B.E. – MECHANICAL ENGINEERING

ACADEMIC CURRICULUM & SYLLABUS

(REGULATIONS 2019)

CHOICE BASED CREDIT SYSTEM

(Applicable to the students admitted from the Academic Year 2019-20 onwards)

EASWARI ENGINEERING COLLEGE
(Autonomous Institution)
Bharathi Salai, Ramapuram, Chennai - 600 089

[A Unit of SRM Group of Educational Institutions, Approved by AICTE | Affiliated to Anna University, Chennai | NAAC Accredited 'A' Grade | 2(f) & 12(B) Status (UGC) | ISO 9001:2015 Certified | NBA Accredited Programmes | FIST Funded (DST) | SIRO Certified (DSIR)]

CONTENTS

I SEMESTER								
S. No	Course Code	Course Title	Category	Hours / Week				Credits
				L	T	P	R	
Theory								
1	191LEH101T	Technical English	HS	3	-	-	-	3
2	191MAB101T	Engineering Mathematics - I	BS	3	2	-	-	4
3	191PYB101T	Engineering Physics	BS	3	-	-	-	3
4	191CYB101T	Engineering Chemistry	BS	3	-	-	-	3
5	191GES101T	Engineering Graphics	ES	2	-	4	-	4
6	191GES102T	Problem Solving through Python Programming	ES	3	-	-	-	3
Laboratory								
7	191GEB111L	Physics and Chemistry Laboratory	BS	-	-	4	-	2
8	191GES111L	Python Programming Laboratory	ES	-	-	3	1	2
Mandatory Course								
9	191GEM101L	Induction Training[&]	MC	-	-	2	-	1[&]
Total Credits				**17**	**2**	**13**	**1**	**24**

[&] Mandatory to attend Induction training programme and earn one credit.

II SEMESTER								
S. No	Course Code	Course Title	Category	Hours / Week				Credits
				L	T	P	R	
Theory								
1	191LEH201T	Professional Communication/ BEC Certification	HS	3	-	-	-	3
2	191MAB201T	Engineering Mathematics - II	BS	3	2	-	-	4
3	191PYB203T	Material Science	BS	3	-	-	-	3
4	191GES201T	Basic Electrical and Electronics Engineering	ES	3	-	-	-	3
5	191GES202T	Engineering Mechanics	ES	3	2	-	-	4
Laboratory								
6	191GES211L	Engineering Practices Laboratory	ES	-	-	4	-	2
7	191GES212L	Basic Electrical and Electronics Engineering Lab	ES	-	-	3	1	2
Mandatory Course								
8	191CYM201T	Environmental Science [&&]	MC	3	-	-	-	3 [&&]
9	191GEM211L	NSS / NCC / YRC - Phase - I *	MC	-	-	2	-	1 *
Total Credits				**18**	**4**	**9**	**1**	**21**

[&&] Mandatory to register for the course and earn three credits

[*] The student may opt for any one. They have to complete the respective Phase II and Phase III. Those who are not opting NSS/NCC/YRC have to opt for Foreign language / Indian constitution in the sixth semester.

III SEMESTER								
S. No	Course Code	Course Title	Category	Hours / Week				Credits
				L	T	P	R	
THEORY								
1.	191MAB301T	Transforms and Partial Differential Equations	BS	3	2	0	-	4
2.	191MEC301T	Manufacturing Technology –I	PC	3	0	0	-	3
3.	191MEC302T	Fluid Mechanics and Machinery	PC	3	0	0	-	3
4.	191MEC303T	Engineering Thermodynamics	PC	3	2	0	-	4
5.	191EES321T	Electrical Drives and Control	ES	3	0	0	-	3
LABORATORY								
6.	191CES331L	Strength of Materials and Fluid Mechanics Laboratory	ES	0	0	3	1	2
7.	191MEC311L	Manufacturing Technology Laboratory –I	PC	0	0	2	0	1
8.	191EES331L	Electrical Engineering Laboratory	ES	0	0	2	0	1
HUMAN EXCELLENCE COURSE								
9.	191GEH311L	Yoga / Social Service (Phase I) **	HS	-	-	2	-	1
TOTAL CREDITS								**22**
EMPLOYABILITY ENHANCEMENT COURSE								
10.	191MEAA311I	Inplant Training / Internship[#]	EEC	-	-	-	-	1[#]
11.	191MEA301I	Industry Supported Course (Optional) [##]	EEC	1	-	-	-	1[##]
ONLINE COURSE								
12.		Online Course (Optional)[$]	PE	-	-	-	-	3[$]

** Student may opt for any one. They have to complete the respective Phase II in semester V.

[#] Mandatory to do Internship and earn minimum one credit between 3rd and 6th semester.

[##] Students may earn credits in lieu of Professional elective - V in 8th semester. Please refer Clause 26.1.1 of B.E. Regulations 2019.

[$] Online courses of three credits each can be considered in lieu of Professional Elective – IV and Professional Elective – VI. A student earned only three credits can drop only Professional Elective – VI. Please refer Clause 14.9 of B.E. Regulations 2019.

IV SEMESTER								
S. No	Course Code	Course Title	Category	Hours / Week				Credits
				L	T	P	R	
THEORY								
1	191MAB401T	Statistics and Numerical Methods	BS	3	2	0	-	4
2	191MEC401T	Manufacturing Technology – II	PC	3	0	0	-	3
3	191MEC402T	Strength of Materials	PC	3	0	0	-	3
4	191MEC403T	Thermal Engineering	PC	3	0	0	-	3
5	191MEC404T	Mechanical Measurements and Metrology	PC	3	0	0	-	3
LABORATORY								
6	191MEC411L	CAD/CAM Laboratory	PC	0	0	3	1	2
7	191MEC412L	Manufacturing Technology Laboratory –II	PC	0	0	2	0	1
8	191MEC413L	Mechanical Measurements and Metrology Laboratory	PC	0	0	2	0	1
TOTAL CREDITS								**20**
MANDATORY COURSE								
9	191GEM411L	NSS / NCC / YRC * - Phase – II	MC	-	-	2	-	1*
EMPLOYABILITY ENHANCEMENT COURSE								
10	191MEA411I	Inplant Training / Internship#	EEC	-	-	-	-	1#
11	191MEA401I	Industry Supported Course (Optional) ##	EEC	1	-	-	-	1##
ONLINE COURSE								
12		Online Course (Optional) $	PE	-	-	-	-	3$

* Students have to complete the respective phase II.

\# Mandatory to do Internship and earn minimum one credit between 3rd and 6th semester.

\## Students may earn credits in lieu of Professional elective – V in 8th semester. Please refer Clause 26.1.1 of B.E. Regulations 2019.

$ Online courses of three credits each can be considered in lieu of Professional Elective – IV and Professional Elective – VI. A student earned only three credits can drop only Professional Elective – VI. Please refer Clause 14.9 of B.E. Regulations 2019.

SEMESTER V								
S. No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**R**	**C**
THEORY								
1.	191MEC501T	Engineering Materials and Metallurgy	PC	3	0	0	-	3
2.	191MEC502T	Mechanics of Machines	PC	3	2	0	-	4
3.	191MEC503T	Heat and Mass Transfer	PC	3	0	0	-	3
4.		Professional Elective – I	PE	3	0	0		3
5.		Open Elective – I	OE	3	0	0	-	3
LABORATORY								
6.	191MEC511L	Mechanics of Machines Laboratory	PC	0	0	3	1	2
7.	191MEC512L	Thermal Engineering Laboratory	PC	0	0	4	-	2
HUMAN EXCELLENCE COURSE								
8.	191GEH511L	Yoga / Social Service – Phase - II**	HS	-	-	2	-	1
TOTAL CREDITS								**21**
EMPLOYABILITY ENHANCEMENT COURSE								
9.	191MEA511I	Inplant Training / Internship#	EEC	-	-	-	-	1#
10.	191MEA501I	Industry Supported Course (Optional) ##	EEC	1	-	-	-	1##
ONLINE COURSE								
11.		Online Course (Optional) $	PE	-	-	-	-	3$

** Students have to complete the respective phase II.

Mandatory to do Internship and earn minimum one credit between 3rd and 6th semester.

Students may earn credits in lieu of Professional Elective - V in 8th semester. Please refer Clause 26.1.1 of B.E. Regulations 2019.

$ Online courses of three credits each can be considered in lieu of Professional Elective – IV and Professional Elective – VI. A student earned only three credits can drop only Professional Elective – VI. Please refer Clause 14.9 of B.E. Regulations 2019.

SEMESTER VI								
S.No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**R**	**C**
THEORY								
1.	191MEC601T	Design of Machine Elements and Transmission Systems	PC	3	2	0	-	4
2.	191MEC602T	Finite Element Analysis	PC	3	2	0	-	4
3.	191MEC603T	Automobile Engineering	PC	3	0	0	-	3
4.		Professional Elective – II	PE	3	0	0	-	3
5.		Open Elective – II	OE	3	0	0	-	3
LABORATORY								
6.	191MEC611L	Simulation and Analysis Laboratory	PC	0	0	3	1	2
7.	191LEH612L	Communication Skills Laboratory	HS	0	0	4	0	2
TOTAL CREDITS								**21**
MANDATORY COURSE								
8.	191GEM611L	NSS / NCC / YRC - Phase - III*	MC	-	-	2	-	1*
9.	191GEM601T	Foreign Language / Indian Constitution&	MC	3	-	-	-	3&
EMPLOYABILITY ENHANCEMENT COURSE								
10.	191MEA611I	Inplant Training / Internship#	EEC	-	-	-	-	1#
11.	191MEA601I	Industry Supported Course (Optional) ##	EEC	1	-	-	-	1##
ONLINE COURSE#								
12.		Online Course (Optional) $	PE	-	-	-	-	3$

* Students have to complete the respective phase III.

& Students those who have not earned 3 credits through NSS / NCC / YRC must register for this course and earn 3 credits.

\# Mandatory to do Internship and earn minimum one credit between 3rd and 6th semester.

\## Students may earn credits in lieu of Professional Elective -V in 8th semester. Please refer Clause 26.1.1 of B.E. Regulations 2019.

$ Online courses of three credits each can be considered in lieu of Professional Elective – IV and Professional Elective – VI. A student earned only three credits can drop only Professional Elective – VI. Please refer Clause 14.9 of B.E. Regulations 2019.

SEMESTER VII								
S.No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**R**	**C**
THEORY								
1.	191MEC701T	Mechatronics	PC	3	0	0	-	3
2.	191MEC702T	Power Plant Engineering	PC	3	0	0	-	3
3.		Professional Elective – III	PE	3	0	0	-	3
4.		Professional Elective – IV	PE	3	0	0	-	3
5.		Open Elective – III	OE	3	0	0	-	3
6.	191MEA701T	Comprehensive Examination[@]	PE	-	-	-	-	3[@]
LABORATORY								
7	191MEC711L	Mechatronics Laboratory	PC	0	0	3	1	2
LABORATORY								
EMPLOYABILITY ENHANCEMENT COURSE								
7.	191MEP711J	Project Work / Start up – Phase – I	EEC	-	-	-	4	2
8.	191MEA711I	Inplant Training / Internship[#]	EEC	-	-	-	-	1
TOTAL CREDITS								**20**
EMPLOYABILITY ENHANCEMENT COURSE								
9.	191MEA701I	Industry Supported Course (optional)[# #]	EEC	1	-	-	-	1[##]
ONLINE COURSE[#]								
10.		Online Course (optional) [$]	PE	-	-	-	-	3[$]

[@] Students may earn credits in lieu of Professional elective – III in 7th semester. Please refer clause 26.2 of B.E. Regulations 2019

[#] Mandatory to earn at least one credit by doing internship between 3rd and 6th semester with one credit reflecting in this semester for CGPA calculation.

[##] Students may earn credits in lieu of Professional Elective - V in 8th semester. Please refer Clause 26.1.1 of B.E. Regulations 2019.

[$] Online courses of three credits each can be considered in lieu of Professional Elective – IV and Professional Elective – VI. A student earned only three credits can drop only Professional Elective – VI. Please refer Clause 14.9 of B.E. Regulations 2019.

