operations, Details and types of basic machine tools such as lathe, milling, and drilling and important machining operations on these machines and types of cutting tools used. Introduction of computer numerical controlled (CNC) machine tools. **Introduction to Joining Methods:** Welding fundamentals, types of welded joints and welding positions, operations and details of gas welding process, manual metal arc welding processes. Soldering and brazing, their applications in electronics industry. **Introduction to Metal Forming Operations:** Working principle and applications of forging, rolling, extrusion, wire drawing, tube drawing, and sheet metal operations. **Practicals:** Simple workshop jobs to be made in the foundry, electric arc welding and gas welding, lathe, milling, and drilling machines. Demonstration of plastic parts manufacturing and Forming machines.
Suggested Books	1. E.P. DeGarmo, J.T. Black, and R. A. Kohser, **Materials and Processes in Manufacturing** (8th edition), Prentice Hall of India Pvt. Limited, New Delhi, 2006. 2. P.N. Rao, **Manufacturing Technology: Volume-1 and Volume-2** (3rd edition), Tata McGraw Hill, New Delhi, 2009.

	3. S.K. Hajra Choudhury, S.K. Bose, and A.K. Hajra Choudhury, **Elements of Workshop Technology: Vol. I and Vol. II** (14th Edition) Media Promoters and Publishers, Mumbai, 2007. 4. M.P. Groover, **Fundamentals of Modern Manufacturing,** John Wiley & Sons Inc (Indian student edition), 2002.

Course Code	**ME 156** [from AY 2014-15 onwards] **IC 156** [from AY 2016-17 onward]
Title of the Course	**Basic Manufacturing Techniques**
Credit Structure	L-T- P-Credits 0-0-3-1.5
Name of the Concerned Department	All the Engineering Departments
Pre–requisite, if any	Nil
Scope of the course	
Course Syllabus	1. Preparation of single piece casting. 2. Preparation of Lap joint in carpentry. 3. Preparation of joint by Arc welding & Gas welding. 4. Preparation of simple job by fitting tool & drilling. 5. Preparation of job on Lathe machine by turning, facing, knurling, drilling etc. 6. Basic Electrical Wiring system. 7. Investigating the casting and weld defects using non-destructive examination. 8. Characterize the defect size, location and distribution using ultrasonic method. 9. Determination of density of the given Casting using Archimedes method.
Suggested Books	

Course Code	**IC 211**
Title of the Course	**Experimental Engineering Lab**
Credit Structure	L-T- P-Credits 0-0-3-1.5
Name of the Concerned Department	All the Engineering Departments and Mathematics
Pre–requisite, if any	Nil
Scope of the course	
Course Syllabus	1. Measurement of Resistance using Kelvin Bridge. 2. Measurement of Inductance using Maxwell Bridge and Measurement of Capacitance using Desauty's and Schearing Bridge. 3. Study of LVDT characteristics. 4. Measurement of Pressure using U-tube manometer, inclined manometer and Dead weight pressure tester. 5. Study of various types of Temperature Measurement Methods 6. Study of Mechatronics sensors. 7. Determination of elastic modulus using 3 point symmetric /asymmetric bending. 8. Determination of surface tension of a given liquid using contact angle measurement. 9. Chain Surveying: To Provide a skeleton or frame work consisting of a number of connected triangles. 10. Prepare and develop a program for data acquisition and presentation from different sensors.
Suggested Books	**Text Books** 1. J. P. Holman, **Experimental Methods for Engineers** (7th Edition), Tata McGraw-Hill, New Delhi, (Special Indian Edition) 2007. 2. E.O. Doebelin, **Engineering Experimentation: Planning, Execution, Reporting**, McGraw-Hill, ISBN: 0070173397, 1995. 3. E.O. Doebelin and D. N. Manik, **Measurement Systems**, McGraw Hill Educations, 2007 **Reference Books** 1. J.P. Holman, **Experimental Methods for Engineers**, McGraw-Hill Inc., New York, 1978. 2. E.O. Doebelin, **Measurement Systems; Application and Design**, McGraw-Hill, 1976. 3. C.F. Jeff Wu, and M.S. Hamada, **Experiments: Planning, Analysis, and Optimization**, Wiley, ISBN: 0471699462, 2009. 4. A.J. Wheeler and A.R. Ganji, **Introduction to Engineering**

	Experimentation, Prentice Hall, ISBN: 0131742760, 1996. 5. W.J. Diamond, **Practical Experiment Designs: for Engineers and Scientists**, Wiley, ISBN: 0471390542, 2001. 6. R.H. Bishop, **Learning with LabVIEW**, Addison Wesley Longman, ISBN: 0201361663, 1999. 7. R.S. Figliola, and D.E. Beasley, **Theory and Design for Mechanical Measurements** - 4th Edition, Wiley, 2006.

Course code	**ME 101**
Title of the course	**Engineering Mechanics**
Course Category	Basic engineering
Credit Structure	L - T - P - Credits 2-0-0-2
Name of the Concerned Department	Mechanical Engineering/ Civil Engineering
Pre-requisite, if any	This is an introductory course to study and make use of the principles required to remedy engineering mechanics issues. Mathematics and physics Ideas can be applied on this course.
Scope of the course (Objectives)	Engineering mechanics involves the study of forces and their effects on matter, and the use of this knowledge to design and analyse structures, machines, and other systems. It is used to analyse and design structures to understand the behaviour of materials under different loading conditions.
Course Outcomes	➢ To develop ability to model and analysis of mechanical engineering systems using vectoral representation of forces and moments. ➢ To develop skills to use the basic principles of mechanics in engineering applications.
Course Content	1. Introduction to statics and dynamics: Mechanics, Basic Concepts, Scalars and Vectors, Newton's Laws, Units, Laws of Gravitation. 2. Force Systems: Two- and Three-Dimensional Force Systems, Rectangular Components, Moment and Couple, Resultants. 3. Equilibrium: Equilibrium in Two-and Three-Dimensions, System Isolation and Free-Body Diagram. 4. Friction: Introduction, Laws of Coulomb Friction, Equilibrium of Bodies involving Dry friction. 5. Centroid and Moment of Inertia: Centroid of the plane, curve, area, volume, and composite bodies, moment of inertia of plane area, parallel axes theorem. 6. Structures: Plane trusses, method of joints, method of sections, frames, and machines. 7. Kinematics of Rigid Body: Introduction, plane motion of the rigid body, velocity and acceleration under translation and rotational motions. 8. Kinetics of Rigid Body: Introduction, force, mass and Acceleration, Work and Energy, Impulse and Momentum, D'Alembert's principles, and dynamic equilibrium. 9. Simple Stress and Strain: Introduction, normal and shear stresses, stress-strain diagrams for ductile and brittle material.

Suggested books	Textbooks: 1. Irving H. Shames, Engineering Mechanics, Pearson Education, Prentice Hall, 2006, ISBN 9788177581232 2. James L. Meriam, L. G. Kraige, J. N. Bolton, Engineering Mechanics: Statics and Dynamics, Ninth edition, Wiley publication, 2018, ISBN: 978-1-119-39262-0 Reference textbook: 3. E.P. Popov, Mechanics of Materials, Second Edition, Prentice Hall of India Private Limited, 2015, ISBN: 9789332559547

Course code	**ME 108**
Title of the course	**Basic Manufacturing Processes**
Course Category	Flexible elective
Credit Structure	L - T - P - Credits 1-0-0-1
Name of the Concerned Department	Mechanical Engineering
Pre-requisite if any	Nil
Scope of the course (Objectives)	It focuses on the design, development, and operation of integrated systems of production to obtain high quality & economically competitive products.
Course Outcomes	➢ This course helps in selecting suitable manufacturing processes to manufacture the products optimally. ➢ This course also recommends the appropriate design of casting process systems, forming processes, welding process and machining (metal cutting) processes.
Course Content	1. Casting: Steps involved in making a casting, its applications, patterns, and types of patterns, pattern allowances and their construction, types of casting processes, solidification of casting. 2. Introduction to machine tools: Preliminary idea of basic machine tools, hand tools and their operations. Ways of specifying tools and operations. Composition of cutting tool materials. 3. Welding: Welding types, Oxy-fuel gas welding, cutting, Outline of different fusion and non-fusion welding processes and their applications. 4. Forming: Hot working, cold working, strain hardening, comparison of properties of cold and hot worked parts, rolling fundamentals 5. Forging processes: Forging operations and principles, tools, forging methods, forging hammers: Rotary forging, forging defects, cold forging.
	Suggested textbooks: 1. P.N. Rao, Manufacturing Technology (Foundation Forming & Welding), Tata McGraw Hill, 2013, ISBN: 978-9383286614 2. J. S. Campbell, Principles of manufacturing materials and processes, Tata McGraw Hill, 1995, ISBN: 9780070992528 **Reference textbooks:** 1. S. Kalpakjian and S.R. Scsimid, Manufacturing Engineering and Technology, 4th Edition, Pearson Education, 2001, ISBN: ISBN:

	9788177581706 2. R. C. S. Mehta N. S. Gaira, Basic Manufacturing Process, 2017, VIVA BOOKS, ISBN: 978-8171881871

Course code	**ME 110**
Title of the course	**Basic Thermal Engineering**
Course Category	Flexible elective
Credit Structure	L - T - P - Credits 1-0-0-1
Name of the Concerned Department	Mechanical Engineering
Pre-requisite if any	Nil
Scope of the course (Objectives)	This course focuses on basic mechanical engineering starting from thermodynamics, fluid mechanics, Heat transfer to its application in different practical processes, analysis of the Internal combustion engines, and the Refrigeration cycle.
Course Outcomes	➢ Able to obtain knowledge of different aspects of designing of a thermal system. ➢ Get fundamental knowledge of fluid, its properties and behavior under various conditions. ➢ Understand various types of I.C. Engines, refrigeration cycles and Heat transfer modes
Course Content	1. Basic concepts and laws of thermodynamics: Thermodynamic definition and scope, system - boundary, surrounding, thermodynamic systems Properties of system, Law of thermodynamics-Zeroth, first & second laws of thermodynamics. 2. Fluid Mechanics: Fluid statistics, Fluid kinematics, and Fluid dynamics 3. Refrigeration & air conditioning: Working principle of VCR and VAR cycles. Performance of refrigeration cycles 4. IC engines: Working principle of Two Stroke and four stroke engine, petrol, and diesel engine. Engine performance and emissions. 5. Heat Transfer: Introduction -Modes of heat transfer- Conduction, convection, and radiation, Simple problems on conduction.
Suggested books	**Textbooks:** 1. Moran, M.J., Moran, H. N. Shapiro, D.D. Boettner, and M.B. Bailey, "Fundamentals of engineering thermodynamics". 8th Edition, John Wiley & Sons; (2010), ISBN: 978-1-118-41293-0 2. Y.A. Cengel and M.A. Boles, Thermodynamics: An Engineering Approach (6th Edition), Tata McGraw Hill, New Delhi, 2008, ISBN: 0071257713 3. F.M. White, Fluid Mechanics, Seventh edition, Tata McGraw Hill, 2008, ISBN: 978-0071333122

	Reference textbook: 1. W. W. Pulkrabek, Engineering Fundamentals of the Internal Combustion Engine, PHI, (2002), ISBN: 978-0131405707 **2.** J. P. Holman, & Souvik Bhattacharyya, Heat Transfer, 10th Edition, 2017, ISBN: 978-0071069670

Course Code	**ME 201**
Title of the Course	**Solid Mechanics**
Credit Structure	L-T-P-Credits 3-1-0-4
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	None
Scope of the course	
Course Syllabus	**Introduction:** Analysis of Axially Loaded Components, Statically Determinate and Indeterminate Problems; Castigliano's Theorem. Stress and Strain Tensors. Mohr Circle. Stress-strain Relations; Stress-strain-temperature Relations. **Analysis of Bending and Shear Loaded Components:** Beams; Shear Force and Bending Moment Diagrams. Stresses in Beams. Torsion of Circular Shaft. Basic Equations of Elasticity. **Material Testing:** Properties under tension, impact, fatigue and creep. Strain Rosettes. Introduction to Elastic-plastic Bending of Beams and Torsion of Circular Shaft. Thick Cylinder; Interference Fit; Rotating Disc.
Suggested Books	1. S.H. Crandall, N.C. Dahl, and T.J. Lardner, **An Introduction to Mechanics of Solids**, McGraw Hill, 1978. 2. E.P. Popov, **Introduction to Mechanics of Solids**, Prentice Hall of India,1993. 3. J. Case and A.H. Chilver, **Strength of Materials and Structures**, Edward Arnold, 1980. 4. L.S. Srinath, P. Desai, N.S. Murthy, and A.S. Murthy, **Strength of Materials**, Macmillan India, 1997. 5. F.P. Beer, E.R. Johnston, **Mechanics of Materials**, Tata McGraw Hill, 2010, 5th ed., New Delhi.

Course code	**ME 201N**
Course title	**Solid Mechanics**
Course Category	Core
Credit Structure	L-T-P-Credits 2-1-0-3
Department	Mechanical Engineering
Pre–requisite, if any	None
Objectives	● Provide students with a solid foundation in solid mechanics, covering essential topics like stress, strain, and material behavior to establish a fundamental understanding of the mechanical response of materials.
Course Outcomes	● Analyze and predict the mechanical response of materials. ● Students will demonstrate practical skills in applying solid mechanics principles to solve engineering problems, and preparing them for roles in engineering and related disciplines.
Course Content	● **Introduction:** Analysis of Axially Loaded Components, Statically Determinate and Indeterminate Problems ● **Stress and Strain:** Stress-strain Relations; Stress-strain temperature Relations; Mohr Circle. ● **Shear Forces and Bending Moments:** Analysis of Bending and Shear Loaded Components: Beams; Shear Force and Bending Moment Diagrams. Stresses in Beams. Basic Equations of Elasticity. ● **Material Testing:** Properties under Tension, Impact, Fatigue and Creep. ● **Torsion:** Introduction, Deformation of Circular Shaft, Stresses and Angle of Twist in Elastic Range. ● **Beam Bending:** Introduction to Elastic-plastic Bending of Beams, Bending of Symmetrical and Unsymmetrical Sections. ● **Thick Cylinder:** Introduction, Solution of General Problem, Special Cases.
Suggested Books	**Text Books** 1. S.H. Crandall, N.C. Dahl, and T.J. Lardner, **An Introduction to Mechanics of Solids**, McGraw Hill, 1978. ISBN: 9780070134416. 2. E.P. Popov, **Introduction to Mechanics of Solids**, Prentice Hall,1993, ISBN: 9780134877693. 3. F.P. Beer, E.R. Johnston, **Mechanics of Materials**,**(5th Edition),** Tata McGraw Hill, , 2012, ISBN: 9780070153899. **Reference Books** 4. L.S. Srinath, P. Desai, N.S. Murthy, and A.S. Murthy, **Strength of Materials**, Macmillan India, 2000, ISBN: 9780333923924. 5. J. Case and A.H. Chilver, **Strength of Materials and Structures**, **(4th Edition),** Edward Arnold,1999. ISBN: 9780470379804.

Course Code	**ME 202**
Title of the Course	**Strength of Materials**
Credit Structure	L-T-P-Credits 3-1-0-4
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	A course in Solid Mechanics
Scope of the course	
Course Syllabus	Bending of Curved Bars. Unsymmetrical Bending. Introduction to Bending of Thin, Plates and Shells. Deflection of Beams: Methods based on integration, Singularity function, Energy Principles (virtual work, minimum potential energy, reciprocal theorem, etc.), Superposition Principle, etc. Statically Indeterminate Problems: Continuous Beams, Buckling of beams, Euler load, Secant and Rankine-Gordon Formulae. Theories of Failure. Introduction to Griffith Theory. Torsion of Thin Box Sections. Thermal Stress Analysis for Rectangular and Circular Plates. Photoelasticity.
Suggested Books	1. L.S. Srinath, **Advanced Mechanics of Solids** (2^{nd} edition), Tata McGraw Hill, 2003. 2. S.P. Timoshenko, and J.N. Goodier, **Theory of Elasticity**, McGraw Hill, (International Students Edition), 1982. 3. S.H. Crandall, N.C. Dahl, and T.J. Lardner, **An Introduction to Mechanics of Solids**, McGraw Hill, 1978. 4. E.P. Popov, **Introduction to Mechanics of Solids**, Prentice Hall of India,1993. 5. J. Case and A.H. Chilver, **Strength of Materials and Structures**, Edward Arnold, 1980.

Course code	**ME 202N**
Course title	**Strength of Materials**
Course Category	Core
Credit Structure	L-T-P-Credits 2-1-0-3
Department	Mechanical Engineering
Pre–requisite, if any	A course in Solid Mechanics
Objectives	● The objective of the course is to learn about the deformation and stresses developed in the simple structures under mechanical loads. ● The understanding of the stress analysis of different deformable structures.
Course Outcomes	● Students will be able to learn stress-strain calculations involved for different structures. ● Stress and strain analysis of beams with advanced geometrical features and buckling phenomena, and the role of failure theories for different materials.
Course Content	● **Advanced Topics in Bending:** Bending of Curved Bars. Unsymmetrical Bending. ● **Deflection of Beams:** Differential Equations of the Deflection Curve, Methods based on integration, Singularity function, ● **Energy Principles**: External Work and Strain Energy, Virtual Work, Minimum Potential Energy, Reciprocal Theorem, Superposition Principle, etc. ● **Columns and Struts**: Buckling of columns and struts, Euler load, Secant Formula. ● **Theories of Failure**: Theories of failure for different materials. Introduction to Griffith Theory. Photoelasticity.
Suggested Books	**Textbooks** 1. L.S. Srinath, **Advanced Mechanics of Solids, (2nd Edition)**, Tata McGraw Hill, 2003, ISBN: 9780070494817. 2. S.P. Timoshenko, and J.N. Goodier, **Theory of Elasticity**, McGraw Hill, (International Students Edition), 2017, ISBN: 9780070701229. 3. S.H. Crandall, N.C. Dahl, and T.J. Lardner, **An Introduction to Mechanics of Solids**, McGraw Hill, 1978, ISBN: 9780070134416. **Reference Books** 4. E.P. Popov, **Introduction to Mechanics of Solids**, Prentice Hall of India, 1993, ISBN: 9780134877693. 5. J. Case and A.H. Chilver, **Strength of Materials and Structures**, **(4th Edition),** Edward Arnold, 1999. ISBN: 9780470379804.

Course Code	**ME 203**
Title of the Course	**Fluid Mechanics**
Credit Structure	L-T- P-Credits 3-1-0-4
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	None
Scope of the course	
Course Syllabus	Introduction and Fundamental Concepts, Fluid Statics, Flow Kinematics, Conservation Equations and Analysis of Finite Control Volume, Applications of Equations of Motion and Mechanical Energy, Dimensional Analysis, Flow of Ideal Fluids, Viscous Incompressible Flows, Laminar Boundary Layers, Flow through Pipes.
Suggested Books	**Text Books** 1. R.W. Fox and A.T. McDonald, **Fluid Mechanics**, John Wiley International, **2005**. 2. F.M. White, **Fluid Mechanics**, Tata McGraw Hill, 2008. **Reference Books** 1. S.K. Som and G. Biswas, **Introduction to Fluid Mechanics and Fluid Machines** (2nd Edition), Tata McGraw-Hill Publishing Company, New Delhi, 2008 2. V.L. Streeter and E.B. Wylie **Fluid Mechanics**, McGraw-Hill, 1983. 3. S.W. Yuan, **Foundation of Fluid Mechanics** (2nd Ed), Prentice Hall, 1988.

Course code	**ME 203N**
Course title	Fluid Mechanics
Course Category	Core
Credit Structure	L-T-P-Credits 2-1-0-3
Department	Mechanical Engineering
Pre–requisite, if any	None
Objectives	● Comprehensive study of fluid properties, statics, and dynamics for a deep understanding of fluid behavior. ● Application-oriented focus on fluid mechanics in engineering systems, preparing students for practical challenges.
Course Outcomes	● Demonstrate a thorough understanding of fluid properties, statics, and dynamics, enabling them to analyze and predict fluid behavior in diverse scenarios. ● Apply fluid mechanics concepts to engineering systems,
Course Content	● **Introduction**: Definition and classification of fluids, concept of continuum, properties of fluids ● **Fluid Statics**: Variation of pressure in as static fluid, forces on submerged surfaces, stability of floating bodies ● **Fluid Kinematics**: Lagrangian and Eulerian Approaches, acceleration of fluid, streamlines, path lines and streak lines ● **Integral relations for control volume**: Reynolds transport theorem, conservation of mass, linear and angular momentum ● **Differential relations for fluid flow**: differential equation for mass and linear momentum ● **Inviscid & Irrotational Flows**: Euler equation, Bernoulli's equation, and its applications ● **Viscous flows in pipes**: Laminar and turbulent pipe flow, friction factor, Moody diagram, minor and major losses ● **Dimensional analysis and similitude**: Buckingham-pi theorem, similarities (geometric, kinematic and dynamic).
Suggested Books	**Text Books:** 1. R.W. Fox and A.T. McDonald, **Fluid Mechanics**, **(8th Edition),** John Wiley International, 2011. ISBN: 9780470547557. 2. F.M. White, **Fluid Mechanics**, **(6th Edition),** Tata McGraw Hill, 2011. ISBN: 9780071333122. **Reference Books** 3. S.K. Som and G. Biswas, **Introduction to Fluid Mechanics and Fluid Machines (2nd Edition)**, Tata McGraw-Hill Publishing Company,2008, ISBN: 9780070702592. 4. V.L. Streeter and E.B. Wylie **Fluid Mechanics**, McGraw-Hill, 1983, ISBN: 9780070622425. 5. S.W. Yuan, **Foundation of Fluid Mechanics (2nd Edition)**, Prentice Hall, 1977, ISBN: 9780133298475.

Course Code	**ME 204**
Title of the Course	**Fluid Machinery**
Credit Structure	L-T- P-Credits 2-1-0-3
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	A course in Fluid Mechanics
Scope of the course	
Course Syllabus	Introduction and classification of Turbo-machines, Compressible fluid flows, Gas turbine systems, Centrifugal and axial flow compressors, Steam and Hydraulic Turbines, Fluid Pumping Machines, Cavitation, Fans and Blowers.
Suggested Books	**Text Books** 1. S.K. Som and G. Biswas, **Introduction to Fluid Mechanics and Fluid Machines** (2nd Edition), Tata McGraw-Hill Publishing Company, New Delhi, 2008. 2. N.S. Govind Rao, **Fluid Flow Machines**, Tata McGraw Hill, New Delhi, 1998. 3. S.L. Dixon, **Fluid Mechanics and Thermodynamics of Turbomachinery** (5th edition), Butterworth-Heinemann, Oxford, 2005. 4. E. Logan, **Turbomachinery: Basic Theory and Applications**, (2nd edition), CRC Press, London, 2002. **Reference Books** 1. A.T. Sayers, **Hydraulics and Compressible flow in Turbomachines**, McGraw Hill, 1990 2. A.J. Stepanoff, **Centrifugal and Axial Flow pumps**, Wiley, 1967 3. D.G. Shepherd, **Principles of Turbomachinery**, Macmillian, 1956.

Course code	**ME 204N**
Course title	**Fluid Machinery**
Course Category	Core
Credit Structure	L-T- P-Credits 2-0-0-2
Department	Mechanical Engineering
Pre–requisite, if any	A course in Fluid Mechanics
Objectives	● Provide students with a foundational understanding of fluid machinery principles, including the operation, design, and analysis of pumps, turbines, and compressors.
Course Outcome	● Demonstrate comprehensive understanding and practical aspects in fluid machinery, covering design, operation, and analysis of pumps, turbines, compressors. ● Apply knowledge to contribute effectively to fluid system design, operation, and optimization across various industries.
Course Content	● **Introduction**: Definition and classification of turbo machines and fluid pumping machines. ● **Pumps**: Introduction to rotodynamic pumps, working principles and energy transfer in a centrifugal pump, Euler's turbomachinery equation, velocity triangles, characteristics of a centrifugal pump, operating point, cavitation, principle of similarity, specific speed, series, and parallel combination of pumps, Compressors. ● **Turbines**: Classification of turbines, Pelton, Francis and Kaplan, draft tube, cavitation in turbines. ● **Introduction to compressible flow**: Thermodynamic relations and speed of sound, stagnation, and sonic properties, effects of area variation on properties in isentropic flow, properties in an isentropic flow, choking in a converging nozzle, isentropic flow through, convergent-divergent duct, Fanno flow, Raleigh flows, normal shock and oblique shock.
Reference Books	**Text Books** 1. S.K. Som and G. Biswas, **Introduction to Fluid Mechanics and Fluid Machines, (2nd Edition),** Tata McGraw-Hill Publishing Company, 2008, ISBN: 9780070667624. 2. N.S. Govind Rao, **Fluid Flow Machines**, Tata McGraw Hill, 1998, ISBN: 9780074518542. 3. S.L. Dixon, **Fluid Mechanics and Thermodynamics of Turbomachinery, (5th Edition),** Butterworth-Heinemann, 2005, ISBN: 9780080470627. 4. E. Logan, **Turbomachinery: Basic Theory and Applications, (2nd Edition)**, CRC Press, 2002, ISBN: 9780429159770. **Reference Books** 5. A.T.Sayers, **Hydraulics and Compressible flow in Turbomachines**, McGraw Hill, 1990, ISBN: 9780077072193. 6. A.J. Stepanoff, **Centrifugal and Axial Flow pumps**, Wiley, 1967, ISBN: 9780471821373. 7. D.G. Shepherd, **Principles of Turbomachinery**, Macmillian, 1956, ISBN: 9780024096609.

Course Code	**ME 205** [from AY 2010-11 to AY 2015-16] **MM 205** [for AY 2016-17 only]
Title of the Course	**Materials Science**
Credit Structure	L-T- P-Credits 2-1-0-3
Name of the Concerned Department	Metallurgical Engineering/Mechanical Engineering
Pre–requisite, if any	Nil
Scope of the course	
Course Syllabus	Introduction and classification of Engineering Materials Structure of Metals and Alloys Iron-carbon Phase Diagrams Classification and Properties of Steels, Properties and Industrial applications of alloys steels, tool steels, stainless steels and cast irons. Principles of Heat Treatment of Steels and alloys, Case-Hardening of steels. Properties and uses of non-ferrous materials: Brasses and bronzes, aluminum and its alloys, zinc, tin alloys, nickel and titanium alloys. Mechanical behavior of metals. Cold and hot working of metals. Fracture, fatigue and creep behavior of metals. Corrosion and its prevention.
Suggested Books	**Text Books** 1. W.D. Callister, Jr., "**Materials Science and Engineering**", Wiley India (P) Ltd., 2007. 2. V. Raghvan, **Material Science and Engineering,** Prentice Hall of India Pvt. Ltd. New Delhi. 3. G.E. Dieter, **Mechanical Metallurgy**, McGraw Hill Book Company (UK) Ltd. London, 1988. 4. R.E. Reed-Hill; **Physical Metallurgy Principles** (4th Edition), Cengage Learning, 2003 **Reference Books** 1. F.C. Compbell '**Elements of Metallurgy and Engineering Alloys'**, ASM International, Ohio, 2008 2. R.E. Smallman, A.H.W. Nagan, "**Physical Metallurgy and Advanced Materials**', 7th edition, Elsevier, 2007 3. D.A. Porter and K.E. Easterling, **Phase Transformations in Metals and Alloys**, 2nd edition, Chapman and Hall, London 1992

Course code	**ME 205N**
Course title	**Materials Science and Engineering**
Course Category	Core
Credit Structure	L-T-P-Credits 2-1-0-1.5 (Half-Semester)
Department	Mechanical Engineering
Pre–requisite, if any	None
Scope of the Course Objectives	• Provide students with a solid foundation in the principles, historical context, and classification of materials.
Course Outcome	• Students will develop a deep understanding of materials science and engineering, encompassing atomic structure, mechanical properties, imperfections, and phase transformations. This knowledge will enable them to analyze and predict material behavior. • Students will acquire practical skills to apply their understanding in addressing real-world challenges related to materials.
Course Content	● **Introduction**: Classification of materials, Futuristic materials. ● **Structure of solids**: Crystalline and non-crystalline materials, Structure - Unit cell and space lattices, Coordination number, APF ● **Dislocations and Strengthening Mechanisms:** Defects, Strengthening by Grain Size Reduction, Solid-Solution Strengthening, Strain Hardening, Precipitation hardening. ● **Phase diagrams and phase transformations**: Basic definitions; Gibbs phase rule, Iron-Carbon Phase diagram; TTT Diagram ● Concept of elastic and plastic deformation; Tensile properties of materials ● **Creep and Fracture:** Creep mechanism-Effects of Stress, Temperature, Alloying, Fracture, Fatigue, The S–N Curve, Factors affecting Fatigue Life. ● Heat treatment; Properties of non-ferrous alloys
Suggested Books	**Text Books** 1. W.D. Callister, **Material Science for Engineers: An Introduction**, John Wily and Sons, Inc., 2006. ISBN: 0471736961 2. C.S. Barrett, T.B. Massalski, **Structure of Metals**, McGraw Hill, 1966. ISBN: 9780070038155. 3. D.R. Askeland, P.P. Fulay, W.J. Wright, **The Science and Engineering of Materials,** Global Engineering, 2010. ISBN: 9780495296023. **Reference books** 4. P.E.J. Flewitt, R.K.Wild, **Physical Methods for Material Characterization,** Institute of Physics Publishing, 2003. ISBN: 0750308087. 5. J.B. Benedict. **Recent Advances in Crystallography**, In Tech., 2012. ISBN 9789535107545.

Course Code	**ME 206**
Title of the Course	**Thermodynamics**
Credit Structure	L-T-P-Credits 3-1-0-4
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	None
Scope of the course	
Course Syllabus	**Introduction:** Thermodynamics and its engineering application, Terminology used in engineering thermodynamics, concept of system, surroundings, boundaries, universe, work, energy, heat. Classification of system, types of boundaries: fixed, moving and imaginary. Equilibrium, processes, interactions, Zeroth law of thermodynamics. **Heat-Work interaction:** Thermodynamic definition of work. Characteristics of the work interaction. Evaluation of different kinds of work: displacement, shaft work, electrical work. **Equation of Ideal Gas:** Difference between ideal and real gases, equations of state, evolution of properties of ideal gases. Van-der-Waals equation of state for real gases, compressibility factor. Properties of steam, introduction to steam tables. **First law of Thermodynamics:** Statement for a cycle, derivation of the First law for processes, energy, internal energy, enthalpy. Extension of the First law to control volume; steady state-steady flow energy equation. **Second law of Thermodynamics:** Kelvin-Planck and Clausius statements and their equivalence, Clausius inequality, entropy, evaluation of entropy, principle of increase of entropy. Formulation of second law for closed and open systems. Property relations, Maxwell's equations. Applications to equations of state Introduction to availability, irreversibility and exergy. **Power Cycles:** Carnot cycle. Vapor power cycles – Rankine cycle and its modifications. Air standard cycles – Otto, Diesel, Brayton cycles.
Suggested Books	**Text books** 1. Y.A. Cengel and M.A. Boles, **Thermodynamics: An Engineering Approach** (6th Edition), Tata McGraw Hill, New Delhi, 2008. 1. M.J. Moran and H.N. Shapiro, **Fundamentals of Engineering Thermodynamics** (6th Edition), Wiley (ISBN: 978-471-78735-8). 2. M.L. Mathur and F.S. Mehta, **Steam and Other Tables (with Mollier Chart)**, Jain Brothers, New Delhi, 2005. **Reference Books** 1. C. Borgnakke, R.E. Sonntag, **Fundamentals of Thermodynamics** (7th edition), Willey, ISBN 978-0-470-04192-5.

	2. A. Bejan, **Advanced Engineering Thermodynamics**, Willey, ISBN: 978-0-471-67763-5. 3. P.L. Dhar, **Engineering Thermodynamics: A Generalized Approach**, Elsevier, ISBN: 8131214699. 4. Y.A. Cengel, and M.A. Boles **Thermodynamics: An Engineering Approach**, (7th edition), McGraw-Hill Inc. 5. M.J. Moran, and H.N. Shapiro, **Fundamentals of Engineering Thermodynamics** (6th edition), Willey, 1995.

Course code	**ME 207**
Course title	**Principles of Industrial Engineering**
Course Category	Core
Credit Structure	L-T-P-Credits 2-1-0-3
Department	Mechanical Engineering
Pre–requisite, if any	None
Scope of the Course Objectives	● The course aims to introduce the students to various techniques used in industries to achieve effectiveness and efficiency in operations.
Course Outcome	● Basic understanding of planning and control of operations, design and improvement of processes, formulation and evaluation of projects, management of logistics operations, as well as development of industrial processes.
Course Content	● **Plant Layout:** Site selection, types of layout, factors affecting layout, plant building, flexibility and expandability, materials handling devices. ● **Production Planning and Control:** Forecasting, Master Production Scheduling (MPS), Material Requirements Planning (MRP), aggregate production planning, machine loading, production scheduling. ● **Inventory Control:** Various models of inventory control such as EOQ, price discount, production lot sizing, inventory control under uncertainty. Selective inventory control. ● **Work Study:** Scope, work measurement and method study, standard data, ergonomics and its industrial applications. ● **Project Management:** CPM and PERT ● **Emerging concepts and philosophies:** JIT, KANBAN, 5S, introduction to digital manufacturing, etc.
Suggested Books	**Text Books** 1. E.S. Buffa, **Modern Production / Operations Management**, **(8th Edition)**. India: Wiley India Pvt. Limited, 2001. ISBN: 9788126513727. 2. Russell, R. S., Taylor, B. W. **Operations Management: Along the Supply Chain,** Wiley, 2009. ISBN: 9780470233795. 3. Eilon, S. **Elements of Production Planning and Control**. United Kingdom, Macmillan, 1962. ISBN: 9780023318009. **Reference Books** 4. Chase, R. B., Jacobs, F. R., Aquilano, N. J. **Operations Management for Competitive Advantage,** McGraw-Hill/Irwin. 2007. ISBN: 9780071260480. 5. Maynard, H. B., Hodson, W. K. **Maynard's Industrial Engineering Handbook**, McGraw-Hill, 1992. ISBN: 9780070410862.