SEMESTER VIII								
S.No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**R**	**C**
THEORY								
1.		Professional Elective –V	PE	3	-	-	-	3
2.		Professional Elective –VI	PE	3	-	-	-	3
EMPLOYABILITY ENHANCEMENT COURSE								
3.	191MEP811J	Project Work / Start up – Phase - II	EEC	-	-	-	20	10
TOTAL CREDITS								**16**

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PROGRAMME TOTAL CREDITS = 165

HUMANITIES & SOCIAL SCIENCE COURSES (HS)

Sl. No	Code No	Subject	Semester	Credits
1.	191LEH101T	Technical English	I	3
2.	191LEH201T	Professional Communication / BEC Certification	II	3
3.	191GEH311L	Yoga / Social Service (Phase I) **	III	1
4.	191GEH511L	Yoga / Social Service (Phase II) **	V	1
5.	191LEH612L	Communication Skills Laboratory	VI	2
TOTAL CREDITS				**10**

BASIC SCIENCE COURSES (BS)

Sl. No	Code No	Subject	Semester	Credits
1.	191MAB101T	Engineering Mathematics I	I	4
2.	191PYB101T	Engineering Physics	I	3
3.	191CYB101T	Engineering Chemistry	I	3
4.	191GEB111L	Physics and Chemistry Laboratory	I	2
5.	191MAB201T	Engineering Mathematics II	II	4
6.	191PYB203T	Material Science	II	3
7.	191MAB301T	Transforms and Partial Differential Equations	III	4
8.	191MAB401T	Statistics and Numerical Methods	IV	4
TOTAL CREDITS				**27**

ENGINEERING SCIENCE COURSES (ES)

Sl. No	Code No	Subject	Semester	Credits
1.	191GES101T	Engineering Graphics	I	4
2.	191GES102T	Problem Solving and Python Programming	I	3
3.	191GES111L	Python Programming Laboratory	I	2
4.	191GES202T	Engineering Mechanics	II	4
5.	191GES201T	Basic Electrical and Electronics Engineering	II	3
6.	191GES211L	Engineering Practices Laboratory	II	2
7.	191GES212L	Basic Electrical and Electronics Engineering Laboratory	II	2

8.	191EES321T	Electrical Drives and Control	III	3
9.	191EES331L	Electrical Engineering Laboratory	III	1
10.	191CES331L	Strength of Materials and Fluid Mechanics Laboratory	III	2
TOTAL CREDITS				**26**

PROFESSIONAL CORE COURSES (PC)

Sl. No	Code No	Subject	Semester	Credits
1.	191MEC301T	Manufacturing Technology –I	III	3
2.	191MEC302T	Fluid Mechanics and Machinery	III	3
3.	191MEC303T	Engineering Thermodynamics	III	4
4.	191MEC311L	Manufacturing Technology Laboratory –I	III	1
5.	191MEC401T	Manufacturing Technology – II	IV	3
6.	191MEC402T	Strength of Materials	IV	3
7.	191MEC403T	Thermal Engineering	IV	3
8.	191MEC404T	Mechanical Measurements and Metrology	IV	3
9.	191MEC411L	CAD/CAM Laboratory	IV	2
10.	191MEC412L	Manufacturing Technology Laboratory –II	IV	1
11.	191MEC413L	Mechanical Measurements and Metrology Laboratory	IV	1
12.	191MEC501T	Engineering Materials and Metallurgy	V	3
13.	191MEC502T	Mechanics of Machines	V	4
14.	191MEC503T	Heat and Mass Transfer	V	3
15.	191MEC511L	Mechanics of Machines Laboratory	V	2
16.	191MEC512L	Thermal Engineering Laboratory	V	2
17.	191MEC601T	Design of Machine Elements and Transmission Systems	VI	4
18.	191MEC602T	Finite Element Analysis	VI	4
19.	191MEC603T	Automobile Engineering	VI	3
20.	191MEC611L	Simulation and Analysis Laboratory	VI	2
21.	191MEC701T	Mechatronics	VII	3
22.	191MEC702T	Power Plant Engineering	VII	3
23.	191MEC711L	Mechatronics Laboratory	VII	2
TOTAL CREDITS				**62**

PROFESSIONAL ELECTIVE COURSES (PE)

Sl. No	Code No	Subject	Semester	Credits
Professional Elective –I				
1.	191MEE501T	Theory of Metal Forming	V	3
2.	191MEE502T	Advances in Casting and Welding Process	V	3
3.	191MEE503T	Hydraulics and Pneumatics	V	3
4.	191MEE504T	Computer aided Design	V	3
5.	191MEE505T	Refrigeration and air Conditioning	V	3
6.	191MEE506T	Cryogenic Engineering	V	3
7.	191MEE507T	Professional Ethics in Engineering	V	3
Professional Elective –II				
8.	191MEE601T	Gas Dynamics and Jet Propulsion	VI	3
9.	191MEE602T	Energy Conservation and Management	VI	3
10.	191MEE603T	Vibrations and Noise Control	VI	3
11.	191MEE604T	Industrial Tribology	VI	3
12.	191MEE605T	Quality Control and Reliability Engineering	VI	3
13.	191MEE606T	Nano Technology	VI	3
14.	191MEE607T	Engineering Economics and Financial Accounts	VI	3
Professional Elective –III				
15.	191MEE701T	Non-Conventional Energy Sources	VII	3
16.	191MEE702T	Computational Fluid Dynamics	VII	3
17.	191MEE703T	Industrial Robotics	VII	3
18.	191MEE704T	Mechanics of Composite Materials	VII	3
19.	191MEE705T	Maintenance Engineering	VII	3
20.	191MEE706T	Operations Research	VII	3
21.	191MEE707T	Mechanical, Electrical and Plumbing (MEP)	VII	3
Professional Elective –IV				
22.	191MEE711T	Process Planning and Cost Estimation	VII	3
23.	191MEE712T	Computer Integrated Manufacturing Systems	VII	3
24.	191MEE713T	Building Automation Systems	VII	3
25.	191MEE714T	Waste Heat Recovery Systems	VII	3
26.	191MEE715T	Design for Sheet Metal Manufacturing	VII	3
27.	191MEE716T	Vehicle Design Engineering	VII	3
28.	191MEE717T	IOT for Mechanical Engineers	VII	3
Professional Elective –V				
29.	191MEE801T	Non-Destructive Testing	VIII	3
30.	191MEE802T	Supply Chain Management and Logistics	VIII	3

31.	191MEE803T	Optimization of Mechanical Systems	VIII	3
32.	191MEE804T	Integrated Product Development	VIII	3
33.	191MEE805T	Design of Heat Exchangers	VIII	3
34.	191MEE806T	Electric and Hybrid Vehicles	VIII	3
35.	191MEE807T	Industrial Safety Engineering	VIII	3
Professional Elective –VI				
36.	191MEE811T	Mechanical Behaviour of Materials	VIII	3
37.	191MEE812T	Design of Experiments	VIII	3
38.	191MEE813T	Additive Manufacturing	VIII	3
39.	191MEE814T	Manufacturing of Composites	VIII	3
40.	191MEE815T	Solar Engineering	VIII	3
41.	191MEE816T	Nuclear Engineering	VIII	3
42.	191MEE817T	Entrepreneurship Development	VIII	3
TOTAL CREDITS				**18**

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

Sl. No	Code No	Subject	Semester	Credits
1.		In plant Training / Internship	III to VII	1
2.		Industry Supported Course	III to VII	
3.	191MEP711J	Project Work / Start up – Phase - I	VII	2
4.	191MEP811J	Project Work / Start up – Phase - II	VIII	10
TOTAL CREDITS				13

MANDATORY COURSES (MC)

Sl. No	Code No	Subject	Semester	Credits
1.	191GEM101L	Induction Training	I	1
2.	191CYM201T	Environmental Science	II	3
3.	191GEM211L	NSS / NCC / YRC (Phase I)	II	1
4.	191GEM411L	NSS / NCC / YRC (Phase II)	IV	1
5.	191GEM611L	NSS / NCC / YRC (Phase III)	VI	1
6.	191GEM601T	Foreign Language / Indian Constitution	VI	3

CREDIT DISTRIBUTION

SEMESTER	I	II	III	IV	V	VI	VII	VIII	CREDIT
Humanities and Social Sciences (HS)	3	3	1		1	2			**10**
Basic Sciences (BS)	12	7	4	4					**27**
Engineering Sciences (ES)	9	11	6						**26**
Professional Core (PC)			11	16	14	13	8		**62**
Professional Electives (PE)					3	3	6	6	**18**
Open Electives (OE)					3	3	3		**9**
Employability Enhancement Courses (EEC)							3	10	**13**
Total Credit	**24**	**21**	**22**	**20**	**21**	**21**	**20**	**16**	**165**

NON CGPA COURSES DETAILS

	I	II	III	IV	V	VI	VII	VIII	Minimum credits to be earned for awarding degree
In plant Training / Internship			√	√	√	√	√		**1**
Industry Supported Course			√	√	√	√	√		**-**
Mandatory courses (MC)	√	√		√		√			**7**
Online Courses (PE)			√	√	√	√	√		**-**

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SYLLABUS OF

SEMESTER – I

COURSES

191LEH101T	TECHNICAL ENGLISH (Common to all branches of Engineering and Technology)	Periods per week				Credits
		L	T	P	R	
		3	0	0	0	3

PREREQUISITES:
NIL

COURSE OBJECTIVES:	
1.	To develop the basic writing skills of the First year Engineering students.
2.	To help learners develop their listening skills, which will, enable them to listen to lectures and enhance their ability to comprehend by asking questions and seeking clarification.
3.	To help learners develop their speaking skills and help them to speak fluently.
4.	To inculcate reading habit and to develop effective reading skills.
5.	To help students improve their active and passive vocabulary.

UNIT	TITLE	PERIODS
I		9
Short comprehension passages – skimming, scanning, predicting and inference of the passage – Tips for effective writing –Hints development – Purpose of a good conversation – Tips for improving Conversation – Active and Passive listening – Types of listening – Barriers to listening – listening for specific purposes – Listening to lectures and note taking - Parts of Speech - Tenses – WH Questions – Yes/No questions – Prefixes and Suffixes – Word formation.		
UNIT	TITLE	PERIODS
II		9
Longer Comprehension passages - Questions – multiple choice –short questions – open-ended questions – Sentence structure - Types of paragraph – Short narrative paragraphs– Comparison and contrast – argumentative paragraph – analytical paragraph – Techniques for writing precisely - Introducing your friend – Exchange information – Expressing opinion/ agreeing /disagreeing - Telephonic conversation - If Clause – Subject verb agreement – degrees of comparison – Pronouns - adverbs.		
UNIT	TITLE	PERIODS
III		9
Short texts – Cloze passage guessing from context – Note making – Use of reference words – Discourse markers – Connectives – Jumbled sentences –Product description–Process description - Prepositions - Direct/Indirect speech – Connotations – One word substitution – Idiomatic expressions		
UNIT	TITLE	PERIODS
IV		9
Different types of texts – Newspapers/ magazines/short stories - Inference – Tips for effective writing – Letter writing –– Letter to the Editor - Speaking about oneself/ hometown – Review of books – listening to native speakers – American accent and neutral accent - Countable/Uncountable nouns – Articles – Synonyms and Antonyms –		

Phrasal verbs.		
UNIT	**TITLE**	**PERIODS**
V		**9**
Reading for specific purpose – Short essays – developing an outline –Group discussion – Giving advice – Modal verbs – Instructions and Recommendations - Collocations.		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Listen, Understand and Respond to others in different situations.
CO2:	Speak correctly and fluently in different situations using appropriate communication strategies.
CO3:	Read and Comprehend a range of texts adopting different reading skills.
CO4:	Write with clarity in simple, apt and flawless language with coherence and cohesion.
CO5:	Use their communicative competency with purpose and clarity in the context of Science and Technology.

TEXT BOOKS:	
1.	Sanjay Kumar, Pushp Lata. English Language and Communication Skills for Engineers, Oxford University Press 2018

REFERENCE BOOKS:	
1.	Bailey, Stephen. Academic Writing: A practical guide for students. New York: Rutledge, 2011.
2.	Dutt P. Kiranmai and Rajeevan Geeta. Basic Communication Skills, Foundation Books: 2013
3.	Means,L. Thomas and Elaine Langlois. English & Communication for Colleges. Cengage Learning USA: 2007

WEBSITES:	
1.	https://www.usingenglish.com
2.	http://grammarbook.com

JOURNALS:	
1.	National Council for Teachers of English https://www2.ncte.org/resources/journals/college-english/

EXTENSIVE READER:	
1.	Spencer Johnson, Who Moved My Cheese, Putnam Adult, 1998

191MAB101T	ENGINEERING MATHEMATICS – I (Common to all branches of Engineering and Technology)	Periods per week				Credits
		L	T	P	R	
		3	2	0	0	4

PREREQUISITES:
NIL

COURSE OBJECTIVES: The objective of this course is to familiarize the prospective engineers with techniques in calculus and matrix algebra.	
1.	Matrix Algebra is one of the powerful tools to handle practical problems arising in the field of engineering.
2.	The goal of this course is to achieve conceptual understanding and to retain the best traditions of traditional calculus.
3.	The syllabus is designed to provide the basic tools of calculus mainly for the purpose of modelling the engineering problems mathematically and obtaining solutions.
4.	This is a foundation course which mainly deals with topics such as single variable and multivariable calculus and plays an important role in the understanding of science, engineering and computer science, among other disciplines.

UNIT	TITLE	PERIODS
I	MATRICES	12
Overview of system of Linear Equations - Eigen values and Eigen vectors of a real matrix – Characteristic equation – Properties of Eigen values and Eigen vectors – Cayley-Hamilton theorem – Diagonalization of matrices – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.		
UNIT	TITLE	PERIODS
II	DIFFERENTIAL CALCULUS	12
Limit of a function - Continuity - Derivatives – Differentiation Rules – Mean Value Theorem – Interval of increasing and decreasing functions – Maxima and Minima - Interval of concavity and convexity –Taylor's Series for one variable.		
UNIT	TITLE	PERIODS
III	MULTIVARIABLE CALCULUS	12
Limits and Continuity – Partial derivatives – Total derivative – Differentiation of implicit functions – Jacobian and properties – Taylor's series for functions of two variables – Maxima, minima and saddle points - Method of Lagrange multipliers.		
UNIT	TITLE	PERIODS
IV	INTEGRAL CALCULUS	12
Definite Integrals and its properties –Fundamental theorem of Calculus - Techniques of integration for Indefinite Integrals using basic integration formulas – Integration by parts – Trigonometric Substitutions – Integration of Rational functions by Partial Fractions.		
UNIT	TITLE	PERIODS
V	MULTIPLE INTEGRATION	12
Double integrals – Change the order of integration in double integrals - Change of variables (Cartesian to polar) -		

Applications: areas and volumes - Triple integrals (Cartesian, Cylindrical and Spherical coordinates).

TOTAL PERIODS:	**60**

COURSE OUTCOMES:

The Course aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines.

Upon completion of this course, student will learn:

CO1:	Examine the consistency of given linear Homogeneous and Non-Homogeneous simultaneous equations by using rank method.
CO2:	Find Eigen values, Eigen vectors of square matrices to convert quadratic form in to canonical form.
CO3:	Find the extreme values of functions of single and multivariable functions by using derivatives and partial derivatives respectively.
CO4:	Evaluate single integral involving trigonometry, algebraic, exponential and logarithmic functions by using methods of substitution and integration by parts.
CO5:	Find area enclosed by simple closed curve using double integral and volume of solid by using triple integral.

TEXT BOOKS:

1.	Grewal B.S., - Higher Engineering Mathematics, Khanna Publishers, New Delhi, 43rd Ed., 2014
2.	Joel Hass, Christopher Heil and Maurice D.Weir “Thomas’ Calculus”, 14th Edition, Pearson.

REFERENCE BOOKS:

1.	Bali N.P.and Manish Goyal “ Engineering Mathematics” (For Semester I) Third Edition, University Science Press.
2.	Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons.
3.	Fritz John and Richard Courant, “Introduction to Calculus and Analysis” Springer.
4.	James Stewart, "Calculus: Early Transcendental", Cengage Learning, 7th Edition, New Delhi, 2015.
5.	Veerarajan T., Engineering Mathematics, Tata McGraw-Hill, New Delhi.

191PYB101T	ENGINEERING PHYSICS (Common to all branches of Engineering and Technology)	Periods per week				Credits
		L	T	P	R	
		3	0	0	0	3

PREREQUISITES:
NIL

COURSE OBJECTIVES:	
1.	To enhance the fundamental knowledge in Physics and its applications relevant to various streams of Engineering and Technology.

UNIT	TITLE	PERIODS
I	PROPERTIES OF MATTER	9

Stress - Strain relationship, Hooke's law, Elastic moduli, Stress - Strain diagram for various engineering materials, Ductile and Brittle materials - Torsional pendulum – Beam, Expression for bending moment - Cantilever, Uniform and Non-uniform bending, Theory and Experimental determination of Young's modulus.

UNIT	TITLE	PERIODS
II	SOUND WAVES AND VIBRATIONS	9

Propagation, Intensity, Loudness of sound waves – Determination of absorption coefficient, Reverberation, Sabine's formula for reverberation time - Factors affecting acoustics of buildings and their remedies - Acoustic Quieting: Aspects, Methods, Quieting for Specific observers, Mufflers, Soundproofing - Ultrasonic waves and properties, Methods of Ultrasonic production, Applications of Ultrasonic in engineering and medicine.

UNIT	TITLE	PERIODS
III	THERMAL PHYSICS	9

Fundamentals of thermal energy – Expansion joints - Bimetallic strips - Thermal conductivity, conductions in solids, Differential equation of one dimensional heat flow- Forbe's and Lee's disc method - Conduction through compound media – Thermal insulation – thermal shock resistance - Applications: Solar water heater- tempered glass- cryogenic materials

UNIT	TITLE	PERIODS
IV	QUANTUM MECHANICS	9

Inadequacies of Classical Mechanics – Black body radiation- Planck's theory of radiation - Dual nature of electromagnetic radiation – De Broglie hypothesis for matter waves – Heisenberg's uncertainty principle – Schrodinger's time dependent and independent wave equation, significance of wave function - Born interpretation - Particle confinement in 1D box.

UNIT	TITLE	PERIODS
V	APPLIED OPTICS	9

Spontaneous and Stimulated emission - Einstein co-efficients (derivation) – Spatial and Temporal coherence – Schawlow-Townes condition for population inversion (Qualitative study) - Types of lasers – Nd:YAG, Semiconductor - Applications of Laser in science, engineering and medicine.

Principle and propagation of light in optical fibre, Derivation for Numerical aperture and Acceptance angle - Types and losses of optical fibre - Fibre Optical Communication (Block diagram) - Active and Passive sensors - Medical endoscope

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course :	
CO1:	The students will gain knowledge on the basics of properties of matter and its applications,
CO2:	The students will acquire knowledge on the concepts of sound waves and vibrations.
CO3:	The students will have adequate knowledge on the concepts of thermal properties of materials and their applications in expansion joints and solar water heaters,
CO4:	The students will get knowledge on advanced physics concepts of quantum theory,
CO5:	The students will acquire knowledge on the concepts of optical devices and their applications in fibre optics

TEXT BOOKS:	
1.	Bhattacharya D.K & T.Poonam, Engineering Physics , Oxford University Press, 2015
2.	Pandey B.K.& S.Chaturvedi, Engineering Physics, Cengage Learning India, 2012.
3.	Senthilkumar, G.Engineering Physics I, VRB Publishers, 2011

REFERENCE BOOKS:	
1.	Aruldhas G, Quantum Mechanics, PHI Learning Pvt. Ltd.,New Delhi, 2011.
2.	Arthur Beiser,Concepts of Modern Physics, 6th edn.,McGraw Hill 2003.
3.	Gaur R.K & S.L.Gupta, Engineering Physics, Dhanpat Rai Publishers, 2012
4.	Halliday D, R.Resnick & J.Walker, Principles of Physics, Wiley, 2015
5.	Serway R.A & J.W.Jewett, Physics for Scientists and Engineers, Cengage Learning, 2010.
6.	Tipler P.A & G.Mosca, Physics for Scientists and Engineers with Modern Physics, W.H.Freeman, 2007.
7.	Zeemansky M.W and R.H.Dittman, Heat and Thermodynamics, 8th edn., Mc.Graw Hill, NewYork, 2017.

191CYB101T	ENGINEERING CHEMISTRY (Common to all branches of Engineering and Technology)	Periods per week				Credits
		L	T	P	R	
		3	0	0	0	3

PREREQUISITES:
NIL

COURSE OBJECTIVES:	
1.	To make the students conversant with boiler feed water requirements, related problems and water treatment techniques.
2.	To get the basic idea about the polymers and applications of polymers and polymer reinforced composites
3.	It deals with the information about the types of fuels, calorific value calculationsand manufacture of solid, liquid and gaseous fuels
4.	It enable the students to gain information about Principles and generation of energy in batteries, nuclear reactors, solar cells, wind mills and fuel cells
5.	To impart knowledge about the nanomaterials synthesis, properties and applications

UNIT	TITLE	PERIODS
I	WATER TREATMENT AND TECHNOLOGY	9

Introduction – characteristics - alkalinity - types and determination – hardness – types only -boiler feed water-requirements-boiler troubles – scale & sludge -disadvantages (wastage of fuels, decrease in efficiency, boiler explosion) - softening of hard water - external treatment process - demineralization and zeolite, internal treatment - boiler compounds (phosphate, calgon, carbonate and colloidal conditioning methods) – desalination of brackish water –reverse osmosis.

UNIT	TITLE	PERIODS
II	POLYMERS AND REINFORCED PLASTICS	9

Introduction- classification of polymers - Natural and synthetic - Thermoplastic and Thermosetting, Functionality–Degree of polymerization,types - addition and condensation polymerization – free radical polymerization mechanism - Preparation, properties and uses of PVC, Nylon 6,6, Teflon and Epoxy resin. Plastics - Compounding of plastics – moulding methods –injection, extrusion and compression – FRP – carbon and glass – applications.

UNIT	TITLE	PERIODS
III	FUELS AND COMBUSTION	9

Classification - Coal – proximate and ultimate analysis, - carbonization -metallurgical coke –manufacture by Otto Hoffmann method – petroleum – refining - cracking –synthetic petrol by Bergius process - knocking in petrol and diesel engines- octane and cetanerating of fuels-synthesis – advantages and commercial application of power alcohol and biodiesel- Gaseous fuels- liquefied petroleum gases (LPG)- compressed natural gas (CNG)-Combustion of fuels:Introduction - calorific value–higher & Lower– theoretical calculation - Flue gas analysis by Orsat method

UNIT	TITLE	PERIODS
IV	ENERGY SOURCES AND STORAGE DEVICES	9

Energy – Types – Non-renewable energy - Nuclear energy –fission and fusion reactions - differences between nuclear fissionand fusion - nuclear chain reactions - light water nuclear reactor for power generation – breeder reactor – renewable energy - solar energy conversion - solar cells - wind energy.

Electrochemical cells – reversible and irreversible cells –Cell construction and representation - Batteries -types of batteries – characteristics – construction and working of primary battery (dry cell) - secondary battery (lead acid battery and lithium-ion-battery) - fuel cells (H2-O2)

UNIT	TITLE	PERIODS
V	CONCEPTS OF NANO CHEMISTRY AND GREEN CHEMISTRY	9

Nano chemistry introduction – basics –general properties - distinction between nanoparticles, molecules and bulk materials–size-dependent properties. Synthesis: precipitation, thermolysis, hydrothermal, solvothermal, electro deposition, chemical vapour deposition, laser ablation - properties of nanoparticles – Types of Nanoparticles:nano cluster, nano rod, nanowire and nano tube – Carbon Nano Tube (Synthesis, properties and applications) – applications of nanoparticles.

Green chemistry introduction - Principles - Applications

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	The knowledge gained on water treatment techniques will facilitate better understanding of engineering processes and applications for further learning.
CO2:	The knowledge gained on water treatment techniques will facilitate better understanding of engineering processes and applications for further learning.
CO3:	Students can get knowledge about various fuels and its applications based on its calorific value.
CO4:	It provides the students to understand about conventional and non-conventional energy sources and its applications
CO5:	It provides the students to gain knowledge about the recent trentds in nano materials.