Course code	**ME 208**
Course title	**Theory of Manufacturing Processes**
Course Category	Core
Credit Structure	2-1-0-3
Department	Mechanical Engineering
Pre–requisite, if any	None
Objectives	● Develop a fundamental understanding of the basic manufacturing techniques and tools, including Casting, Forming, Welding and Powder Metallurgy.
Course Outcomes	• Develop an understanding about different manufacturing processes, capabilities, limitations, and remedies. • Identifying a manufacturing method for a series of processes to be adopted for fabrication of a product.
Course Content	● **Theory of Casting processes:** Dispensable and permanent mould processes; Analysis of melting, pouring and solidification phenomena; Cooling and solidification of castings; Cooling curves; Nucleation and Dendrite formation; Various casting defects their inspection remedies: Design of gating and risering system. ● **Theory of Joining processes:** Fusion and solid-state welding; Thermal effects in welding, cooling rate, structure in weld, heat affected zones, distortion and residual stresses; weld quality; weldability or joinability; weld joint design; welding defects and inspection, hard facing, brazing and soldering. ● **Theory of Metal Forming Processes: (A) Theoretical Background:** Concept of stress and strain tensor, hydrostatic and deviatoric components, elastic stress-strain relations, strain energy, anisotropy of elastic behavior; Theory of Plasticity: true stress and strain, flow curve, concept of anelastic, hysteresis, and visco-elastic behavior, Bauschinger effect, Tresca and Von- Mises yield criteria, anisotropy in yielding, octahedral normal and shear stresses and strains, invariants of stress and strains, flow rules or plastic stress-strain relations. **(B) Analysis of Metal Forming Processes:** Introduction of forming process analysis methods (slab method, uniform deformation energy method, limit analysis); analysis of drawing, extrusion, rolling, forging, deep drawing, and bending, forming defects, formability & workability, temperature & lubrication aspects in forming; sheet metal working.

	Text Books 1. R.W. Heine, C.R. Loper, and P.C. Rosenthal, **Principles of Metal Casting, (21st reprint),** Tata McGraw-Hill, 1997,ISBN: 9780070993488. 2. G.E. Dieter, **Mechanical Metallurgy**, McGraw Hill Book Company (UK) Ltd. 1988, ISBN: 9781259064794. 3. A. Ghosh and A.K. Mallik, **Manufacturing Science**, Affiliated East West Press, 2001,ISBN: 9788176710636. 4. E.P. DeGarmo, J.T. Black, and R.A. Kohser, **Materials and Processes in Manufacturing, (8th Edition)**, Prentice Hall of India Pvt. Limited, 2006, ISBN: 9780023286216. **Reference books** 5. HMT, **Production Technology**, Tata McGraw Hill, 1980, ISBN: 9780070964432. 6. Lange, K., & Pöhlandt, K. **Handbook of metal forming**,1985. **Society of Manufacturing Engineers,** ISBN: 978-0872634572. 7. S. Kuo, **Welding Metallurgy**, John-Wiley & Sons Inc. 2003, ISBN: 978-0471434917.

Course Code	**ME 209**
Course title	**Thermodynamics**
Course Category	Core
Credit Structure	L-T-P-Credits 2-1-0-3
Department	Mechanical Engineering
Pre–requisite, if any	A course in Basic Thermal Engineering
Objectives	● The objective of this course is imparting knowledge to mechanical engineering students about the laws of thermodynamics and their applications.
Course Outcomes	● Students will know in detail about various vocabularies related to thermodynamics. ● They will get adequate knowledge on the application of thermodynamics laws for various real life applications.
Course Content	● **Introduction**: Applications, terminologies, system, boundaries: fixed, moving and imaginary, equilibrium, processes, interactions, Zeroth law of thermodynamics. Work interaction, various kinds of work. ● **Equation of Ideal Gas**: Ideal and real gasses, equations of state, evolution of properties of ideal gasses. Van-der-Waals equation of state for real gasses, compressibility factor; Properties of pure substances. ● **First Law of Thermodynamics**: Statement for a cycle, derivation of the first law for closed systems, energy, internal energy, enthalpy, extension of the first law to control volume; state-steady flow energy equation, transient system analysis. ● **Second Law of Thermodynamics**: Kelvin-Planck and Clausius statements, Clausius inequality, entropy, evaluation of entropy, principle of increase of entropy, entropy generation, formulation of 2nd law for closed and open systems; Availability, irreversibility, and exergy. ● **Thermodynamic Property Relations**: Maxwell relations, Clapeyron relation, Joule-Thomson coefficient, generalized relationship for change in u, h, s and c_p
Suggested Books	**Text Books** 1. Y.A. Cengel, M.A. Boles, and M. Kanoglu: **Thermodynamics- An Engineering Approach, (9th Edition)**, McGraw Hill, 2019, ISBN: 9789353165741. 2. M.J. Moran and H.N. Shapiro, **Fundamentals of Engineering Thermodynamics, (7th Edition)**, Wiley, ISBN: 9780470495902. 3. C. Borgnakke, R.E. Sonntag, **Fundamentals of Thermodynamics, (10th Edition)**, Wiley, ISBN 9780470041925. **Reference Books** 4. A. Bejan, **Advanced Engineering Thermodynamics, (4th Edition)**, Wiley, 2016, ISBN: 9781119245964. 5. P.L. Dhar, **Engineering Thermodynamics: A Generalized Approach**, Elsevier, 2008, ISBN: 9788131214695.

	6. M.J. Moran and H.N. Shapiro, **Fundamentals of Engineering Thermodynamics, (7th Edition)**,Wiley, 2010, ISBN: 9780470495902. 7. PK Nag, **Engineering Thermodynamics**, (6th Edition), McGraw Hill Education, 2017, ISBN: 9789352606429

Course code	**ME 214**
Course title	Introduction to Additive Manufacturing
Course Category	Department Core
Credit Structure	L-T- P-Credits 2-1-0-1.5 (Half-Semester)
Department	Mechanical Engineering
Pre–requisite, if any	Basic knowledge of different manufacturing processes
Objectives	● This course aims to introduce the additive manufacturing process, its fundamentals, types, and its capability in various engineering and other applications.
Course Outcomes	● Engineering Knowledge: Develop an understanding of the fundamentals of additive manufacturing and the process steps involved. ● Design of application-oriented additive manufacturing product, choice of appropriate method and parametric control.
Course Content	● **Introduction:** Process fundamentals, the global developments and adaptability of AM, advantages, limitations, and future scopes. ● **Steps involved**: CAD modeling, appropriate file formatting (STL, AMF, etc.), slicing methods, fabrication and post-processing. ● **Classification:** Classification as per ISO/ASTM standards, including VAT Photopolymerization, Binder Jetting, Material Jetting, Material Extrusion, Powder Bed Fusion, Sheet Lamination and Directed Energy Deposition; associated process parameters in these processes. ● **Design and analysis:** Design of various application-oriented AM products, selection of material and methods, identification of process parameters and steps. ● **Post-processing:** Types of post processing for AM, discussion on geometrical accuracy, energy consumption, defects and other aspects.
Suggested Books	**Textbooks** 1. I.Gibson, D.W. Rosen, B. Stucker, **Additive Manufacturing Technologies**, 2e, Springer-Verlag, New York, 2015. ISBN 9781493921126 2. C.K. Chua, K.F. Leong. **3D Printing and Additive Manufacturing: Principles and Applications**, World Scientific Publishing Co. Pvt. Ltd., Singapore, 2017, ISBN: 978-9-8131-4675-4 **Reference book** 3. L.W. Liou, and F.W. Liou, **Rapid Prototyping and Engineering applications: A toolbox for prototype development**, CRC Press, New York, 2011, ISBN 9780429029721 4. A. Gebhardt, J. Kessler, and, L. Thurn. **3D Printing: Understanding Additive Manufacturing**, Hanser Publications,Germany, 2019, ISBN: 978-1-56990-702-3

Course code	**ME 216**
Course title	Thermal Systems and Applications
Course Category	Department Elective
Credit Structure	L-T- P-Credits 2-1-0-1.5 (Half-Semester)
Department	Mechanical Engineering
Pre–requisite, if any	None
Objectives	● This subject explores the fundamental principles of thermal systems and their ubiquitous applications in everyday life, including heating, cooling, energy efficiency, and thermal comfort.
Course Outcomes	● Develop a foundational understanding of thermal systems, including their principles and practical applications in daily life and various industries. ● Explore the sustainability and emerging technologies related to thermal systems.
Course Content	● **Foundations of Thermal Systems:** The importance of thermal systems in daily life; Historical developments in thermal science ● **Heating and Cooling Systems:** Residential heating/cooling systems; Heat exchangers; AC and refrigeration technology; Insulations and energy efficiency in homes ● **Thermal Systems in Common Applications:** Solar and geothermal heating and cooling systems; Cooking, food preservation, and thermal applications; Designing clothing for various environments; Electronics cooling and thermal management. ● **Thermal Systems in Transportation and Sustainability:** Vehicle engine cooling/heating systems; Energy-efficient transportation technologies; Innovations in vehicle thermal management. ● **Future Trends and Green Engineering:** Thermal considerations in product design; Thermal systems across industries; Emerging thermal technologies and their applications
Suggested Books	**Text Books:** 1. M. Moran, H. Shapiro, B. Munson, D. DeWitt, **Introduction to Thermal Systems Engineering**, Wiley, 2002, ISBN: 9780471204909 2. T.H. Kuehn, J.W. Ramsey, J.L. Threlkeld, **Thermal Environmental Engineering**, Prentice Hall, 1998, ISBN: 9780139172205 3. G.M. Masters, **Renewable Energy and Efficient Electric Systems**, Pearson, 2004, ISBN: 9780136155319 **Reference Books** 4. J.H. Lund and T.L. Boyd, **Geothermal Heat Pump and Heat Engines**, IGI Global, 2008, ISBN: 9781599043368 5. J.T. Williams, **Textiles for Cold Weather Apparel**, Woodhead Publishing, 2009, ISBN: 9781845694111 6. C.J.M. Lasance and A. Ortega (Editors), **Thermal Management of Electronic Systems II**, Kluwer Academic Publishers, 1997, ISBN: 9780792347638 7. M. Concepcion, **Automotive Cooling System Basics**, CreateSpace Independent Publishing Platform, 2012, ISBN: 9781479328072

Course code	**ME 217**
Course title	**Industrial Data Analytics**
Course Category	**Elective**
Credit Structure	L - T - P - Credits 2-1-0-3
Department	Mechanical Engineering
Prerequisite, if any	NA
Scope of the Course Objectives	● The course is designed to teach how to choose and use various data-driven tools to solve analytical challenges in modern-day industries
Course Outcome	● Basic understanding of building end-to-end data and analytical pipeline to develop and deploy data analytics solutions. ● Be able to choose and implement essential data science tools on real-life industrial problems using Python.
Course Syllabus	● **Introduction**: Introduction to Data Science and Analytics; Artificial Intelligence (AI); Industry 4.0; Industrial Internet of Things; The need for Industrial Analytics; The role of a Data Scientist in industry. ● **Challenges in Industry**: Types of industries; types of assets; types of enterprise goals; ● **Data and Related Challenges**: Data sources; Most common industrial data types; data storage and retrieval; data context; data and communication standards. ● **Data Collection**: Identifying critical data; identifying appropriate data collection mechanisms; DAQ systems; Fundamentals of Signal Processing and Transmission ● **Data Inference and Visualization**: Exploratory data analysis; Data synchronization, segmentation, and pre-processing; data visualization basics; selection of visual tools for effective information delivery. ● **Data Analysis**: Types of algorithms; descriptive, diagnostic, predictive, and prescriptive analysis; Analytical tool selection; constructing analytical pipelines; model performance assessment. ● **Insight Delivery**: Algorithm deployment; long-term performance validation; deployment platforms; model performance monitoring platforms; introduction to model retraining and adaptation

Suggested Books	**Text Books** 1. R. Hill, S. Berry, **Guide to Industrial Analytics**, Solving Data Science Problems for Manufacturing and IoT, Springer International Publishing, 2021, ISBN: 9783030791049 2. A. Kelleher, A. Kelleher, **Machine Learning in Production**, Developing and Optimizing Data Science Workflows and Applications, Pearson Education, 2019, ISBN:9780134116563 **Reference Books** 3. K. P. Murphy, **Machine Learning**, A Probabilistic Perspective, MIT Press, 2012,ISBN: 9780262018029. 4. J. Lee, **Industrial AI**, **Applications with Sustainable Performance**, Springer Nature, 2020, ISBN:9789811521447.

Course code	**ME 218**
Course title	**Quality Management**
Course Category	Department Elective
Credit Structure	L-T-P-Credits 2-1-0-1.5 (Half-Sem)
Department	Mechanical Engineering
Pre–requisite, if any	None
Objectives	● Develop a fundamental understanding of techniques for statistical quality control.
Course Outcomes	● Develop quality-oriented critical thinking in designing products and processes. ● Learn to select and apply tools to achieve, maintain and improve quality in industrial applications
Course Content	● **Introduction**: Different definitions, dimensions, and aspects of quality, Traditional and modern view of Quality Control, Different Philosophies by Quality Gurus, Quality Function Deployment (QFD). ● **Process Capability (PC) Analysis and Statistical Process Control (SPC)**: Manufacturing process variability, manufacturing process capability, and tolerances; Tools/methods used in SPC: Control Charts, Pareto charts, Fishbone diagram, etc. Implementation of SPC. ● **Control Charts:** Theory and applications of control charts; Control charts for variables: charts averages, ranges, and standard deviation; Control charts for attributes: p and c charts; Fraction defective and number of defects per unit; Different adaptation of control charts. Other advanced quality control charts such as CUSUM, EWMA. ● **Acceptance Sampling:** Concept of acceptance sampling; Sampling by attributes: Single and double sampling plans, Use of Dodge Romming and Military standard sampling tables, Construction and use of operating characteristic (OC) curves; Sampling by variables: Continuous sampling plans.
Suggested Books (Textbooks, Reference Books)	**Textbook** 1. Mitra, A.. **Fundamentals of Quality Control and Improvement**, Wiley, 2016. ISBN: 9781118705148. 2. Montgomery, D. C.. **Introduction to Statistical Quality Control,** Wiley, 2020. ISBN: 9781119723097. **Reference Books** 3. Grant, E. L., Leavenworth, R. S.**Statistical Quality Control**, McGraw-Hill, 1996. ISBN: 978007844354. 4. Taguchi, G., Chowdhury, S. Wu, Y.. **Taguchi's Quality Engineering Handbook,** Wiley, 2005. ISBN: 9780471413349.

Course code	**ME 219**
Course title	**Energy Storage Systems**
Course Category	Department Elective
Credit Structure	L - T - P - Credits 2-1-0-1.5 (Half-Semester)
Department	Mechanical Engineering
Pre–requisite, if any	None
Objectives	This course thoroughly covers different energy storage systems, their real-world applications, and their environmental and future implications.
Course Outcomes	● Learn about different energy storage methods. ● Develop the ability to create and apply energy storage solutions for real-world energy challenges.
Course Content	● **Energy Storage Fundamentals:** Role in energy sector, historical context and current relevance, terminologies and metrics. ● **Thermal, and Mechanical Energy Storage systems**: Sensible and Latent heat systems; Thermochemical, Pumped hydro, Gravity, Compressed air, and Flywheel systems. ● **Chemical, and Electrochemical Energy Storage systems**: Hydrogen storage systems, synthetic natural gas, and solar fuels. Flow battery energy storage; Paper, and Flexible batteries. ● **Electrical and Hybrid Energy Storage Systems**: Capacitor, Supercapacitor, and Superconducting magnetic energy storage; Pumped thermal energy storage. ● **Grid Integration, Environmental**, **Economic, and Future Considerations:** Comprehensive exploration of grid integration, applications, and considerations, cost analysis, government policies, global energy storage status, comparative analysis, TRL.
Suggested Books	**Text Books** 1. R.A. Huggins. **Energy Storage: Fundamentals, Materials and Applications. Springer, (2nd Edition)**, Springer, 2016. ISBN: 9783319212388. 2. A. Rufer. **Energy Storage: Systems and Components**. CRC Press, 2018. ISBN: 9781138082625. 3. E. Dincer and M. Rosen. **Thermal Energy Storage: Systems and Applications, (2nd Edition)**, Wiley, 2011, ISBN: 9780470747063. **Reference Books** 4. Francisco Díaz-González, F. Sumper, O. Gomis-Bellmunt. **Energy storage in power systems.** Wiley, 2016. ISBN: 9781118971321. 5. K. Brun, T. Allison and R. Dennis. **Thermal, Mechanical, and Hybrid Chemical Energy Storage Systems**. Academic Press, 2021. ISBN: 9780128198926.

Course code	**ME 220**
Course title	**Fundamentals of Acoustics**
Course Category	Departmental Elective
Credit Structure	L-T-P Credits 2-1-0-1.5 (Half-Semester)
Department	Mechanical Engineering
Prerequisite, if any	None
Objectives	● This course will give the foundation of acoustics. ● Students will understand the propagation of plane waves, 3-D waves, and symmetric spherical waves.
Course Outcomes	● Students will be able to find frequencies of higher order modes in circular and rectangular ducts, and acoustic pressure fields. ● Find the criteria for near field and far field for symmetric spherical waves. ● Design an impedance tube for the desired frequency range of interest.
Course Content	● **Acoustic Plane Waves**: Plane wave equation, Energy density of plane waves, Acoustic Intensity, Decibel Levels: Sound Intensity Level, Sound Pressure Level, and Sound Power Level. ● **3-D Waves in Rectangular and Cylindrical Waveguides**: 3-D Wave Equation in Cartesian and Cylindrical Coordinate Systems, Mode shapes of a cross-section, Acoustic pressure and acoustic particle velocity in waveguides. ● **Symmetric Spherical Waves**: Acoustic pressure and acoustic particle velocity of symmetric spherical waves, Concepts of far field and near field. ● **Impedance Tube**: Design of an impedance tube for a frequency range of interest, Transmission and Absorption Characteristics Measurements in Impedance tube.
Suggested Books	**Text Books** 1. L. E. Kinsler, A. R. Frey, A. B. Coppens, and J. V. Sanders, **Fundamentals of Acoustics**, **4th Edition**, Wiley, 2000, ISBN: 9780471847892. 2. D. T. Blackstock, **Fundamentals of Physical Acoustics,** Wiley, 2000, ISBN: 9780471847892. **Reference Books** 3. J. W. S. Rayleigh, **The Theory of Sound: Volume II, 2nd Edition,** Dover Publications, 1998, ISBN: 9780486602936**.** 4. A. D. Pierce, **Acoustics: An Introduction to Its Physical Principles and Applications, 3rd Edition,** ASA Press, 2019, ISBN: 9783030112134.

Course code	**ME 221**
Course title	**Optical Measurement Techniques in Fluid Mechanics**
Course Category	Department Elective
Credit Structure	L - T - P - Credits 2-1-0-1.5 (Half-Semester)
Department	Mechanical Engineering
Pre–requisite, if any	None
Objectives	● To establish a fundamental understanding of experimental measurements in fluid mechanics.
Course Outcomes	● Students will be get understanding of optics and light to measure fluid flow ● Students will be able to design optical setup for measurements
Course Content	● **Basics of Imaging:** Lens, Focusing, Depth of field, Diffraction limits, Light sheet generation, Imaging fundamentals, Wave propagation and Scattering from small particles. ● **Velocity measurement:** Particle image velocimetry, particle tracking velocimetry, particle streak velocimetry ● **Flow measurement:** Shadowgraphy, Schlieren, Background oriented Schlieren, Interferometry. ● **Particle measurement:** Interference, Laser Doppler velocimetry, Phase Doppler Technique, Interferometric particle imaging. ● **Laser Induced Fluorescence techniques:** Fluorescence and phosphorescence principles, temperature measurements in a liquid, temperature and concentration measurement in a gas, line and planar configurations.
Suggested Books	**Text Books** 1. Goldstein, R. J. 1996. **Fluid Mechanics Measurements, 2nd Edition, Taylor and Francis**. ISBN: 9780203755723. 2. Tropea, C., Foss, J.F. and Yarin A. 2007 **Handbook of Experimental Fluid Mechanics,** Springer: Berlin. ISBN: 9783662491621. **Reference Books** 3. Adrian R.J. and Westerweel J. **Particle Image Velocimetry**. Cambridge University Press, 2010. ISBN: 9780521440080 4. A. Eckbreth., **Laser Diagnostics for Combustion Temperature and species**, CRC press, 1996 ISBN: 9789056995324

Course code	**ME 222**

Course title	**Introduction to Experimental Aerodynamics**
Course Category	Departmental Elective
Credit Structure	L-T-P Credits 2-1-0-1.5 (Half-Semester)
Department	Mechanical Engineering
Prerequisite, if any	None
Objectives	● Introduce students to fundamental principles of experimental aerodynamics. ● Develop skills in basic experimental techniques and data analysis in aerodynamics.
Course Outcomes	● Students will demonstrate understanding of basic principles of experimental aerodynamics and its applications. ● Students will be able to effectively conduct and analyze simple aerodynamic experiments, laying the groundwork for further study in the field.
Course Content	● **Introduction to Experimental Aerodynamics**: Basic concepts, significance in aerospace engineering. Experimental Methods: Wind tunnels, pressure measurements, force balance, flow visualization techniques. ● **Measurement Techniques**: Pressure Measurement - pressure sensors, pressure taps, and manometers. Flow visualization techniques - smoke flow, oil flow, and particle image velocimetry (PIV). ● **Wind Tunnel Testing:** Types of wind tunnels, testing procedures, and instrumentation. Boundary Layer Measurements - Boundary layer probes, hot-wire anemometry. ● **Aerodynamic Forces and Moments Force**: Force balance and torque balance. Calculation of Aerodynamic Coefficients - Lift, drag, and moment coefficients. ● **Airfoil and wind testing**: Lift and drag measurement of airfoils in wind tunnels; measurement of lift and drag on wind models.
Suggested Books	**Text Books** 1. S. Discetti and A. Ianiro, **Experimental Aerodynamics**, CRC Press, 2017, ISBN: 9781498704014. 2. J.J. Bertin and R.M. Cummings, **Aerodynamics for Engineers**, 5e, Pearson Education International, 2009. ISBN: 9780132272681. **Reference Books** 3. J.P. Holman, **Experimental methods for Engineering**, McGraw Hill, 2007, ISBN: 9780070295957. 4. J.B. Barlow, W.H.Rae Jr., A. Pope, **Low-speed Wind Tunnel Testing**, 3e, John Wily and Sons. ISBN: 9788126525683

Course code	**ME 223**
Course title	**Design Thinking**
Course Category	Department Elective
Credit Structure	L - T - P - Credits 2-1-0-1.5 (Half-Semester)
Department	Mechanical Engineering
Pre–requisite, if any	None
Objectives	● The course is designed to teach how to use design thinking to generate innovative ideas and solutions. The course objective is to prepare student to see opportunities and make them learn how to take the many ideas and determine which ones are likely to produce specific, desired outcomes
Course Outcomes	● Basic understanding of design thinking, creativity and innovation. ● Be able to see opportunities, generate ideas and identify product needs. ● Understand process of converting idea in product specifications
Course Content	● **Introduction to Design Thinking**: Understanding Design Thinking Skills, Core Principles, The Foundation of Design Thinking, The Collaborative Nature of Interdisciplinary Teams for Design Thinking, Exercises and Case-Based Discussions. ● **Development Processes and Organizations:** Concept Development: The Front-End Process, Adapting the Generic Product Development Process. ● **Opportunity Identification**: Tournament Structure of Opportunity Identification, Opportunity Identification Process. ● **Identifying Customer Needs**: Gather Raw Data from Customers, Organize the Needs into a Hierarchy, Establish the Relative Importance of the Needs. ● **Product Specifications**: Understanding Specifications, Timing for Establishing Specifications, Establishing Target Specifications, and the Quality Function Deployment Method.
Suggested Books	**Text Books** 1. Karl T. Ulrich, Steven D. Eppinger, , Maria C. Yang, Product **Design and Development, 7th Edition,** McGraw Hill, 2020, ISBN: 9789390113231. 2. 2. J. Liedtka, A. King, and K. Bennett, **Solving Problems with Design Thinking,** Columbia Business School Publishing, 2013, ISBN: 9780231163569. **Reference Books** 3. D.G. Ullman, **The Mechanical Design Process**, 6th edition, David Ullman LLC, 2017, ISBN: 9780999357804. 4. I. Mootee, **Design Thinking for Strategic Innovation**, John Wiley & Sons 2013, ISBN: 9781118620120.

Course code	**ME 224**
Course title	**Fundamentals of Microscale Flows**
Course Category	Departmental Elective
Credit Structure	L - T - P Credits 2-1-0-1.5 (Half-Semester)
Department	Mechanical Engineering
Prerequisite, if any	Fluid Mechanics
Objectives	● The course aims to provide an understanding of the unique characteristics and behaviors of fluid flows at the microscale level, including phenomena such as microfluidics, nanofluidics, and rarefied gas flows. ● Encourage critical thinking and exploration of future advancements and societal implications of microfluidics.
Course Outcomes	● Students will be equipped with the knowledge, and skills necessary to understand, analyze, and apply microscale flows in various engineering and scientific contexts. ● Students will be able to recognize the interdisciplinary nature of microscale flows and their applications.
Course Content	● **Introduction to Microscale Flows**: Definition and significance of microscale flows, applications in various fields (biomedical, chemical engineering, aerospace, etc.), historical overview and development of microfluidics; Review of fluid mechanics fundamentals. ● **Scaling Laws and Dimensional Analysis**: Introduction to scaling laws for microscale flows, dimensionless numbers relevant to microfluidics, application of dimensional analysis to predict flow behavior. ● **Applications of Microscale Flows:** Lab-on-a-chip systems for medical diagnostics, microreactors for chemical synthesis, Microscale heat exchangers and cooling systems, microfluidic bioreactors and cell manipulation, emerging trends and future directions in microfluidics. ● **Introduction to Microfabrication Techniques**: Overview of microfabrication methods (photolithography, soft lithography, micromachining, etc.), Fabrication of microfluidic devices, surface modifications, and functionalization for microfluidic applications.
Suggested Books	**Text Books** 1. Nguyen, N. T., Werely,S. T., **Fundamentals and applications of Microfluidics**, Artech house Inc., 2002. ISBN: 9781630813642. 2. Tabeling, P., **Introduction to microfluidics**, Oxford University Press Inc., 2005. ISBN: 9780198568643. **Reference Books** 3. Kirby, B.J., **Micro- and Nanoscale Fluid Mechanics**: Transport in Microfluidic Devices, Cambridge University Press, 2010. ISBN-9781139489836**.** 4. Madou, M. J., **Fundamentals of Microfabrication**, CRC press, 2002. ISBN: 9781315274225.

Course code	**ME 225**
Course title	**Fundamentals of Vibrations**
Course Category	Department Elective
Credit Structure	L - T - P - Credits 2-1-0-1.5 (Half-Semester)
Department	Mechanical Engineering
Pre–requisite, if any	None
Objectives	● Students will understand the vibration response of simple systems. ● Students will understand the methods to find out natural frequencies of a system.
Course Outcomes	● Students will be able to make mathematical models for vibration of simple systems. ● Students will be able to perform Modal Analysis and Harmonic Analysis of Multi Degrees Freedom Systems.
Course Content	● **Vibration of Single Degree of Freedom (SDOF) Systems:** Free vibration and harmonically excited vibration response of undamped and viscously damped SDOF system, Transient response of SDOF system for impulse excitation and arbitrary excitation. ● **Vibration of Multi Degrees of Freedom (MDOF) Systems:** Natural frequencies and Mode shapes of a MDOF system, Free vibration response of a MDOF system for given initial conditions, Forced harmonic excited vibration response of a MDOF system.
Suggested Books	**Text Books** 1. W. T. Thomson, M. D. Dahleh, and C. Padmanabhan, **Theory of Vibration with Applications**, **5th Edition**, Pearson, 2008, ISBN: 9788131704820. 2. L. Meirovitch, **Fundamentals of Vibrations**, Waveland Press, 2010, ISBN: 9781577666912. **Reference Books** 3. L. E. Kinsler, A. R. Frey, A. B. Coppens, and J. V. Sanders, **Fundamentals of Acoustics**, **4th Edition**, 2000, ISBN: 9780471847892. 4. S. S. Rao, **Mechanical Vibrations**, **5th Edition**, Pearson, 2011, ISBN: 9780132128193.

Course code	**ME 227**
Course title	**Plastic Parts Manufacturing**
Course Category	Department Elective
Credit Structure	L - T - P - Credits 2-0-2-1.5 (Half-Semester)
Department	Mechanical Engineering
Pre–requisite, if any	None
Objectives	● To expose the students about design considerations and different manufacturing processes for the plastic parts
Course Outcomes	● The student will learn different processes used for manufacturing different types of plastic parts used in different daily use products, home appliances, computer peripherals, industrial products etc.
Course Content	● **Requirements for manufacturing**: Types, Classifications and Properties of plastics; Functional, Mechanical Strength, Wear Resistance, Hollowness, Transparency, Decoration, Characteristics of different manufacturing processes for plastic parts ● **Manufacturing Processes**: Working principles, Types, Applications, Advantages, and Limitations of different plastic parts manufacturing processes such as Extrusion; Blow Moulding; Injection Moulding; Rotational Moulding; Compression Moulding; Transfer Moulding; Structural Foam Moulding; Thermoforming; Casting; Potting; Encapsulation; Cold forming; Solid-phase forming ● Economics of plastic parts manufacturing
Suggested Books	**Text Books** 1. M.P. Groover, F**undamentals of Modern Manufacturing: Materials, Processes, and Systems (7th edition)**, John-Wiley & Sons Inc. 2020, ISBN: 9781119722014. 2. E. P. DeGarmo, J. T Black, R. A. Kohser, **Materials and Processes in Manufacturing**, Prentice Hall of India, New Delhi, 1997, ISBN: 9780132613712. **Reference Books** 3. Akira Kobayashi, **Machining of Plastics**, McGraw-Hill; First Edition (January 1, 1967), ISBN: 9780070352667 4. S. Kalpakjian, S.R. Schmid, **Manufacturing Engineering and Technology** (8th edition), Pearson Education Asia, New Delhi, 2020, ISBN:9780135228609. 5. P.N. Rao, **Manufacturing Technology: Vol 1 (4th edition),** McGraw Hill Education (India) Pvt. Ltd, New Delhi, 2013, ISBN: 9781259062575.

Course code	**ME 228**
Course title	**High Strain Rate Forming Process**
Course Category	Departmental Elective
Credit Structure	L - T - P Credits 2-1-0-1.5 (Half-Semester)
Department	Mechanical Engineering
Prerequisite, if any	Basic Manufacturing
Objectives	● The course aims to introduce students to the principle, procedure and applications of forming process recent advances in the forming.
Course Outcomes	● Students will be able to understand the concept of different advanced forming processes. ● Able to approach forming processes both analytically and numerically
Course Content	● **Introduction:** State of stress, Components of stress, symmetry of stress tensor, principal stresses, Stress deviator, Octahedral shear stress and shear strain theory, Hot, cold and warm working, Residual stresses, Spring back ● **Recent Advances:** Super plastic forming, Electro-magnetic forming, Electro-hydraulic forming, Explosive forming, Vaporising Foil Actuator metal forming, Hydroforming, Laser Forming, Micro forming, P/M forging, Isothermal forging, High speed hot forging, High speed stamping process, computer application in forming. ● **Applications in Industry:** Utilization of bulk sheet/plate metal forming in sectors like defence, aerospace, shipbuilding, and automotive industries. Techniques for forming complex geometries for applications in space exploration, solar panels, and general manufacturing.
Suggested Books	**Text Books** 1. Dieter G.E., **Mechanical Metallurgy**, McGraw Hill, Co., S.I. Edition, 1988, ISBN: 9780071004068. 2. Nagpal G.R. **Metal forming processes**, Khanna publishers, New Delhi, 2004, ISBN: 9788174090171 **Reference Books** 3. ***ASM Metals Handbook: Forming and Forging, Volume 14***. ASM International, 1996. ISBN: 9780871700209 4. Serope Kalpakjian, Steven R Schmid, **Manufacturing Process for Engineering Materials**, 4th Edition, Pearson Education, 2017, ISBN: 9780134290553. 5. Edward M.Mielink, **Metal working Science Engineering**, McGraw Hill, Inc, 1990, ISBN: 9780070419056.