TEXT BOOKS:	
1.	Kannan P and Ravikrishnan A, “Engineering Chemistry”, Sri Krishna, Hitech publishing Company Pvt. Ltd, 2014
2.	Jain P.C. and Monika Jain, “Engineering Chemistry” Dhanpat Rai, Publishing Company (P) Ltd.,New Delhi, 2015

REFERENCE BOOKS:	
1.	Dara S.S &S.S Umare, “A Text book of Engineering Chemistry”, S.Chand & Company Ltd., New Delhi, 2015
2.	Palanna O.G, “Engineering Chemistry”, McGraw Hill Education (India)Pvt. Ltd, Chennai,2017
3.	Vairam S ,P. Kalyani and Suba Ramesh., “Engineering Chemistry”,Wiley India PVT, Ltd, New Delhi, 2013

191GES101T	ENGINEERING GRAPHICS (Common to all branches of Engineering and Technology)	Periods per week				Credits
		L	T	P	R	
		2	0	4	0	4

PREREQUISITES:
NIL

COURSE OBJECTIVES:	
1.	To develop students, graphic skills for communication of concepts, ideas and design of engineering products
2.	To expose them to existing National standards related to technical drawings.
3.	To Familiarize with basic geometrical constructions and orthographic projections.
4.	To make the students to draw the different projections of the solids.
5.	To view the true shape and apparent shape of the sectioned solids and their developments
6.	To get an idea about 3D views through isometric projections.

UNIT	TITLE	PERIODS
0	CONCEPTS AND CONVENTIONS USED	2
Principles of Engineering graphics and their significance - Use Of drawing Instruments-BIS conventions and specifications-Size, Layout and folding of drawing sheets-Lettering and Dimensioning.		
UNIT	TITLE	PERIODS
I	PLANE CURVES, PROJECTION OF POINTS	17
Conic Sections - Construction of Ellipse, Parabola & hyperbola by eccentricity method – Construction of cycloid – Introduction to Scales. Introduction of Orthographic projection - Principal planes - First angle projection - projection of points.		
UNIT	TITLE	PERIODS
II	PROJECTION OF LINES AND PLANES	17
Projection of straight lines inclined to both the principal planes by rotating line method. Projection of simple planes inclined to both the principal planes by rotating object method.		
UNIT	TITLE	PERIODS
III	PROJECTION OF SOLIDS	17
Projection of simple solids like Prism, Pyramid, Cylinder & Cone when the axis is inclined to one of the principal planes by rotating object method.		
UNIT	TITLE	PERIODS
IV	SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES	17
Sectioning of simple solids (Prism, Pyramid, Cylinder & Cone) in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of surfaces of right regular and sectioned solids.		

UNIT	TITLE	PERIODS
V	ISOMETRIC AND ORTHOGRAPHIC PROJECTIONS	17
Principles of Isometric projections-Isometric scale- Isometric Views of simple and truncated solids – combination of two solid objects in simple vertical positions. Conversion of Isometric views to Orthographic views of the objects.		
UNIT	TITLE	PERIODS
VI	COMPUTER AIDED DRAFTING	3
(Demonstration Only, Not for Exam) The Concepts of Computer Aided Drafting for Engineering drawing, Computer graphics & Geometrical modeling (2D Orthographic Views) and 3D drafting (Isometric Views) using AutoCAD.		

TOTAL PERIODS:	90

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Construct conic sections and cycloids
CO2:	Draw the projections of points, Straight lines and planes inclined to both the principal planes.
CO3:	Draw the projections of the simple solids like cylinder, cone, prisms and pyramids inclined to one of the principle planes.
CO4:	Draw the sectional views of simple solids, obtain true shape and develop the sectioned solids.
CO5:	Construct Orthographic views from pictorial views.
CO6:	Draw the isometric view and isometric projection of simple and truncated solids in vertical position.

TEXT BOOKS:	
1.	Natarajan K.V., “A text book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2009
2.	Jayapoovan T, “Engineering Graphics using AUTOCAD”, Vikas Publishing ,7 th Edition.
3.	Venugopal K. and Prabhu Raja V., “Engineering Drawing with AUTOCAD and building drawing”, New Age International (P) Limited, 2018, 5th edition.

REFERENCE BOOKS:	
1.	Basant Agarwal and Agarwal C.M., “Engineering Drawing”, Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
2.	Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 50th Edition, 2010.
3.	Dinesh Kumar S, K.Sivakumar and R.Ramadoss, “ Engineering Graphics”, Maruthi Publishers, Chennai,2019.
4.	Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
5.	Parthasarathy N S and Vela Murali, “Engineering Graphics”, Oxford University, Press, New Delhi, 2015.
6.	Shah M.B., and Rana B.C., “Engineering Drawing”, Pearson, 2nd Edition, 2009.

191GES102T	PROBLEM SOLVING THROUGH PYTHON PROGRAMMING (Common to all branches of Engineering and Technology)	Periods per week				Credits
		L	T	P	R	
		3	0	0	0	3

PREREQUISITES:
NIL

COURSE OBJECTIVES:	
1.	The course on Python Programming is intended to enhance the computational and logical thinking of students. Upon completion of the course, the students would be able to master the principles of Python programming and demonstrate significant experience in problem solving.

UNIT	TITLE	PERIODS
I	ALGORITHMIC PROBLEM SOLVING	9
Algorithms, building blocks of algorithms (statements, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Case study: Towers of Hanoi, insertion sort, guess an integer number in a range.		
UNIT	TITLE	PERIODS
II	CONTROL FLOW STATEMENTS	9
Python interpreter, interactive mode and script mode; variables, expressions, statements; values and data types; Operators and Precedence of operators, comments; Conditionals: conditional, alternative, chained conditional, nested conditional; Iterations: while, for, break, continue		
UNIT	TITLE	PERIODS
III	FUNCTIONS AND STRINGS	9
Modules and functions: function definition and use, flow of execution, parameters and arguments; Fruitful functions: return values, composition, recursion; Strings: string slices, immutability, Looping and counting, String methods.		
UNIT	TITLE	PERIODS
IV	LIST, TUPLE AND DICTIONARIES	9
Lists: list operations, list slices, list methods, traversing, mutability, aliasing, list arguments, list comprehension; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and functions, Looping and dictionaries, histogram		
UNIT	TITLE	PERIODS
V	FILES, EXCEPTIONS	9
Files: text files, reading and writing files, format operator, filenames and paths; Exceptions: handling exceptions, multiple exception blocks, finally block; Case study: tkinter		

TOTAL PERIODS:	45

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Design solutions to simple computational problems
CO2:	Read, write and execute Python programs.
CO3:	Decompose a Python program into functions
CO4:	Implement compound data using Python lists, tuples, and dictionaries.
CO5:	Read and write data from/to files in Python Programs.
CO6:	Understand the GUI concepts and implement in Python.

TEXT BOOKS:	
1.	Allen B. Downey, ``Think Python: How to Think Like a Computer Scientist‘‘, Version 2.0.17 edition, Updated for Python 3, Shroff/O‘Reilly Publishers, (http://greenteapress.com/wp/thinkpython/)
2.	Reema Thareja “Python Programming using Problem solving Approach”, Oxford University Press.

REFERENCE BOOKS:	
1.	Paul Gries, Jennifer Campbell and Jason Montojo, —Practical Programming: An Introduction to Computer Science using Python 3‖, Second edition, Pragmatic Programmers, LLC, 2013.
2.	Robert Sedgewick, Kevin Wayne, Robert Dondero, —Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.
3.	Timothy A. Budd, —Exploring Python‖, Mc-Graw Hill Education (India) Private Ltd. 2015

191GEB111L	PHYSICS AND CHEMISTRY LABORATORY (Common to all branches of Engineering and Technology)	Periods per week				Credits
		L	T	P	R	
		0	0	4	0	2

PREREQUISITES:
NIL

A. PHYSICS LABORATORY

COURSE OBJECTIVES:	
1.	The purpose of this course is to develop scientific temper in experimental techniques and to reinforce the physics concepts among the engineering students

INSTRUCTIONAL OBJECTIVES:	
1.	To gain knowledge in the scientific methods and learn the process of measuring different Physical variables
2.	Develop the skills in arranging and handling different measuring instruments
3.	Get familiar on experimental errors in various physical measurements and to plan/ suggest on how the contributions could be made of the same order, so as to minimize the errors.

ANY FIVE EXPERIMENTS	
1.	Torsion Pendulum – Rigidity modulus of wire and moment of inertia of disc.
2.	Non Uniform Bending – Young's modulus determination.
3.	Spectrometer – Wave length of spectral lines using grating.
4.	Lee's Disc – Thermal Conductivity of bad conductor.
5.	Semiconductor Laser –Wavelength of laser light, Size of particle and Numerical aperture of optical fiber.
6.	Air Wedge – Measurement of thickness of thin wire.
7.	Determination of the Band gap of a semiconductor.
8.	Ultrasonic Interferometer - Velocity of sound and Compressibility of liquid.

TOTAL PERIODS:	30

TEXT BOOKS:	
1.	G.Rajkumar, Physics laboratory Practical, McGraw Hill publication, 2019.
2.	R.K.Shukla and Anchal Srivastava, Practical Physics, 1st Edition, New Age International (P) Ltd, New Delhi, 2006.
3.	Physics Laboratory Manual, Faculty Members, Department of Physics, Easwari Engineering College, Chennai

REFERENCE BOOKS:	
1.	Chattopadhyay D, P.C.Rakshit and B.Saha, An Advanced Course in Practical Physics, 2nd ed., Books & Allied Ltd., Calcutta, 1990.

2.	Souires G L , Practical Physics, 4th Edition, Cambridge University, UK, 2001.

B. CHEMISTRY LABORATORY

COURSE OBJECTIVES:	
1.	To make the student to acquire practical skills in the determination of water quality parameters
2.	To acquaint the students with the determination of molecular weight of polymer by using viscometer.

ANY FIVE EXPERIMENTS	
1.	Determination of chloride content of water sample by Argentometric method
2.	Determination of strength of given HCl using pH meter
3.	Determination of strength of acid in a mixture using conductivity meter
4.	Determination of permanent, total and temporary hardness of water sample.
5.	Estimation of Fe^{2+} by Potentiometric titration
6.	Determination of molecular weight of PVA using Ostwald viscometer
7.	Determination of alkalinity in water sample
8.	Estimation of Iron content in water sample using spectrophotometer (1,10 – Phenanthroline/thiocyanate method)
9.	Conductometric titrations of strong acid Vs strong base
10.	Determination of DO Content of water sample by Wrinkles method
11.	Determination of BOD and COD in water sample

TOTAL PERIODS:	**30**

OUTCOMES:	
1.	The students will be outfitted with hands-on knowledge in the quantitative chemical analysis of water quality related parameters.

REFERENCE BOOKS:	
1.	Dr. C. Ravichandran, “Engineering Chemistry Laboratory-I” Global publications, 2019.
2.	Furniss B.S. Hannaford A.J, Smith P.W.G and Tatchel A.R., “Vogel’s Textbook of practical organic chemistry, LBS Singapore (1994).
3.	Jeffery G.H, Bassett J., Mendham J. and Denny R.C., “Vogel’s Text book of quantitative analysis chemical analysis”, ELBS 5th Edn. Longman, Singapore publishers, Singapore, 1996.
4.	Daniel R. Palleros, “Experimental organic chemistry” John Wiley & Sons, Inc.,New York (2001).

191GES111L	PYTHON PROGRAMMING LABORATORY (Common to all branches of Engineering and Technology)	Periods per week				Credits
		L	T	P	R	
		0	**0**	**3**	**1**	**2**

PREREQUISITES:
NIL

COURSE OBJECTIVES:	
1.	The course on Python programming laboratory is used to write, test and debug simple Python programs. Upon completion of the course, the students would be able to master the concepts of data types, loops, functions, list, tuples, dictionary , files and GUI.

LIST OF PROGRAMS:	
1.	LCM of two numbers.
2.	Sum of squares of first n natural numbers
3.	Fibonacci series.
4.	Armstrong number
5.	Sum of Digits in a Number.
6.	First n prime number.
7.	Factorial of a number using recursion
8.	Count the number of vowels in a string
9.	Matrix multiplication.
10.	Simple calculator
11.	Linear search
12.	Selection sort
13.	Insertion sort
14.	Word count
15.	Mini Project (any ONE): Design GUI for • Airline reservation system • Feedback system • Employee management system • Student management system • Banking system

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Write, test, and debug simple Python programs.
CO2:	Implement Python programs with conditionals and loops.