Course code	**ME 230**
Course title	**Introduction to Smart Materials**
Course Category	Departmental Elective
Credit Structure	L - T - P Credits 2-1-0-1.5 (3/2 Half-Semester)
Department	Mechanical Engineering
Prerequisite, if any	Material science
Objectives	● To provide understanding of smart materials. ● Analysis of various smart materials and their potential applications
Course Outcomes	● To understand the principle of smart materials and know types of smart materials ● Know different types of smart materials for sensing, actuation and energy harvesting
Course Content	● **Introduction:** Definition and distinction between monolithic and smart materials; Basic characteristics and criteria for smart materials, different forms of smart materials (single crystals, polycrystalline, thin films, nanorods and nanoparticles) ● **Classification and mechanisms:** Active vs passive smart materials; Response mechanisms to external stimuli such as mechanical field, electrical field, magnetic field, heat and light. ● **Applications:** Applications in transducers, sensors, and actuators. Innovative uses in cooling, energy harvesting, and environmental applications such as water treatment and splitting.
Suggested Books	**Text Books** 1. Mohsen Shahinpoor (Ed.), **Fundamentals of Smart Materials**, RSC Publication, 2020, ISBN: 9781839168819. 2. Jasprit Singh, **Smart Electronic Materials-Fundamentals and Applications**, Cambridge University Press, 2005, ISBN: 9780521850274. **Reference Books** 3. P. L. Reece, **Smart Materials and Structures: New Research**. Nova Science Publishers., 2006, ISBN: 9781616681180 4. Mel Schwartz, **Smart Materials**, CRC Press, 2008, ISBN: 9781420043723.

Course Code	**ME 251**
Title of the Course	**Solid Mechanics Lab**
Credit Structure	L-T-P-Credits 0-0-3-1.5
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	None
Scope of the course	
Course Syllabus	Exp.1 Experiments associated with tensile testing Exp.2 Experiments associated with torsion testing Exp.3 Experiments associated with buckling Exp.4 Experiments associated with hardness and micro-hardness testing Exp.5 Experiments associated with fatigue testing and impact testing Exp.6 Experiments associated with beam bending Exp.7 Experiments associated with strain gauges Exp.8 Experiments associated with photo-elasticity Exp.9 Experiments associated with creep test and biaxial loading experiments
Suggested Books	1. S.H. Crandall, N.C. Dahl, and T.J. Lardner, **An Introduction to Mechanics of Solids**, McGraw Hill, 1978. 2. J.W. Dally, and W.F. Riley, **Experimental Stress Analysis**, McGraw Hill,1987. 3. E.O. Doebelin and D.N. Manik, **Measurement Systems: Applications and Design**, Tata McGraw Hill, New Delhi, 2007.

Course code	**ME 251N**
Course title	**Solid Mechanics Lab**
Course Category	Core
Credit Structure	L-T-P-Credits 0-0-2-1
Department	Mechanical Engineering
Pre–requisite, if any	None
Objectives	● Explore the mechanical properties of materials and enhance understanding through practical applications.
Course Outcomes	● Develop practical skills in materials testing through hands-on experiments in tensile testing, torsion testing, hardness & microhardness testing, impact testing, strain gauges, photo-elasticity, and creep tests.
Course Content	**List of representative experiments:** ● Tensile testing experiment. ● Torsion testing experiment. ● Hardness & microhardness testing experiment. ● Impact testing experiment. ● Strain gauges experiment. ● Photo-elasticity experiment. ● Creep tests experiment.
Suggested Books	**Reference Books** 1. S.H. Crandall, N.C. Dahl, and T.J. Lardner, **An Introduction to Mechanics of Solids**, McGraw Hill, 1978, ISBN: 9780070134416. 2. J.W. Dally, and W.F. Riley, **Experimental Stress Analysis**, McGraw Hill, 1987, ISBN: 9780070152182. 3. E.O. Doebelin and D.N. Manik, **Measurement Systems: Applications and Design**, Tata McGraw Hill, 2007, ISBN: 9780070616721. 4. L.S. Srinath, P. Desai, N.S. Murthy, and A.S. Murthy, **Strength of Materials**, 2000, ISBN: 9780333923924. 5. F.P. Beer, E.R. Johnston, **Mechanics of Materials,(5th Edition),** Tata McGraw Hill, , 2012, ISBN: 9780070153899.

Course Code	**ME 254**
Title of the Course	**Fluid Mechanics and Machinery Lab**
Credit Structure	L-T- P-Credits 0-0-3-1.5
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	ME-203: Fluid Mechanics
Scope of the course	
Course Syllabus	Experiments for (i) Measurement of Friction factor in pipes for turbulent flow conditions, (ii) Evaluation of Losses due to pipe fittings, (iii) Measurement of force due to impact of jets, (iv) Demonstration of Bernoulli's Theorem, (v) Visualization of flow regimes in channels, (vi) Determination of laminar velocity profile and friction factor in pipe flow, (vii) Determination of performance characteristics of Francis turbine, Pellton turbine, centrifugal pump, and blower.
Suggested Books	1. R.W. Fox and A.T. McDonald, **Fluid Mechanics**, John Wiley International, **2005**. 2. S. K. Som and G. Biswas, **Introduction to Fluid Mechanics and Fluid Machine**s (2nd Edition), Tata McGraw-Hill, New Delhi, 2008.

Course code	**ME 254N**
Course title	**Fluid Mechanics and Machinery Lab**
Course Category	Core
Credit Structure	L-T-P-Credits 0-0-2-1
Department	Mechanical Engineering
Pre–requisite, if any	None
Objectives	● Students will grasp fluid mechanics principles through experiments, including orifice characteristics, flow measurements, fluid machinery performance, pipe losses analysis, and applications of Bernoulli's theorem, leading to aerodynamics understanding in a wind tunnel.
Course Outcomes	● Develop a comprehensive understanding of fluid mechanics principles and their practical applications through hands-on experiments. ● Gain proficiency in utilizing a range of instruments and techniques for fluid flow measurement and machinery performance assessment.
Course Content	**List of representative experiments:** ● Determination of the coefficient of discharge, velocity and contraction of a small orifice. ● Flow measurement through notches. ● Flow Measurement through venturi nozzle, orifice meter, nozzle meter, rotameter and magnetic flow meter. ● Determination of performance characteristics of Francis turbine, Pellton turbine and centrifugal pump. ● Measurement of major and minor losses in pipes. ● Demonstration of Bernoulli's theorem. ● Measurement inside a wind tunnel: pressure and velocity.
Suggested Books	**Reference Books** 1. R.W. Fox and A.T. McDonald, **Fluid Mechanics**, John Wiley International, 2005, ISBN: 9780470547557. 2. S. K. Som and G. Biswas, **Introduction to Fluid Mechanics and Fluid Machines, (2nd Edition)**, Tata McGraw-Hill, 2008, ISBN: 9780070702592.

Course code	**ME 256**
Course title	**Computer Aided Machine Drawing**
Course Category	Core
Credit Structure	L-T-P-Credits (1-0-2-2)
Department	Mechanical Engineering
Pre–requisite, If any	None
Objectives	● This course is dedicated for learning the skill to interpret, to prepare machine drawings and their assembly process using the standard conventions and also to build on visualization power to imagine, analyze and communicate.
Course Outcome	● Students will master fundamental design processes and advanced drawing techniques to produce precise and comprehensive engineering drawings.
Course Content	● **Introduction**: Introduction to design process and drawings. ● **Review of Fundamentals**: Review of sectioning, Drawing standards, Dimensioning and notes. ● **Computer Aided Drawing**: Use of software packages for engineering drawings and drafting. - **Production drawings**: Limits, Fits and Tolerances, Dimensional and geometric tolerances, Computer Aided Tolerances,Tolerance Stacks, Surface finish representations and symbols. - **Jigs and Fixtures**: Tool drawings including jigs and fixtures. - **Fasteners and Joints**: Screws, Bolts and nuts, Riveted joints, Pins,Locking devices, Welded joints, Pipe joints, Unions and valves. Cotter and Knuckle Joints. Assembly drawings with sectioning and bill of materials. - **Machine Assemblies**: Involving machine elements like shafts, couplings, bearing, pulleys, gears, belts, brackets. Detailed part drawings from assembly drawings. Engine mechanisms assembly and disassembly. - **Layout drawings**: Schematics, process and instrumentation diagrams, piping drawings. - **Structural drawings**: examples for reading and interpretation.
Suggested Books	**Text Books** 1. N.D. Bhatt, and V.M. Panchal, **Machine Drawing**, Charotar Publishing House, 2009, ISBN: 9788185594958. 2. R K Dhawan, **A Textbook of Machine Drawing**, S Chand, 2015, ISBN: 9789385676499. 3. Foster, L. W. **Introduction to geometric dimensioning and tolerancing**. National Tooling & Machining Association,1996,ISBN:978-0910399180 4. Meadows, James D. **Geometric dimensioning and tolerancing: applications, analysis & measurement**. 2009, American Society of Mechanical Engineers, ISBN: 978-0971440166 **Reference Books** 5. N. Sidheswar, P. Kannaiah, and V.V.S. Sastry, **Machine Drawing**, Tata McGraw Hill, 1980, ISBN: 9780074603376.

Course Code	**ME 257**
Title of the Course	**Machine Drawing**
Credit Structure	L-T-P-Credits 1-0-3-2.5
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	A course in Engineering Graphics
Scope of the course	
Course Syllabus	Exp.1 Introduction to design process and drawings. Exp.2 Review of sectioning, Drawing standards, Dimensioning and notes. Exp.3 Fasteners and Joints: Screws, Bolts and nuts, Riveted joints, Pins, Locking devices, Welded joints, Pipe joints, Unions and valves. Cotter and Knuckle Joints. Assembly drawings with sectioning and bill of materials. Exp.4 Machine Assemblies: involving machine elements like shafts, couplings, bearing, pulleys, gears, belts, brackets. Detailed part drawings from assembly drawings. Engine mechanisms assembly and disassembly. Exp.5 Tool drawings including jigs and fixtures. Exp.6 Production drawings: Limits, Fits and Tolerances, Dimensional and geometric tolerances, Surface finish symbols. Exp.7 Layout drawings: Schematics, process and instrumentation diagrams, piping drawings. Exp.8 Structural drawings: examples for reading and interpretation. Exp.9 Computer aided drawing and drafting (CADD): use of software packages for engineering drawings and drafting.
Suggested Books	1. N.D. Bhatt, and V.M. Panchal, **Machine Drawing**, Charotar Publishing House, 2009. 2. N. Sidheswar, P. Kannaiah, and V.V.S. Sastry, **Machine Drawing**, Tata McGraw Hill New Delhi, 1980. 3. Bureau of Indian Standards, **SP 46: 1988.**

Course Code	**ME 258**
Title of the Course	**Manufacturing Processes Lab**
Credit Structure	L-T-P-Credits 0-0-3-1.5
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	A course in Basic Manufacturing Techniques
Scope of the course	
Course Syllabus	Exp.1 (a) Preparation of a core for producing a typical hollow-shaped part by the sand casting process. (b) Preparation of a Sand mold using the two-piece pattern and the core prepared in practical no.a, and production of the desired casting. Exp.2 (a) To prepare a single 'V' butt joint using MIG/MAG welding process and die penetrant testing. (b) Welding Metallurgy (MIG/MAG) Exp.3 Demonstration of non-traditional and CNC tools Exp.4 Manufacturing of thread and cylindrical grinding. Exp.5 Surface grinding and manufacturing of tapped holes in square plate
Suggested Books	Same as associated theory course ME 208: Theory of Manufacturing Processes.

Course code	**ME 258N**
Course title	**Manufacturing Processes Lab**
Course Category	Core
Credit Structure	L-T-P-Credits (0-0-2-1)
Department	Mechanical Engineering
Pre–requisite, if any	None
Objectives	The student will be able to understand the effect of process parameters, and related possible defects in different types of manufacturing processes.
Course Outcomes	Understanding of different manufacturing processes related to Casting, Forming, welding and powder compaction.
Course Content	List of representative experiments: ● Foundry and Molding: (a) Preparation of a core for producing a typical hollow-shaped part by the sand-casting process. Measurement of green strength of core. (b) Demonstration of centrifugal casting of aluminum pipe, including calculation of RPM and wall thickness for given volume of liquid metal. (c) Preparation of a sand mold using the two-piece pattern and the core preparation and production of the desired casting. (d) Measurement of green strength of sand mould. (e) Simulation of casting for demonstrating hot spots in the mould using E-Foundry. ● Welding: (a) To prepare two different samples of 'V' butt joints using MIG and TIG welding processes. (b) Resistance welding lap joint preparation. (c) To perform die penetrant test for both the samples prepared by TIG and MIG (Exp. 2.a). (d) To check strength and formability of welded joints by performing a bending test. ● Metal forming: (a) Design, development and manufacturing of typical sheet-metal product using various forming processes namely (i) sheet shearing, (ii) sheet roll-bending, (iii) nibbling and (iv) deep drawing. (b) Sheet metal forming of V shape, effect of nose radius (5, 10 & 20 mm), bend angle (60o, 90o & 120o) and measure the spring back. (c) Perform cold rolling operation on Aluminum sheet and estimate the strain that occurred during the process. (d) Perform wire drawing operation on Aluminum wire and estimate the strain that occurred during the process. (e) Demonstration of Injection molding, and evaluate mass flow rate. ● Powder Compaction: Execution of green compaction, sintering of aluminum/ plastic pallet power for the making of solid cylinder.
Suggested Books	**Reference Books** 1. E.P. DeGarmo, J.T. Black, and R.A. Kohser, **Materials and Processes in Manufacturing**, Prentice Hall of India Pvt. Limited, 2006, ISBN: 9780023286216.

	2. S. Kuo, **Welding Metallurgy**, John-Wiley & Sons Inc. 2003, ISBN: 1119524814. 3. R.W. Heine, C.R. Loper, and P.C. Rosenthal, **Principles of Metal Casting,** Tata McGraw-Hill, 1997,ISBN: 9780070993488. 4. G.E. Dieter, **Mechanical Metallurgy**, McGraw Hill Book Company Ltd. 1988, ISBN: 9781259064794. 5. A. Ghosh and A.K. Mallik, **Manufacturing Science**, Affiliated East West Press, 2001. ISBN: 9788176710636. 6. HMT, **Production Technology**, Tata McGraw Hill, 1980. ISBN: 9780070964432.

Course Code	**ME 301**
Title of the Course	**Heat Transfer**
Credit Structure	L-T-P-Credits 3-1-0-4
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	None
Scope of the course	
Course Syllabus	Modes of heat transfer and their mechanism. **Conduction:** Introduction to conduction; Thermal conductivity, diffusivity and heat generation; derivation of general heat conduction equation in Cartesian coordinate, boundary value problems, steady state conduction with heat generation and extended surfaces. Lamped capacitance and simple transient models. Finite difference formulation of differential equations, solution methods for system of algebraic equations. **Convection:** Forced and free convection, mass, momentum and energy conservation equations, non dimensional numbers, hydrodynamic and thermal boundary layer, basics of heat transfer in external and internal laminar and turbulent flows. Free convection from plate: Governing equations and non-dimensionalization. Similarity and integral solutions for vertical plate. Free convection for other cases; Mixed convection Introduction to pool boiling; correlations. **Radiation:** Basic concepts; Planck, Wien and Stefan-Boltzmann laws. Irradiation; solid angle; radiation intensity. Heat exchange between two surfaces. Shape factor: Definition, common configurations. Radiation exchange between two diffuse-gray surfaces. **Heat Exchangers:** Applications and classification of heat exchangers; Fouling factor. Design analysis using LMTD method. Performance analysis using ϵ - NTU method. Design considerations for heat exchangers.
Suggested Books	**Text Books** 1. J.P. Holman, **Heat Transfer** (10th edition), Tata McGraw Hill, New Delhi (ISBN: 9780071267694). 2. F.P. Incropera, and D.P. Dewitt, **Fundamentals of Heat and Mass Transfer** (5th edition) Wiley India, (ISBN: 9788126512614). **Reference Books** 1. F.P. Incropera, and D.P. Dewitt, **Fundamentals of Heat and**

	Mass Transfer (5th edition), John Wiley & Sons, New York, 2002, (ISBN: 978-0-470-05554-0). 2. A.F. Mills, **Basic Heat and Mass Transfer**, Prentice Hall, 1998. (ISBN: 0130962473) 3. Y.A. Cengel and A. Ghajar, **Heat and Mass Transfer: Fundamentals and Applications,** McGraw-Hill, (ISBN: 0077366646). 4. M. Necati Ozisik, **Heat Transfer: A Basic Approach**, McGraw-Hill, 1984. (ISBN: 0070479828)

Course code	**ME 301N (From 2025-26 onwards)**
Course Title	**Heat Transfer**
Course Category	Core
Credit Structure	L-T-P-Credits 2-1-0-3
Department	Mechanical Engineering
Pre–requisite, if any	None
Objectives	• Develop a fundamental understanding of the mechanisms of heat transfer, including conduction, convection, and radiation.
Course Outcomes	• Understanding of the fundamental principles of heat transfer • Ability to solve heat transfer problems
Course Content	• **Introduction**: Modes of heat transfer and their mechanism. • **Conduction**: Thermal conductivity, diffusivity and heat generation, boundary value problems, steady state conduction with heat generation; extended surfaces. Lumped capacitance and simple transient models. • **Convection**: Internal and external convection forced convection heat transfer, natural convection heat transfer. • **Radiation**: Planck, Wien and Stefan-Boltzmann laws. Irradiation; solid angle; radiation intensity. Heat exchange between two surfaces. Shape factor: Definition, common configurations. Radiation exchange between two diffuse gray surfaces. • **Heat Exchangers**: Applications and classification; Fouling factor. Design analysis using LMTD method. Performance analysis using ϵ-NTU method. Design considerations for heat exchangers.
Suggested Books	**Text Books** 1. Y.A. Cengel and A. Ghajar, **Heat and Mass Transfer: Fundamentals and Applications**, McGraw-Hill, 1997, ISBN: 9780077366646. 2. J.P. Holman, **Heat Transfer (10th Edition)**, Tata McGraw Hill, 2017, ISBN: 9780071267694. 3. F.P. Incropera, and D.P. Dewitt, **Fundamentals of Heat and Mass Transfer, (5th Edition)**, Wiley India, 2007, ISBN: 9788126512614. **Reference Books** 4. S.P. Sukhatme, **A Textbook on Heat Transfer**, University Press, 2005, ISBN: 9788173715440. 5. A.F. Mills and Carlos F.M. Coimbra. **Basic Heat and Mass Transfer**, Temporal Publishing LLC, 2015, ISBN: 9780996305303. 6. M. Necati Ozisik, **Heat Transfer: A Basic Approach**, McGraw-Hill, 1984, ISBN: 9780070479828.

Course code	**ME 309**
Course Title	**Instrumentation and Control Systems**
Course Category	Core
Credit Structure	L-T-P-Credits 2-0-0-2
Department	Mechanical Engineering
Pre–requisite, if any	None
Objectives	• To expose the student towards the characteristics of an actuator, sensor and controller for Electro mechanical and Smart Systems.
Course Outcome	• To understand and represent the system in terms of block diagram • To design electro mechanical system for different technological needs • Exposure to optical instrumentation for designing precise measurement setups
Course Content	• **Characteristics of Instruments:** Instrument and measurement systems, measurement system performance, dynamic characteristics. **Transducers and sensing elements:** thermal detectors, thermo-couples, hydro pneumatic sensors, mechano-electrical transducers,Piezo-electric, magneto-striction transducer, optical based sensors. • **Actuators and Drives :** Electro mechanical Actuators, Pneumatic and hydraulic drives and systems, Circuit design in pneumatic systems, Smart Actuators for Industry 4.0 and beyond. • **Data Acquisition and Interfacing:** Analog to Digital(A/D) and Digital to Analog (D/A) conversion, Programmable Logic Controller, interfacing of mechanical systems. • **Introduction to control systems:** Concept of Feedback, open and closed loop, Negative Feedback in control systems, Impulse response and transfer functions of linear systems, modeling of mechanical system elements, DC motor in control systems, linearization of nonlinear systems.

Suggested Books	**Text books:** 1. William Bolton, **Instrumentation and Control systems**, Newnes, 2013, ISBN: 9780750664325 2. Ernest O. Doebelin, Dhanesh N. Manik, **Measurement systems**, Tata McGraw Hill, 2006, ISBN: 9780070616721. 3. A.K.Sawhney, **A course in electrical and electronics measurements and instrumentation, (17th Edition),** Dhanpat Rai & C, 2015, ISBN: 9788177001006 4. I.J. Nagrath and M. Gopal, **Control system engineering**, **(7th Edition),** New Age International, 2021. ISBN:9788195175581. **Reference Books:** 5. J.W. Dally, W.F. Riley, **Instrumentation for engineering measurements**, Wiley India Edition, 2010, ISBN: 9788126528011. 6. T.G. Beckwith, J.H. Lienhard, R.D. Marangoni **Mechanical Measurements,** Pearson. 2013, ISBN: 97881317171889.

Course code	**ME 311**
Course Title	**Introduction to Robotics**
Course Category	Core
Credit Structure	L-T-P-Credit 2-1-0-1.5 (Half-Semester)
Department	Mechanical Engineering
Prerequisite, if any	None
Objectives	● This course covers robotics essentials, including core principles, latest technologies, and applications ● It prepares students to create robots for various purposes.
Course Outcome	● Identify key unanswered questions in soft robotics. ● Model soft robot mechanics using analytical/numerical tools. ● Build soft robot parts via 3D printing and elastomer casting.
Course Content	● **Introduction:** Introduction to robots, Soft versus Hard Robots, Types and classification, Specifications. ● **Forward and Inverse Kinematics:** Introduction, Representation of position and orientation of a rigid body, Homogeneous transformations ● **Velocity and Statics analysis:** Linear and angular velocity of links, Velocity propagation, Statics and force transformation of robotic manipulators. ● **Robot Dynamic analysis:** Introduction, Forward and inverse dynamics, Mass and inertia of links, Lagrangian formulation for equations of motion for robotic manipulators.
Suggested Books	**Text Books** 1. J.R. Schilling, **Fundamentals of Robotics: Analysis and Control,** Prentice Hall India, 1992. ISBN: 9780133444339. 2. A. Ghosal, **Robotics: Fundamental Concepts and Analysis,** Oxford University Press, 2008. ISBN: 9780195673913. 3. J. J. Craig, **Introduction to Robotics: Mechanics and Control**, John Wiley & Sons Inc., 2004. ISBN: 9788131718360. **Reference Books** 4. M.W. Spong, Seth Hutchinson, M. Vidyasagar, **Robot Modeling and Control,** John Wiley & Sons Inc., 2006. ISBN: 9780471649908.


भारतीय प्रौद्योगिकी संस्थान इंदौर
Indian Institute of Technology Indore
IIT Indore
।। ज्ञानम् सर्वजनहिताय ।।

Course code	**ME 305 (From AY 2025-26 onwards)**
Course title	**Machining Science and Metrology**
Course Category	Core
Credit Structure	L-T- P-Credits (2-1-0-3)
Department	Mechanical Engineering
Prerequisite, if any	None
Objectives	● Develop an in-depth understanding of the machine tool & machining operations. ● Acquiring knowledge about the metrology of a given product.
Course Outcome	● For a given design and material of a desired component students will be able to prepare a proper process engineering chart for the same. ● Having the theoretical and practical knowledge of this course, the students will be able to select an effective, efficient, and economic machining technique to produce a product with desired shape, size and surface finish
Course Content	● **Conventional Machining**: Concept of Generatrix and Directrix, Tool geometry of single point turning tool, Basic definitions of different machining operations with MRR estimation, Mechanism of chip formation, Introduction to wedge cutting; Mechanics of machining: Cutting forces, Theory of Ernst and Merchant, MCD, specific cutting energy and power consumption relations, Cutting temperature, Cutting tool wear, Tool life: Taylor's tool life equation, Machinability study ● **Nano-Mechanical Polishing:** Brittle to ductile transition, Scaling effects in indentation and scratching (Hertz's contact theory). ● **Non-Conventional Machining**: Introduction to NCM, Abrasive Jet Machining, Ultrasonic Machining, Electro Chemical Machining, Electrical Discharge Machining, Electron Beam Machining, Water Jet and Abrasive Water Jet Machining. ● **Engineering Metrology:** Role of metrology in design, Evaluation of limits and fits, Definitions of limits and fits (shafts and holes), Grades of tolerance, Selection of fits. ● **Machining Process engineering** of industrial components: Preparing step-wise machining process chart and its prototype making by using 3D printing technology.
Suggested Books	**Text Books** 1. G. Boothroyd, and W. A. Knight, **Fundamentals of Machining and Machine Tools**, Marcel Dekker, 1989, ISBN: 9780824778529. 2. A. Ghosh, and A.K. Mallik, **Manufacturing Science**, Affiliated East-West press Pvt. Ltd., 1985, ISBN: 9788176710633. 3. G. F. Benedict, **Nontraditional Manufacturing Processes**, Marcel Dekker, Inc., 1987. ISBN: 978024773527. 4. J. F. W. Galyer, and C. R. Shotbolt, **Metrology for Engineers**, ELBS, 1990, ISBN: 9780304318445. **Reference Books** 5. J.R.Davis, American Society for Metals. **ASM Metals Handbook**: Machining. Vol. 16, 1989. ISBN: 9780871700223 6. Society of Manufacturing Engineers, T. Drozda, R. Bakerjian, C.

	Wick, J.T. Benedict, R.F. Veilleux. **Tool and Manufacturing Engineers (TMEH) Handbook**, Vol. 6, 1992. ISBN: 9780872634022

Course code	**ME 351N (From AY 2025-26)**
Course title	**Heat Transfer Lab**
Course Category	Core
Credit Structure	L-T-P-Credits 0-0-2-1
Department	Mechanical Engineering
Prerequisite, if any	Heat transfer
Objectives	• The course provides a foundation in the basic principles of heat transfer, including conduction, convection, and radiation, and how they are related to real-world applications.
Course Outcomes	● The course provides students with an understanding of how to analyze and interpret heat transfer data obtained from experiments.
Course Content	**List of representative experiments:** ● Determination of coefficient of thermal conduction (thermal conductivity) of gasses and liquids. ● Steady state one dimensional radial and linear conduction; heat transfer from fins. ● Determination and comparison of thermal conductivity of different insulating and building materials (Cork, Plaster, POM, etc) ● Determination of heat transfer in free and forced convection modes. ● Determination of overall heat transfer coefficient in various heat exchangers (Tubular, Shell and tube, and Plate type). ● Verification of different laws of radiation (Lambert's distance law, Lambert's direction law, Stefan Boltzmann's law and Kirchhoff's law)
Suggested Books	**Reference Books** 1. J.P. Holman, **Experimental methods for Engineers, (8th Edition)**, McGraw Hill, 2012, ISBN: 9780073529301 2. Y.A. Cengel and A. Ghajar, **Heat and Mass Transfer: Fundamentals and Applications**, McGraw-Hill, 2017, ISBN: 9780077366646. 3. J.P. Holman, **Heat Transfer,(10th Edition)**, Tata McGraw Hill, 2017, ISBN: 9780071267694. 4. F.P. Incropera, and D.P. Dewitt, **Fundamentals of Heat and Mass Transfer, (5th Edition)**, Wiley, 2001, ISBN: 9788126512614.

Course code	**ME 357**
Course Title	**Instrumentation and control systems lab**
Course Category	Core
Credit Structure	L-T-P-Credits 0-0-2-1
Department	Mechanical Engineering
Pre–requisite, if any	None
Objectives	● To understand interfacing and designing instruments for multidisciplinary applications.
Course Outcomes	● Knowledge on understanding the instruments and exposure to different devices will equip students to develop systems for complex engineering, industries and societal applications .
Course Content	**List of representative experiments:** **Actuators for Automation, Pneumatic System Design & smart actuators:** ● Operation of Double Acting Cylinder for different conditions and Valve timings ● Automatic operation of Double multi Cylinder ● Sequencing of Cylinders ● Multi cycle automation of multiple cylinders using cascading method ● SMA based Smart Actuator integration and applications **Sensors Integration:** ● Potentiometer based position and displacement sensor ● Contact and Non contact Based Temperature measurement ● Flow, Pressure, Velocity, Vibration sensing of different systems **Optical Instrumentation:** ● Optical Fiber sensors based experiments ● Laser Based Displacement Sensor based system design and integration ● Interferometer based system design and integration **Process control Kit:** ● Introduction to different sensors and Control Loop system ● Study of Feedback flow Control Loop with Supervisory Station ● Study of Feedback Level Control System with Scada Station ● Study of Feedback Pressure Control System **Automotive instrumentation:** Demonstrating Engine Sensors and Controls. **Microprocessor and Applications**: ● Microprocessor architecture and instruction set ● Memory interface and mapping ● Stepper motor control ● Temperature regulation
Suggested Books	**Reference Books** 1. T T. G. Beckwith, J. H. Lienhard, R. D. Marangoni **Mechanical Measurements**, Pearson, 2020, ISBN: 97881317171889.

	2. S. O. Kasap, **Optoelectronics and photonics principles and practices**, Pearson, 2018, ISBN: 9788131724682. 3. William Bolton, **Instrumentation and Control systems**, Newnes, 2004, ISBN: 9780750664325. 4. I.J. Nagrath and M. Gopal, **Control system engineering, (2nd Edition)** Wiley, 2021, ISBN: 9788122417005

Course code	**ME 355 (From AY 2025-26)**
Course title	**Machining Science and Metrology Lab**
Course Category	Core
Credit Structure	L-T-P-Credits 0-0-2-1
Department	Mechanical Engineering
Prerequisite, if any	None
Objectives	● Learning the machining operations through hands-on experience and measurement of different dimensional aspects of the cutting tool and machined product by different methods. ● Finding the roles of process parameters on the shape, size and surface of the machined product.
Course Outcomes	● With the practical knowledge from this course, students will be able to select an effective, efficient, and economic machining process, the suitable tools and process conditions to produce the desired product with proper shape, size and surface finish.
Course Content	**List of representative experiments:** ● Measurement of cutting forces on turning and drilling tools during the machining operations by using Piezo-electric type dynamometer. ● To find the wedge angle of a given specimen with the help of Sine Bar technique. ● Study the effects of feed rate, tool nose radius and cutting velocity on the average surface roughness (R_a) of a turned surface. ● Determination of average cutting temperature at tool-work interface during turning operation by using tool-work thermocouple technique. ● Preparing a threaded sample by thread cutting operation in lathe and measurement of the thread parameters by using the Tool Maker's Microscope. ● Estimation of the life of a single point carbide turning tool by using the Taylor's Tool Life Equation. ● Effects of grinding environment and wheel condition on the material removal rate and average surface roughness of the machined surface. ● Study the chip morphology under different machining conditions and determination of the shear angle. ● Measurement of flatness, circularity, cylindricity, and concentricity of a given specimen by using Dial Gauge measurement technique
Suggested Books	**Reference Books:** 1. G. Boothroyd, and W. A. Knight, **Fundamentals of Machining and Machine Tools**, Marcel Dekker, 1989, ISBN: 9780824778529. 2. A. Ghosh, and A.K. Mallik, **Manufacturing Science**, Affiliated East-West press Pvt. Ltd., 1985, ISBN: 9788176710633. 3. G. F. Benedict, **Nontraditional Manufacturing Processes**, Marcel Dekker, Inc., 1987. ISBN: 978024773527. 4. J. F. W. Galyer, and C. R. Shotbolt, **Metrology for Engineers**, ELBS, 1990, ISBN: 9780304318445. **Reference Books** 5. Joseph R Davis, **ASM Metals Handbook: Machining. Vol. 16**,

	ASM International, 1989, ISBN: 9780871700223 6. T Drozda, R Bakerjian, C Wick, John T. Benedict, Raymond F. Veilleux, **Tool and Manufacturing Engineers (TMEH) Handbook, Vol. 6**, Society of Manufacturing Engineers, 1992, ISBN: 9780872634022

Course code	**ME 313**
Course title	**Introduction to Finite Element Methods**
Course Category	Core
Credit Structure	L-T-P-Credit 2-1-0-1.5 (Half-Semester)
Department	Mechanical Engineering
Prerequisite, if any	None
Objectives	The course provides a concise overview of the fundamental concepts and applications of finite element methods, emphasizing their significance in numerical analysis and engineering problem-solving.
Course Outcome	● To learn a robust numerical method for numerical solution of differential equations. ● To learn basic features of 1D and 2D FEM for solid mechanics and heat transfer problems. ● To learn computer implementation of FEM Model through computer programming.
Course Content	● **Introduction:** Analytical and approximate solution, differential equations, Galerkin method, weighted residual methods, weight functions, rod under axial load, beam equation, solution of rod and beam problems by weighted residual methods. ● **Weak Formulations:** Weak formulation of governing equations, weak formulation of rod and beam equation, weak formulation of Poisson's Equations, Solution of differential equations by weak formulation, Piecewise FE model from weakform. ● **1D Element formulation**: Shape functions, isoparametric formulation, derivation of stiffness matrix, assembly of stiffness matrix, solution methods, implementation of boundary conditions. ● **Single Variable Problems in 2D:** Heat conduction in plate, Elemental equation, triangular and rectangular element, Computer implementation of 2D elements. ● **Introduction to Energy Methods:** Variational Formulation
Suggested Books	**Text Books** 1. Seshu, P., **Finite Element Analysis**, Prentice Hall of India, New Delhi, 2018. ISBN: 9788120323155. 2. David Hutton, **Fundamentals of Finite Element Analysis**, McGraw Hill Education, 2003. ISBN: 9780070601222. 3. J. N. Reddy, **An Introduction to the Finite Element Method**. McGraw Hill Education, 1993 ISBN: 9780070607415 **Reference Books** 4. K. J. Bathe, **Finite Element Procedures in Engineering Analysis**, Prentice-Hall, Englewood Cliffs, NJ, 1982, ISBN: 9780133014587. 5. Olek C Zienkiewicz and R. L. Taylor, **The Finite Element Method: Its Basis and Fundamentals**, Butterworth-Heinemann Ltd, ISBN: 9781856176330. 6. Ferreira, A.J.M., **MATLAB codes for Finite Element Method**. Springer, 2009. ISBN: 9783030479541

Course code	**ME 315**
Course Title	**Operations Research**
Course Category	Department Elective
Credit Structure	L-T-P-Credits 2-1-0-3
Department	Mechanical Engineering
Pre–requisite, if any	None
Objectives	● The course aims at analyzing different situations in the industrial/business scenario involving limited resources and finding the optimal solution within constraints.
Course Outcomes	● Understanding of tools from optimization, probability, statistics, and economic analysis, including fundamental applications of those tools in manufacturing and service industry.
Course Content	● **Introduction:** Origin and development of operations research. ● **Linear Programming Problems:** Different types of models, formulation of linear programming problems (LPPs), product-mix problems, deterministic models, graphical solutions. ● **Simplex Method:** Simplex algorithm, computational procedure in simplex method, applications of simplex technique to industrial problems, duality and its concept, dual linear programming, application of elementary sensitivity analysis. ● **Linear Optimization Techniques:** Integer programming problems (IPPs), assignment problems, transportation problems for manufacturing and service industry. ● **Game Problems:** Introduction and scope of game problems in business and industry, min-max criterion and optimal strategy, solution of two- person zero-sum game, game problem as a special case of linear programming. ● **Queuing Problems:** Queuing systems and concepts, classification of queuing situations; Kendall's notation, solution of queuing problems, single channel, single stage, finite and infinite queues with Poisson arrival and exponential service time, applications to industrial problems.
Suggested Books	**Text Books** 1. Taha, H. A.. **Operations Research: An Introduction. India:** Pearson Education, 2013, ISBN: 9789332518223. 2. Hillier, F. S., Lieberman, G. J.. **Introduction to Operations Research.** McGraw-Hill Education, 2021, ISBN: 9781260575873. **Reference Books** 3. Wagner, H. M.. **Principles Of Operations Research With Applications To Managerial Decisions, (2nd Edition)**: Prentice-Hall of India, 1999, ISBN: 9788120301627. 4. Shortle, J. F., Thompson, J. M., Gross, D., Harris, C. M. **Fundamentals of Queueing Theory.** Wiley., 2018, ISBN: 9781118943526.

Course code	**ME 317**
Course Title	**Trends and Developments in Solid Mechanics**
Course Category	Departmental Elective
Credit Structure	L - T - P Credits 2-1-0-1.5 (Half-Sem)
Department	Mechanical Engineering
Prerequisite, if any	None
(Objective)	● To encourage the students to think and admire the contributions of the great scientists. ● To excite the students about the importance of Mechanics of Solids and how it helped us design and innovate.
Course Outcomes	● Engineering knowledge: Different attempts of application of the knowledge of solid mechanics to the design-process of structural members in the history and their refinements. ● Problem analysis: using the sense of early rational mechanics via different approaches.
Course Content	● **Classical solid mechanics:** Mechanics of Leonardo da Vinci. Newton's Principia; Galileo's work on solid mechanics; and Contributions of chief scientists. The beginning of mathematical theory of elasticity. ● **Modern solid mechanics:** Theory of elasticity, properties, fracture of brittle materials, testing of ductile materials, strength theories, creep and experimental stress analysis. ● **Solid mechanics at varied length and time scales:** Bohr's correspondence principle. The breakdown of solid mechanics models at nanolevel and the appropriate assumptions to treat nanostructures as continuum. Multiscale modeling of advanced solids.
Suggested Books	**Text Books** 1. S. P. Timoshenko, **History of Strength of Materials**, Dover Publications Inc, 2003. ISBN: 9780486611877. 2. I. Todhunter, **A History of the Theory of Elasticity and of the Strength of Materials**, from Galileo to the Present Time, Vol. 1: Galilei to Saint-Venant, 1639-1850, Forgotten Books, 2018. ISBN: 9781527650480. **Reference Books** 3. Todhunter, **A History of the Theory of Elasticity and of the Strength of Materials**: From Galileo to the Present Time, Volume 2, Part 1, Nabu Press, 2010. ISBN: 9781144726667. 4. Todhunter, K. Pearson, **A history of the theory of elasticity and of the strength of materials,** from Galileo to the present time (Volume 2) Saint-Venant to Lord Kelvin. Part 2, Alpha Edition, 2020. ISBN: 9789353970642.

Course code	**ME 319**
Course Title	**Solid-State Cooling Technologies**
Course Category	Department Elective
Credit Structure	L-T-P Credit (2-1-0-3)
Department	Mechanical Engineering
Pre–requisite, if any	Materials Science
Objectives	● Learning the fundamental principles and different methods of solid-state cooling. ● Study of various solid-state cooling technologies and expose the importance of their applications
Course Outcomes	● To understand the principle of solid state refrigeration and know types of solid state cooling technology ● Know different types of materials for cooling and portal devices
Course Content	● **Introduction**: conventional cooling methods; need of solid-state cooler, cooling potential in solids; types of solid state refrigeration system. ● **Thermoelectric cooling:** concept of Peltier cooling, thermodynamics, materials requirement, types of material available for thermoelectric, applications, current status. ● **Electrocaloric cooling:** introduction to electrocaloric, thermodynamics of electrocaloric effect, materials requirement, measurement techniques, types of material available for electrocaloric, applications and prototypes, current status. ● **Mechanocaloric cooling:** concept of elastocaloric and barocaloric, thermodynamics of mechanocaloric, materials requirement, measurement techniques, types of material available for mechanocaloric, applications and prototypes, current status. ● **Magnetocaloric cooling:** introduction of magnetocaloric, thermodynamics of magnetocaloric effect, materials requirement, measurement techniques, types of material available for magnetocaloric, applications and prototypes, current status.
Suggested Books	**Text Book** 1. Lidong Chen, Ruiheng Liu and Xui Shi, **Thermoelectric Materials and Devices**, Elsevier 2020, ISBN: 9780128184134 2. Kholkin, A.L., Pakhomov, O.V., Semenov, A.A. and Tselev, A. eds., **The Electrocaloric Effect Materials and Applications**, Elsevier Publisher, 2023, ISBN: 9780128216477. 3. Pol Lloveras, **Barocaloric Effects in the Solid State: Materials and methods,** IOP Publishing, 2023, ISBN: 9780750346900. **Reference Books** 4. A. Kitanovski, J. Tušek, U. Tomc et al. **Magnetocaloric Energy Conversion: From Theory to Applications**, Springer, 2015, ISBN: 9783319087412. 5. Florian Brüderlin, **Advanced Elastocaloric Cooling Devices Based on Shape Memory Alloy Films**, KIT Scientific Publishing, 2022, ISBN: 9783731510659. 6. D.M. Rowe, **Thermoelectrics Handbook**: Macro to nano, Taylor & Francis Group, 2006, ISBN: 9780849322648.

Course code	**ME 321**
Course Title	**Introduction to Hybrid Additive Manufacturing Techniques**
Course Category	Department Elective
Credit Structure	L-T-P Credit (2-1-0-1.5) (Half-Semester)
Department	Mechanical Engineering
Pre–requisite, if any	None
Objectives	● The course aims to introduce students to new Additive manufacturing techniques and their applications.
Course Outcomes	● The students will learn about different newly developed Additive Manufacturing techniques.
Course Content	● **CAD Modelling and Data Processing for AM**: CAD model preparation, Chordal error, error associated with STL and repair procedure; Part orientation and support generation, Support structure design, Slicing, Tool path generation. ● **AM Processes**: Basics of the AM process, Classification, Material, and Technological aspects, Applications, limitations of conventional AM processes, Defects associated with different AM techniques and post-processing methods. ● **Advanced AM Processes**: New AM processes like Micro-stereolithography, Continuous Fiber Fabrication, Digital Light Processing, Composite Based additive manufacturing. ● **Bioprinting**: Basics of bioprinting, Classification, Material and technological aspects, Application. ● **4D Printing**: Basics of 4D printing process, Material and technological aspects, Applications. ● **Hybrid AM processes**: Basics of Hybrid AM, Classification, Material and technological aspects, Application. ● **Reverse Engineering**: Reverse engineering, Different techniques of RE and its file formats like Dicom file, point cloud data, etc, Application.
Suggested Books	**Text Book** 1. C.P. Paul and A.N. Jinoop, **Additive Manufacturing: Principles, technologies and Application**, Tata McGraw-Hill, 2021, ISBN: 9789390727480 2. Kun Zhou, **Additive Manufacturing Technology: Design, Optimization, and Modeling**, Wiley, ISBN:9783527349524 **Reference Books** 3. K.Shivananda Devi and R. Nilanjana, **Additive Manufacturing**, Laxmi Publications, 2022, ISBN: 9789393738572. 4. Fuewen F Liou, **Rapid Prototyping and Engineering applications: A tool box for prototype development**, CRC Press, 2019,ISBN: 9781498798926.

Course code	**ME 323**
Course Title	**Mechanics of Sheet Metal Forming Processes**
Course Category	Department Elective
Credit Structure	L-T-P Credit (2-1-0-1.5) (Half-Semester)
Department	Mechanical Engineering
Pre–requisite, if any	Basics of Materials Science
Objectives	● The course aims to introduce students to the principle, procedure and theoretical analysis of sheet metal forming processes
Course Outcomes	● Students able to understand the concept sheet metal forming and plasticity ● Able to approach theoretical analyses of few sheet forming and tube forming operations.
Course Content	● **Sheet deformation processes:** Uniaxial tension, general sheet forming processes, isotropic and anisotropic yield functions, Bauschinger effect modeling, effective stress and strain. ● **Sheet deformation in plane stress:** strain distributions, strain diagram, deformation modes, effective stress-strain laws, principal tensions. ● **Stamping analysis:** 2-D and 3-D model of stamping, stretch and draw ratios in stamping. Load instability and tearing: uniaxial tension of perfect strip and imperfect strip, tensile instability in stretching continuous sheet. ● **Sheet formability:** Forming limit curve, concept and evaluation, formability tests, theoretical prediction, factors affecting FLC. ● **Sheet bending:** Variables in bending a continuous sheet, equilibrium conditions, material models, bending without tension, springback.
Suggested Books	**Text Books** 1. D. Banabic, **Sheet metal forming processes**, Springer-Verlag Berlin Heidelberg, 2010, ISBN-13: 9783540881124 2. Z. Marciniak, J. L. Duncan, S. J. Hu, **Mechanics of sheet metal forming**, Elsevier,Butterworth-Heinemann, 2002, ISBN: 9780750653008 3. R. H. Wagoner, J. L. Chenot, **Fundamentals of metal forming,** John Wiley and Sons,1997, ISBN: 9780471570042 **Reference Books** 4. W. F. Hosford, R. M. Caddell, **Metal forming Mechanics and Metallurgy,** PrinticeHall, 2007, ISBN-13: 9781107004528 5. J. Chakrabarty, **Theory of Plasticity**, McGraw Hill, 1998, ISBN-13: 9780750666381

Course code	**ME 325**
Title of the course	**Textiles for Noise Control**
Course Category	**Elective**
Credit Structure	L - T - P – Credits, 2-1-0-3
Department	Mechanical Engineering
Pre-requisite, if any	None
Scope of the course (Objectives)	● Understand the basic mechanisms responsible for noise attenuation by the textiles used for noise control. ● Learn the noise attenuation characteristics measurements as per well-established standards.
Course Outcomes	● Apply the appropriate noise attenuation materials as per the requirements of real-world applications. ● Design of acoustic textiles considering the environmental challenges.
Course Content	● Introduction to acoustic textiles; classification of acoustic textiles: Nonwovens, Knitted Fabrics, Weft Knit Fabrics etc. ● Manufacturing methods for acoustic textiles: weaving, nonwoven, polymer composites, knitting, hybrid textiles. ● Noise attenuation mechanisms of acoustic textiles; Measurement of flow resistivity, absorption coefficient, and reverberation time; ISO and ASTM Standards for flow-acoustic characterization of acoustic textiles. ● Application of Acoustic Textiles: Civil Engineering and Automotive/ Transportation. ● Design of eco-friendly acoustic textiles.
Suggested Books	**Text Books:** 1. R. Padhye and R. Nayak, **Acoustic Textiles**, Springer, 2016. ISBN: 9789811014741. 2. T. Adams, **Sound Materials**, Frame Publishers, 2016. ISBN: 9789492311016. **Reference Books:** 3. J. F. Allard and N. Atalla, **Propagation of Sound in Porous Media: Modelling Sound Absorbing Materials**, Wiley, 2009. ISBN: 9780470746615. 4. P. Saha, **Acoustic Materials: Solving the Challenge of Vehicle Noise**, SAE International, 2021. ISBN: 9780768080841.

Course code	**ME 302 (From AY 2025-26 Onwards)**
Course Title	**Applied Thermodynamics**
Course Category	Core
Credit Structure	L-T-P-Credits 2-1-0-3
Department	Mechanical Engineering
Prerequisite	A course in Thermodynamics

Objectives	● Objective of the course is to introduce and train student on application of thermodynamics laws to real life systems
Course Outcome	● Understand the components, basic assumptions, and compute energy and entropy balances of vapor and gas power cycles, and refrigeration cycles ● Compute thermodynamic properties for mixtures, stoichiometric balances and equivalence ratios
Course Content	● **Review of First Law of Thermodynamics:** for Closed and Open Systems. Classification of cycles ● **Performance parameters:** Net work, thermal efficiency, heat rate, specific fuel consumption, work ratio, specific output, MEP. ● **Stoichiometry:** General stoichiometry and definition of terms (rich mixture, lean mixtures). ● **Combustion:** Heat of formation, Heat of reaction, Calorific Value of fuel, Estimation methods for Calorific values, Exhaust Gas Analysis, Orsat Apparatus. ● **Power Cycles:** Air-standard cycles and Actual cycles, Otto, Diesel, Brayton cycle. Application of power cycles in power plants and various modifications. Rankine cycle, Modifications to Rankine cycle, Feed water Heaters and analysis, Moisture separators. ● **Introduction of Internal Combustion (IC) Engines:** Spark ignition (SI) and compression ignition (CI) engines, combustion and knocking in SI and CI engines, Carburetion. ● **Introduction of Refrigeration and Air Conditioning:** Vapour Compression and Reverse Brayton Cycles; Vapour Absorption Cycles; Psychometry. ● **Compressors:** Reciprocating, rotary and centrifugal compressors.
Suggested Books	**Text Books** 1. M.J. Moran and H.N. Shapiro, **Fundamentals of Engineering Thermodynamics, (6th Edition),** Wiley, ISBN: 978471787358. 2. Y.A. Cengel and M.A. Boles, **Thermodynamics: An Engineering Approach, 6th Edition)**, Tata McGraw Hill, 2008, ISBN: 9780070262179. **Reference Books** 3. G.F.C. Rogers, and Y.R. Mayhew, **Engineering Thermodynamics: Work and Heat Transfer (4th Edition)**, Longman, 1992, ISBN: 9780582045668. 4. Granet, and M. Bluestein, **Thermodynamics and Heat Power**, Prentice Hall, ISBN: 9780131106724. 5. E. Logan, **Thermodynamics Process and Application**, Marcel Dekker, 1999, ISBN: 9780824799593. 6. C. Wu, **Thermodynamics and Heat Powered Cycles: A Cognitive Engineering Approach**, Nova Science Publishers, 2006, ISBN: 9781606926260.

Course code	**ME 310**
Course Title	**Design of Machine Elements**
Course Category	Core
Credit Structure	L-T-P-Credits 2-1-0-3
Department	Mechanical Engineering
Pre–requisite, if any	NA
Objectives	Prepare mechanical engineering students to: ● Apply solid mechanics knowledge to understand the design process/methods of mechanical system components. ● Design of common machine elements.
Course Outcomes	● Apply the knowledge to the design-process of machine elements. ● Stress analysis of machine elements. ● Design and development of machine elements.
Course Content	● **Introduction:** Fundamentals of machine design; design for static loading, stress concentration, and design for dynamic loading. ● **Joints:** Design of welded and riveted joints. ● **Gears and Bearings**: Design procedure of gears. Design of rolling contact bearings. ● **Belts, Brakes, and Clutches**: Design of flat and V-belt drives. Design of shoe and band brakes. Design of plate clutches – for uniform pressure and wear.

Suggested Books (Text Books , Reference Books)	**Text Books** 1. R. G. Budynas,, J. K. Nisbett, K. Tangchaichit, **Shigley's Mechanical Engineering Design, (11th Edition)**, Tata McGraw Hill, 2020, ISBN: 9789813158986 2. R. L. Norton, **Machine Design, (5th Edition)**, Pearson Education, 2013, ISBN: 9780133356717. 3. M.F Spotts, **Design of Machine Elements, (8th Edition)**, Prentice Hall, India, 2019, ISBN: 9789353433130. **Reference Books** 4. 4. T. Brown, **Mark's Calculations For Machine Design**, Tata McGraw Hill, 2005, ISBN: 9780071436892. 5. 5. Alfred S. Hall, A. R. Holowenko, H. G. Laughlin, **Schaum's Outline of Machine Design**, McGraw Hill, 2010, ISBN: 9780070255951. 6. 6. V. Bhandari, **Design of Machine Elements, (4th Edition)**, Tata McGraw Hill, 2017, ISBN: 9789339221126.

Course code	**ME 312**
Course Title	**Introduction to Computational Fluid Dynamics**
Course Category	Core
Credit Structure	L-T-P-Credits 2-1-0-1.5 (Half-Semester)
Department	Mechanical Engineering
Pre–requisite, if any	None
Objectives	● Understand the fundamental principles of fluid mechanics and their application in Computational Fluid Dynamics (CFD). ● Gain proficiency in basic numerical methods and algorithms used in CFD simulations.
Course Outcomes	● Demonstrate knowledge of the basic equations governing fluid flow and their discretization techniques for numerical analysis. ● Apply CFD software to solve simple engineering problems, interpret results, and demonstrate an understanding of best practices in CFD simulations.
Course Content	● **Basics of fluid mechanics and numerical methods**: Overview of fluid mechanics and CFD. Basic equations of fluid flow Introduction to Numerical Methods in CFD ● **Fundamentals of CFD:** Finite difference and Finite volume methods; Discretization techniques; Governing equations in CFD; Boundary conditions and laminar/turbulent flow Modeling ● **CFD Solvers and Algorithms:** Overview of CFD solvers; Iterative methods and time integration schemes; Introduction to CFD Software ● **Applications and Case Studies:** Applications of CFD in engineering; Case studies and hands-on examples; Best practices and future directions
Suggested Books	**Text Books** 1. J.D. Anderson Jr. **Computational Fluid Dynamics: Basics with applications**. McGraw Hill, 1995. ISBN: 9781259025969 2. H. Versteeg and W. Malalasekera, An **Introduction to Computational Fluid Dynamics: The finite volume methods**, Pearson, 2007. ISBN: 9780131274983 **Reference Books** 3. C.A.J. Fletcher, **Computational Techniques for Fluid Dynamics** (Vol.1 & 2), Springer Verlag, 1988. ISBN: 9783540530589 4. S.V. Patankar, **Numerical Heat Transfer and Fluid Flow**, Academic Press, 2017. ISBN: 9781138564695

Course code	**ME 352N (From AY 2025-26)**
Course Title	**Applied Thermodynamics Lab**
Course Category	Core
Credit Structure	L-T-P-Credits 0-0-2-1
Department	Mechanical Engineering
Pre–requisite, if any	None
Objectives	● To give students hands-on training on energy conversion devices, performance measurement and heat balance calculation.
Course Outcomes	● Understand operation of energy conversion devices: Steam turbine, I.C. Engine, Gas turbine. ● Measurement of performance parameters of thermodynamic systems. ● Preparing heat balance sheets for energy conversion devices.
Course Content	**List of representative experiments:** ● **Cooling Tower** • To investigate the effect of cooling load on "Approach to wet bulb" and draw up energy and mass balances. • To investigate the effect of the packing density ● **Vapour compression refrigeration** • Study the effect of condenser load on vapor compression refrigeration cycle. • Study the effect of evaporator load on vapor compression refrigeration cycle. ● **Rankine cycle** • Study the effect of boiler pressure on turbine power output and calculation of efficiencies related to Rankine cycle ● **Air conditioning** • To study (i) Sensible heating (ii) heating and Humidification (iii) Cooling and Dehumidification processes • To determine the energy and mass transfer rates at heater, boiler and refrigeration unit. • To study the effect of adiabatic mixing of different quantities of air in two different states and plot on a psychrometric chart. ● **Jet engine**: To study jet engine performance ● **Petrol or Diesel engine** • To study the performance of 4-stroke Petrol / Diesel engine and prepare heat balance sheet ● **Bomb Calorimeter**: To find the calorific value of a sample fuel calorimeter
Suggested Books	**Text Books** 1. M.J. Moran and H.N. Shapiro, **Fundamentals of Engineering Thermodynamics, (6th Edition)**, Wiley, U.S, ISBN: 978471787358. 2. Y.A. Cengel and M.A. Boles, **Thermodynamics: An Engineering Approach, (6th Edition)**, Tata McGraw Hill, 2008, ISBN: 9780070262179.

	Reference Books 3. G.F.C. Rogers, and Y.R. Mayhew, **Engineering Thermodynamics: Work and Heat Transfer, (4th Edition)**, Longman, England, 1992, ISBN: 9780582045668. 4. Granet, and M. Bluestein, **Thermodynamics and Heat Power**, Prentice Hall, ISBN: 9780131106724. 5. E. Logan, **Thermodynamics Process and Application**, Marcel Dekker, 1999, ISBN: 9780824799593. 6. C. Wu, **Thermodynamics and Heat Powered Cycles: A Cognitive Engineering Approach,** Nova Science Publishers, 2006, ISBN: 9781606926260.

Course code	**ME 356**
Course Title	**Kinematics and Dynamics of Machines Lab**
Course Category	Core
Credit Structure	L-T-P-Credits 0-0-2-1
Department	Mechanical Engineering
Pre–requisite, if any	None
Objectives	● The Objectives of this lab are to get hands-on training on the kinematic and dynamics analysis of a variety of mechanisms and linkages via analytical, CAD, MATLAB and experimental approaches.
Course Outcomes	● Engineering knowledge: Apply the knowledge of mechanical engineering fundamentals and engineering mechanics to the kinematic and dynamics analysis of linkages and mechanical components. ● Problem analysis: Analyze mechanisms and machines problems using analytical, CAD, MATLAB and experimental techniques. Design/development of solutions: Demonstrate engineering applications involving the selection, specification, design, and sizing of mechanisms to accomplish specific motionObjectives.
Course Content	**List of representative experiments:** ● Graphical position analysis of planar linkages. ● Graphical synthesis of planar mechanisms. ● Experiment on position analysis using MATLAB. ● Experiment on velocity analysis of planar linkages using MATLAB and AUTOCAD. ● Experiment on acceleration analysis of planar mechanisms. ● Synthesize of different inversions of the four-bar mechanism using MAKIT KIT. ● Experiments on static and dynamic balancing of the unbalanced mass. ● To draw the elevation curve for the various cam designs and determine the limiting speed of the cam. ● Experiment on whirling of the shaft.
Suggested Books	**Reference Books** 1. J.J. Uicker, G.R. Pennock, and J.E. Shigley, **Theory of Machines and Mechanisms, (3rd Edition)**, Oxford University Press, 2003, ISBN: 9780195155983. 2. D.H. Myszka, **Machines and Mechanisms, (4th Edition)**, Pearson, 2011, ISBN: 9780132157803. 3. T. Beven, **Theory of Machines,(3rd Edition)**, Pearson, 2010, ISBN: 9788131729656. 4. S.S. Rattan, **Theory of Machines, (5th Edition)**, Tata McGraw Hill, 2019, ISBN: 9789353166281 5. W.T. Thomson, **Theory of Vibration with Applications**, CBS, 2002, ISBN: 9788123908830.

Course code	**ME 316**
Course Title	**Automobile Engineering**
Course Category	Department Elective
Credit Structure	L-T-P Credit (2-1-0-3)
Department	Mechanical Engineering
Pre–requisite, if any	Nil
Objectives	• To explore the anatomy of the automobile in general, location and importance of each part. • To understand the functioning of gear box, clutch, brakes, steering, axles and wheels Suspension and other connections.
Course Outcomes	• Design solutions for complex engineering problems and design system components needs for automobile • Understand the impact of the steering geometry, steering mechanism and suspension systems in automobiles.
Course Content	• **Introduction:** General introduction of chassis and body system, types of chassis layouts and frames • **Power train:** Clutch system-Purpose, functions and operation. Gearbox-Purpose, functions and operation, types of gearbox, Automatic gearbox, Overdrive. Transfer case, Universal joint and propeller shaft, Final drive, Axle • **Brake System:** Purpose and functions, Braking distance and stopping distance, Types: Mechanical, hydraulic, servo, air assisted hydraulic, pneumatic, exhaust brake and anti-lock braking system (ABS), Disc, drum brakes and their components. • **Steering system:** Purpose and functions, Types: Manual and powered steering, Steering gear box and types, Steering geometry. • **Suspension system:** Purpose, functions, Main parts, Types • **Wheel and tires:** Purpose and functions, Wheels, wheel dimension and its types, Factors affecting tire life, tire pressure, Tire rotation, tire changing, Wheel alignment, wheel balancing Charging and Ignition systems recent developments, Automotive Electronics: Vehicle electrical and electronic systems, Automotive pollution and its control strategies.
Suggested Books	**Text Books** 1. K Ramakrishna, **Automobile Engineering**. PHI, 2012, ISBN: 9788120346019 2. David A. Crolla, **Automotive Engineering Powertrain, Chassis System and Vehicle Body,** Butterworth-Heinemann Ltd, 2009, ISBN: 9781856175777. 3. T. Denton and H. Pells, **Automobile Mechanical and Electrical systems, (3rd Edition)**, Routledge, 2023, ISBN: 9781032289083 **Reference Books** 4. R. Sakthivel et al. **Introduction to Automotive Engineering**, Wiley-Scrivener Publishing, ISBN: 9781119480051, 2019 5. G.K. Awari, V.S. Kumbhar, R.B. Tirpude, **Automotive Systems Principles and Practice**, CRC Press, ISBN:9781000261998, 2021

Course code	**ME 318**
Course Title	**Mechatronics System Design**
Course Category	Department Elective
Credit Structure	L-T- P-Credits 2-1-0-3
Department	Mechanical Engineering
Pre–requisite, if any	None
Objectives	● To train the students towards understanding the interdisciplinary systems and devices.
Course Outcomes	● To design electro mechanical system for different technological needs ● Exposure to Opto-Mechatronics, Autotronics and Micro-Mechatronics systems for designing smart and intelligent systems
Course Content	● **Introduction to Mechatronics Integrated design issues**- Key elements and design processes, Physical system modeling, Electrical systems, Mechanical translation and rotational systems Electromechanical Coupling-Fluid system and smart material based systems. ● **Fundamentals of Elements and classifications of Mechatronics Systems:** Electro mechanical Actuators, Motors drives, Sensors, Transducers, Opto-Mechatronics, Autotronics and Adaptronics systems. ● **Software and Hardware components in Mechatronics systems:** Signals, system and controls, system representation, Signal conditioning and devices, Elements of Data acquisition and control systems, real time interfacing, micro controllers and IoT modules. ● **Micro-Mechatronics:** Micro actuators - actuation using shape memory alloys, piezoelectric crystals and electrostatic forces- micro valves and pumps- micro sensors- Piezotronics systems Overview on applications of Robotics in automobiles and other industries.
Suggested Books	**Text Books** 1. W. Bolton, **Mechatronics**, Pearson publications. ISBN: 97881 31762533. 2. Devdas Shetty, Richard A. Kolk, **Mechatronics System Design**, Brooks/Cole, Thomson learning. ISBN: 9780534952852. **Reference Books** 3. Safa O.Kasap, **Optoelectronics and photonics principles and practices,** Pearson. ISBN: 9788131724682 4. T. G. Beckwith, J. H. Lienhard, R. D. Marangoni **Mechanical Measurements,** Pearson. ISBN: 97881317171889

Course code	**ME 320**
Course Title	**Experimental Methods in Thermal Science**
Course Category	Department Elective
Credit Structure	L-T- P-Credits 2-0-2-1.5 (Half-Semester)
Department	Mechanical Engineering
Pre–requisite, if any	Fluid Mechanics, Basic Electrical Engineering
Objectives	● The course aims to introduce students to various measurement sensors and their integration into energy technology. ● Employ technical and economic criteria to select the most appropriate thermal equipment for a given application.
Course Outcomes	● Students will develop a deep understanding of the basics of experimental techniques in thermal engineering. ● Able to apply the appropriate instruments for measuring the data set for a given application.
Course Content	● **Introduction:** Overview of Instruments and Measurement Systems: Principles of measurements and measurement errors. ● **Data Acquisition and Control:** Principles of electronics and signals emitted by different types of sensors (electrical response to a thermal/mechanical disturbance). Introduction to the software and hardware for data acquisition required to measure and interpret any disturbances. ● **Temperature sensors:** Basic principle of temperature measurement. Study of common temperature sensors based on the physical principles ● **Pressure sensors:** Study of the most common type of sensor for measuring absolute, relative, and differential pressures. ● **Velocity and flowmeters:** Velocity Measurement: Hotwire, and PIV Techniques. Description of common types of flow meters (Coriolis, magnetic, turbine, vortex, etc.) ● **Sensors moisture content/concentration**: Fundamentals of psychrometry. Background of humidity sensors. ● **Instrumentation and measurement in the vacuum:** Vacuum technology (construction, control, etc). Measurement instruments in vacuum applications; emphasis on mass spectrometry. **List of Representative Experiments:** ● Introduction to signals and data recording instruments. ● Fabrication of a thermocouple bead and determination of its response time and calibration. ● Two-dimensional temperature measurement using an IR camera. ● Pressure measurement using manometers and pressure sensors. ● Velocity measurement using a pitot tube and hot wire anemometry.

Suggested Books	**Text Books** 1. Holman, J. P. (Jack Philip). **Experimental Methods for Engineers.** 8th ed. New York: McGraw-Hill, 2011. ISBN 9780071326483 2. Benedict, Robert P. **Fundamentals of Temperature, Pressure and Flow Measurements**. 3a ed. New York: Wiley, cop. 1984. ISBN: 9780471893837. 3. Tavoularis, Stavros. **Measurement in Fluid Mechanics**. Cambridge University Press, 2005.ISBN:9780521815185 **Reference Books** 4. Wiederhold, Pieter R. **Water Vapor Measurement,** New York: Marcel Dekker Inc, 1997. ISBN: 9780824793197 5. Müller, Ulrich, Karl G. Roesner, and Bernd Schmidt, eds. **Recent developments in Theoretical and Experimental fluid mechanics,** Springer Science & Business Media, 2012. ISBN: 9780387092287

Course code	**ME 322**
Course Title	**Introduction to Electric Vehicles**
Course Category	Department Elective
Credit Structure	L-T- P-Credits 2-1-0-1.5 (Half-Semester)
Department	Mechanical Engineering
Pre–requisite, if any	None
Objectives	● Provides a comprehensive exploration of Electric Vehicles (EVs), focusing on the technology, and design principles ● Students will gain a thorough understanding of the components and systems that constitute EVs, including batteries, electric drivetrains, charging infrastructure, and advanced technologies in EVs
Course Outcomes	● Course will equip students with a holistic understanding of electric mobility, Battery Technologies, Charging infrastructure ● It prepares them for careers in the rapidly evolving field of electric vehicles and contributing to sustainable transportation solutions.
Course Content	● **Electric Vehicles:** Significance of electric vehicles, Key features and benefits of electric mobility, Battery technology for EVs, Lithium-ion battery technology, Electric machines and their Controllers. ● **Types of Electric Vehicles:** Battery Electric Vehicles, Plug-in Hybrid Electric Vehicles, Fuel Cell Electric Vehicles, Hybrid Electric Vehicles. ● **Charging Infrastructure and Grid Integration:** Charging technologies, fast charging, wireless charging, and smart charging, Charging station types and standards, V2G (Vehicle-to-Grid) technology. ● **Advanced Technologies in EVs:** Solid-state batteries and other advanced energy storage solutions, Innovations in materials and design for improved performance
Suggested Books	**Text Books:** 1. J. Larminie and J. Lowry, **Electric Vehicle Technology Explained**, Wiley-Blackwell; 2nd edition, 2012. ISBN: 9781119942733. 2. Per Enge, Nick Enge, and Stephen Zoepf, **Electric Vehicle Engineering**, McGraw Hill Publications, 1st Edition, 2021, ISBN: 9781260464078. 3. M. Ehsani, Y. Gao, S.E. Gay, A. Emadi, **Modern electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design**, CRC Press, 2004, ISBN: 9780849331541. **Reference Books:** 4. G. Pistoia, **Electric and Hybrid Vehicles**, Taylor & Francis, 2010, ISBN: 9780444535658 5. I. Husain, **Electric and Hybrid Vehicles: Design Fundamentals**, CRC Press; 3rd Edition, 2021. ISBN: 9781138590588.