CO3:	Use functions for structuring Python programs.
CO4:	Represent compound data using Python lists, tuples, dictionaries.
CO5:	Read and write data from/to files in Python
CO6:	Design GUI applications

SYLLABUS OF

SEMESTER – II

COURSES

191LEH201T	PROFESSIONAL COMMUNICATION (Common to all branches of Engineering and Technology)	Periods per week				Credits
		L	T	P	R	
		3	0	0	0	3

PREREQUISITES:
NIL

COURSE OBJECTIVES:	
1.	To strengthen their listening skills which help them comprehend lectures and talks in their areas of specialization
2.	To develop their speaking skills to make technical presentations, participate in Group Discussions.
3.	To develop strategies and skills to enhance their ability to read and comprehend engineering and technology texts.
4.	To foster their ability to write convincing job applications
5.	To equip with appropriate skills for writing effective reports.

UNIT	TITLE	PERIODS
I		9
Communication – Process of Communication – Different forms of communication – Communication flow- Barriers of communication - Purpose and Function expressions – Extended definitions – Cause and Effect expressions - Compound nouns- Homonyms/homophones		
UNIT	TITLE	PERIODS
II		9
Listening to technical talks - Body language pertaining to Presentation– countering stage fright – Preparing PPT for presentation – Interpreting charts/graphs/pie charts/ bar diagram/tabular column/ tree diagram – Words often confused – Active/ Passive/ Impersonal Passive Voice – Numerical adjectives.		
UNIT	TITLE	PERIODS
III		9
Etiquette of Group discussion – discussing GD topics - reading journals and paraphrasing – Report Writing – Accident report/– Industrial visit report – Words often Misspelt – Describing a process using sequence words – Words used as different parts of speech		
UNIT	TITLE	PERIODS
IV		9
Small talk – review on films and books – email etiquette - Cover letter & Resume – Calling for quotations – Placing order – Letter of complaint - escalation letter - Feasibility report - Project report – - Abbreviations and Acronyms pertaining to Science and Technology – Types of Essays - Argumentative, Analytical, Descriptive & Expository		
UNIT	TITLE	PERIODS

V		9
Writing Statements of Purpose-format, Sample – Modifiers, Redundancies-Direct indirect speech-Project Proposal – Minutes of Meeting - Verbal Analogies – Case studies relating to Goal Setting- Writing articles		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Learners can draft effective formal letters and emails.
CO2:	Listen and comprehend different technical/non-technical excerpts critically and infer the implied meaning.
CO3:	Write ungrammatically and help in organizing ideas logically on a topic using a wide range of vocabulary
CO4:	Read different genres of texts and evaluate them for content and structure.
CO5:	Be proactive in using the language confidently and effectively for personal and professional growth.

TEXT BOOKS:	
1.	Raymond Murphy, English Grammar in Use: Reference and Practice for Intermediate Students, Cambridge : CUP, 2004

REFERENCE BOOKS:	
1.	M. Ashraf Rizvi ‘Effective Technical Communication’, Tata McGraw-Hill, New Delhi, 2005
2.	Richard Johnson - Sheehan, Technical Communication Today, Longman Publishing Group, 2011
3.	Golding S.R. ‘Common Errors in English Language’, Macmillan, 1978

WEBSITES:	
1.	https://owl.purdue.edu
2.	https:www.hellolingo.com

JOURNALS:	
1.	IEEE/transactions on Professional Communication
2.	https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=47

EXTENSIVE READER:	
1.	Stephen R. Covey, The Seven Habits of Highly Effective People, Free Press, 1989

191MAB201T	ENGINEERING MATHEMATICS – II (Common to all branches of Engineering and Technology)	Periods per week				Credits
		L	T	P	R	
		3	2	0	0	4

PREREQUISITES:
NIL

COURSE OBJECTIVES:	
1.	The objective of this course is to familiarize the prospective engineers with techniques in ordinary differential equations, complex variables and complex integration.
2.	The Study of Laplace transform help to solve the differential equations that occur in various branches of engineering disciplines.
3.	Vector calculus can be widely used for modelling the various laws of physics.
4.	The various methods of complex analysis can be used for efficiently solving the problems that occur in various branches of engineering disciplines.

UNIT	TITLE	PERIODS
I	ORDINARY DIFFERENTIAL EQUATIONS	12

Basic concepts - Separable differential equations - Exact differential equations - Integrating factors - Linear differential equations – Second order linear differential equations with constant coefficients – Particular Integral using operator method and Method of variation of parameters – Homogenous equation of Euler's and Legendre's type.

UNIT	TITLE	PERIODS
II	LAPLACE TRANSFORMS	12

Existence conditions – Transforms of elementary functions –Transform of unit step function and unit impulse function – Basic properties – Shifting theorems -Transforms of derivatives and integrals – Transform of periodic functions - Inverse transforms: Convolution theorem (Statement only) and Partial Fractions - Application to solution of linear second order ordinary differential equations with constant coefficients.

UNIT	TITLE	PERIODS
III	VECTOR CALCULUS	12

Gradient and directional derivative – Divergence and curl – Irrotational and Solenoidal vector fields – Line integral – Surface integral - Area of a curved surface - Green's, Gauss divergence and Stokes' theorems in evaluating line, surface and volume integrals (Planar, Cylindrical and Spherical Surfaces).

UNIT	TITLE	PERIODS
IV	COMPLEX VARIABLES	12

Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian form - Properties – Harmonic conjugates – Construction of analytic function – Conformal mapping – Mapping by function $w = z + c,\ cz,\ \frac{1}{z},\ z^2$ - Bilinear transformation.

UNIT	TITLE	PERIODS
V	COMPLEX INTEGRATION	12
Complex integral - Cauchy's integral theorem – Cauchy's integral formula – Taylor's and Laurent's series – Singularities – Residues – Residue theorem – Application of residue theorem for evaluation of real integrals – Use of circular contour and semicircular contour (No poles on the real axis).		

TOTAL PERIODS:	**60**

COURSE OUTCOMES:

The Course aims to equip the students to deal with advanced level of mathematics and applications that would be essential for their disciplines.

Upon completion of this course, student will be able to:

CO1:	Solve linear first and higher order ordinary differential equations (ODE).
CO2:	Solve ODEs by using Laplace transform technique.
CO3:	Use vector calculus to convert triple integrals into double and double integrals into single integral.
CO4:	Derive necessary condition for a given complex function to be analytic.
CO5:	Identify a suitable method of complex integration for evaluating certain indefinite integrals.

TEXT BOOKS:

1.	Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2.	Joel Hass, Christopher Heil and Maurice D.Weir Thomas' Calculus , 14th Edition, Pearson.

REFERENCE BOOKS:

1.	Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons.
2.	N.P.Bali and Manish Goyal " Engineering Mathematics"(For Semester II) Third Edition, University Science Press
3.	Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi.
4.	O'Neil, P.V. "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, New Delhi, 2007 .
5.	James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 7th Edition, New Delhi, 2015.

191PYB203T	MATERIALS SCIENCE	Periods per week				Credits
		L	T	P	R	
		3	0	0	0	3

PREREQUISITES:
NIL

COURSE OBJECTIVES:	
1.	To disseminate to the students, the concepts of phases in solid solutions, electrical and thermal properties of solids, materials science, theories of solid state physics in the development of materials and its properties and facilitate students to apply in their area of specialization.

UNIT	TITLE	PERIODS
I	PHASE EQUILIBRIA IN MATERIALS	9

Solid solutions - Hume-Rothery rules and intermediate phases - phase rule- phase diagrams- single component system – Tie line rule – Lever rule - binary isomorphous - binary eutectoid, peritectoid systems - Iron carbon equilibrium diagram - Fick's laws of diffusion- mechanisms of diffusion, temperature dependence of diffusivity - steady and non-steady state diffusion - factors that influence diffusion – Properties and applications of copper alloys, aluminium alloys and titanium alloys.

UNIT	TITLE	PERIODS
II	CONDUCTING MATERIALS	9

Conductors – classical free electron theory of metals – Expression for electrical and thermal conductivity – Wiedemann – Franz law – Lorentz number – draw backs of classical theory – Quantum theory – Fermi distribution function – Effect of temperature on Fermi Function – Density of energy states – carrier concentration in metals.

UNIT	TITLE	PERIODS
III	SEMICONDUCTING MATERIALS	9

Direct and indirect semiconductors - Carriers concentration in intrinsic semiconductor – Extrinsic semiconductors (Qualitative study) - variation of Fermi level with temperature and impurity concentration in n and p types – Carrier transport: Velocity-electric field relations – drift and diffusion transport – Hall Effect and determination of Hall Coefficient.

UNIT	TITLE	PERIODS
IV	MAGNETIC AND SUPERCONDUCTING MATERIALS	9

Magnetism in materials – magnetic field and induction – magnetization - magnetic permeability and susceptibility – types of magnetic materials – Ferromagnetism: origin and exchange interaction - saturation magnetization and Curie temperature – Domain Theory - Hard and soft magnetic materials – Applications. Superconductivity: properties – Type I and Type II superconductors – BCS theory of superconductivity (Qualitative) - High Tc superconductors – Applications of superconductors – SQUID, cryotron, magnetic levitation

UNIT	TITLE	PERIODS
V	ADVANCED ENGINEERING MATERIALS	9

Polymer matrix composites (PMC): classification, role of matrix and reinforcement, fillers, processing of fiber reinforced PMCs, applications – Metallic glasses: types, glass forming ability of alloys, melt spinning process, applications - Shape memory alloys: phases, shape memory effect, pseudo elastic effect, Ni:Ti alloy, applications – nano materials: Bucky balls - Graphene – Carbon nanotubes, types, applications – High Entropy Alloys (HEA) and Super alloys (SA)

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	The students will have knowledge on various phase diagrams and their applications,
CO2:	The students will gain knowledge on magnetic, dielectric and superconducting properties of materials,
CO3:	The students will understand the basics of polymers, composites and nano materials
CO4:	The students will have knowledge on advanced materials

TEXT BOOKS:	
1.	W.D.Callister, Materials Science and Engineering, John Wiley & Sons, 2007.
2.	V.Raghavan, Physical Metallurgy, Prentice Hall of India, 2006.
3.	V.Rajendran, Materials Science, McGraw Hill Education (India) Private Ltd., 2017

REFERENCE BOOKS:	
1.	D.A. Porter and K. E. Easterling, Phase Transformations in Metals and Alloys, Taylor and Francis, 2009
2.	S.H.Avner Introduction to Physical Metallurgy, 2nd edition, McGraw Hill, 1985.
3.	S.O. Pillai, Solid State Physics, New Age International (P) Ltd., publishers, 2009.
4.	T.Pradeep, Nano: The Essentials, Mc Graw Hill Publishing Co. Ltd., 2007.
5.	Charles P. Poole Jr., Frank J. Owens, Introduction to nano technology, Wiley, 2003.

191GES201T	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING (Common to Auto., ME, CE, CSE & IT)	Periods per week				Credits
		L	T	P	R	
		3	0	0	0	3

PREREQUISITES:
NIL

COURSE OBJECTIVES:	
1.	To understand the Basic Fundamentals in Electrical Circuits.
2.	To study the construction, Principle of operation and performance of DC and AC Machines
3.	To understand the principles of PN Junction diode and BJT
4.	To Study the protection and safety measures in Electricity

UNIT	TITLE	PERIODS
I	FUNDAMENTALS OF ELECTRICITY AND CIRCUITS	9

Evolution of Electricity and Inventions- Electrical Quantities—Charge- Electric Potential, Voltage, Current, Power Energy, DC, AC, time period, Frequency, Phase, Flux density, RMS, Average, Peak, Phasor and Vector diagram. Electric circuit elements – Sources - Ohm's Law - Kirchhoff's Laws, Faradays Law, Lenz's Law- Wiring- House wiring and Industrial Wiring systems.

UNIT	TITLE	PERIODS
II	MEASURING INSTRUMENTS	9

Principle of Operation Moving Coil and Moving Iron Types of Voltmeters and Ammeters - Multimeters – Measurements of resistance, inductance & capacitance-Power and Energy Measurements- Energy Efficient Equipment's and sample load (Domestic load) calculations.

UNIT	TITLE	PERIODS
III	ELECTRICAL MACHINES	9

Construction - Principle of Operation - EMF Equation –Application of DC Generator, DC Motor – types and Characteristics – Applications – Transformer-AC Machines – Construction, Operation and types of Single phase and three Phase Induction Motors.