Course code	**ME 324**
Course title	**Applied Impact Mechanics**
Course Category	Department Elective
Credit Structure	L-T-P Credit 2-1-0-1.5 (Half-Semester)
Department	Mechanical Engineering
Pre–requisite, if any	Basic understanding of stresses and strains, elastic and plastic behaviour of material.
Objectives	● The course is designed to expose to the students the basics of impact mechanics applied in automobile and defense industries. ● This course is designed to motivate the students to choose the field of impact mechanics for their higher studies. Students will get an idea about the expertise required to solve a problem related to impact and crash of a mechanical system.
Course Outcomes	● Students will get an idea about the subjects and expertise needed to learn to work in the area of impact mechanics and crash analysis.
Course Content	● **Introduction to impact mechanics**: Appreciating impact problems in Engineering; Historical background. ● **Rigid body impact mechanics**: Impulse, coefficient of restitution, oblique impact, limitation of rigid body impact mechanics. ● **Introduction to impact mechanics of deformable body**: 1D wave propagation, waves in infinite and semi-infinite media. ● **Introduction to experimental Impact mechanics:** Quasi-static material tests, Split Hopkinson's Pressure Bar (SHPB) test, cylinder impact test and drop impact test. ● **Introduction to Computational Impact Mechanics**: Application of computational Impact mechanics, Various numerical techniques, commercially available software packages, Expertise required for computational Impact Mechanics. ● **Case Studies**: Case studies on the problem related to impact and crash analysis.
Suggested Books	**Text Books** 1. C.L. Rao, V. Narayanamurthy, K.R.Y. Simha, **Applied Impact Mechanics**, Ane Books Pvt. Ltd., 2023, ISBN: 9789385462276. 2. M. Andre,J. Meyers, **Dynamic Behaviour of Materials,** Wiley, 1994, ISBN: 9780471582625. **Reference Books** 3. W.W. Chen, B. Song, Split Hopkinson (Kolsky) Bar: **Design, Testing and Applications**, Springer, 2011, ISBN: 9781441979827. 4. K. T. Ramesh (edited by Sharpe Jr., N. William), **High Strain Rate and Impact Experiments**, Springer Handbook of Experimental Solid Mechanics, 2008, ISBN: 9780387343624.

Course code	**ME 328**
Course Title	**Surface Modification Methods**
Course Category	Department Elective
Credit Structure	L-T-P Credit 2-0-2-1.5 (Half-Semester)
Department	Mechanical Engineering
Pre–requisite, if any	None
Objectives	● Develop an in-depth understanding and knowledge about different surface modification technologies and their applications among the UG students
Course Outcomes	● Students will be able to decide the suitable material and technique to modify the surface of a mechanical component to enhance its functional capabilities
Course Content	● Significance of surface engineered materials in modern engineering applications with few examples. ● **Substrate preparation techniques**: Chemical and Mechanical Processes, Various surface modification techniques: Heat treatment processes, Electrochemical Deposition, Chemical Vapour Deposition, Physical Vapour Deposition, Thermal Spraying. ● **Characterization of the modified surface**: Measurement of Hardness, Roughness, Thickness, Coating Adhesion, and studying microstructure of different coatings. ● **Case study**: Application of coating materials in various components and systems. **List of representative Experiments** ● Deposition of Ni on steel by Electrochemical deposition process ● Deposition of Al_2O_3 coating on steel by Flame Spraying process ● Measurement of the thickness and roughness of the as-deposited coatings ● Study the microstructure of the deposited coatings under optical microscope ● Study the hardness of the deposited coatings by using Vickers microhardness tester
Suggested Books	**Text Books:** 1. **Coatings Technology: Fundamentals, Testing, and Processing Techniques** (Hardback) By (author) Arthur A. Tracton, 2006, CRC Press Inc. ISBN: 9781420044065. 2. **Coatings Materials and Surface Coatings (Hardback)** By (author) Arthur A. Tracton, CRC Press ISBN: 9781420044041 **Reference Books:** 3. **Handbook of Hard Coatings: Deposition Technologies, Properties and Applications** (Materials Science and Process Technology) (Hardback) Edited by Rointan F. Bunshah, 2015, ISBN: 9780815514381. 4. **Handbook of Surface Treatment and Coatings** (Tribology in Practice S.) by Michel Cartier, 2003, ISBN: 9781860583759 5. **Smart Coatings: V. 2** (ACS Symposium) (Hardback) Edited by

	Theodore Provder, Edited by Jamil Baghdachi, ISBN: 9780841272187.

Course Code	**ME 302 (Till AY 2024-25)**
Title of the Course	**Applied Thermodynamics**
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	A course in Thermodynamics
Scope of the course	
Course Syllabus	Introduction to Energy Resources, Heat Engines. **Review of First Law of Thermodynamics:** for Closed and Open Systems. Classification of cycles as Open/Closed, Refrigeration/Power, Multi-component/Single- component, Internal combustion/ external combustion, etc. **Performance parameters:** Net work, thermal efficiency, heat rate, specific fuel consumption, work ratio, specific output, mean effective pressure, volumetric efficiency, COP, refrigeration effect. Carnot vs. other cycles. **Stoichiometry:** General stoichiometry and definition of terms (rich mixture, lean mixtures). **Combustion:** Heat of formation, Heat of reaction, Calorific Value of fuel, Estimation methods for Calorific values, Exhaust Gas Analysis, Orsat Apparatus. **Power Cycles:** Otto Cycles, Diesel Cycles, Air-standard cycles and Actual cycles, Dual cycle, p-theta diagram. Brayton cycle with explanation of various terms Modifications of Brayton cycle. Rankine cycle, Modifications to Rankine cycle, Feed water Heaters and analysis, Moisture separators, application of Rankine to Nuclear power plants. **Introduction of Internal Combustion (IC) Engines:** Spark ignition (SI) and compression ignition (CI) engines, combustion and knocking in SI and CI engines, Carburetion. **Introduction of Refrigeration and Air Conditioning:** Vapour Compression and Reverse Brayton Cycles Vapour Absorption Cycles. Psychometry. **Compressors:** Reciprocating, rotary and centrifugal compressors.
Suggested Books	**Text Books** 1. M.J. Moran and H.N. Shapiro, **Fundamentals of Engineering Thermodynamics** (6th Edition), Wiley (ISBN: 978-471-78735-8). 2. Y.A. Cengel and M.A. Boles, **Thermodynamics: An Engineering**

	Approach (6th Edition), Tata McGraw Hill, New Delhi, 2008. (ISBN: 0070262179). **Reference Books** 1. G.F.C. Rogers, and Y.R. Mayhew, **Engineering Thermodynamics: Work and Heat Transfer** (4th edition), Longman, England, 1992. 2. Granet, and M. Bluestein, **Thermodynamics and Heat Power**, Prentice Hall (ISBN: 0131106724). 3. E. Logan, **Thermodynamics Process and Application**, Marcel Dekker, 1999. (ISBN: 0824799593) 3. C. Wu, **Thermodynamics and Heat Powered Cycles: A Cognitive Engineering Approach**, Nova Science Publishers, 2006. (ISBN: 978-1-60692-626-0)

Course Code	**ME 303**
Title of the Course	**Kinematics and Dynamics of Machines**
Credit Structure	L-T-P-Credits 3-1-0-4
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	None
Scope of the course	
Course Syllabus	**Mechanisms:** Introduction to different types of mechanisms, Analysis of position, velocity and acceleration along with their diagram. **Cam and Follower:** Design of Cam-Follower Mechanisms. **Gears and Gear train:** Gear tooth profiles, spur gears and helical gears. Epicyclic Gear trains. **Dynamics of Machines:** Dynamic analysis of different mechanisms, Balancing. **Mechanical Vibrations:** Analysis and applications of discrete and continuous system of vibration.
Suggested Books	1. B. Paul, **Kinematics and Dynamics of Planar Mechanisms**, Prentice Hall, 1979. 2. J.J. Uicker, G.R. Pennock, and J.E. Shigley, **Theory of Machines and Mechanisms** (3rd edition), Oxford University Press, New York, 2005. 3. S.S. Rattan, **Theory of Machines** (2nd edition), Tata McGraw Hill, New Delhi, 2005. 4. R.L. Norton, **Design of Machinery** (3rd edition), Tata McGraw Hill, New Delhi, 2005. 5. F.S. Tse, I.E. Morse, and R.T. Hinkle, **Mechanical Vibrations**, CBS Publishers and Distributors, 1983. 6. J.S. Rao, and K. Gupta, **Introductory Course on Vibrations**, Wiley Eastern, 1984. 7. J.P. Den Hartog, **Mechanical Vibrations**, McGraw Hill, 1956.

Course Code	**ME 304**
Title of the Course	**Instrumentation and Control Systems**
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	None
Scope of the course	
Course Syllabus	**Characteristics of Instruments:** Instrument and measurement systems, classification of instruments, elements of measurements systems, measurement system performance-type of errors. Dynamic characteristics –filtering and signal analysis-Fourier transforms. **Transducers and sensing elements:** Mass sensing elements, thermal detectors, thermo-couples, hydro pneumatic sensors, mechano-electrical transformation, simple transducer element, LVDT, differential, velocity, acceleration-Piezo-electric, magneto-striction transducer-optical instrumentation-Interferometer. **Microprocessor and its application:** Functional architecture of microprocessors-instruction set –Basic concept of memory interfacing - memory mapping- stepper motor and temperature control. **Data Acquisition and Interfacing:** Elements of data loggers, Input condition, Analog to Digital(A/D) and Digital to Analog (D/A) conversion, Computer based Data Acquisition, Programmable Logic Controller, Switching diagram, interfacing of mechanical systems. **Introduction to control systems:** Concept of Feedback, open and closed loop, Negative Feedback in control systems, Impulse response and transfer functions of linear systems, modelling of mechanical system elements, sensors and encoders in control systems –DC motor in control systems- linearization of nonlinear systems.
Suggested Books	**Text books:** 1) James.W.Dally,William F.Riley, Instrumentation for engineering measurments, Wiley India Edition (ISBN 978-81-265-2801-1) 2) Ernest O. Doebelin, Dhanesh N. Manik, Measurement systems, Tata McGraw Hill (ISBN 978-0-07-061672-8). 3) B.C. Kuo, Automatic control systems, (4th edition), Printence hall of India, NewDelhi,1985. 4) R.S. Goankar, Microprocessor Architecture: Programming and and application with the 8085/8080A, penram international publishing, 1986. **Reference Books:**

	1) A.K.Sawhney, **A course in electrical and electronics measurements and instrumentation,** Dhanpat Rai & C, 17th edition, NewDelhi 2) Safa O.Kasap, **Optoelectronics and photonics principles and practices,** Pearson (ISBN-978-81-317-2468-2) 3) T. G. Beckwith, J. H. Lienhard, R. D. Marangoni **Mechanical Measurements,** Pearson (ISBN-978-81-317-17188-9) 4) S. O. Kasap, **Optoelectronics and photonics principles and practices,** Pearson (ISBN-978-81-317-2468-2) 5) I.J. Nagrath and M. Gopal, **Control system engineering**, (2nd Edition) Wiley Eastern, New Delhi,1982.

Course Code	**ME 305 (Till AY 2024-25)**
Title of the Course	**Machining Science and Metrology**
Credit Structure	L-T- P-Credits 2-1-0-3
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	None
Scope of the course	
Course Syllabus	**Theory of Machining:** Concept of generatrix and directrix, classification of machining processes, chip formation: mechanism, chip types, chip control, tool geometry: single point cutting tool geometry, specifications in different standards, selection of tool angles, mechanics of single point orthogonal machining: Merchant's circle, force, velocity, shear angle, and power consumption relations, cutting tool wear and tool life: wear mechanisms, wear criterion, Taylor's tool life equation, facing test, variables affecting tool life; Machinability and its measures, economics of machining. **Finishing and Superfinishing Processes:** Principles and applications of honing, superfinishing, lapping, polishing, buffing, shot-peening, and burnishing. **Advanced Machining Processes:** Process principle, equipment, analysis and applications of advanced machining processes such as Abrasive Jet Machining (AJM), Ultrasonic Machining (USM), Electro Chemical Machining (ECM), Chemical Machining (CHM), Electro-Discharge Machining (EDM), Wire Electro Discharge Machining (WEDM), Electron Beam Machining (EBM), and Laser Beam Machining (LBM). **Metrology:** Introduction, inspection types and principles, basic inspection methods, characteristics of measuring instrument, measurement errors, linear measurement: line and end standards, gauge blocks, comparators, dial gauge, angular measurement: gauge block, clinometer, sine-bar, autocollimators, radius and taper measurement, measurement of screw threads and gears. **Limits and Fits:** Limits, fits, and dimensional and geometrical or form tolerances, computer vision system based measurement, coordinate measuring machines, measurement of form tolerances, measurement of surface roughness: surface roughness terminology, different methods of surface roughness measurement.

Suggested Books	1. A. Ghosh, and A.K. Mallik, **Manufacturing Science,** Affiliated East-West press Pvt. Ltd., 1985. 2. G.K. Lal, **Introduction to Machining Science**, New Age International Publishers, 1996. 3. G. Boothroyd, and W.A. Knight**, Fundamentals of Machining and Machine Tools**, Marcel Dekker, 1989. 4. V. K. Jain, **Advanced Machining Processes**, Allied Publishers, New Delhi, 2002. (ISBN 81-7764-294-4) 5. G.F. Benedict, **Nontraditional Manufacturing Processes**, Marcel Dekker, Inc. New York, 1987. (ISBN 0-8247-7352-7) 6. J.F.W. Gayler, and C.R. Shotbolt, **Metrology for Engineers**, ELBS, 1990. 7. I.C. Gupta, **Text Book of Engineering Metrology,** Dhanpat Rai Publishing Co. New Delhi, 2003.

Course Code	**ME 306**
Title of the Course	**Machine Design - I**
Credit Structure	L-T- P-Credits 2-2-0-4
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	Solid Mechanics, Strength of Materials and Kinematics and Dynamics of Machines
Scope of the course	The objectives of this course are to develop in mechanical engineering students the knowledge and skills required 1. To apply engineering analysis principles and methods to the proper analysis of a variety of common mechanical system components. 2. To design these mechanical system components so as to perform safely their intended functions in harmony with other components of the system. 3. To use information resources to identify appropriate and elegant component solutions for mechanical system design problems, locate sources for these components, and understand the analysis and design methods for these components. 4. To conform to the right codes and standards. 5. To solve an open-ended design problem involving cost, drawings, and structural analysis.
Course Syllabus	**Introduction and Design for Strength:** Fundamentals of machine design: Brief overview of design and manufacturing**,** Stresses in machine elements, Strain analysis. Design for Strength: Design for static loading, Stress Concentration, Design for dynamic loading, and Low and high cycle fatigue. **Fasteners and Power Screws:** Fasteners: Types of fasteners - Pins and keys, Threaded Fasteners and Design of bolted joints**.** Power Screws: Power Screw drives and their efficiency and Design of power screws. **Couplings and Springs:** Couplings: Introduction, types and uses, design procedures for rigid and flexible rubber-bushed couplings**.** Springs: Introduction to Design of Helical Springs, Design of Helical Springs for Variable Load and Design of Leaf Springs. **Shafts and Cylinders:** Shafts: Introduction to shaft and its design based on strength and Design of shaft for variable load and based on stiffness. Cylinders: Thin and thick cylinders, Stresses due to internal and external pressures, and Design principles for cylinders. **Welded and Riveted Joints:** Riveted Joints: Types and Uses, Design of Riveted Joints. Welded Joints: Types and Uses, Design of Welded Joints and Design of Adhesive Joints. Design of Joints for Special Loading: Design of Eccentrically Loaded Bolted/Riveted Joints and Welded Joints, and Design of Joints with Variable Loading.

Suggested Books	1. J.E. Shigley, **Mechanical Engineering Design**, Tata McGraw Hill, 2008, ISBN:0070668612. 2. B.J. Hamrock, and S.R. Schmid, **Fundamentals of Machine Elements**, Tata McGraw Hill, 2005, ISBN:0072976829. 3. R.L. Norton, **Machine Design**, Pearson Education, 2012, ISBN-10: 0131481908. 4. M.F Spotts, **Design of Machine Elements**, Prentice Hall India, 1991, ISBN: 9788177584219. 5. V. Bhandari, **Design of Machine Elements**, Tata McGraw Hill, 2007, ISBN: 9780070611412. 6. A. S. Hall, A. R. Holowenko and H. G. Laughlin, **Schaum's Outline of Machine Design**, McGraw Hill, 2010, ISBN: 9780070255951.

Course Code	**ME 307**
Title of the Course	**Principles of Industrial Engineering**
Credit Structure	L-T-P-Credits 3-0-0-3 [from AY 2010-11 to AY 2013-14] 2-0-2-3 [from AY 2014-15 onwards]
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	None
Scope of the course	
Course Syllabus	**Organization:** Factory system, principles of organization, types of organization and their selection. **Plant Layout:** Site selection, types of layout, factors affecting layout, plant building, flexibility and expandability, materials handling devices. **Production Planning and Control:** Functions, forecasting, routing, operations planning; Gantt chart, work order, dispatching and follow-up; CPM and PERT techniques. **Inventory Control:** Scope, purchasing and storing, economic lot size; ABC Analysis. **Work Study:** Scope, work measurement and method study, standard data, ergonomics and its industrial applications. **Industrial Relations:** Labour welfare, wage and incentives, absenteeism and labour turnover.
Suggested Books	1. E.S. Buffa, and R.K. Sarin, **Modern Production / Operations Management**, John Wiley & Sons, 1994. 2. R.S. Russell, and B.W. Taylor, **Operations Management**, Pearson Education, 2003. 3. C.A. Jocobs, **Production and Operations Management**", Tata McGraw Hill, 1999. 4. H.B. Maynard, **Industrial Engineering Handbook**, McGraw Hill, 2001.

Course Code	**ME 308**
Title of the Course	**Quality Management**
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	None
Scope of the course	
Course Syllabus	**Introduction:** Different definitions, dimensions, and aspects of quality, Traditional and modern view of Quality Control, Different Philosophies by Quality Gurus. **Modern Quality Control Technologies:** Quality engineering using Taguchi Methods, Off-line and On-line quality control, Concepts of Robust Design, Taguchi Loss Function, Quality Function Deployment (QFD) . **Process Capability (PC) Analysis and Statistical Process Control (SPC):** Manufacturing process variability, manufacturing process capability, and tolerances; Tools/methods used in SPC: Control Charts, Pareto charts, Fishbone diagram, etc. Implementation of SPC. **Control Charts:** Theory and applications of control charts; Controls charts for variables: charts averages, ranges, and standard deviation; Control charts for attributes: p and c charts; Fraction defective and number of defects per unit; Different adaptation of control charts. **Acceptance Sampling:** Concept of acceptance sampling; Sampling by attributes: Single and double sampling plans, Use of Dodge Romming and Military standard sampling tables, Construction and use of operating characteristic (OC) curves; Sampling by variables: Continuous sampling plans. **Reliability:** Concept and definition, Measurement and test of reliability, Design for reliability (DFR), Concepts of Maintainability and Availability. **Total Quality Management (TQM):** Concept and philosophy, Scope, Applications, Implementation, Quality circles: objectives, structures, and techniques.
Suggested Books	**Text book** 1. A. Mitra, **Fundamentals of Quality Control and**

	Improvement (2nd edition), Prentice Hall of India, New Delhi, 2005. **Reference books** 1. D.C. Montgomery, **Introduction to Statistical Quality Control** (3rd edition), John-Wiley & Sons Inc. New York, 1996. 2. E. Grant, and R. Leavenworth, **Statistical Quality Control**, McGraw-Hill Inc. New York, 1996. 3. G. Taguchi, **Introduction to Quality Engineering**, Kraus Int. Publications, 1986. 4. D.H. Besterfield, M.C. Besterfield, G. Besterfield, and S.M. Besterfield, **Total Quality Management**, Prentice Hall International Inc. 1996.

Course Code	**ME 351 (Till AY 2024-25)**
Title of the Course	**Heat Transfer Lab**
Credit Structure	L-T-P-Credits 0-0-3-1.5
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	None
Objective/Scope of the course	
Course Syllabus	Exp.1 **Objective: 1** • Determination of coefficient of thermal conduction (thermal conductivity) of gases and liquids. Exp.2 **Objective: 2** • Study of heat transfer in free and forced convection modes. • Study the forced convection: In this experiment, the effect of flow velocity on the convection heat transfer is observed by recording and calculating different parameters at different values of air flow velocity. Exp.3 **Objective: 3** • To study the parameters governing steady state one dimensional heat conduction in radial direction and also to study the initial unsteady state heat conduction. Exp.4 **Objective: 4** • Study of Different types of Heat Exchangers (Tubular, Shell and tube and Plate type HE) apparatus. • To investigate the effect of changes in hot and cold fluid flow rate on the temperature efficiencies and overall heat transfer coefficient. (For cocurrent and counter flow) • To investigate the effect of driving force with cocurrent and counter current flow. • To investigate the heat loss from Heat Exchangers by replacing the cold fluid by hot fluid and vice-versa. (For cocurrent and counter current flow) Exp.5 **Objective: 5** • Study of one dimensional steady state linear heat conduction and understanding the significance of contact resistance. • Temperature distribution measurement for steady state conduction through a plane wall. • Temperature distribution measurement for steady state conduction through a composite wall and determine the overall heat transfer coefficient. • Determination of thermal conductivity of a metal specimen

	• To verify that the temperature gradient is inversely proportional to the cross sectional area for one dimensional conduction. • Demonstration of the effect of contact resistance on thermal conduction Exp.6 **Objective: 6** • Determination and comparison of Thermal Conductivity of different insulating and building materials (Cork, Plaster, POM etc) Exp.7 **Objective: 7** • Verification of different laws of radiation (Lambert's distance law, Lambert's direction law, Stefan Boltzmann's law and Kirchhoff's law)
Suggested Books	Same as associated theory course

Course Code	**ME 352 (Till AY 2024-25)**
Title of the Course	**Applied Thermodynamics Lab**
Credit Structure	L-T-P-Credits 0-0-3-1.5
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	None
Scope of the course	
Course Syllabus	Exp.1 **Objective:1** • To investigate the effect of cooling load on "Approach to wet bulb" and the application of the steady flow equation to selected systems to draw up energy and mass balances. • To investigate the effect of the packing density on the performance of a cooling tower and pressure drop across column Exp.2 **Objective: 2** • Demonstration of vapour compression refrigeration or heat pump cycle with visual observation of the important processes. • Study the effect of condenser load on vapor compression refrigeration cycle performance. • Study the effect of evaporator load on vapor compression refrigeration cycle performance. Exp.3 **Objective: 3** • Demonstration of the Rankine cycle • Study the effect of boiler pressure on turbine power output and calculation of efficiencies related to Rankine cycle Exp.4 **Objectives: 4** • To draw the following air conditioning processes on the psychometric chart and analyze them thermodynamically. • Sensible heating (ii) heating and Humidification (iii) Cooling and De-humidification. • To determine the energy and mass transfer rates at heater, boiler and refrigeration unit. • To study effect of adiabatic mixing of different quantities of air in two different states and plot on psychometric chart. Exp.5 **Objective: 5** • Study of jet engine Exp.6 **Objective: 6** • To study the performance of 4 cylinders, 4 strokes,

	Petrol engine coupled with eddy current dynamometer. • Calculate heat balance sheet for SI engine. Exp.7 **Objective: 7** • To study the performance of 4 cylinders, 4 strokes, Diesel engine coupled with eddy current dynamometer. • Calculate heat balance sheet for CI engine Exp.8 **Objective: 8** • To find the calorific value of a sample fuel using Bomb Calorimeter.
Suggested Books	Same as associated theory course

Course Code	**ME 353**
Title of the Course	**Kinematics and Dynamics of Machines Lab**
Credit Structure	L-T-P-Credits 0-0-3-1.5
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	None
Scope of the course	
Course Syllabus	Exp.1 Experiments on velocity Exp.2 Experiments on static force and acceleration analysis of mechanisms Exp.3 Experiments on friction Exp.4 Experiments on belt drives and cam-follower Exp.5 Experiments on balancing Exp.6 Experiments on bearings Exp.7 Experiments on gyroscopes Exp.8 Experiments on mechanical vibrations
Suggested Books	1. J.J. Uicker, G.R. Pennock, and J.E. Shigley, **Theory of Machines and Mechanisms** (3rd edition), Oxford University Press, New York, 2005. 2. S.S. Rattan, **Theory of Machines** (2nd edition), Tata McGraw Hill, New Delhi, 2005.

Course Code	**ME 354**
Title of the Course	**Instrumentation and Control Systems Lab**
Credit Structure	L-T-P-Credits 0-0-3-1.5
Name of the Concerned Department	Mechanical and Electrical Engineering
Pre–requisite, if any	None
Scope of the course	
Course Syllabus	Exp.1 **Transducer Kit:** a) Displacement measurement with electro-mechanical transducers b) Temperatures gradient measurement with Heat Transducers Exp.2 **Process control trainer:** Heating Element controlled by thyrisistor circuits Exp.3 **Michelson's Interferometer:** a) Calibration of Slip gauges b) Wavelength Measurement of monochromatic light c) Measurement of Change in pressure Exp.4 **Optical Instrumentation:** a) Characteristics of LDR b) Measurement of Groove spacing in a CD by its reflection grating c) optical based thickness measurement using Ellipsometry Exp.5 **Microprocessor based:** a) Basic Study b) DC motor position control Stepper motor Milli step interfacing with 8051microcontroller Exp.6 Experimental implementation of different controller behavior in Swinging Pendulum Interfaced using MATLAB Simulink. **Digital PID controller based:** a) Dc motor speed control module (fast process) b) Temperature control system (slow process) PLC based Interfacing of multiple cylinder sequences in electro pneumatic systems Exp.7 Study on PLC based Interfacing of micro controlled XY Stage for Laser based marking Exp.8 Characteristics measurement using Impedance Analyzer Exp.10 Experiments in Hydraulic trainer kit Exp.11 Experiments on Optical fibre sensor kit Exp.12 Experiments on Autotronics trainer kit
Suggested Books	Same as associated theory course

Course Code	**ME 355 (Till AY 2024-25)**
Title of the Course	**Machining Science and Metrology Lab**
Credit Structure	L-T- P-Credits 0-0-2-1
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	Nil
Scope of the course	
Course Syllabus	Exp.1 To find the wedge angle with the help of a sine bar Exp.2 Measurement of thread parameters using tool makers microscope Exp.3 To determine the temperature of tool-work interface using a tool work thermocouple Exp.4 Estimation of tool life of a HSS cutting tool during turning of C-20 steel bar using Taylor's relation Exp.5 Measurement of cutting forces by using lathe dynamometer Exp.6 Measurement of cutting forces by using drill dynamometer Exp.7 The effects of cutting velocity, nose radius and feed rate on surface roughness Exp.8 Effect of speed and feed on chip morphology
Suggested Books	Same as associated theory course ME 305: Machining Science and Metrology

Course Code	**ME 401**
Title of the Course	**Machine Design - II**
Credit Structure	L-T- P-Credits 2-2-0-4
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	Machine Design - I
Scope of the course	The objectives of this course are to develop in mechanical engineering students the knowledge and skills required 1. To apply engineering analysis principles and methods to the proper analysis of a variety of common mechanical system components. 2. To design these mechanical system components so as to perform safely their intended functions in harmony with other components of the system. 3. To use information resources to identify appropriate and elegant component solutions for mechanical system design problems, locate sources for these components, and understand the analysis and design methods for these components. 4. To conform to the right codes and standards. 5. To solve an open-ended design problem involving cost, drawings, and structural analysis.
Course Syllabus	**Introduction:** Different theories of failure and design based on theories. Design for fatigue, design for creep and design for wear and corrosion. **Design of Gears:** Law of gearing - conjugate action and gear tooth profile-basics Analysis of forces on spur, helical, bevel and worm gears. Design procedure of various gears. **Design of belt and chain drives:** Belt drives: Introduction to Belt drives, Design of Flat Belt drives and Design of V- Belt drives. Chain drives: Introduction and classification, design procedure for chain drive. **Design of Bearings:** Brief overview of bearings, Design of Fluid Film bearings and Rolling contact bearings. **Brakes and Clutches** Brakes: Types, Design of shoe brakes, and Design of Band and Disc Brakes. Clutches: Types, Plate clutches – design for uniform pressure and wear.

Suggested Books	1. J.E. Shigley, **Mechanical Engineering Design**, Tata McGraw Hill, 2008. ISBN:0070668612. 2. B.J. Hamrock, and S.R. Schmid, **Fundamentals of Machine Elements**, Tata McGraw Hill, 2005. ISBN:0072976829 3. R.L. Norton, **Machine Design**, Pearson Education, 2012. ISBN-10: 0131481908 4. M.F Spotts, **Design of Machine Elements**, Prentice Hall India, 1991. ISBN: 9788177584219 5. V. Bhandari, **Design of Machine Elements**, Tata McGraw Hill, 2007. ISBN: 9780070611412 6. Alfred S. Hall, A. R. Holowenko, H. G. Laughlin, **Schaum's Outline of Machine Design**, McGraw Hill, 2010. ISBN: 9780070255951 7. D.G. Ullman, **The Mechanical Design Process**, Tata McGraw Hill, 2008. ISBN: 9780072975741

Course Code	**ME 406/ ME 606**
Title of the Course	**Smart Materials based Energy Harvesters Design**
Credit Structure	L-T-P-Credit 2-1-0-3
Name of the Concerned Department	Mechanical Engineering
Pre-requisite, if any	Introduction of Materials Science
Scope of the course	The main scope of this course is to develop an understanding of various aspects of smart materials energy harvesters design.
Course Syllabus	**Thermoelectric energy harvesting:** Thermoelectric principles and phenomena, conversion efficiency and figure-of-merit, performance and behaviors of thermoelectric devices; waste heat recovery and power generation, energy harvesting applications of thermoelectric devices. **Piezoelectric:** Piezoelectric material structure and properties; processing parameter effect on piezoelectricity; effects of material constants and mechanical damping on power generation. Modeling of piezoelectric energy harvesters; mechanical designs of piezoelectric energy harvester; design of a bistable piezoelectric energy harvester; performance evaluation of vibration-based piezoelectric energy scavengers; piezoelectric energy harvester with magnets; piezoelectric energy harvesting equivalent circuit models, applications of piezoelectric energy harvesting systems. **Pyroelectric:** Pyroelectric materials structure and properties; effect of processing parameters, poling techniques, electroding on energy harvesting; waste thermal, solar and phase change material embedded energy harvesting system; electrical circuit model for actual energy harvesting potential.

Suggested Books	**Text Book** 1. R. Funahashi, **Thermoelectric Energy Conversion**, Elsevier Woodhead Publishing, 2021, ISBN:978-0-12-818535-3 2. S. Priya and D. J. Inman, **Energy Harvesting Technologies**, Springer, 2009. ISBN: 978038776464 3. Q. Xu and L. M. Tam, **Mechanical Design of Piezoelectric Energy Harvesters**, Elsevier, 2021, ISBN: 9780128236536 **Reference Book** 1. R. Kumar and R. Singh, **Thermoelectricity and Advanced Thermoelectric Material**, Elsevier Woodhead Publishing, 2021, ISBN:9780128199848 2. D. M. Rowe, CRC Handbook of Themoelectrics, 1995. ISBN 9780367248161 3. A. Erturk, Daniel J. Inman, **Piezoelectric Energy Harvesting**, John Wiley & Sons, 2011, Print ISBN: 9780470682548. 4. H. Huang and J. F. Scott **Ferroelectric Materials for Energy Applications**, Wiley-VCH, 2018, ISBN:9783527807505

Course Code	**ME 407/ ME 607**
Title of the course	**Biofluid Mechanics**
Credit Structure	L-T-P-Credits ~~2-1-0-3~~ 2-0-2-3 *from AY 2021-22*
Name of Department	Mechanical Engineering
Pre-requisites, if any	None
Scope of the course	(a) To understand the physiology and anatomy of different systems in the human body (b) To integrate fluid mechanics concepts to model biological flows in the human body (c) To identify specific diseases and to analyze how they are related to fluid mechanics.
Course Syllabus	**Introduction:** Introduction to fluid mechanics, and human physiology in relation to heart, lungs and blood vessels. **Cardiovascular structure and function:** Electro-cardiogram, heart valves, cardiac cycles, heart sounds, coronary circulation, microcirculation, lymphatic circulation. **Pulmonary Anatomy, Pulmonary physiology and Respiration:** Respiratory system, alveolar ventilation, mechanics of breathing, airway resistance, gas exchange and transport, pulmonary pathophysiology, respiration in extreme environment. **Hematology and Blood Rhelogy:** Elements of blood, blood characteristics, viscosity measurement, erythorcytes, leukocytes; blood types, plasma. **Anatomy and Physiology of Blood vessels:** General structure & types of arteries, mechanics of arterial walls, compliance, vascular pathologies, stents, coronary artery bypass grafting. **Mechanics of Heart Valves:** Aortic and pulmonic valves; Mitral and Tricuspid valves; Pressure gradients across a stenotic heart valve; Prosthetic mechanical valves; Prosthetic tissue valves. **Pulsatile flow in large arteries:** Introduction to blood flow in large arteries, pulsatile flow in tubes, instability in pulsatile flow. Mathematical modeling: Introduction to finite difference, finite volume & finite element methods, non-Newtonian flow models, modeling of flow through Mitral valve, modeling of blood flow in vascular system.