UNIT	TITLE	PERIODS
IV	BASIC ELECTRONICS AND COMMUNICATION	9

PN Junction Diode, Zener Diode – V-I Characteristics – Applications – Rectifier – Half Wave – Full Wave and Rectifiers – Transistors types – Transistor as an Amplifier — Junction Field Effect Transistor (JFET) operation and characteristics, SCR - characteristics and its applications- CRO-Principle of Cathode Ray Tube-regulated power Supply- Function Generators. Communication systems- types- Analog, Digital and Wireless.

UNIT	TITLE	PERIODS
V	PROTECTION, SAFETY AND INDIAN ELECTRICITY SCENARIO	9

Hazards of Electricity-Shock, Burns, arc- blast, Thermal Radiation, Explosives, fires, effect of electricity on the human Body. Electrical safety practices, Protection devices. Electrical power- Generation resources- transmission

and Distribution. Regulatory authorities- role of MNRE, MNRE, NTPC, TEDA, TANGEDCO.

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Demonstrate knowledge on basics of electrical circuits, Construction and working principle of various electrical machines.
CO2:	Analyze the behaviour and performance of electrical circuits and machines.
CO3:	Apply knowledge on CRO and function generator.
CO4:	Describe electrical hazards and safety equipment.
CO5:	Analyze and apply various grounding and bonding techniques.
CO6:	Select appropriate safety method for low, medium and high voltage equipment.
CO7	Participate in a safety team.
CO8	Carry out proper maintenance of electrical equipment by understanding various standards

TEXT BOOKS:	
1.	S.Hasan Saeed, D.K.Sharma, Non-Conventional Energy Resources, Katson Books, 3rd Edition, 2013
2.	John Cadick, Mary Capelli-Schellpfeffer, Dennis Neitzel, Al Winfield,'Electrical Safety Handbook', McGraw-Hill Education, 4thEdition, 2012.
3.	D.P.Kothari and I.J. Nagarath –"Basic Electrical & Electronics Engineering", Mc.Grawhill publications, 1st Edition, 2014.
4.	Leonard S Bobrow, "Foundations of Electrical Engineering", Oxford University Press, 2013
5.	Vincent Del Toro, Electrical Engineering Fundamentals, Prentice Hall, 2006.

REFERENCE BOOKS:	
1.	Del Toro, "Electrical Engineering Fundamentals", Pearson Education, New Delhi, 2007 2. John Bird, "Electrical Circuit Theory and Technology", Elsevier, First Indian Edition, 2006.
2.	Maxwell Adams.J, 'Electrical Safety- a guide to the causes and prevention of electric hazards', The Institution of Electric Engineers, IET 1994. 2. Ray A. Jones, Jane G. Jones, 'Electrical Safety in the Workplace', Jones & Bartlett Learning, 2000.
3.	V.K.Mehta& Rohit Mehta, Principles of Electrical Engineering, S.Chand publications, 2nd Edition, 2003.
4.	Lawmans, Electricity act 2003, Act No. 36 of 2003, Kamal Publishers, New Delhi.

191GES202T	ENGINEERING MECHANICS	Periods per week				Credits
		L	T	P	R	
		3	2	0	0	4

PREREQUISITES:
NIL

COURSE OBJECTIVES:	
1.	To apply the fundamental concepts in determining the effect of forces on a particle and rigid body
2.	To determine the geometry dependant properties of solids and sections
3.	To apply the principles of kinetics and kinematics in dynamics
4.	To understand the concepts of static friction
5.	To know the basics of solid mechanics

UNIT	TITLE	PERIODS
I	STATICS OF PARTICLES	12

Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces – Vectorial representation of forces – Vector operations of forces - Coplanar Forces – Resolution and Composition of forces – Free body diagram - Forces in space – Equilibrium and equivalent system of forces in space – Principle of transmissibility.

UNIT	TITLE	PERIODS
II	EQUILIBRIUM OF RIGID BODIES	12

Free body diagram – Types of supports –reaction forces –stable equilibrium –- Moments and Couples – Vectorial representation of moments and couples – Varignon's theorem – Single equivalent force - Resultant and equilibrium - Equilibrium of Rigid bodies in two and three dimensions - Analysis of truss elements – method of joints.

UNIT	TITLE	PERIODS
III	PROPERTIES OF SURFACES AND SOLIDS	12

Centre of gravity, Centre of mass and Centroid – Moment of Inertia of simple and complex areas -Theorems of Pappus - Area moments of inertia of plane areas -Parallel axis theorem and perpendicular axis theorem – Principal moments of inertia of plane areas – Radius of gyration – Polar moment of inertia – Product of inertia - Mass moment of Inertia of simple solids.

UNIT	TITLE	PERIODS
IV	DYNAMICS OF PARTICLES AND FRICTION	12

Kinematics – Rectilinear and curvilinear motion – projectile motion Kinetics – Newton's second law – D'Alembert's Principle – Work Energy method – Principle of Impulse momentum – Laws of friction – coefficient of friction – Dry friction – wedge friction – ladder friction – rolling resistance.

UNIT	TITLE	PERIODS
V	STRESS, STRAIN AND DEFORMATION OF SOLIDS	12

Stresses - Strain - - Hooke's law-Relationship among elastic constants- Factor of safety-Thermal stresses-

Compound bars- Strain energy due to axial force, impact and suddenly applied load.

TOTAL PERIODS:	**60**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Analyze the particle and rigid body in equilibrium
CO2:	Evaluate the properties of surfaces and solids
CO3:	Calculate dynamic forces exerted in rigid body
CO4:	Determine the friction and the effects by the laws of friction
CO5:	Evaluate the properties of deformable solids
CO6:	Evaluate the important properties of statics and dymamics.

TEXT BOOKS:	
1.	Beer, F.P and Johnston Jr. E.R., “Vector Mechanics for Engineers (In SI Units): Statics and Dynamics”, 8th Edition, Tata McGraw-Hill Publishing company, New Delhi (2004).
2.	Popov, E.P, “Engineering Mechanics of Solids”, Prentice-Hall of India, New Delhi, (2009).
3.	Kazmi, S. M. A., Solid Mechanics, TMH, Delhi, India., 2008.
4.	Rajasekaran S and Sankarasubramanian G., “Engineering Mechanics Statics and Vikas Publishing House Pvt. Ltd., 2005. Dynamics”, 3rd Edition

REFERENCE BOOKS:	
1.	Bhavikatti, S.S and Rajashekarappa, K.G., “Engineering Mechanics”, New Age International (P) Limited Publishers, 2009.
2.	Hibbeller, R.C and Ashok Gupta, “Engineering Mechanics: Statics and Dynamics”, 11th Edition, Pearson Education 2010.
3.	Irving H. Shames and Krishna Mohana Rao. G., “Engineering Mechanics – Statics and Dynamics”, 4th Edition, Pearson Education 2006

191CYM201T	ENVIRONMENTAL SCIENCE	Periods per week				Credits
		L	T	P	R	
		3	0	0	0	3

PREREQUISITES:
NIL

COURSE OBJECTIVES:	
1.	To appreciate and acquire knowledge about nature, environmental education and biodiversity.
2.	To understand the interrelationship between living organism and environment, environment functions and its value.
3.	To assess the environmental pollution and its impact on the human world.
4.	To find and implement scientific, economic and political solutions to environmental problems.
5.	To gain knowledge about waste management and resource recovery for protecting the environment.

UNIT	TITLE	PERIODS
I	ENVIRONMENT AND BIODIVERSITY	9

Definition and scope of an environment – structure of an ecosystem –biotic and abiotic components– ecological succession – food chain, food web – Introduction to biodiversity definition, types – biogeographical classification of India, India as a mega-diversity nation – values of biodiversity– endangered and endemic species of India hot-spots of biodiversity – threats to biodiversity – conservation of biodiversity.

UNIT	TITLE	PERIODS
II	NATURAL RESOURCES AND ITS CONSERVATION	9

Forest resources - Uses and over exploitation, Deforestation, causes and its effects - Water Resources – Uses and over utilization - Water conservation- Dams, benefits and their effects, Rain Water Harvesting, Watershed Management – Mineral resources - Uses and exploitation, Food resources- World food problems - Effects of modern agriculture – Energy resources - Ocean energy, Geothermal energy, Biomass energy.

UNIT	TITLE	PERIODS
III	ENVIRONMENTAL DEGRADATION	9

Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Noise pollution (e) Thermal pollution – role of an individual in prevention of pollution – pollution case studies – disaster management: cyclone, flood, drought, earthquake and landslides - case studies

UNIT	TITLE	PERIODS
IV	SOCIAL ISSUES	9

Population and Sustainability: Population explosion - Sustainable development – Equitable use of resources for sustainable lifestyles-urban problems related to energy - Role of information technology in environment and human health.

Industrial effluent treatment: Removal of organic constituents-Biological oxidation process-Removal of inorganic constituents-Metal and radioactive wastes, zero liquid discharge solutions from textile industries.

UNIT	TITLE	PERIODS

V	WASTE MANAGEMENT AND RESOURCE RECOVERY	9
Introduction –Biodegradable, non-biodegradable waste, Municipal solid waste and its management - Special waste – E-waste and Scrap tires - Definition, causes, effects and its management - Resource recovery: a) Waste land reclamation b) Sewage treatment c) Recycling of Plastic, Glass and Paper wastes.		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Environmental education initiates an awareness, deeper understanding and sensitivity to the environment and environmental challenges.
CO2:	Acquired knowledge about the principles of nature, environment and their protection
CO3:	Created an involvement to the public to implement environmental laws effectively.
CO4:	Environmental education allows an individual to explore and think about the modern lifestyle has lead to serious environmental disasters and should develop the skills to make responsible decisions.
CO5:	Acquired skills to behave ecofriendly.

TEXT BOOKS:	
1.	Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2006.
2.	Handbook of Solid Waste Management (McGraw-Hill Handbooks), George Tchobanoglous, Frank Kreith, Publisher: McGraw-Hill Education; 2 edition July, 2002

REFERENCE BOOKS:	
1.	R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media.
2.	Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT LTD,New Delhi, 2007.
3.	Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press 2005.
4.	Waste Management and Resource Recovery, Charles R. Rhyner, Leander J.Schwartz, Robert B. Wenger, Mary G. Kohrell, CRC Press Published August 31, 1995.
5.	Industrial wastewater management, treatment and disposal, Water management" Federation Alexandria Virgiia, Third Edition, 2008.

191GES211L	ENGINEERING PRACTICES LABORATORY (Common to all branches of Engineering and Technology)	Periods per week				Credits
		L	T	P	R	
		0	0	4	0	2

PREREQUISITES:
NIL

COURSE OBJECTIVES:	
1.	To provide exposure to the students with the concepts involved in product realization by carrying out manufacturing shop exercises. Hands-on practice with manufacturing shop exercises and assembly leading to realization of a new product in a group.

GROUP A (CIVIL & MECHANICAL)

I

CIVIL ENGINEERING PRACTICE

A. Plumbing Works:

1. Pipeline joints, its location and functions: Valves, Taps, Couplings, Unions, Reducers, Elbows in household fittings.
2. Connection of two Galvanized Iron pipes
3. Connection of PVC pipes
4. Basic pipe connections involving the fitting like Valves, Taps and Bends

B. Carpentry works:

1. Joints in Roofs, Doors, Windows and Furniture.
2. Cross Lap joint
3. Mortise and Tenant joint

MECHANICAL ENGINEERING PRACTICE

A. Welding:

1. Arc welding of Butt joints, Tap joints and Tee joints.
2. Gas welding practice

B. Basic machining:

1. Simple Turning and Taper turning
2. Drilling practice

C. Sheet metal work:

1. Rectangular tray making
2. Funnel making

GROUP B (ELECTRICAL & ELECTRONICS)

ELECTRICAL ENGINEERING PRACTICE

1. Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2. Fluorescent lamp wiring.
3. Stair case wiring
4. Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.

5. Measurement of energy using single phase energy meter. Measurement of resistance to earth of electrical equipment
I. ELECTRONICS ENGINEERING PRACTICE
1. Electronic components and equipments – Resistor, colour coding measurement of AC signal parameter (peak-peak, RMS period, frequency) using CR. 2. Logic gates AND, OR, EX-OR and NOT. 3. Generation of Clock Signal. 4. Soldering practice – Components Devices and Circuits – Using general purpose PCB. **5.** Measurement of ripple factor of HWR and FWR.
TOTAL PERIODS: 60

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Fabricate carpentry components and pipe connections including plumbing works.
CO2:	Use welding equipments to join the structures.
CO3:	Carry out the basic machining operations
CO4:	Make the models using sheet metal works
CO5:	Carry out basic home electrical works and Understand works of Home Appliances Measure the electrical quantities
CO6:	Elaborate on the Electronic components, Logic gates and soldering practice.