Suggested Books	**Text Book** 1. L. White and J.M. Fine, **Applied biofluid mechanics**, *McGraw Hill* 2007 (ISBN: 5551694623). 2. J.N. Mazumdar, **Biofluid Mechanics**, *World Scientific*, Singapore, 2004 (ISBN: 981-02-3801-0) **Reference Books** 1. L. White, **Biomechanics in Cardiovascular Systems**, *McGraw Hill*, 2006. 2. C. Kleinstruer, **Biofluid Dynamics: Principles and Applications,** *CRC Press*, *Taylor and Francis Group*, 2006. 3. M. Zamir, **The Physics of Pulsatile Flow,** Springer Verlag, New York, 2000. 4. Sir James Lighhill, **Mathematical Biofluid Dynamics,** *Society for Industrial and Applied Mathematics, Philadelphia*, 1975 (ISBN: 0-89871-014-6)

Course code	**ME 408/ ME 608**
Title of the course	Hybrid Electric Vehicles
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Concerned Department	Mechanical Engineering
Pre-requisite, if any	Basic knowledge of Mechanical and Electrical Engineering
Scope of the course	This course is designed for final year undergraduate students and masters students who want to develop their knowledge about hybrid electric vehicles. Conventional I.C. Engine and electric powered vehicle will be analysed along with requirement of hybrid vehicle. Various mechanical layouts of hybrid powertrains will be examined to understand how they influence the performance and complexity of the powertrain. Sizing of the powertrains, Energy Management system and controls in the hybrid powertrain modes will be examined.
Course Syllabus	History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, and Switch Reluctance Motor drives. Energy Storage: Energy Storage Requirements in Hybrid and Electric Vehicles with Battery, Fuel Cell, Super Capacitor, and Flywheel based energy storage, Hybridization of different energy storage devices. Matching the electric machine and the internal combustion engine.

	Energy Management Strategies.
Suggested Books	1. I. Husain, ***Electric and Hybrid Vehicles*: Design Fundamentals,** CRC Press, Washington, 2011, 9781439811757 2. J. Larminie, J. Lowry, ***Electric Vehicle Technology Explained***, 2nd edition, John Wiley & Sons Ltd, U.K., 2012, 9788126557608 3. B. D. McNicol, D. A. J. Rand, ***Power Sources for Electric Vehicles,*** Elsevier publications, New York, 1988, 044442315X 4. S. Leitman, ***Build Your Own Electric Vehicle***, McGraw Hill, 1st Edition, WW, 2013, 978-0830642328

Course Code	**ME 411/ ME 611**
Title of the Course	**Refrigeration and Air Conditioning**
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	A course on Thermodynamics
Scope of the course	
Course Syllabus	**Introduction:** Single stage and multistage vapour compression refrigeration systems, psychrometry and psychrometric processes. **Vapour Absorption Refrigeration Systems:** Aqua-ammonia absorption refrigeration system, Lithum bromide-water absorption systems, p-t-x chart, enthalpy concentration chart, three fluid electrolux system, multistage absorption system, resorption absorption refrigeration, new mixtures for absorption systems. **Non-conventional Refrigeration Systems:** Water refrigeration, Vortex and pulse tube refrigeration systems, thermoelectric refrigeration systems, multistage thermoelectric systems. **Refrigerant Compressors:** Type of compressors; Reciprocating compressors: Volumetric efficiency, performance characteristic, capacity control, construction features, rotary compressors, screw compressors, centrifugal compressors, scroll compressors. **Infiltration and Ventilation:** Basic concepts and terminology, driving mechanism of infiltration and ventilation, indoor air quality, natural ventilation, residential air leakage, residential ventilation, residential ventilation requirements, simplified models of residential ventilation and infiltration. **Fenestration:** Fenestration components, determination of energy flow; U-factor, solar heat gain and visible transmission, shading, visual and thermal controls, air leakage, day lighting, selecting fenestration, condensation resistance, occupant comfort and acceptance. **Cooling Load Calculations:** Residential cooling and heating load calculations: features, calculation approach, residential heat balance method, residential cooling load factor method, cooling load, heating load, nonresidential cooling and heating load calculations. **Duct Design and Space Air Diffusion:** Room air distribution, total, static and velocity pressures, friction loss in ducts, dynamic loss in ducts, air duct design, equal friction method, static regain method, velocity reduction method, fitting loss coefficient, air diffusion: principles of jet behavior, room air diffusion methods. **Pipe Sizing:** Pressure drop equations, water piping, hydronic system piping, steam piping, gas piping and fuel oil piping.

Suggested Books	1. W.F. Stoecker, and J.W. Jones, **Elementary Refrigeration and Air conditioning**, McGraw Hill, 2002. 2. R.J. Dosset, **Principles of Refrigeration**, Pearson Education Asia, 2002. 3. C.P. Arora, **Refrigeration and Air conditioning**, Tata-MCGraw Hill, 2002. 4. M. Prasad, **Refrigeration and Air Conditioning**, New Age International, 2004. 5. ASHRAE Handbook (Fundamentals), 2005.

Course Code	**ME 412**
Title of the Course	**Energy Conversion**
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	Thermodynamics
Scope of the course	
Course Syllabus	**Introduction:** Fundamentals of thermodynamics**,** Classification of Energy Sources, Various methods of conversion to Electrical Energy and their efficiencies, availability analysis of energy conversion cycles. **Conversion of hydro energy**: Essential features and elements, Principal Auxiliaries, Plant Layout , Classification of Hydro power plants, Hydraulic Turbines, Water wheel Generators. **Conversion of thermal energy:** Coal fired power plants, Essential features and elements, Principal Auxiliaries, Plant Layout, Steam Turbines, Turbo Alternators. Gas Electric power plants, Diesel Electric power plants**.** **Conversion of nuclear energy**: Fundamentals of nuclear fission. Fission reactor design considerations, Basic construction and comparison of various types of nuclear reactors, Plant Layout, Risks and Safety measures, Nuclear fuels. **Advanced systems:** Combined cycles, cogeneration, trigeneration **Conversion of other forms of energy**: Solar to thermal energy-Solar collectors, Electromagnetic to electrical energy-Photo voltaics, Chemical to electrical energy-Fuel cells Comparison of various energy conversion systems, their prospects and limitations. **Thermodynamics of Energy Conservation**: Basic principle. Optimum use of prime-movers, energy efficient housekeeping, energy recovery in thermal systems, waste heat recovery techniques, thermal insulation. Thermal energy audit in heating, ventilation and air conditioning.
Suggested Books	1. D.Yogi Goswami, and Frank Kreith, **Energy conversion**, CRC Pr I LIc, 2007, **ISBN:** 9781420044317. 2. M.M. El-Wakil, **Power Plant Technology**, McGraw Hill, 2002. 3. E.B. Norris, and E. Therkelsen, **Heat Power**, McGraw Hill, 1999. 4. Paul O Callaghan, **Energy Management**, McGraw Hill, 1993. 5. Paul O Callaghan, **Design and Management for Energy**

	Conservation, Pergamon, ISBN: 0080272878

Course Code	**ME 413/ ME 613**
Title of the Course	**IC Engines**
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	None
Scope of the course	
Course Syllabus	**Introduction:** Basic Nomenclature, Classification of IC Engines, working principle of 2-stroke and 4-stroke SI and CI engines. Air stand, fuel-air and actual cycles for SI and CI engines. Engine performance parameters. Valve and port timing diagrams. **Combustion:** *In SI Engines* - Combustion initiation, Flame development and propagation, ignition lag, preignition, normal and abnormal combustion-knocking, physical and chemical aspects of knocking, effect of operating parameter and chemical structure on knocking tendency, Octane number, design considerations of combustion chamber, Stratified charge combustion, Concept of lean burning engines. *In CI Engines***-** Various stages of combustion-Vaporization of fuel droplets and spray formation **Engine Accessories:** *SI Engines* - Carburetors**,** Properties of air-fuel mixtures, mixture requirement, Main metering system, Idling system, Economizer system, acceleration pump and cold starting system. Spark plug, fly wheel, DTS-I system. Nozzle lip, venturi depression, calculation of fuel jet and venturi throat diameter for given air fuel ratio, Battery and magneto ignition system and their comparative study, firing order, Ignition timing, Petrol Injection system, electronic fuel injection, advantage and disadvantage of petrol injection. *CI Engine*- Fuel pump, types of fuel injector, fly- wheel, types of piston and properties, high pressure pipe, Governor- Necessity of governing, various methods of governing. Fuel injection system- Requirement, types of nozzle, atomization, spray penetration and spray direction, multiple point fuel injection system, injection timing, common rail fuel injection system. **Cooling and Lubrication Systems:** Cooling requirement, air cooling, liquid cooling, type of liquid cooling system, advantage and disadvantage of air cooling and water cooling system, Antifreeze mixture. Function of lubricating system, properties of lubricating oil, wet sump, dry sump and mist lubrication system. **Fuels:** Basic requirement of I.C. Engine fuels, requirement of an ideal gasoline, structure of petroleum, effect of fuel structure on combustion, volatility of liquid fuels, effect of volatility on engine performance for starting, vapor lock, acceleration, percolation, carburetor icing, and crank case dilution, Alternative fuels-Bio Diesel types, Compressed Natural Gas, Hydrogen Energy- Solid, Liquid, Gas.

	Fuel Cells. **Emissions:** Emissions from SI and CI engines, types of emission gasses, emission control system, types of emission control system, EGR system.
Suggested Books	1. J. B. Heywood, **Internal Combustion Engine**, McGraw Hill, ISBN-0-07-100499-8; , 2. V. Ganeshan, **Internal Combustion Engine**, Tata McGraw Hill, 1992. 3. M.L. Mathur and R.P. Sharma, **A Course in Internal Combustion Engines,** Dhanpat Rai and Sons 4. V. Ganeshan, **Computer simulation of SI Engine Process**, Orient, 1996.

Course Code	**ME 414**
Title of the Course	**Power Plant Engineering**
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	None
Scope of the course	
Course Syllabus	**Introduction:** Energy sources for generation of electric power, energy policy of India, present status and future trends, major power plants in India. **Thermal Power Plants:** Selection of site, general layout of the plant, major components-boilers, economizers, super-heaters, air pre-heaters, fuels; Fuel and ash handling equipment's; High pressure Boilers; Steam turbines; Station heat balance and plant efficiency. **Diesel Power Plants:** Diesel engine, engine performance and operation, super charging; Diesel Electric Power plant layout. **Gas Turbine Power Plants:** Gas turbine power plants, basic cycles, cycle calculation, the ideal and real operating cycles, components and layout. **Hydro Power Plants:** Classification of hydro-plants, selection of site, rain fall and run off, calculation of storage capacity, plant layout, estimation of power available, selection of hydraulic turbines and their governing. **Nuclear Power Plants:** Introduction; Atomic structure and radio-activities nuclear reactions, binding energy; Nuclear Reactors; Types of reactors: Pressurized water reactors, boiling heater reactors; Heavy water-cooled and moderated (CANDU) reactor; Gas-cooled reactors; Liquid metal cooled reactors. Indian Nuclear power installations, comparison between Nuclear and Thermal plants. **Non-Conventional Power Plants:** Geothermal power plants; Tidal power plants; Wind power plants; Solar power plants; M.H.D. Generators. **Power Plant Economics:** Plant investment costs, fixed charges; Operation cost, energy cost, depreciation and operating costs on the selection of equipments, incremental cost, comparison of fixed and operating costs.
Suggested Books	1. P.J. Potter, **Power Plant Theory and Design**, Kreiger Pub. Co.,

	1988. 2. M.M. El-Wakil, **Power Plant Technology**, McGraw Hill, 2002. 3. E.B. Norris, and E. Therkelsen, Heat Power, McGraw Hill, 1999. 4. J.H. Rust, **Nuclear Power Plant Engineering**, Haralson Pub Co., 1999. 5. Central Electricity Generating Board, **Modern Power Station Practical**, Pergamon Press, 1992.

Course Code	**ME 416/ ME 616**
Title of the Course	**Non-Conventional Energy Sources**
Credit Structure	L-T- P-Credits 2-1-0-3
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	None
Scope of the course	To inculcate energy consciousness and environment sensitivity among engineering graduates
Course Syllabus	**Introduction:** Energy resources; conventional and non-conventional, Energy and infrastructural development; Ecosystems, the environment and its cycles, energy and environment relationship **Solar energy:** Solar radiation, radiation measurement and predictions; solar thermal conversions, basics, flat plate collectors-liquid and air type, theory of flat plate collectors, selective coating, advances collectors,; concentrators; Solar water heater, solar dryer; Solar phtovoltaic, science and technology of photovoltaic devices. organic PV cells **Wind Energy:** Metrology of wind speed distribution, energy estimation of wind regimes; Wing energy conversion, power torque and speed characteristics, wind turbine; Application of wind energy **Biomass:** Biomass sources, CO_2 fixation potential of biomass, physicochemical characterstics of biomass as fuel; Biomass conversion, biochemical, chemical and thermal; biogas production mechanism, technology, types of digesters, plant design, biogas plant manure-utilization and manure values; Biomass gasification and combustion; anaerobic digestion of biomass; biomass utilization to produce solis, liquid and gaseous fuels **Hydro-energy**: Overview of micro, mini and small hydro system; hydrology; elemnets of turbine; assessment of hydropower; selection and design criteria of turbines; speed and voltage regulations; Ocean energy; principle of ocean thermal energy conversion system, principles of ocean wave energy and tidal energy conversion **Geothermal energy**: Origin of geothermal resources, types of geothermal deposits; **Hydrogen energy**; Hydrogen production and storage; Fuel cells, principles of working, basic thermodynamics

Suggested Books	1) Donald K**., Biomass for renewable energy, Fuels and chemicals**, Academic press 2) S.P. Sukhatme: **Solar energy principles of thermal collection and storage**, 2nd edition, Tata McGraw Hill 3) G. Boyle, **Renewable energy: Power for sustainable future**, Oxforfd OUP 4) J. Twidell and T. Weir, **Renewable Energy Resources**. 5) T. B. Johansson, H. Kelly, A.K.N. Reddy, R. H. William, **Renewable Energy- Sources for fuels and Electricity**.

Course Code	**ME 418/ ME 618**
Title of the Course	**Computational Fluid Dynamics (CFD)**
Credit Structure	L-T-P-Credits ~~2-1-0-3~~ 2-0-2-3 (from AY 2021-22)
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	Heat Transfer
Scope of the course	
Course Syllabus	Control volume discretization of heat conduction equation in Cartesian and general curvilinear coordinate systems – Dirichlet, Neumann and Periodic boundary conditions; Gauss Seidel, TDMA, TVA, STONE, CD algorithms for solving resulting algebraic equations; convergence and accuracy and multigrid methods for convergence enhancement; General equations for boundary layer flows with heat and mass transfer and chemical reaction; boundary conforming transformation of equations, control volume discretization of equations; marching integration; application to wall boundary layers, free shear layers and mixing layers with and without comport equations in Cartesian and curvilinear coordinates; control volume discretization of equations; staggered and non-staggered grids; pressure correction algorithm; time marching predictor-corrector algorithm; application to recirculating elliptic flows and partially parabolic flows; compressible flows and shock capturing. Diffusion models; turbulence – zero, one and two equation models; stress equation models; low Reynolds number models; algebraic models; equivalent flux models. Source laws; Combustion models, radiation models, porous body models, mass sources; Numerical grid generation; algebraic, parabolic and elliptic equations.
Suggested Books	1. S.V. Patankar, **Conduction and Laminar Fluid Flow**, Innovative Press, 1992. 2. S.V. Patankar, **Numerical Heat Transfer and Fluid Flow**, Academic Press, 1983. 3. S.V. Patankar, and D.B. Spalding, **Heat and Mass Transfer in Boundary Layers**, Academic Press, 1968. 4. W.M. Kays, **Convective Heat and Mass Transfer** (6^{th} edition), Tata McGraw Hill, New Delhi, 1992. 5. C.A.J. Fletcher, **Computational Techniques for Fluid Dynamics**

	(Vol. 1 & 2), Springer Verlag, 1988.

Course Code	**ME 420/ ME 620**
Title of the Course	**Alternative Cooling Technologies**
Credit Structure	L-T-P-Credit (2-1-0-3)
Name of the Concerned Department	Mechanical Engineering
Pre-requisite, if any	None
Scope of the course	To inculcate various cooling technique available apart from the conventional vapor compression and absorption method among engineering graduates
Course Syllabus	**Introduction:** Cooling methods; conventional and nonconventional cooling technologies; requirement of the alternative cooling **Heat activated cooling methods:** adsorption, Vuilleumier heat pump and ejector, working principle; waste heat to cooling integration; **Gas based cooling system:** Working principle and design of Thermoacoustic, Brayton cooler, J-T cryocooler, Stirling cooler, Vortex-tube, Pulse-tube; representation on T-s and h-s diagrams; and their applications **Solid state cooling:** Cooling potential in solids; working principle, types of solid state refrigeration system, design of Thermoelectric, Thermoionic, Electrocaloric, Magnetocaloric, Mechanocaloric and their current status;. **Liquid-vapor cooling:** Principle of liquid-vapor based cooling system: Membrane heat pump; Metal hydride Transcritical CO_2 heat pump; Malone heat pump
Suggested Books	**Text Book** 1. C. P. Arora; **Refrigeration and Air Conditioning**, 3rd edition, Tata McGraw Hill, New Delhi, 2009, ISBN- 9780070083905 2. T. Correia and Q. Zhang; Electrocaloric Materials: New Generation of Coolers, Springer, 2014, ISBN-9783642402647 **Reference Book** 1. A. Ameen, Refrigeration and Air Conditioning, Prentice-Hall India Pvt. Lmt. New Delhi, 2012, ISBN-9788120326712 2. R. Wang, L. Wang and J. Wu, Adsorption Refrigeration Technology: Theory and Application, John Wiley and Sons. Singapore Pvt. Ltd., 2014, ISBN- 9781118197431 3. A. Kitanovski, J. Tušek, U. Tomc et al. Magnetocaloric Energy Conversion: From Theory to applications, Springer, 2015, ISBN-9783319087412

Course Code	**ME 431**
Title of the Course	**Mechanical Vibrations**
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	None
Scope of the course	
Course Syllabus	**Introduction:** Simple Harmonic motion, Fourier analysis, Conservative systems. **Systems Having Single Degree of Freedom:** Free vibrations of systems without damping, equilibrium and energy methods for determining natural frequency; Rayleigh's method; Equivalent systems, systems with compound springs, shaft of different diameters; Free vibrations of system with viscous damping, over damped, critically and under damped systems, logarithmic decrement; Coulomb and structural damping; Forced vibrations of systems with viscous damping, equivalent viscous damping, power consumption in vibrating system, impressed forces due to unbalanced masses and excitation of supports, vibration isolation, transmissibility, commercial isolators; Vibration isolation using ER fluids. **Systems with two Degrees of Freedom:** Free undamped vibrations, static and dynamic coupling, principal modes of vibration, undamped dynamic vibration absorber, centrifugal pendulum absorber. **Multi-Degree of Freedom Systems:** Influence coefficients, eigen values and eigen vectors, matrix iteration; Dunkerley and Rayleigh's method. **Continuous Systems:** Vibration of strings, free longitudinal vibrations of prismatic bars, torsional vibrations of circular shafts, lateral vibrations of uniform beams. **Vibration Measuring Instruments:** Principle of frequency, displacement, velocity and acceleration measuring instruments, distortion effect. **Whirling of Shafts:** Whirling of light flexible vertical/horizontal shaft with an unbalanced disc at the centre of its length with and without damping.
Suggested Books	1. W.T. Thomson, **Theory of Vibration and Applications**, Prentice Hall, 1979. 2. R.F. Steidel, **An Introduction to Mechanical Vibration**, John

	Wiley and Sons, 1979. 3. M.P. Norton, and D. Karczub, **Fundamentals of Noise and Vibration Analysis for Engineers** (2nd edition), Cambridge University Press, 2003. 4. J.S. Rao, and K. Gupta, **Theory and Practice of Mechanical Vibrations**, New Age International (Pvt.) Ltd. New Delhi, 1999.

Course code	**ME 432/ ME 632**
Title of the course	**Vibrations and Noise Control**
Credit Structure	L-T-P–Credits 2-1-0-3
Name of the Concerned Department	Mechanical Engineering
Pre-requisite, if any	NA
Scope of the course	With the increasing demand of noise and vibration engineers in industry, this course is designed to know theoretical and practical aspects of noise and vibration. This course covers basics of noise and vibration, measurement and analysis of noise and vibration, control of noise and vibration and industrial case studies.
Course Syllabus	**Introduction:** Basic vibration theory, vibration of one degree, two degrees, and multi-degrees of freedom systems. **Transient vibrations**, vibration of beams. **Measurement and Analysis of Vibrations:** Lagrange's equation, vibration measuring and analyzing instruments. Various types of transducers, data acquisition system, vibration analysis techniques **Design for vibration control**: Vibration absorbers, viscoelastic damping, active vibration control. **Fundamentals of Noise**: One dimensional wave equation, Sound propagation in 3-D space, some important acoustic quantities and relations, additive effects of sound. **Measurement of sound:** Various types of transducers, measurement of sound pressure, sound intensity and sound power. **Noise Control:** Principles of passive noise control, sound absorption, noise barriers. **Case studies:** Source identification and fault detection from noise and vibration signals in mechanical systems such as bearings, gears, fans, blower and pumps, electrical equipment etc.
Suggested Books	• W.T. Thomson, **Theory of Vibration and Applications**, Prentice Hall, 1979, ISBN-13: 978-0136510680 • R.F. Steidel, **An Introduction to Mechanical Vibration**, John Wiley and Sons, 1979, ISBN-13: 978-0471845454 • J.S. Rao, and K. Gupta, **Theory and Practice of Mechanical Vibrations**, New Age International (Pvt) Ltd. New Delhi, 1999, ISBN-13: 978-8122412154 • Brandt, Anders, **Noise and vibration analysis : signal analysis and experimental procedures,** John Wiley & Sons, West Sussex, 2011, ISBN-13: 978-0470746448 • Cheremisinoff, Nicholas, **Noise control in industry : a practical guide,** Noyes Publications, New Jersey, 2003, ISBN-13: 978-0815513995 • Fahy, Frank and Walker, John, **Fundamentals of noise and vibration**, Taylor and Francis, London, 1998, ISBN-13: 978-

	0419227007 • Norton, M.P and Karczub, D.G**, Fundamentals of noise and vibrations analysis for engineers**, Cambridge University press , New York , 2003, ISBN-13: 978-0521499132

Course Code	**ME 433**
Title of the Course	**Condition Monitoring and Diagnostics**
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	None
Scope of the course	
Course Syllabus	**Introduction:** Introduction to condition based maintenance, application and economic benefits. Typical defects in gears and rolling element bearings **Vibrations of Gears and Bearings:** Vibration characteristics of non-defective gears; Vibration characteristics of non-defective bearings; Vibration characteristics of defective gears; Vibration characteristics of defective bearings. **Monitoring Methods:** Early time domain methods, spectral methods, cepstral methods, envelope methods. **Vibration Analysis:** Vibration- simple harmonic motion concept, vibration monitoring equipment, system monitors and vibration limit detectors, vibration monitoring examples, critical vibration levels. **Sound Monitoring:** Sound frequencies, sound loudness measurement, acoustic power, sound measurement, sound level meters, sound analyzers, sound signal data processing, sound monitoring. **Discrete Frequencies:** Simple vibrations, transverse vibration of bars-approximate frequency calculations, more precise evaluations- overtones, torsional oscillation of flywheel-bearing shafts, belt drives, whirling of shafts, gear excitation, rolling element bearing, blade vibration, cam mechanism vibration. **Machine Condition Indicators:** RMS value, peak value and crest factor, kurtosis, defect severity index. **Measurement Techniques:** Instrumentation, data acquisition, signal filtering, signal analysis - online and offline techniques, normalized order analysis. **Signal Processing Tools:** Sample rate and aliasing**, t**ime and frequency domain analysis. **Case Studies:**Practical applications of diagnostic maintenance, condition monitoring of mechanical and electrical machines.
Suggested Books	1. M.P. Norton, and D. Karczub, **Fundamentals of Noise and**

	Vibration Analysis for Engineers (2nd edition), Cambridge University Press, 2003. 2. R.A. Collacott, **Mechanical Fault Diagnosis and Condition Monitoring**, Chapman & Hall, 1977. 3. F.J. Fahy, and J.G. Walker**, Fundamentals of Sound and Vibration**, Spon Press, 1998. 4. M. Abom, **Sound and Vibration**, KTH, 2006. 5. Davies, **Handbook of Condition Monitoring- Techniques and Methodology**, Springer, 2006.

Course code	**ME 434/ ME 634**
Title of the course	**Principles of Product Design**
Credit Structure	L-T-P–Credits 2-1-0-3
Name of the Concerned Department	Mechanical Engineering
Pre-requisite, if any	NA
Scope of the course	The scope of the course is to integrate the design, marketing, engineering, and business functions of the firm in creating a new product. The course is intended to provide the following benefits: •Competence with a set of tools and methods for product design and development. • Describe an engineering design and development process •Ability to coordinate multiple, interdisciplinary tasks to achieve a common objective. •Employ engineering, scientific, and mathematical principles to execute a design from concept to finished product. •Reinforcement of specific knowledge from other courses through practice and reflection in an action-oriented setting.
Course Syllabus	Overview of the Design Process – Philosophy of Engineering Design, Steps involved in the Design Process S curves, Communications during design process. Understanding the customer need – Steps involved in developing Engineering Design Specifications. The technique of Quality Function Deployment (QFD). Case studies in QFD. Functional Design – Functions in engineering Design. Basics of Function Structure – Functional Basis, Functional decomposition and flow. Product Concept – Various methods of concept generation. The method of theory of the resolution of invention-related tasks (TRIZ). Concept Selection and methods of evaluation. Embodiment design- product architecture, configuration, parametric design, systems approach and other consideration of embodiment design. An introduction to product metrics. Product evaluation techniques.
Suggested Books	• K. Otto and K. Wood, **Product Design: Techniques in Reverse Engineering and New Product Development**, Pearson, New Jersey, 2001, ISBN 978-0130212719 • D.G. Ullman, **The Mechanical Design Process**, McGraw-Hill, New York, 2009, ISBN 978-0072975741 • G. Dieter and L. Schmidt, **Engineering Design (Mechanical Engineering)**, McGraw-Hill, New York, 2012, ISBN 978-0073398143 • K.T. Ulrich and S.D. Eppinger, **Product Design and Development**, McGraw-Hill, New York, 2007, ISBN 978-0073101422

Course Code	**ME 435**
Title of the Course	**Experimental Stress Analysis**
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	None
Scope of the course	
Course Syllabus	**Introduction:** Basic equations in elasticity, state of strain, brittle coating method, crack patterns produced by direct loading, refrigeration method, releasing method, effect of coating thickness and environment. **Photoelasticity Methods:** behaviour of light, plane polarised and circular polariscope, isochromatic and isoclinic fringe patterns for two dimensional photoelasticity, three dimensional photoelasticity, model slicing and shear difference method, birefringent coating method. **Strain Measurement Methods:** types of gauges, electric strain gauge, strain rosette analysis, three element, delta, four element rosette, strain gauge circuits and recording instrument. **Misc. Topics:** Moire fringe technique, surface strain measurements and flexural studies, Grid analysis, X-ray techniques and holography, Motion measurements.
Suggested Books	1. J .W. Dally, and W.P. Riely, **Experimental Stress Analysis**, McGraw Hill Book Co., 1978. 2. G.S. Holister, **Experimental Stress Analysis**, Cambridge University Press, 1967. 3. R.C. Dove, and P.H. Adams, **Experimental Stress Analysis and Motion Measurements**, Prentice Hall, 1965.

Course Code	**ME 436 / ME 736**
Title of the Course	**Finite Element Analysis (FEA)**
Credit Structure	L-T-P-Credits 2-0-2-3
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	None
Scope of the course	
Course Syllabus	**Basic Concepts:** Introduction, Weak formulations, Weighted residual methods, Variational formulations, weighted residual, collocation, subdomain, least square and Galerkin's method, virtual work principle. **One-Dimensional Problems:** Basis steps, Discretization, Element equations, Linear and quadratic shape functions, Assembly, Local and global stiffness matrix and its properties, boundary conditions, penalty approach, multipoint constraints, Applications to solid mechanics, heat and fluid mechanics problems, axisymmetric problems, Transient problems. **Trusses:** Plane truss, local and global coordinate systems, stress calculations, temperature effect on truss members, solution of practical problems. **Beams and Frames**: Euler Bernoulli beam element, Rayleigh beam element, frame element, problems. **Two-Dimensional Problems:** Single variables in 2-D, triangular and rectangular elements, constant strain triangle, isoparametric formulation, higher order elements, six node tringle, nine node quadrilateral, master elements, numerical integration, computer implementation. **Scalar Field Problems:** Torsion, heat transfer, heat transfer in thin fins, potential flow problems. **Elasticity Problems**: Review of equations of elasticity, stress-strain and strain-displacement relations, dynamic problems on vibrations, plane stress and plane strain problems.
Suggested Books	1. J.N. Reddy, **An Introduction to Finite Element Method** (3rd edition), Tata McGraw-Hill, 2005. 2. S.S. Rao, **The Finite Element Method in Engineering** (4th edition) Elsevier Science, 2005. 3. K.H. Huebner, D.L. Dewhirst, D.E. Smith, and T.G. Byrom, **The Finite Element Method for Engineers** (4th edition), John Wiley

	and Sons, 2001. 4. J. Fish, and T. Belytschko, **A First Course in Finite Elements**, John Wiley and Sons, 2007. 5. J. Chaskalovic, **Finite Element Methods for Engineering Sciences**, Springer, 2008.

Course code	**ME 437/ ME 637**
Title of the course	**Fracture Mechanics**
Credit Structure	L - T - P – Credits 2-1-0-3
Name of the Concerned Department	Mechanical Engineering
Pre-requisite, if any	Theory of elasticity
Scope of the course	This course introduces the fundamental concepts of the fracture mechanics useful in designing high risk products such as nuclear plants, airplanes, space vehicles, submarines, etc. This course will not only provide enough background to work in industries but also build foundation to start research in the area of fracture mechanics, computational fracture mechanics and mechanical behaviour of materials.
Course Syllabus	Introduction and overview, Energy concepts in fracture mechanics: atomistic view of fracture, Griffith energy balance, Irwin-Orowan extension, Energy release rate G and R curve; Linear elastic fracture mechanics: stress and displacement fields near crack tip for mode-I, II and III fracture, stress intensity factor K, relation between G and K, small scale yielding conditions, Irwin's plastic zone correction, Dugdale model, Fracture toughness Kc, Westergaard method, Principle of superposition, Non Linear fracture mechanics; J Integral, Plastic crack tip (HRR) fields, Ductile fracture criterion, J Integral Testing, J-controlled crack growth and stability, Engineering approach to Plastic Fracture; Fatigue Failure.
Suggested Books	• T.L. Anderson, **Fracture Mechanics – Fundamentals & Applications**, CRC press, 3rd Edn., 2005, ISBN-10: 0849316561. • M.F.Kanninen and C.H.Popelar, **Advanced Fracture Mechanics**, Oxford press, 1985, ISBN-10: 0195035321 • D. Broek, **Elementary Engineering Fracture Mechanics**, Martinus Nijhoff publishers, 1982, ISBN-13:- 978-90-247-2580-9 • Kare Hellan, **Introduction to Fracture Mechanics**, McGraw Hill, 1984, ISBN-10: 0070280487

Course Code	**ME 438 / ME 738**
Title of the Course	**Composite Materials**
Credit Structure	L-T- P-Credits 2-1-0-3
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	Nil
Scope of the course	
Course Syllabus	**Introduction:** classifications, terminologies, manufacturing processes. **Macro-mechanical analysis of lamina:** Hooke's law for anisotropic, monoclinic, orthotropic, transversely isotropic and isotropic materials–2D Unidirectional and angle ply lamina – Strength theories of lamina. **Micro-mechanical analysis of lamina:** Volume and mass fraction, density and void content – Evaluation of Elastic module, Ultimate strength of unidirectional lamina. **Macro-mechanical analysis of laminates:** Laminate code, Stress strain relations – In-plane and Flexural modulus, Hydrothermal effects. **Failure Analysis and Design:** Special cases of laminates, symmetric, cross ply, angle ply and anti-symmetric laminates, failure criteria and failure modes.
Suggested Books	1. Jones, R M, ***Mechanics of Composite Materials*****,** Scripta Book Co. 2. Agarwal, B D and Broutman, J. D, ***Analysis and Performance of Fiber Composites*****,** New York, John Willey and Sons, 1990 3. Mallik, P. K, ***Fiber reinforced composites : materials, manufacturing and design,*** New York- Marcel and Dekker, 1993 (2nd edition) 4. Arthur, K Kaw, ***Mechanics of Composite Materials***, CRC Press, 1997. 5. Reddy J N, ***Mechanics of Laminated Composite Plates***, CRC Press 6. Mallik, P. K, ***Composite Engineering Hand Book***, New York, Marcel and Dekker, 1997 (2nd edition)

Course code	**ME 439/ ME 639**
Title of the course	**Mechanical Behavior of Materials**
Credit Structure	L-T-P–Credits 2-1-0-3
Name of the Concerned Department	Mechanical Engineering
Pre-requisite, if any	NA
Scope of the course	This course will discuss crystal structure, basic mechanism of plastic deformation and their influence on the mechanical behavior of metallic materials. In addition, it will provide an understanding of the atomistic modelling of solid materials to characterize their mechanical behavior.
Course Syllabus	Introduction and overview, Elastic deformation, Crystal structure, Theory of dislocation (edge, screw and mixed dislocations, cross slip, Peirls-Nabarro stress, Peach-Koehler equation, Frank-Read source), Twining, Plastic deformation in single and polycrystal, Strengthening mechanisms, Hardening mechanisms, Atomic/molecular structure of nanomaterials and their synthesis, overview of nanomechanical testing methods, atomistic modelling tools (DFT, tight-binding modelling, MD with their advantages and limitations), Functionalization, Size-scale strength, Nano-biomechanics and nanocomposites
Suggested Books	• William F. Hosford, **Mechanical behavior of materials**, Cambridge University Press, 2 edition, New York, 2009, ISBN 978-0521195690 • G.E. Dieter, **Mechanical Metallurgy**, McGraw-Hill, London, 1988, ISBN 0–07–016893–8 • Andrew Leach, **Molecular Modelling: Principles and Applications,** Pearson, London, 2001, ISBN 978-0582382107 • Alan Hinchliffe, **Molecular Modelling for Beginners**, John Wiley & Sons Ltd., United Kingdom, 2008, ISBN 978-0470513149

Course Code	**ME 440 / ME 640**
Title of the Course	**Smart Materials and Structures**
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	None
Scope of the course	
Course Syllabus	**Intelligent materials:** Primitive functions of intelligent materials; Intelligence inherent in materials; Materials intelligently harmonizing with humanity; Intelligent biological materials. **Smart Materials and Structural Systems:** Actuator materials; Sensing technologies; Micro-sensors; Intelligent systems; Hybrid smart materials; Passive sensory smart structures; Reactive actuator-based smart structures; Active sensing and reactive smart structures; Smart skins **Electro-Rheological (ER) Fluids:** Suspensions and electro-rheological fluids; The electro-rheological phenomenon; Charge migration mechanism for the dispersed phase; Electro-rheological fluid actuators. **Piezoelectric Materials:** Background; Piezoelectricity; Industrial piezoelectric materials; Smart materials featuring piezoelectric elements. **Shape Memory Materials (SMM):** Background on shape-memory-alloys; Applications of shape-memory-alloys; Continuum applications: structures and machine systems; Discrete applications; Impediments to applications of shape-memory-alloys; Shape-memory-plastics. **Fiber-optics:** an overview; Advantages of fiber-optics; Light propagation in an optical fiber; Embedding optical fibers in fibrous polymeric thermosets; Fiber-optic strain sensors. **The piezoelectric Vibrations Absorber Systems:** Introduction; The single mode absorber, theory, design solution, extension including viscous modal damping, the electromechanical coupling coefficient, inductance, experimental results; The multimode absorber, derivation of transfer function, design solution, self-tuning absorber, performance function, control scheme.
Suggested Books	1. M.V. Gandhi, and B.S. Thompson, **Smart Materials and structures** (2nd edition), Chapman & Hall, 1992.

	2. Guran, H.S. Tzou, G.L. Anderson, and M. Natori, **Structure Systems: Smart Structures, Devices and System** (Part 1), and **Materials and Structures** (Part 2), World Scientific Publications, 1998. 3. U. Gabbert, and H.S. Tzou, **Smart Structures and Structuronic System**, Kluwer Academic Publishers, 2001. 4. H.T. Banks, R.C. Smith, and Y.W. Qang, **Smart Material structures: Modeling, Estimation and Control** (6th edition), John Wiley & Sons, 1997.

Course code	**ME 441/ ME 641**
Title of the course	**Design of Laminated Composite Structures**
Credit Structure	L-T-P–Credits 2-1-0-3
Name of the Concerned Department	Mechanical Engineering
Pre-requisite, if any	Solid Mechanics, Strength of Materials, Composite Materials
Scope of the course	This course introduces various aspects of composite structural design based on different applications. This course is intended to educate the students in basics, advantages, design, fabrication, and applications of composite materials in various advanced structures.
Course Syllabus	Introduction to different thermo-set and thermo-plastic composites, manufacturing process of thermo-set and thermo-plastic composites, application of thermo-set and thermo-plastic composites based on the design requirement, Design of composite beams, review of laminate strength and failure theories , experimental testing of the composites for stiffness and strength parameters, Introduction to fatigue of composite materials, design and analysis of composite beams, shear flow and shear center calculation in thin walled closed sections, analysis of loads and load paths in the advanced industrial composite structures such as wind turbine rotor blade and gas turbine compressor fan blade, Selection of ply angles based on the load paths.
Suggested Books	• Isaac M. Daniel , Ori Ishai, **Engineering mechanics of composite materials**, Oxford university press, New Delhi, 2011, ISBN 019568580-6 • Carl T. Herakovich: **Mechanics of fibrous composites,** Wiley Publications, Newyork, 1998, ISBN: 978-0-471-10636-4 • Louis C. Dorworth, Ginger L. Gardiner, Greg M. Mellema, **Essentials of advanced composite fabrication & repair**, Aviation supplies & Academics, Inc., Newyork, 2009, ISBN 978-1-61954-229-7 • Christos Kassapoglou, **Design and analysis of composite structures with applications to aerospace structures**, Wiley publications, The Netherlands, 2011, ISBN9781118401606

Course code	**ME 443/ ME 643**
Title of the course	**Micromechanics and Nanomechanics**
Credit Structure	L - T - P – Credits 2-1-0-3
Name of the Concerned Department	Mechanical Engineering
Pre-requisite, if any	NA
Scope of the course	This course is designed for students from diverse fields of study. This course provides a single window for students to comprehend wide range of subjects/research topics of advanced micro- and nano-materials and prepare them to characterize multifunctional behavior of advanced material systems. The first part of the subject includes modules of fundamentals of micromechanics. The second part of the subject includes modules on useful concepts in molecular modeling. A partial focus of the subject is to provide a hands-on training in the application of computer modeling of SOLID materials at the atomic scale.
Course Syllabus	Introduction to micromechanics and nanomechanics. Preliminaries of continuum mechanics, micromechanical homogenization theory: Ergodicity principle, representative volume element, eigenstrains and eigenstress, inclusions and inhomogeneities; Effective moduli of heterogeneous materials (single and multi-inclusion approaches), Hill's bounds, Voigt and Reuss bounds, Hashin-shtrikman variational principles Micromechanical damage theory. Basics of atomistic, interatomic potentials, lattice defects; Molecular statics and dynamics: time integration, temperature and pressure control, statistical ensembles, potential field, Virial stress; Bohr's correspondence principle; Multiscale modeling; Structural mechanics of carbon-based and boron nitride-based nanomaterials.
Suggested Books	• S. Nemat-Nasser and M. Hori, **Micromechanics: Overall Properties of Heterogeneous Materials**, North Holland, Amsterdam, 1998, ISBN 978-0444500847 • Shaofan Li and Xin-Lin Gao, **Handbook of Micromechanics and Nanomechanics**, Taylor & Francis Group, LLC, Boca Raton, 2013, ISBN 978-981-4411-24-0 • Jianmin Qu and Mohammed Cherkaoui: **Fundamentals of Micromechanics of Solids,** John Wiley & Sons Inc., New Jersey, 2006 ISBN 978-0-471-46451-8 • Alan Hinchliffe, **Molecular Modelling for Beginners**, John Wiley & Sons Ltd., United Kingdom, 2008 ISBN 978-0470513149

Course Code	**ME 444/ ME 644**
Title of the Course	**Robotics**
Credit Structure	L-T-P-Credit 2-0-2-3
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	None
Scope of the course	
Course Syllabus	**Introduction:** Introduction to robots – Robot manipulators – Mobile robots – Robot anatomy – Coordinate systems, Work envelope – Types and classification – Specifications – Sensors – Actuators and drives. **Forward and Inverse Kinematics:** Introduction – Representation of position and orientation of a rigid body – Homogeneous transformations – Forward and inverse kinematics problems – Denavit-Hartenberg (D-H) notations and parameters – Representation of joints, link representation using D-H parameters – Closed-form solutions – Geometric and Numerical methods. **Velocity and Statics analysis:** Linear and angular velocity of links – Velocity propagation – Jacobians for robotic manipulators – Statics and force transformation of robotic manipulators – Singularity analysis. **Robot Dynamic analysis:** Introduction – Forward and inverse dynamics – Mass and inertia of links - Lagrangian formulation for equations of motion for robotic manipulators – Newton-Euler formulation method – Dynamic modelling – State space representation of dynamic equations of robotic manipulators. **Trajectory Planning and Control:** Joint and Cartesian space trajectory planning and generation – Classical control concepts using the example of control of a single link – Independent joint PID control – Control of a multi-link manipulator – Nonlinear model based control schemes – Simulation and experimental case studies on robotic manipulators.
Suggested Books	1. J. J. Craig, **Introduction to Robotics: Mechanics and Control,**

	John Wiley & Sons Inc., 2004 2. M.W. Spong, Seth Hutchinson, M. Vidyasagar, **Robot Modeling and Control**, John Wiley & Sons Inc., 2006. 3. J.R. Schilling, **Fundamentals of Robotics: Analysis and Control** Prentice Hall India, 1992. 4. K. Fu, R. Gonzalez and C.S.G. Lee, **Robotics: Control, Sensing, Vision and Intelligence,** McGraw- Hill, 1987. 5. A. Ghosal, **Robotics: Fundamental Concepts and Analysis** Oxford University Press, 2008.

Course code	**ME 445/ ME 645**
Title of the course	**Mobile Robotics**
Credit Structure	L - T - P - Credits 2-0-2-3
Name of the Concerned Department	Mechanical Engineering
Pre-requisite, if any	NA
Scope of the course	This course provides an introduction to mobile robotic systems and motion control methods with such systems from a computational and real-time perspective. •Students will understand the algorithmic approach towards designing intelligent and autonomous mobile robotic systems. •Students will learn about a variety of mobile robotic platforms, their applications and uses. •Students will learn the basics mechanical and electrical systems of these mobile robots, including sensors, locomotion and manipulation hardware.
Course Syllabus	Introduction to Mobile Robots - Tasks of mobile robots, robot_s manufacturers, type of obstacles and challenges, tele-robotics, philosophy of robotics, service robotics, types of environment representation. Ground Robots: Wheeled and Legged Robots, Aerial Robots, Underwater Robots and Surface Robots. Kinematics and Dynamics of Wheeled Mobile Robots (two, three, four - wheeled robots, omni-directional and macanum wheeled robots). Sensors for localization: magnetic and optic position sensor, gyroscope, accelerometer, magnetic compass, inclinometer, GNSS and Sensors for navigation: tactile and proximity sensors, ultrasound rangefinder, laser scanner, infrared rangefinder, visual system, Kinect. Localization and Mapping in mobile robotics. Motion Control of Mobile Robots (Model and Motion based Controllers): Lyapunov-based Motion Control Designs and Case Studies. Understand the current application and limitations of Mobile Robots. Introduction to Mobile Manipulators and Cooperative Mobile Robots.
Suggested Books	1. R Siegwart, IR Nourbakhsh, D Scaramuzza, ***Introduction to Autonomous Mobile Robots***, The MIT Press, USA , 2011, 9780262015356 2. SG Tzafestas, ***Introduction to Mobile Robot Control***, Elsevier, USA, 2014, 9780124170490 3. A Kelly, ***Mobile Robotics***, Mathematics, Models, and Methods, Cambridge University Press, USA, 2013, 9781107031159 4. G Dudek, M Jenkin, ***Computational Principles of Mobile Robotics,*** Cambridge University Press, USA, 2010, 9780521692120

Course Code	**ME 446 / ME 646**
Title of the Course	**Dynamics and Control Systems**
Credit Structure	L-T- P-Credits 2-1-0-3
Name of the Concerned Department	Mechanical Engineering / School of Engineering
Pre–requisite, if any	Courses on Controls and Kinematics & Dynamics of the Machines
Scope of the course	The Scope of the Courses of this course are to develop in mechanical engineering students the knowledge and skills required • To establish the fundamental techniques for modeling dynamic systems. • To analyze and manipulate system models in the time and frequency domain. • To develop an understanding of feedback control systems and the parameters that influence their stability and performance.
Course Syllabus	**Dynamic Modelling of Systems:** Introduction to Dynamics, Systems and Control. Dynamic modelling of systems. Lumped system. Modelling of translational and rotational mechanical spring-mass-damper systems. Nonlinear systems and Linearization of nonlinear systems. Numerical computations and simulations with MATLAB / MATHEMATICA, and simulations in MSC ADAMS. **Analysis of Linear Systems:** Introduction, Laplace transform, Transfer functions, System response, Stability analysis, Routh-Hurwitz criteria. Time domain analysis: Root locus method. Frequency domain analysis: Bode plot and Nyquist plot. Numerical computations with MATLAB. **Linear Feedback Control Systems:** Lead and Lag compensator, Design and analysis of linear feedback control systems using time and frequency domain techniques. Numerical computations with MATLAB. Proportional (P), proportional-derivative (PD), proportional-integral (PI) and proportional-integral-derivative (PID) controller, Gain tuning methods and modifications. Case studies on PID Controller and its applications. **Analysis of Systems in State Space:** Concept of state and state variables. State space representation of dynamic systems. State models of linear time invariant systems, State transition matrix, and Solution of state equations. Controllability and Observability. Numerical computations with MATLAB. **State Space Controllers and Observers for Linear systems:** Full state feedback controller and Pole placement technique. Design of full state feedback controller. State observer and design of state observer with controller. Numerical computations and

	simulations with MATLAB.
Suggested Books	1. K. Ogata, **Modern Control Engineering, 5/e**, Prentice Hall India, 2003. 2. B.C.Kuo, **Automatic Control Systems, 7/e**, Prentice Hall India, 2003. 3. N.S. Nise, **Control Systems Engineering, 4/e**, John Wiley, 2003. 4. M. Gopal, **Control Systems, 2/e**, Tata McGraw-Hill, 2000. 5. G. F. Franklin, **Feedback Control of Dynamic Systems, 6/e**, Pearson Edition, 2009. 6. R.C. Dorf and R.H. Bishop, **Modern Control Systems, 12/e**, Prentice Hall India, 2011. 7. C.L. Phillips, and R.D. Harbour, **Feedback Control Systems, 2/e**, Prentice Hall, 1991. 8. I.J. Nagrath and M. Gopal, **Control System Engineering, 2/e**, Wiley Eastern, 1982.

Course Code	**ME 448 / ME 648**
Title of the Course	**MEMS and Micro-system Design**
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Concerned Department	Mechanical Engineering Department
Pre–requisite, if any	None
Scope of the Course	
Course Syllabus	**Introduction to MEMS and Micro-systems:** Micro-electro-mechanical- systems (MEMS) and micro-system products, the multidisciplinary nature of micro-systems, scaling laws in miniaturization, application of micro system in other industries, intrinsic characteristics of MEMS. **Micro-actuators and Micro-sensors:** Micro-sensors, acoustic wave sensors, biomedical and nano-sensors, chemical sensors, optical sensors, pressure sensors, themal sensors, micro-actuation through thermal forces, SMA-Piezo electric crystals, and electrostatic forces, magnetic actuation, micro-grippers, micro-motors, micro-valaves, micropumps, micro-accelelrometers. **Materials, Mechanics and design of micro-systems:** Silicon as a substrate, compounds, piezo-resisitors, polymers and packaging materials, micro-fabrication and micro-etching: static bending of thin plates, thermo mechanics and thin film mechanics. **Case studies of MEMS Products:** Micro-fluidic devices, micro/nano transducers, blood pressure sensor, microphone-acceleration sensors, gyroscope, an overview of micro-system packaging.
Suggested Books	1) Tai-Ran Hsu, **MEMS and Micro system Design and Manufacturing**, Tata McGraw Hill, ISBN 07-239391-2. 2) Chang Liu, **Foundation of MEMS**, Pearson Education, ISBN (978-81-317-6475-6) 3) Guozhong Cao,Ying, **Nanostructure and Nano materials, synthesis, properties and applications**, World Scientific Publishing Co. 2011 4) Robert Kelsall, Ian W.Hamley, Mark Geoghegan, **NanoScale Science and Technology**, ISBN 13:978047085086 5) Lifeng Chi, **Nano technology-Volume 8: Nanostructured**

	surfaces, Wiley Publication, ISBN13:9783527317394.

Course Code	**ME 451 / ME 751**
Title of the Course	**Theory of Advanced Machining Processes**
Credit Structure	L-T-P-Credits 2-0-2-3
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	None
Scope of the course	To introduce the process principle, mechanism and modeling of material removal, parametric analysis, applications, limitations of various advanced machining processes and the derived and hybrid processes based on them.
Course Syllabus	**Introduction:** Types of advanced machining processes (AMPs); evolution, and need. **Mechanical Type AMPs:** process principle and elements; Mechanism of material removal, parametric analysis; Shape and material applications; Operational characteristics; Limitations of USM, AJM, WJM, AWJM processes. **Advanced Fine Finishing Process:** Process principle, process equipment, Parametric analysis, Applications of Abrasive Flow Machining (AFM); Magnetic Abrasive Finishing; Magneto Rheological Abrasive Finishing (MRF) processes. **Chemical Type AMPs:** Process principle and details of Chemical Machining (CHM); Photo-Chemical Machining (PCM), and Bio-Chemical Machining processes (BCM). **Electro Chemical Type AMPs:** ECM-Process principle, mechanism of material removal; Kinematics and dynamics and dynamics of ECM; Tooling design; Choice and analysis of process parameters; Surface finish and accuracy. **Thermal Type AMPs:** Working principle; Power circuits; Mechanism of material removal; Process parameters and characteristics; Surface finish and accuracy, Shape and materials applications, limitations of EDM, LBM, EBM, IBM, PAM processes. **Derived and Hybrid AMPs:** Introduction of processes like rotary ultra sonic machining (RUM), electro stream drilling (ESD), shaped tube electro machining (STEM), wire electro discharge machining (WEDM), electro chemical grinding (ECG), electro chemical honing (ECH), electro chemical deburring (ECD), and electro-chemical spark machining (ECSM).
Suggested Books	1. G.F. Benedict, **Nontraditional Manufacturing Processes**, Marcel

	Dekker, Inc., 1987. 2. V.K. Jain, **Advanced Machining Processes**, Allied Publishers, 2002. 3. A. Ghosh, and A.K. Mallik, **Manufacturing Science**, Affiliated East-West Press Ltd, 1985. 4. P.C. Pandey, and H.S. Shan, **Modern Machining Processes**, Tata McGraw-Hill Publishing Co. Ltd, 1977. 5. J.A. McGeough, **Advance Methods of Machining**, Chapman and Hall, 1988.

Course Code	**ME 453 / ME 653**
Title of the Course	**Computer Aided Manufacturing (CAM)**
Credit Structure	L-T-P-Credits 2-0-2-3
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	None
Scope of the course	
Course Syllabus	**Introduction:** Introduction to manufacturing systems and their performance analysis; Introduction to Automation; Introduction to Computer Integrated Manufacturing (CIM). **Numerical Control (NC):** Introduction, Numerical Control – its growth and development, Components of NC system, Input devices, Control systems – point to point, straight cut, and continuous path NC, Open loop and closed loop NC systems, NC interpolations – linear, circular, helical, parabolic and cubic interpolation, Applications of NC systems, Merits and demerits. **Extensions of NC:** Concepts of Computer Numerical Control (CNC), Machining Center, and Direct Numerical Control (DNC), and their advantages. **Robotics:** Robot anatomy and related attributes, Robot control systems – limited sequence, playback with point to point, playback with continuous and intelligent control, End effectors – gripper, tools, Sensors in Robotics – tactile sensors, proximity, optical sensors and machine vision, Applications of industrial robots, Robot programming. **Material Handling and Storage:** Overview of Material Handling Equipments, Automated material handling equipments – AGVs, Conveyor systems, Performance analysis of material handling systems, Automated material storage systems – ASRS and Carousel storage, Analysis of automated storage systems. **Manufacturing Support Functions:** Introduction to Group Technology (GT), Computer Aided Process Planning (CAPP), Material Requirement Planning MRP (MRP), Capacity Planning, Scheduling etc.
Suggested Books	1. M.P. Groover, **Automation, Production systems and Computer Integrated Manufacturing**, Prentice-Hall Inc. Englewood Cliffs 1987. (ISBN087692-618-7) 2. N. Singh, **Systems Approach to Computer Integrated Design and Manufacturing**, John Wiley & Sons, 1996. Sons (ISBN0-471-

	58517-3) 3. T.C. Chang, R.A. Wysk, and H.P. Wang, **Computer Aided Manufacturing**, Prentice Hall Inc. New Jersey, 1991, (ISBN0-13-161571-8) 4. Y. Koren, **Computer Control of Manufacturing Systems**, McGraw Hill Inc., 1983. (ISBN 007-035-3417) 5. M. Lynch**, Computer Numerical Control for Machining**, , McGraw-Hill Inc. 1992. (ISBN 0-07-039223-4) 6. M. Sava, and J. Pusztai, **Computer Numerical Control Programming**, Prentice Hall, 1990. (ISBN 0-13-156084-0)

Course Code	**ME 454 / ME 654**
Title of the Course	**Rapid Product Manufacturing**
Credit Structure	L-T- P-Credits 2-0-2-3
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	None
Scope of the course	To introduce various concepts of involved in rapid product manufacturing starting from product modeling, reverse engineering, product data exchange, concurrent engineering, rapid prototyping, and rapid tooling
Course Syllabus	**Product Modeling and Reverse Engineering:** Wireframe modeling; Surface modeling – Boundary representation; Solid modeling: CSG; Concept of reverse engineering. **Product Data Exchange:** Neutral file formats for product data exchange- DXF, IGES, STEP. **Concurrent Engineering:** Concept of concurrent engineering; Design for X; Design for manufacturability (DFM); design for assemblability (DFA); Design for reliability (DFR); Design for quality (DFQ) **Rapid Prototyping (RP) Methods:** Liquid based RP methods – Stereolithography apparatus (SLA), Solid Ground Curing (SGC), Solid Creation System (SCS), etc.; Solid based RP methods: Fused Deposition Modeling (FDM), Laminated Object Manufacturing (LOM), etc. Powder based RP methods– Selective Laser Sintering (SLS), 3D printing (3DP), Ballistic Particle Manufacturing (BPM), etc. **Rapid Tooling (RT):** Introduction, various techniques of RT.
Suggested Books	1. M.M. Anderson, and L. Hein, **"Integrated Product Development",** IFS Publication, Springer Verlag, Berlin, 1987. 2. I. Zeid "CAD/CAM: **Theory and Practice"**, , Tata McGraw Hill, New Delhi, 1998 (ISBN 0-07-463126-8) 3. M. E. Mortenson, **"Geometric Modeling",** John Wiley & Sons, New York, 1985 (ISBN 0-471-88279-8) 4. G.Q. Huang, **"Design for X: Concurrent Engineering Imperatives",** Chapman and Hall, London, 1996 (ISBN 0-412-78750-4) 5. G. Boothroyd, P. Dewhurst, and W. Knight, **"Product Design for Manufacture and Assembly (2nd Edition)"**, Marcel Dekker, New York, 2002 (ISBN 0-08247-0584-7)

	6. C.K. Chua, and K.F. Leong, **"Rapid Prototyping: Principles and Applications in Manufacturing",** John Wiley & Sons. Inc. Singapore, 1997. 7. A.K. Chitale, and R.C. Gutpa, **"Product Design and Manufacturing"**, Prentice Hall of India, New Delhi, 1997.

Course Code	**ME 456 / ME 756**
Title of the Course	**Industrial Automation**
Credit Structure	L-T-P-Credits 2-0-2-3
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	None
Scope of the course	
Course Syllabus	**Basic Concepts:** Introduction of Mechanization and Automation, Classification and Strategies of Automation, Reasons for and Arguments against Automation. Mechanical, Electrical, Hydraulic, and Pneumatic Devices and Controls. **High Volume Manufacturing or Hard Automation:** Automated Flow Lines, Types of Automatic Transfer Mechanisms, Design and Fabrication Considerations, Analysis of Automated Flow Lines. **Assembly Automation:** Assembly Systems and their Types, Manual Assembly Lines and Line Balancing, Automated Assembly Lines and their Types, Automatic Assembly Transfer Systems, Automatic Feeding and Orienting Devices:- Vibratory and Mechanical Feeders and their types, Orientation of Parts, Performance and Economics of Assembly Systems, Feasibility Study for Assembly Automation. **Design for Assembly:** Design for Manual Assembly, Design for High-Speed Automatic Assembly, Design for Robot Assembly. **Flexible Automation:** Introduction of Group Technology (GT), Steps in Implementing GT, Part Families and Machine Cell Formation, Introduction of Flexible Manufacturing Systems (FMS). **Programmable Automation:** Brief Introduction of Numerical Control (NC), Computer Numerical Control (CNC), Machining Centers, Programmable Robots, Direct Numerical Control (DNC), and Adaptive Control.
Suggested Books	1. M.P. Groover, **Automation, Production systems and Computer Integrated Manufacturing**, Prentice-Hall Inc. Englewood Cliffs 1987. (ISBN087692-618-7) 2. G. Boothroyd, **Assembly Automation and Product Design**, Marcel Dekker, New York, 1992. 3. G. Boothroyd, C. Poli, and L. E. Murch, **Automatic Assembly**, Marcel Dekker Inc. New York, 1982. 4. G. Boothroyd, P. Dewhurst, and W. Knight, **Product Design for Manufacture and Assembly** (2nd Edition), Marcel Dekker, New York, 2002.

Course Code	**ME 458 / ME 658**
Title of the course	**Laser based Measurements and Micro-Manufacturing**
Credit Structure	L-T-P-Credit 2-1-0-3
Name of the Concerned Department	Mechanical Engineering
Pre-Requisite, if any	None
Scope of the course	
Course Syllabus	**Thermal Process in laser material interaction:** Introduction to working of Laser- Absorption of laser radiation-optical properties of materials-Macroscopic transport-conductive heat transfer. Thermal effects using laser – laser heating- melting- vapor expansion and recoil pressure-Plasma formation-Hydrodynamic stability of transient melts-modelling of laser ablation and plume prorogation **Laser based micro-manufacturing:**Laser based micro-manufacturing-casting-forming/shaping-joining-micro-drilling- Laser micromachining mechanism-laser cutting of various materials- - Three dimensional machining- laser micro-machining mechanism-laser ablation-laser assisted chemical etching **Laser induced surface processing:** Laser based hardening, Laser cladding Laser ablation-Laser assisted chemical etching-laser micromachining-direct writing technique-mask projection-laser based interference processing and combined techniques. Laser shock processing, laser dressing of grinding wheels, Laser marking, laser direct writing, Laser micro-stereo lithography, and Laser tissue interaction –(Photochemical- photo disruptive interactions) **Ultra fast laser interaction and dynamics of laser based micro fabrication:** Femto-second laser interaction with metals- Femto-second laser interaction with semiconductor materials-Laser induced periodic surface structure formation(LIPSS) formation by Femto second laser-second laser- Laser processing of organic materials, Ultrafast phase explosion-nonlinear absorption and breakdown in dielectric materials-generation of highly energetic particle-vapour kinetics-Pico-second laser plasma's **Characterization and diagnosis using lasers:** In situ and Ex-situ diagnostics measurements- Surface topographical measurements using- optical Instruments-scanning optical technique-Triangulation instruments-Confocal instruments-Laser's in AFM. Surface composition and property diagnosis using, In- situ measurement techniques- Laser Induced Break down Spectroscopy (LIBS)- Shadow graphic techniques, Ex-situ measurements-Raman Spectroscopy analysis. Surface evaluation using Holographic techniques.

Suggested books	**Text books:** 1) John. C. Ion, **Laser processing of engineering materials-principal**, procedures and industrial applications, Elsevier Butterworth-Heinemann, ISBN 0750660791. 2) Narendra B.Dahotre, Sandip P.Harimkar,**Laser fabrication and maching of materials,** ISBN (978-0-387-7234-3) 3) Jacques Perriere, Eric Million, Eric Fo Garassy, **Recent advances in Laser processing of materials**, European Material research Society, Elsevier Publictaions. 4) K.Ding and L.Ye, **Laser shock peening performance and processes simulations**, Woodhead publishing in materials. 5) Richard K.Leach, **Fundamental principles of engineering nanometrology**, Elesevier publication 6) R.Hull, R.M.Osgood, J.Parisi, H. Warlimont, **The Theory of laser material processing,heat and mass transfer in modern technology**-springer series in material science.

Course Code	**ME 459 / ME 659**
Title of the Course	**Micro and Precision Manufacturing**
Credit Structure	L-T- P-Credits 2-0-2-3
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	Basic courses related to manufacturing engineering
Scope of the Course	To expose the students about the concepts of micro and precision manufacturing, the various processes involved in it and, the metrology of the micro and precision manufactured components
Course Syllabus	**Micro-manufacturing:** Introduction to micromachining, milling-machining and nanotechnology, different fabrication and other processes involved and related process parameters, application of miniaturized components. **Micro-machines:** Mesoscopic domain of micromachines - introduction, biological systems, cells as machines, role of proteins, physics of micromechanism, future prospects. **Precision manufacturing:** Introduction, concept of accuracy, tolerance and fits, influence of different factors on the maintainability of accuracy of the machine tools and the product, compensation of thermal errors and location errors, effects of vibration and tool wear, dimensioning and dimensional chains, microfinishing processes. Characterization techniques for products manufactured out of micro and precision manufacturing. **Metrology and Characterization Techniques for Micro and Precision Manufactured Products:** – Profilometric, Microscopic and diffractometric techniques. **Scales in Tribology,** micromechanical mechanisms involved, tribochemical reactions, measurement of hardness and wear resistance at micro and nano-scale.

Suggested Books	1. I. Fujimasa, **Micromachines: A New Era in Mechanical Engineering**, Oxford Science Publications, ISBN: 9780198565284. 2. J. P. Davim, M. J. Jackson, **Nano and Micromachining**, Wiley-ISTE, ISBN: 9781848211032. 3. N.P. Mahalik, **Micromanufacturing and Nanotechnology**, Springer, ISBN: 9783540253778. 4. P.C. Pandey and H.S. Shan, **Modern Machining Processes**, Tata McGraw Hill Publication, ISBN: 9780070965539. 5. V.K. Jain, **Introduction to Micromachining**, Narosa Publishing House, New Delhi, 2010. 6. Y. Qin, **Micromanufacturing Engineering and Technology**, Elsevier, 2010, ISBN-13: 978-0-8155-1545-6. 7. R. L. Murty, **Precision Engineering in Manufacturing**, New Age International Publishers, ISBN: 9788122407501. 8. C. R. Brundle, C. A. Evans, Shaun Wilson, **Encyclopedia of Materials Characterization: Surfaces, Interfaces, Thin Films, Material Characterization Series, Surfaces, Interfaces, Thin Films,** Butterworth-Heinemann, ISBN: 9780750691680.

Course Code	**ME 460/ 660**
Title of the Course	**Technology of Surface coating**
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	None
Scope of the Course	To expose students towards different surface coating techniques
Course Syllabus	Lecture Significance of surface engineered materials in modern engineering applications. Role of surface coating and surface modification technologies in obtaining required surface characteristics of a product. Substrate preparation by chemical, mechanical, electro-chemical and other routes. Structure and working principle of various coating processes: Chemical Vapour Deposition (CVD) with variants, Physical Vapour Deposition (PVD) with variants, Electro-plating processes, Electroless deposition, Thermal Spray Processes. Various process parameters controlling the yield of coating and various surface properties of the coating. Physical and mechanical characterization of coating: hardness, roughness, thickness, adhesion, phases and microstructure of different coatings. Various methods for evaluating the performance of the coating. Case study: Application of coating materials on cutting tools. Practical 1) Preparation of steel substrates by sand blasting/chemical /machining with desired roughness. (1 hr) 2) Demonstration of thermal evaporation technique. Deposition of a coating material (Al/Ni/Cu) on steel substrate by thermal evaporation technique. (2-3 hrs.)