191GES212L	BASIC ELECTRIC AND ELECTRONICS ENGINEERING LABORATORY	Periods per week				Credits
		L	T	P	R	
		0	0	4	0	2

PREREQUISITES:
NIL

COURSE OBJECTIVES:	
1.	To train the students in performing various tests on Electrical machines, Sensors and circuits.

LIST OF EXPERIMENTS:	
1.	Load test on separately excited DC generator
2.	Load test on Single phase Transformer
3.	Load test on Induction motor
4.	Verification of Circuit Laws
5.	Load test on DC shunt motor.
6.	Diode based application circuits
7.	Transistor based application circuits
8.	Study of CRO and measurement of AC signals
9.	Characteristics of LVDT
10.	Calibration of Rotometer
11.	RTD and Thermistor

TOTAL PERIODS:	60

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Ability to understand and apply circuit theorems, basic concepts in Electrical and Electronics Engineering applications

SYLLABUS OF

SEMESTER – III

COURSES

191MAB301T	TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS	Periods per week				Credits
		L	T	P	R	
		3	2	0	0	4

PREREQUISITES:
NIL

COURSE OBJECTIVES:	
1.	To introduce the basic concepts of PDE for solving standard partial differential equations.
2.	To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
3.	To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
4.	To acquaint the student with Fourier transform techniques used in wide variety of situations.
5.	To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems

UNIT	TITLE	PERIODS
I	PARTIAL DIFFERENTIAL EQUATIONS	12
Formation of partial differential equations – Singular integrals - Solutions of standard types of first order partial differential equations - Lagrange's linear equation - Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.		
UNIT	TITLE	PERIODS
II	FOURIER SERIES	12
Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Complex form of Fourier series – Parseval's identity – Harmonic analysis		
UNIT	TITLE	PERIODS
III	APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS	12
Classification of PDE – Method of separation of variables - Fourier Series Solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction.		
UNIT	TITLE	PERIODS
IV	FOURIER TRANSFORMS	12
Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.		
UNIT	TITLE	PERIODS
V	TRANSFORMS AND DIFFERENCE EQUATIONS	12

Z-transforms - Elementary properties – Inverse Z-transform (using partial fraction and residues) – Initial and final value theorems - Convolution theorem - Formation of difference equations – Solution of difference equations using Z - transform.

TOTAL PERIODS:	**60**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Solve linear, first and higher order, homogeneous and non-homogeneous partial differential equations.
CO2:	Use Fourier series expansion of a complicated periodic function, in terms of simple periodic functions to know its basic nature better.
CO3:	Solve one dimensional wave and two dimensional steady state heat flow PDEs with initial and boundary conditions.
CO4:	Evaluate definite integrals by using Fourier transform techniques.
CO5:	Evaluate definite integrals by using Fourier transform techniques.

TEXT BOOKS:	
1.	Grewal B.S., “Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, New Delhi, 2014.
2.	Narayanan S., ManicavachagomPillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.

REFERENCE BOOKS:	
1.	Andrews. L.C, L.C and Shivamoggi, B, "Integral Transforms for Engineers" SPIE Press, 1999.
2.	Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 9th Edition, Laxmi Publications Pvt. Ltd, 2014.
3.	Erwin Kreyszig, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, India, 2016.
4.	James. G., "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2007.
5.	Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
6.	Wylie R.C., and Barrett, L.C., “Advanced Engineering Mathematics “Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.

191MEC301T	MANUFACTURING TECHNOLOGY-I	Periods per week				Credits
		L	T	P	R	
		3	0	0	0	3

PREREQUISITES:
NIL

COURSE OBJECTIVES:	
1.	To learn various sand casting, special casting processes and familiarize to make mould preparations.
2.	To gain knowledge in various metal joining processes and select proper welding process for suitable applications.
3.	To provide knowledge in various bulk deformation processes and its applications.
4.	To gain knowledge in sheet metal forming processes and special forming processes and familiarize to make small sheet metal parts
5.	To learn about various plastic moulding, forming processes and its applications

UNIT	TITLE	PERIODS
I	METAL CASTING PROCESSES	9
Sand casting – Sand moulds - Type of patterns – Pattern materials – Pattern allowances – Types of Moulding sand – Properties – Core making – Runner, Riser and Gating Design,– Working principle of Special casting processes – Shell, investment casting – Pressure die casting – Centrifugal casting- Sand Casting defects – Inspection methods, Melting Practices: cupola, Induction furnaces and Hearth Furnace construction and operations.		
UNIT	TITLE	PERIODS
II	JOINING PROCESSES	9
Fusion welding processes-Types of Gas Welding-Fuel Gases, Oxy-Acetylene Welding Equipment-Flame characteristics- Filler and Flux materials, Inert-Gas Shielded Arc Welding, Tungsten Inert-Gas Welding (TIG), Gas Metal-Arc Welding (GMAW), Submerged Arc-Welding (SAW), Resistance Welding, Thermit Welding, Laser Beam welding, Electron Beam Welding, Friction welding, Friction stir welding, Explosion welding and Ultrasonic welding-Welding Defects.		
UNIT	TITLE	PERIODS
III	BULK DEFORMATION PROCESSES	9
Hot and cold working processes-Forging processes-Open, impression and closed die forging-types of Forging machines-Typical forging operations-Swaging- Defects in forged parts-Rolling of metals-Types of rolling mills-Flat strip rolling-Shape rolling operations-Defects in rolled parts-principle of rod and wire drawing-Tube drawing-Principles of extrusion-Types of Extrusion-hot and cold extrusion-Equipments used.		
UNIT	TITLE	PERIODS
IV	SHEET METAL PROCESSES	9
Sheet metal characteristics - Typical shearing operations, bending and drawing operations – Stretch forming		

operations – Formability of sheet metal – Test methods – Presses for sheet metal working, Elements of a simple die; punch and die clearances- Working principle and application of special forming processes - Hydro forming – Rubber pad forming – Metal spinning – Explosive forming – Magnetic pulse forming – Super plastic forming-Electro hydraulic forming.

UNIT	TITLE	PERIODS
V	**PLASTIC PROCESSING**	9

Processing of plastics: General aspects-Plastic processing methods-compression moulding-Transfer moulding-Injection moulding-Expandable bead moulding- rotational moulding-blow moulding-Extrusion-Thermoforming-Introduction to 3D printing and its applications.

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Select an appropriate casting process for a given simple industrial components.
CO2:	Choose suitable welding processes for industrial applications.
CO3:	Design the method of bulk deformation for a given product.
CO4:	Choose a suitable sheet metal forming technique for a given component.
CO5:	Design a molding process for a given plastic component.

TEXT BOOKS:	
1.	Gowri P. Hariharan, A. Suresh Babu, "Manufacturing Technology I", Pearson Education, 2013.
2.	Rao P N, “Manufacturing Technology”, Tata McGraw Hill Publishing Co. Ltd., Volume 1, New Delhi, 2010.
3.	Serope Kalpakjian and Stephen Schmid,”Manufacturing, Engineering and Technology”, SI 6th Edition -”, Pearson Education, 2010.

REFERENCE BOOKS:	
1.	Heine R W, Loper C R and Rosenthal P C, “Principles of Metal Casting”, Tata McGraw Hill Publishing Co. Ltd., New Delhi,2010.
2.	Mikell P. Groover,” Principles of Modern Manufacturing”, SI Version, Wiley & sons Pvt. Ltd, 2013.
3.	Rajput,R.K.”A textbook of manufacturing technology (manufacturing processes)”,Laxmi publications (p) ltd, 2015.

191MEC302T	FLUID MECHANICS AND MACHINERY	Periods per week				Credits
		L	T	P	R	
		3	0	0	0	3

PREREQUISITES:
NIL

COURSE OBJECTIVES:	
1.	To introduce the fundamental properties of fluids.
2.	To impart the boundary layer concepts and losses in pipes.
3.	To emphasize the importance of dimensional analysis in modeling and prototyping.
4.	To interpret the performance characteristics in types of pumps.
5.	To comprehend the importance, types and governing of turbines.

UNIT	TITLE	PERIODS
I	FLUID PROPERTIES	10

Units and dimensions- Properties of fluids- mass density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapor pressure, surface tension and capillarity, Buoyancy forces. Flow characteristics – application of continuity equation, energy equation and momentum equation. Manometer and its Applications

UNIT	TITLE	PERIODS
II	FLOW THROUGH PIPES AND CHARACTERISTICS	10

Hydraulic and energy gradient - Laminar flow through circular conduits and circular annuli-Boundary layer concepts – types of boundary layer thickness – Darcy Weisbach equation –friction factor - minor losses – Flow through pipes in series and parallel.

Fluid Kinematics - Velocity and Acceleration of a fluid particle-Stream line, stream tubes and path line- Vorticity and irrotationality.

UNIT	TITLE	PERIODS
III	DIMENSIONAL ANALYSIS	7

Need for dimensional analysis – methods of dimensional analysis – Similitude –types of similitude - Dimensionless parameters- application of dimensionless parameters – Model analysis

UNIT	TITLE	PERIODS
IV	PUMPS	9

Impact of jets - Euler's equation - Theory of roto-dynamic machines – various efficiencies– velocity components at entry and exit of the rotor- velocity triangles - Centrifugal pumps– working principle - work done by the impeller - performance curves - Reciprocating pump- working principle – Rotary pumps –classification.

UNIT	TITLE	PERIODS
V	TURBINES	9

Classification of turbines – heads and efficiencies – velocity triangles. Axial, radial and mixed flow turbines- Pelton wheel, Francis turbine and Kaplan turbines- working principles - work done by water on the runner – draft tube. Specific speed - unit quantities – performance curves for turbines – governing of turbines.
Case Studies: Selection of suitable pumps to transfer the fluids for Domestic, Agricultural and other purposes - Economic considerations for installing Hydro-electric power plant and Selection of suitable turbine.

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Apply the basic equations of fluid statics to predict the properties of fluids.
CO2:	Analyze the flow characteristics and the losses associated in piping networks.
CO3:	Apply principles of Dimensional analysis and similitude to basic problems.
CO4:	Evaluate the performance characteristics of Centrifugal and Reciprocating Pumps.
CO5:	Select an appropriate Hydraulic turbine for power generation.

TEXT BOOKS:	
1.	Bansal. R.K , “Fluid mechanics and hydraulic machines”, Laxmi publications, tenth Edition 2018
2.	Modi P.N. and Seth, S.M. "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi 2015.

REFERENCE BOOKS:	
1.	Graebel. W.P, "Engineering Fluid Mechanics", Taylor & Francis, Indian Reprint, 2011
2.	Kumar K. L., "Engineering Fluid Mechanics", Eurasia Publishing House(p) Ltd., New Delhi 2016
3.	Robert W.Fox, Alan T. McDonald, Philip J.Pritchard, “Fluid Mechanics and Machinery”, 2011.
4.	Streeter, V. L. and Wylie E. B., "Fluid Mechanics", McGraw Hill Publishing Co. 2010

191MEC303T	ENGINEERING THERMODYNAMICS	Periods per week				Credits
		L	T	P	R	
		3	2	0	0	4

PREREQUISITES:
NIL

COURSE OBJECTIVES:	
1.	To enable the students to understand the fundamentals and first law of thermodynamics
2.	To make the students to understand second law of thermodynamics and apply it to open and closed systems, and to analyze the availability and entropy of a system.
3.	To help the students to understand and apply the properties of pure substances to analyze steam power cycles.
4.	To enable the students to understand and apply the concepts of real and ideal gases, equations of state and thermodynamic relations.
5.	To enable the students to learn about the properties of gas mixtures for evaluating the properties of moist air.
(Use of Standard Steam Table, Mollier chart, Compressibility Chart and Psychrometric Charts are permitted)	

UNIT	TITLE	PERIODS
1	BASIC CONCEPTS AND FIRST LAW	12

Fundamental concepts and definitions- continuum, Microscopic and Macroscopic approaches. Path and point functions. Intensive and extensive properties, total and specific quantities. System, surrounding, boundary and their types. Thermodynamic Equilibrium. State, path and process. Quasi-static, reversible and irreversible processes. Heat and work transfer - definition and comparison, sign convention. Displacement work, P-V diagram and other modes of work. Zeroth law - concept of temperature and thermal equilibrium. First law - application to closed and open systems - steady and unsteady flow processes.