	3) Demonstration of flash evaporation technique. (1 hr) 4) Demonstration of magnetron sputtering technique. Deposition of coating material (Al/Cu) on steel substrate by sputtering. (2-3 hrs.) 5) Demonstration of Electron beam evaporation technique. (1 hr) 6) Demonstration of Laser beam deposition. (1 hr) 7) Physical and mechanical characterisation of the deposited coating (measuring surface roughness, microhardness). (2-3 hrs)
Suggested Books	1. A. A. Tracton, **Coatings Technology: Fundamentals, Testing, and Processing Techniques**, CRC Press Inc. ISBN 13: 9781420044065. 2. A. A. Tracton, **Coatings Materials and Surface Coatings**, CRC Press ISBN 13: 9781420044041. 3. R. F. Bunshah (Ed.) **Handbook of Hard Coatings: Deposition Technologies, Properties and Applications,** ISBN 13: 9780815514381 ISBN 10: 0815514387 4. M. Cartier, **Handbook of Surface Treatment and Coatings**, 9781860583759 ISBN 10: 186058375X 5. T. Provder, J. Baghdachi (Eds.) **Smart Coatings** (Vol. 2), ISBN 13: 9780841272187 ISBN 10: 0841272182 6. Gerhard Franz, **Low Pressure Plasmas and Microstructuring Technology**, ISBN 13: 9783540858485 ISBN 10: 3540858482

Course code	**ME 462/662**
Course title	**Continuum Mechanics**
Credit Structure	L - T - P Credits (2-1-0-3)
Department	Mechanical Engineering
Prerequisite, if any	None
Objectives	• Course provides a concise overview of the fundamental concepts of deformation of a continuum body. • Also, it provides a comprehensive understanding of different measure of stress and strain.
Course Outcomes	• The course will develop the physical insight of different measures of stress and strain. • Students will be able to formulate the problems in continuum media.
Course Content	• **Mathematical Preliminaries**: Indicial notation, vector and tensor algebra, tensor analysis: derivatives of functions, fields, divergence, gradient, curl, divergence theorem, transport theorem. • **Kinematics**: Configuration of a body, displacement field, velocity field, motion, deformation gradient tensor, rotation, stretch tensor, strain tensor, strain rate tensor, spin tensor, assumption of small deformation and small strain. • **Balance laws:** Balances of mass, linear momentum and angular momentum, contact forces and concept of stress, balance of energy and Clausius-Duhem inequality. • **Constitutive relation:** Frame indifference, objective rates of stresses, material symmetry, kinematic constraints (incompressibility, etc.), thermodynamical restrictions.
Suggested Books	**Text books** 1. M. E. Gurtin , ***An Introduction to Continuum Mechanics***, Academic Press Inc., 1982, ISBN: 9780123097507. 2. C. S. Jog, ***Continuum Mechanics***, Cambridge, 2015, ISBN: 9781108437141. 3. P. Chadwick, ***Continuum Mechanics***, Dover Publications Inc., 1998, ISBN: 9780486401805. **Reference book** 4. J. M. Spencer, ***Continuum Mechanics***, Dover Publications Inc., 2004, ISBN: 9780486435947. 5. Allan F. Bower, ***Applied Mechanics of Solids***, CRC Press, 2009, ISBN: 9781439802472.

Course code	**ME 464/ ME 764**
Title of the course	**Microrobotics**
Credit Structure	L - T - P - Credits 2-1-0-3
Name of the Concerned Department	Mechanical Engineering
Pre-requisite, if any	NA
Scope of the course	The main objective of the course is to focus on the fundamentals of the physical laws that predominate at the micro scale for fabricating small device and bio-inspired microrobots
Course Syllabus	Scaling laws for designing macro, micro and nano systems: scaling laws in fluids, electo-magnetism, thermodynamics, optics and quantum effect. Micro-mechanics, design and selection of materials for micro- robotics systems, control for surface walkers. Introduction to different micro-fabrication techniques. Micro actuators and micro sensors: micro force sensors and tactile sensors, Magnetic actuation, electrostatic actuation, piezo electric actuation, shape memory alloy and conducting polymer based actuation, stick slip, comb drive actuator, micro-pumps, micro engines, magnetic helical micro machines, haptic interface and sensory skin for robotic systems Micro-manipulation: Mechanics of micro-manipulation, Atomic force microscope as micro/Nano robot, micro manipulation in particle assembly, 3D micro/Nano fiber pulling, integrated nano tool carrier, micro-assembly, micro air vehicles (MAVS) and multi robot systems. Bio- inspired micro-mechanics: Microscale propulsion, locomotion in liquids, modeling of propulsion systems, micro mechanical flying insect, Gecko inspired climbing robots, bio-inspired fibrillar adhesive, lizard inspired water runner robot, water strider inspired water walker robot, Magnetic swimming micro-robot for bio-medical application, medical micro-robots for endoscopy and other applications.
Suggested Books	1. N. Chaillet, S. Regnier, **Microrobotics for Micromanipulation**, Wiley, IST, 2010, ISBN 978-1-84821-186-5 2. Y. Bellouard, **Microrobotics, methods and applications**, CRC Press, 2009, ISBN 9781420061956 3. Fatikow, Sergej, Rembold, Ulrich, **Microsystem technology and microrobotics,** Spirnger publication, 2000, ISBN 978-3-662-03450-7 4. Ananthasuresh, **Micro and Smart Systems: Technology and**

	Modelling, Wiley, 2012, India, ISBN:9780470919392

Course code	**ME 466/666**
Course title	**Theory of Plasticity**
Credit Structure	L - T - P Credits (2-1-0-3)
Department	Mechanical Engineering
Prerequisite, if any	Solid Mechanics
Objectives	• Course provides a concise overview of the fundamental concepts of plastic deformation in continuum scale. • Students will be equipped to solve complex engineering problems by applying fundamental and advanced principles of plasticity theory.
Course Outcomes	• Students will be able to formulate problems accounting for plastic deformation in continuum scale. • Students will be able to implement plasticity models in numerical framework.
Course Content	• **Introduction**: Introduction to Continuum Mechanics, physical basis of plasticity, uniaxial tensile test, necking, experimentally observed features of plasticity, plasticity and viscoplasticity via network models. • **1D plasticity**: yield criterion, flow rule, plastic multiplier, Kuhn-Tucker conditions, consistency, hardening. elasto-plastic tangent moduli, Integration of 1D plasticity models, return mapping for 1D. • **3D plasticity**: yield criteria, yield surfaces in the Haigh-Westergaard space, flow rules, plastic and viscoplastic potentials, dissipation, normality and convexity properties, consistency condition, isotropic and kinematic hardening, principle of maximum plastic dissipation and its consequences, Drucker's postulates, uniqueness theorems and variational principles, limit analysis. • **Computational plasticity**: Integration algorithms for rate dependent and rate independent plasticity models. • **Boundary value problems**: tension and torsion of thin-walled tubes, torsion of a rod, pressurized thick cylindrical and spherical shells. • **Application of plasticity**: damage mechanics, shear localization, forming, creep, fatigue and crystal plasticity.
Suggested Books	**Textbooks** 6. L. M. Kachanov, ***Fundamentals of the theory of plasticity***, Dover Publications Inc., 2004, ISBN: 9780486435831. 7. J. Lubliner, ***Plasticty Theory***, Dover Publications Inc., 2008, ISBN: 9780486462905. 8. J. Chakrabarty, ***Theory of Plasticity***, Butterworth-Heinemann

	Ltd, 2006, ISBN: 9780750666381. 9. Simu and Huges, ***Computational Inelasticity***, Springer New York, NY, 2006, ISBN: 9780387975207. **Reference book** 1. P. M. Dixit and U. S. Dixit, ***Plasticity: Fundamentals and applications***, CRC Press, 2018, ISBN: 9781138074965. 2. D. Bigoni, ***Nonlinear Solid Mechanics: Bifurcation Theory and Material Instability***, Cambridge University Press, 2012, ISBN: 9781107025417.

Course code	**ME 468/ ME 668**
Title of the course	Propulsion System
Course Category	Elective
Credit Structure	L - T - P – Credits 2-1-0-3
Name of the Concerned Department	Mechanical Engineering
Pre-requisite, if any	Thermodynamics and Fluid Mechanics
Scope of the course (Objectives)	• List and explain the characteristics and performance of aerospace propulsion systems. • Model newly conceived rocket or air breathing propulsion systems and estimate their performance and behavior. • Carry out preliminary designs of rocket and air breathing propulsion systems to meet specified requirements.
Course Outcomes	• Identify the source of mass and source of energy for different aerospace propulsion systems. • Explain the choice of rocket based on requirements • Estimate the specific impulse and mass flow for a rocket engine accounting • Explain the different performance metrics, and the corresponding performance limits, for gas turbine aeroengines and link these to the design features.
Course Content	• **Unified view of aerospace propulsion systems**: classification, fundamentals, thrust, efficiencies, rocket propulsion and types, review of thermodynamics and compressible flows. • **Solid rockets:** Gas generators, stability, grain design. • **Liquid rockets:** Pressurization cycles, turbomachinery. • **Aircraft propulsion:** Mission requirements, design for passenger aircraft, structure of the atmosphere, endurance and range, thrust. • **Gas turbine thermodynamic modeling**: Thermodynamics, propulsive, thermal, overall efficiencies, isentropic efficiency for components, gas turbine cycles and thermodynamic analysis. • **Engine configurations:** Turbojet and turbofan. turbofan bypass ratio. • **Dimensional analysis** of propulsion system components • **Environmental aspects**: Emissions and Sustainability
Suggested Books	Textbooks: 1. Sutton, G. P., and O. Biblarz. **Rocket Propulsion Elements**. 9th ed. Wiley Interscience, 2017. ISBN: 978-1118753651. 2. Kerrebrock, J. L. **Aircraft Engines and Gas Turbines**. 2nd ed. MIT Press, 1992. ISBN: 9780262111621. Reference books: 3. Kroes Michael J; Wild Thomas W; **Aircraft Powerplants**;

	2010(7 Ed), Tata McGraw-Hill. ISBN: 978-0070701267

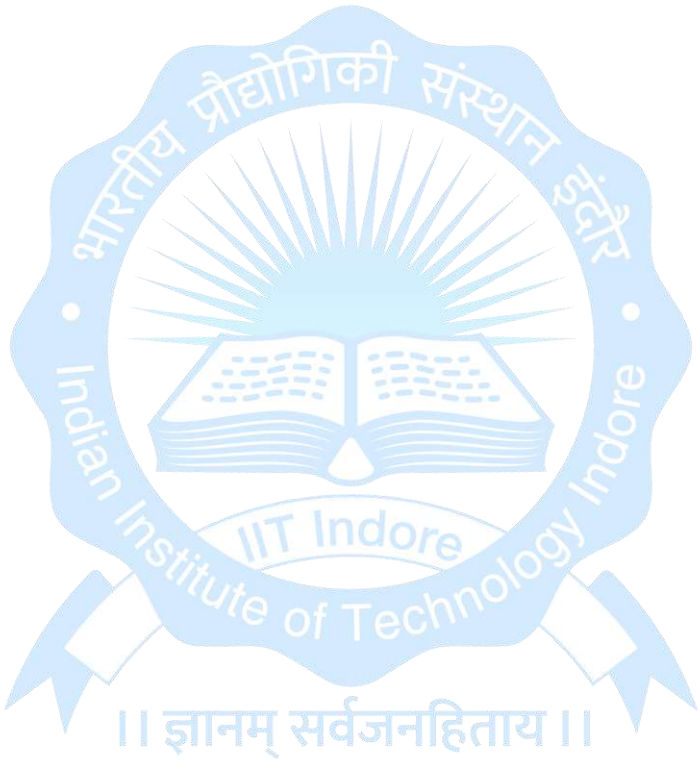
Course code	**ME 470/ ME 670**
Title of the course	**Machine Component Design**
Course Category	Elective
Credit Structure	L - T - P – Credits 2-1-0-3
Name of the Concerned Department	Mechanical Engineering
Pre-requisite, if any	None
Scope of the course (Objectives)	• Apply machine design knowledge to the analysis of common automobile machine components. • Understand the design process/methods of machine components.
Course Outcomes	• Design-process of automobile machine components. • Stress analysis of machine components.
Course Content	• Introduction: Theories of failure for even and uneven materials, Fatigue. • Advanced loadings: Pressure loadings – thin and thick cylinders, and press fits. Contact loading – spheres and cylinders in contact. • Lubrication, Bearings and Surface Damage: Lubricants and lubrication. Design of fluid film bearings and rolling contact bearings. Cathodic protection of automotive components, corrosion control and wear, and surface fatigue failures. • Axle and Disk Brakes: Design of axles of under torsion/bending. Design of disc brakes. • Springs: Design of helical and leaf springs of vehicles.
Suggested Books	**Textbooks:** 1. R. C. Juvinall, K. M. Marshek, **Fundamentals of Machine Component Design**, John Wiley and Sons, Inc, 2011. ISBN: 978-1118012895 (5th edition) 2. V. Bhandari, **Design of Machine Elements** (4th edition), Tata McGraw Hill, 2017. ISBN: 978-9339221126. 3. M.F Spotts, Terry E. Shoup, L. E. Hornberge, **Design of Machine Elements, (8th Edition)**, Prentice Hall, India, 2019, ISBN: 978-9353433130. **Reference Books:** 4. R. G. Budynas, J. K. Nisbett, K. Tangchaichit, **Shigley's Mechanical Engineering Design** (11th edition), Tata McGraw Hill, 2020. ISBN: 978-9390219636. 5. T. Brown, **Mark's Calculations for Machine Design**, Tata McGraw Hill, 2005. ISBN: 978-0071436892.

Course Code	**ME 471/ ME 671**
Title of the Course	**Operations Research**
Credit Structure	L-T-P-Credits 2-0-2-3
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	None
Scope of the course	
Course Syllabus	**Introduction:** Origin and development of operations research, general methodology of OR, applications of OR to industrial problems. **Linear Programming Problems:** Different types of models, formulation of linear programming problems (LPPs), product-mix problems, deterministic models, graphical solution. **Simplex Method:** Simplex algorithm, computational procedure in simplex method, applications of simplex technique to industrial problems. **Duality and Sensitivity:** Duality and its concept, dual linear programming, application of elementary sensitivity analysis. **Linear Optimization Techniques:** Integer programming problems (IPPs), assignment models: mathematical formulation, methods of solutions, transportation problems: methods of obtaining optimal solution degeneracy in transportation problems, transshipment problems. **Game Problems:** Introduction and scope of game problems in business and industry, min-max criterion and optimal strategy, solution of two-person zero-sum game, game problem as a special case of linear programming. **Queuing Problems:** Queuing systems and concepts, classification of queuing situations; Kendall's notation, solution of queuing problems, single channel, single stage, finite and infinite queues with Poisson arrival and exponential service time, applications to industrial problems.
Suggested Books	1. H.A. Taha, **An Introduction to Operations Research** (6th edition), Prentice Hall of India, 2001. 2. F.J. Hillier, G.J. Lieberman, **Introduction to Operations Research** (7th edition), Holden Day Inc., 2001. 3. H.M. Wagner, **Principles of Operations Research**, Prentice

	Hall of India, 1980. 4. D. Gross, and C.M. Harris, **Fundamentals of Queuing Theory** (2nd edition), John Wiely & sons, NY, 1985.

Course Code	**ME 472/ ME 672**
Title of the Course	**Reliability Engineering**
Credit Structure	L-T- P-Credits 2-0-2-3
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	
Scope of the course	To introduce the various concepts of reliability, its assessment, and its applicability to different products and processes. Also, to introduce the concepts of availability and maintainability.
Course Syllabus	**Fundamentals of reliability:** Scope of reliability engineering, concept of bath tub curve, types of failure data, reliability estimations, constant failure rate models, time dependent failure rate models, concept of failure on demand. **System reliability assessment:** Reliability estimation of series/parallel/mixed/complex system configurations. **Design for reliability:** Capturing user's reliability requirements, reliability and/or redundancy allocation/optimization, design methods, FMEA/FMECA, reliability testing (burn-in testing, reliability assurance testing, reliability growth testing, accelerated life testing), fault tree analysis. **Availability assessment:** Point, mission and steady state availability, Markov modeling approach for availability estimation. **Maintainability and maintenance:** Maintainability assessment, and design for maintainability, concept of maintenance, types of maintenance, maintenance optimization. **Warranty management:** Types of warranty, reliability and warranty. **Practical applications of reliability engineering to systems, products and processes:** Case studies
Suggested Books	1. Charles Ebeling, **An Introduction to Reliability and Maintainability Engineering,** Waveland Pr Inc; 2 Har/Cdr edition, 2009. 2. Igor Bazovsky, **Reliability Theory and Practice,** Dover Publications (October, 2004). 3. Patrick O'Connor, **Practical Reliability Engineering**, John Wiley & Sons Inc. 2002. 4. Gregg K. Hobbs, **Accelerated Reliability Engineering: HALT and HASS,** Wiley, 2000.

	Suggested web page: www.weibull.com



Course Code	**ME 473**
Title of the Course	**Engineering Optimization**
Credit Structure	L-T-P-Credits 2-0-2-3
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	None
Scope of the course	
Course Syllabus	**Introduction:** Need for optimization and historical development, classification and formulation of optimization problem, classical optimization methods, differential calculus, Lagrangian theory, **Unconstrained Optimization Techniques:** one-variable optimization techniques -Bracketing methods, Region-elimination methods, Point-estimation method, Gradient based methods. Multi-variable optimization: Unidirectional search, Direct search methods, Gradient-based methods. **Constrained Optimization Techniques:** Kuhn-Tucker (KT) conditions, Transformation methods - Methods of multipliers and Penalty function method, Direct search methods for Constrained optimization, Linearized search techniques, Sensitivity analysis, Feasible direction method, Gradient project method, Generalized reduced gradient method. **Special Optimization Methods:** Integer programming and geometric programming. **Examples and applications** of the above methods in the recent engineering design problems.
Suggested Books	1. K. Deb, **"Optimization for Engineering Design: Algorithms and Examples",** Prentice Hall of India, New Delhi, 1995. 2. S.S. Rao, **Optimization - Theory and Applications**, Wiley Eastern Ltd, 1978. 3. J.S. Arora, **Introduction to Optimum Design**, McGraw- Hill Book Co, 1989. 4. R.L. Fox, **Optimization Methods for Engineering Design**, Addison Wesley, 1971.

Course Code	**ME 474**
Title of the Course	**Non-traditional optimization techniques**
Credit Structure	L-T- P-Credits 2-0-2-3
Name of the Concerned Department	Mechanical Engineering
Pre–requisite, if any	Operations research/Engineering optimization
Scope of the course	To introduce various non-traditional optimization techniques and its applicability to real world engineering problems.
Course Syllabus	**Introduction:** Traditional vs non-traditional optimization, need for non-traditional optimization techniques, evolution of non-traditional optimization techniques in engineering. **Introduction to some non-traditional optimization algorithms:** Genetic Algorithms, Simulated Annealing, Particle Swarm Optimization, Tabu Search, Ant-Colony Algorithms, Bee-colony algorithms, Artificial Neural Network (ANN) based Optimization. **Applications of non-traditional optimization techniques for solving real-world complex industrial problems**
Suggested Books	1. Kalyanmoy Deb, **Optimization for Engineering Design: Algorithms and Examples**, PHI, New Delhi, 2005 2. Goldberg, D.E., Genetic **Algorithms in Search, Optimization, and Machine, Learning**, Addision-Wesley, 1989. 3. Kalyanmoy Deb, **Multi-Objective Optimization using Evolutionary Algorithms,** John-Wiley & Sons, Ltd. Chichester, 2001. 4. Fred Glover, Gary A. Kochenberger **Handbook of metaheuristics**, Springer, 2003 5. Teofilo F. Gonzalez, **Handbook of Approximation Algorithms and Metaheuristics**, Chapman & Hall/CRC Computer and Information Science Series,Taylor & Francis Group, 1 edition (May 15, 2007)

Course Code	**ME 479/ ME 679**
Title of the Course	**Additive Manufacturing**
Credit Structure	L-T- P-Credits (2-0-2-3)
Name of the Dept.	Mechanical Engineering
Pre–requisite, if any	Basic knowledge of different manufacturing processes
Scope of the course	To impart knowledge about philosophy of additive manufacturing (AM) which is one of the most important enablers of Industry 4.0 and evolution of different types of AM processes, state-of-art research in their field, capabilities, limitations, applications.
Course Syllabus	**1. Introduction:** Philosophy of additive manufacturing (AM) and its role in Industry 4.0; its advantages over subtractive, deformative and formative manufacturing processes; Evolution of different AM processes; classification of different AM processes (i.e. direct energy deposition (DED) or diffusion based processes, energy-beam based processes, arc-based processes, plasma-based processes, solid-state processes) and their comparative study; Different forms of deposition materials and their comparative study; Concept of track, layers, dilution, aspect ratio, different efficiencies in AM; Major application areas of AM processes including rapid prototyping (RP), rapid tooling (RT), rapid manufacturing (RM). **2. Energy-beam based AM Processes:** Laser-beam based AM processes i.e. **s**elective laser sintering (SLS), direct metal laser sintering (DMLS), direct metal deposition (DMD), laser engineered net shaping (LENS), direct laser forming/fabrication (DLF), laser rapid manufacturing (LRM), laser metal wire deposition (LMWD); Electron-beam based AM processes. **3. Arc-based AM processes:** AM processes using arc for deposition: manual metal arc (MMA) based, gas metal arc (GMA) based, gas tungsten arc (GTA) based, metal active gas (MAG) based, hybrid layered manufacturing (HLM) **4. Transferred arc-based AM Processes:** Processes using arc for plasma formation: Plasma transferred arc (PTA) based, micro-plasma transferred arc (μ-PTA) based, plasma wire deposition (PWD), 3D micro-deposition (3DMD) **5. Solid state AM Processes:** AM processes in which deposition material is not melted: Rotary friction-based deposition (RFD), Linear friction-based (LFD), Friction deposition (FD), Friction surfacing (FS), Friction assisted seam deposition (FASD), Friction stir based deposition (FSD). **6. Advanced Topics:** Issues of dimensional and geometrical accuracy, surface finish, inter-layer bonding, microstructure, scaling of production, productivity, energy consumption, modeling, parametric optimization, and sustainability in AM. **Practical classes** will be conducted for AM processes based on

	laser beam, micro-plasma transferred arc, and some AM processes based on arc.
Suggested Books	1. C.K. Chua, and K.F. Leong, **3D Printing and Additive Manufacturing: Principles and Applications**, World Scientific Publishing Co. Pvt. Ltd. Singapore, 2017 (ISBN: 978-9-8131-4675-4) 2. R. Noorani, **3D Printing: Technology, Applications, and Selection,** CRC Press, Boca Raton, 2017 (ISBN: 978-1-4987-8375-0) 3. T.S. Srivatsan, T.S. Sudarshan (Editors) **Additive Manufacturing: Innovations, Advances, and Applications** (1st Edition), CRC Press, Boca Raton, 2015 (ISBN: 978-1-4987-1477-8) 4. I. Gibson, D.W. Rosen, B. Stucker, **Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing** (2nd edition), Springer-Verlag, New York, 2015 (ISBN 978-1-4939-2112-6)

Course code	**ME 480 / ME 680**
Title of the course	**Laser Material Processing and systems**
Course Category	Core / Departmental Elective
Credit Structure	L - T - P - Credits 2-0-2-3
Name of the Concerned Department	Department of Mechanical Engineering
Pre-requisite, if any	Nil
Scope of the course (Objectives)	The objective of this course is to understand the fundamentals of the laser application in manufacturing, involved physics, design functions and parametric constrains.
Course Outcomes	Engineering Knowledge: The fundamental of laser material processing and involved physics. The role of laser and delivery systems to execute the different modalities of manufacturing. Design of application-oriented laser systems and parametric control.
Course Content	**Lasers based Manufacturing:** **Laser matter interaction;** Fundamentals of Lasers; Laser Beam Characteristics; Reflection or Absorption: Effect of Wavelength, Temperature, Surface Films, Angle of Incidence, Materials and Surface Roughness. **Laser Cutting, Drilling and Piercing:** Introduction; Drilling Process Variations; Percussion and Single- or Double-shot Drilling; Trepanning, Helical Trepanning; Applications of Laser Drilling; Methods of Cutting - Vaporization Cutting/Drilling, Fusion Cutting – Melt and Blow, Reactive Fusion Cutting; Controlled Fracture; Scribing; Cold Cutting; Laser-assisted Oxygen Cutting – LASOX Process **Laser Welding:** Introduction; Process Arrangement; Process Mechanisms – conduction, Keyholes and Plasmas; Operating Characteristics – Power, Spot Size and Mode, Wavelength, Speed, Focal Position, Joint Geometries, Gas Shroud and Gas Pressure; Arc- augmented Laser Welding,. **Laser Surface Treatment:** Introduction; Laser Heat Treatment; Laser Surface Melting - Solidification Mechanisms; Surface Texturing; Laser Surface Alloying and Cladding; Particle Injection;

	Laser-assisted Cold Spray Process; Laser shock peening: physics, process and applications; Laser forming physics, process and applications; Laser based additive manufacturing, laser safety; **Laser systems for manufacturing**: Principles and working of CO_2 , Nd:YAG, fibre, Excimer, diode lasers; Optical Components - Lens Doublets, Collimators, Metal Optics; Graded-index Lenses; Laser Scanning Systems; Fiber Delivery Systems. ; Laser Machining; Arc-augmented Laser Cutting; System design for various modalities of the laser cutting and parametric control. Twin-beam Laser Welding, Walking and Spinning Beams; Laser Welding of Plastics; Various architecture designs for the laser welding systems. Laser based Additive Design of application-oriented laser systems and parametric control.
Suggested Books	**Textbooks** 1. William M. Steen, Jyotirmoy Mazumder, Laser Material Processing, Springer London, London, 2010, ISBN 978-1-84996-062-5 2. Peter Schaaf, Laser Processing of Materials Fundamentals, applications and Developments, Springer Berlin, Heidelberg, 2010, ISBN 978-3-642-13281-0 **Reference book and publications** 3. Narendra B. Dahotre, Sandip P. Harimkar, Laser Fabrication and Machining of Materials, Springer New York, NY, 2008, ISBN 978-1-4899-7371-9 4. Jyotsna Dutta Majumdar, Indranil Manna, Laser-Assisted Fabrication of Materials, Springer Berlin, Heidelberg, 2013, ISBN 978-3-642-28358-1

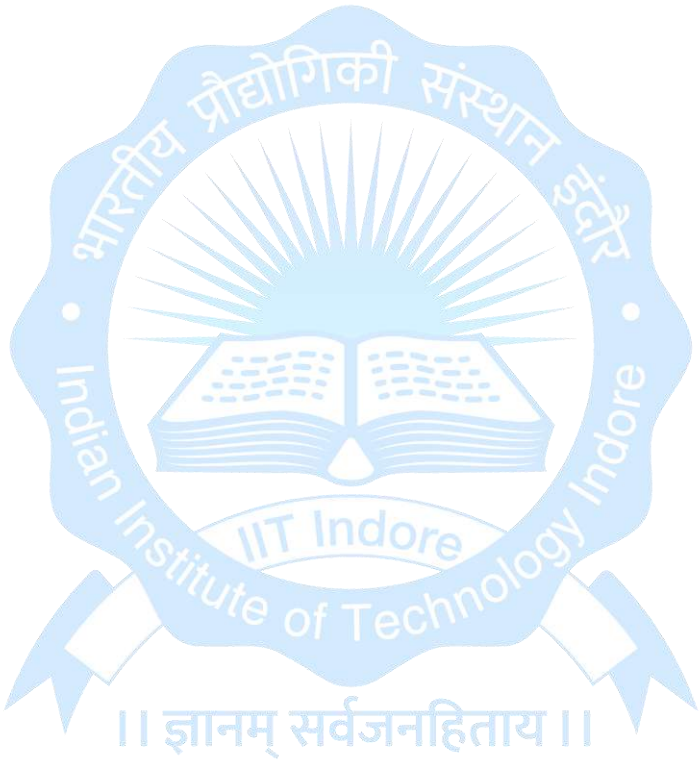
Course code	**ME 482/682**
Title of course	**Heat and Mass Transfer in Textiles**
Course Category	Elective
Credit Structure	L - T - P – Credits 2-1-0-3
Department	Mechanical Engineering
Prerequisite	Heat Transfer
Scope of the course (Objectives)	• Understand heat and moisture transfer in technical textiles and their impact on performance. • Apply these principles to improve design, manufacturing and sustainability of advanced textile systems.
Course Outcomes	● Analyze heat and moisture transport in textile materials. ● Apply modeling techniques to optimize drying and finishing processes.
	● **Heat Transfer**: Diffusion and capillarity in fibrous media; Influence of fiber structure, porosity and material properties on thermal behavior; Thermal conductivity, resistance and conduction models; Effects of layering, compression, contact resistance and air gaps. ● **Moisture and mass transfer**: Moisture diffusion, wicking, sorption–desorption and vapor transmission in multi-layer textile systems; Influence of material structure and environment on mass transfer. ● **Coupled heat and moisture transfer modeling**: Governing equations and numerical modeling (FDM/FVM); Thermal comfort and simulation in protective and smart textiles. ● **Radiation heat transfer:** Microwave and hybrid drying methods; Modeling of radiation–convection interactions in textile heating processes. ● **Applications and testing**: Thermal management in fire-resistant, cold-weather and PCM-based textiles; Testing methods: guarded hot plate, sweating hotplate, MVTR, IR thermography; ASTM/ISO standards; Applications in apparel, medical, geotextiles and automotive textiles.
Suggested Books	**Text Books** 1. A.K. Haghi, **Heat & Mass Transfer in Textiles** (2nd edition), WSEAS Press. 2011. ISBN: 9781618040251 2. N. Pan, P. Gibson, **Thermal and Moisture Transport in Fibrous Materials** (1st edition), Woodhead Publishing, 2006. ISBN: 9781845690571. 3. F.P. Incropera, D.P. DeWitt, T.L. Bergman, A.S. Lavine,

	Fundamentals of Heat and Mass Transfer (6th edition), John Wiley & Sons, 2018. ISBN: 9788126578245 **Reference Books** 4. Y.A. Çengel, **Heat Transfer: A Practical Approach** (6th edition), McGraw-Hill, 2020. ISBN: 9780070115057. 5. D.A. Nield & A. Bejan, **Convection in Porous Media** (5th edition), Springer International Publishing AG, 2017. ISBN: 9783319495613.

Course code	**ME 484/ 684**
Title of course	**Transport Phenomena in Porous Textiles**
Course Category	Elective
Credit Structure	L - T - P – Credits 2-1-0-3
Department	Mechanical Engineering
Prerequisite	Heat Transfer
Scope of the course (Objectives)	• Understand heat, moisture and fluid transport in porous textiles and their application relevance. • Apply this knowledge to optimize processes like drying, dyeing and filtration for sustainable, high-performance textiles.
Course Outcomes	● Analyze and model heat and moisture transport in textiles. ● Design solutions for sustainable and advanced textile applications.
	● **Fluid flow in porous textiles**: Fundamentals of fluid flow in textiles including Darcy's law, continuity, momentum and energy equations; Non-Darcian flow and permeability linked to pore structure; Mechanisms of single and multiphase flow; Applications in dyeing, filtration and finishing. ● **Characterization technique**: Measurement of permeability, capillary rise and fluid retention; Experimental flow visualization and thermal imaging. ● **Modeling and simulation**: Analytical, empirical and CFD models for fluid flow in porous textiles; Integration with textile deformation and moisture transfer models; Applications in drying optimization and filtration design. ● **Applications in technical and biomedical textiles**: Use in filtration, moisture management, wound dressings and fluid-sensing smart textiles; Design implications for performance and comfort. ● **Industrial relevance and innovations**: Design of porous textiles with tailored pore structures; Eco-friendly and nanofiber-based materials for sustainable textile systems; Case studies on fluid flow behavior in industrial processes.
Suggested Books	**Text Books** 1. A.F. Turbak, **Nonwovens: Theory, Process, Performance and Testing**. Technical Association of the Pulp and Paper Industries (TAPPI) Press, Georgia, USA, 1993. ISBN: 9780898524558. 2. D.B. Ingham, I. Pop, **Transport Phenomena in Porous Media** (1st edition), Pergamon, United Kingdom, 1998. ISBN: 9780080428439. **Reference Books** 1. Y.A. Çengel, J.M Cimbala, **Fluid Mechanics: Fundamentals and Applications** (4th edition). McGraw-Hill Education, New York,

	2018. ISBN: 9781259696534. 2. F.M. White, J. Majdalani, **Viscous Fluid Flow** (4th edition), McGraw-Hill Education, New York, 2021. ISBN: 9781260597806 3. N.T. Akankwasa, D. Veit, **Advances in Modeling and Simulation in Textile Engineering: New Concepts, Methods and Applications**, The Textile Institute Book Series, Woodhead Publishing, Cambridge UK, 2021. ISBN: 9780128229774.

Course code	**ME 486/686**
Title of the course	**Technical Textiles for Ballistic Protection**
Course Category	**Elective**
Credit Structure	L - T - P – Credits 2-1-0-3
Department	Mechanical Engineering
Pre-requisite, if any	None
Scope of the course (Objectives)	● Understand the response of soft materials to ballistic impact and requirement of ballistic fibres. ● Familiarize with experimental evaluation for ballistic materials. ● Understand the working mechanism of body armour.
Course Outcomes	● Design of ballistic armour. ● Numerical analysis of impact and influence of fiber properties on ballistic resistance.
Course Content	● Response of soft materials (Yarn and Fabric) to ballistic impact. Requirements of ballistic fibres and ballistic fabrics. ● Experimental evaluation for ballistic materials: Photographic and monitoring techniques, penetration approaches, and non-penetration approaches. ● Penetration Mechanics of textile structures: Numerical analysis of impact on woven panels, and Influence of fiber properties on ballistic resistance. ● Fabric Structures used for body armour, working mechanism of body armour. ● Design and manufacture of ballistic body armour.
Suggested Books (Text Books, Reference Books)	**Text Books:** 1. R.C. Laible, **Ballistic Materials and Penetration Mechanics**, Elsevier, 1980. ISBN: 9780444601643. 2. R.A. Scott, **Textiles for Protection**, Woodhead Publishing, 2005. ISBN: 9781855739215. **Reference Books:** 1. A. R. Horrocks, S. C. Anand, **Handbook of Technical Textiles Volume 2: Technical Textiles Applications** (2nd edition), Woodhead Publishing, 2016. ISBN: 9781782424659. 2. R. Kinslow, **High-Velocity Impact Phenomena**, Academic Press, 1970. ISBN: 978-0-12-408950-1.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