UNIT	TITLE	PERIODS
2	SECOND LAW AND AVAILABILITY ANALYSIS	12

Heat Reservoir - source and sink. Heat Engine, Refrigerator, Heat pump. Statements of second law and its corollaries. Carnot cycle, Reversed Carnot cycle, Performance. Clausius inequality. Concept of entropy, T-s diagram, Tds Equations - entropy change for a pure substance, ideal gases undergoing different processes, principle of increase in entropy. Applications of II Law. High and low grade energy. Availability and Irreversibility analysis for open and closed systems, I and II law Efficiency.

UNIT	TITLE	PERIODS
3	PROPERTIES OF PURE SUBSTANCE AND STEAM POWER CYCLE	12

Properties of pure substances – formation of Steam and its thermodynamic properties p-v, p-T, T-v, T-s, h-s diagrams. p-v-T surface. Determination of dryness fraction. Calculation of work done and heat transfer in non-flow and flow processes using Steam Table and Mollier Chart. Rankine cycle- cycle efficiency-reheat cycle-regenerative cycle (concept only)

UNIT	TITLE	PERIODS

4	IDEAL AND REAL GASES, THERMODYNAMIC RELATIONS	12

Properties of Ideal gas, real gas, and their comparison. Equations of state for ideal and real gases. Van der Waal's relation, Reduced properties, Compressibility factor, Principle of Corresponding states. Generalized Compressibility Chart and its use. Maxwell relations, Tds Equations, heat capacities relations, Energy equation, Joule-Thomson experiment, Phase Change Processes, Clausius-Clapeyron equation. Simple Calculations.

UNIT	TITLE	PERIODS
5	GAS MIXTURES AND PSYCHROMETRY	12

Gas and gas-vapour mixtures - Dalton's and Amagat's laws, properties of ideal gas mixtures. Psychrometric properties - Property calculations using Psychrometric chart and expressions. Psychrometric processes - adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing.

TOTAL PERIODS:	60

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Determine the thermal parameters of open and closed systems using first law of thermodynamics.
CO2:	Calculate the thermal parameters of open and closed systems using second law of thermodynamics for energy grading.
CO3:	Determine the performance parameters of steam power cycles
CO4:	Calculate the thermodynamic properties of ideal and real gases.
CO5:	Estimate the thermodynamic properties of gas mixtures, moist air for psychrometric processes.

TEXT BOOKS:	
1.	Rajput R.K. “A Text Book Of Engineering Thermodynamics “, Fifth Edition, 2016.
2.	Yunus A. Cengel & Michael A. Boles, “Thermodynamics, An Engineering Approach”, Ninth Edition 2019.

TABLES:	
1.	Khurmi, R.S, “Steam Tables with Mollier Diagram”, S.Chand Publishers, 2008
2.	Kothandaraman, C.P, “Refrigeration tables and charts including air conditioning data”, New Age International Publishers, 2014

REFERENCE BOOKS:	
1.	Arora C P, “Thermodynamics”, Tata McGraw-Hill, New Delhi, 2008
2.	Borgnakke & Sonnatag, “Fundamental of Thermodynamics”, Eighth Edition, 2016.
3.	Chattopadhyay,P,”Engineering Thermodynamics”, Oxford University Press, 2016.
4.	Holman J P, “Thermodynamics”, Third Edition, McGraw-Hill, 2000.
5.	Nag P K, “Engineering Thermodynamics”, Tata McGraw-Hill, New Delhi, 5th Edition, 2013.

191EES321T	ELECTRICAL DRIVES AND CONTROL	Periods per week				Credits
		L	T	P	R	
		3	0	0	0	3

PREREQUISITES:
NIL

COURSE OBJECTIVES:	
1.	To understand the basic concepts of different types of electrical machines and their performance.
2.	To study the different methods of starting D.C motors and induction motors.
3.	To study the conventional and solid-state drives

UNIT	TITLE	PERIODS
1	INTRODUCTION	8
Basic Elements – Types of Electric Drives – factors influence the choice of electrical drives – heating and cooling curves – Loading conditions and classes of duty – Selection of power rating for drive motors with regard to thermal overloading and Load variation factors.		
UNIT	TITLE	PERIODS
2	DRIVE MOTOR CHARACTERISTICS	9
Mechanical characteristics – Speed-Torque characteristics of various types of load and drive motors – Braking of Electrical motors – DC motors: Shunt, series and compound - single phase and three phase induction motors.		
UNIT	TITLE	PERIODS
3	STARTING METHODS	8
Types of D.C Motor starters – Typical control circuits for shunt and series motors – Three phase squirrel cage and slip ring induction motors.		
UNIT	TITLE	PERIODS
4	CONVENTIONAL AND SOLID STATE SPEED CONTROL OF D.C. DRIVES	10
Speed control of DC series and shunt motors – Armature and field control, Ward-Leonard control system - Using controlled rectifiers and DC choppers –applications.		
UNIT	TITLE	PERIODS
5	CONVENTIONAL AND SOLID STATE SPEED CONTROL OF A.C. DRIVES	10
Speed control of three phase induction motor – Voltage control, voltage / frequency control, slip power recovery scheme – Using inverters and AC voltage regulators – applications.		

TOTAL PERIODS:	45

COURSE OUTCOMES:

Upon completion of this course, student will be able to:	
	Upon Completion of this subject, the students can able to
CO1:	Illustrate the heating and cooling curves of an electric drive for different load conditions.
CO2:	Assess the characteristics of various types of DC and AC machines.
CO3:	Correlate the types of starters for starting D.C and AC machines.
CO4:	Analyze the conventional and solid state speed control of DC drives.
CO5:	Outline the conventional and solid state speed control of AC drives.

TEXT BOOKS:	
1.	Nagrath .I.J. & Kothari .D.P, “Electrical Machines”, Tata McGraw-Hill, 2006
2.	Vedam Subrahmaniam, “Electric Drives (Concepts and Applications)”, Tata McGraw-Hill, 2010

REFERENCE BOOKS:	
1.	Partab. H., “Art and Science and Utilisation of Electrical Energy”, Dhanpat Rai and Sons, 2017
2.	Pillai.S.K “A First Course on Electric Drives”, Wiley Eastern Limited, 2012
3.	Singh. M.D., K.B.Khanchandani, “Power Electronics”, Tata McGraw-Hill, 2006.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191CES331L	**STRENGTH OF MATERIALS AND FLUID MECHANICS LABORATORY**	**0**	**0**	**3**	**1**	**2**

COURSE OBJECTIVES:	
1.	To study the mechanical properties of materials when subjected to tension, torsion, hardness & deformation test.
2.	To make use of impact testing to measure the impact strength of the given material
3.	To investigate the effectiveness of the flow measuring device.
4.	To get exposure in frictional losses of fluid flow through pipes.
5.	To investigate the performance of the hydraulic turbines

LIST OF EXPERIMENTS (STRENGTH OF MATERIALS)	
1.	Tension test on a mild steel rod
2.	Double shear test on Mild steel and Aluminium rods
3.	Torsion test on mild steel rod
4.	Impact test on metal specimen
5.	Hardness test on metals - Brinnell and Rockwell Hardness Number
6.	Deflection test on beams
7.	Compression test on helical springs
8.	Strain Measurement using Rosette strain gauge
9.	Effect of hardening- Improvement in hardness and impact resistance of steels.
10.	Tempering- Improvement Mechanical properties Comparison
	Unhardened specimen
	Quenched Specimen and
	Quenched and tempered specimen.
11.	Microscopic Examination of
	Hardened samples and
	Hardened and tempered samples.
	LIST OF EXPERIMENTS (FLUID MECHANICS AND MACHINES)
1.	Determination of the Coefficient of discharge of given Orifice meter.
2.	Determination of the Coefficient of discharge of given Venturi meter.
3.	Calculation of the rate of flow using Rota meter.
4.	Determination of friction factor for a given set of pipes.
5.	Conducting experiments and drawing the characteristic curves of centrifugal pump/ submergible pump
6.	Conducting experiments and drawing the characteristic curves of reciprocating pump.
7.	Conducting experiments and drawing the characteristic curves of Gear pump.

8.	Conducting experiments and drawing the characteristic curves of Pelton wheel.
9.	Conducting experiments and drawing the characteristics curves of Francis turbine.
10.	Conducting experiments and drawing the characteristic curves of Kaplan turbine.

TOTAL PERIODS:	**60**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Perform Mechanical testing of given material including tension & compression, torsion, Hardness, and Deformation test on solid materials.
CO2:	Characterize mechanical properties given specimen including impact strength.
CO3:	Calibrate the fluid flow using Orifice & Venturi meter.
CO4:	Investigate the various losses takes place in fluid flow through pipes.
CO5:	Select the suitable Hydraulic turbines for power generation.

REFERENCES: (OPTIONAL)	
1.	Bansal. R.K , “Fluid mechanics and hydraulic machines”, Laxmi publications, tenth Edition 2018
2.	Dr.Bansal.R.K,“Strength of Materials”, Laxmi publications, Fifth edition, Chennai, 2013

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEC311L	**MANUFACTURING TECHNOLOGY LABORATORY I**	**0**	**0**	**2**	**0**	**1**

COURSE OBJECTIVES:	
1.	Practice the various operations that can be performed in lathe, shaper machines etc. and equip with the practical knowledge required in the core industries.
2.	Acquire knowledge on sand casting processes and equipped with practical skills, applications in real life manufacture of components in the industry.
3.	Increase the level of confidence of students by working individually in various machine tools.

LIST OF EXPERIMENTS	
1.	Taper Turning using compound rest Method
2.	Taper Turning using Tailstock set over Method
3.	Eccentric Turning
4.	External Thread Cutting
5.	Internal Thread Cutting
6.	Square Head Shaping
7.	Hexagonal Head Shaping
8.	V-Block Shaping
9.	Preparation of Green Sand Mould using Solid piece pattern
10.	Preparation of Green Sand Mould using Split piece pattern
11.	Metal Casting Process (Demo)
12.	Injection Moulding Process (Demo)

TOTAL PERIODS:	**30**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Perform turning operations on cylindrical objects for given specification.
CO2:	Perform Thread cutting operations on cylindrical objects for given specification.
CO3:	Perform shaping operation on components for the given specifications.
CO4:	Perform sand casting operation and produce different Mould components
CO5:	Fabricate components by using the process of injection moulding, casting.

REFERENCES: (OPTIONAL)	
1.	Heinrich Gerling, “All about Machine Tools”, Wiley Publishers, 1979.
2.	Hajra Choudhary, “Workshop Technology” Vol. 1 & Vol. 2 15th Edition, Media Promoters Publication-2008
3.	Prashant P. Date, "Introduction to Manufacturing Technologies: Principles & Practice", Jaico Publishing House, 2010.

4.	Rao P. N, "Manufacturing Technology", Vol.1 & Vol. 2, 4th Edition, Tata McGraw-Hill, 2013.
5.	Serope Kalpakjian, and Steven R. Schmid, "Manufacturing Engineering and Technology", 5th Edition, Pearson Education, 2015.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191EES331L	**ELECTRICAL ENGINEERING LABORATORY**	**0**	**0**	**2**	**0**	**1**

COURSE OBJECTIVES:	
1.	To validate the principles studied in theory by performing experiments in the laboratory

LIST OF EXPERIMENTS	
1.	Load test on DC Series motor
2.	Load test on DC Series motor
3.	O.C.C & Load characteristics of DC Shunt and DC Series generator
4.	Speed control of DC shunt motor (Armature, Field control)
5.	O.C & S.C Test on a single phase transformer
6.	Regulation of an alternator by EMF & MMF methods.
7.	V curves and inverted V curves of synchronous Motor
8.	Load test on three phase squirrel cage Induction motor
9.	Speed control of three phase slip ring Induction Motor
10.	Study of DC & AC Starters

TOTAL PERIODS:	**30**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Ability to perform speed characteristic of different electrical machine.

SYLLABUS OF

SEMESTER – IV

COURSES

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MAB401T	**STATISTICS AND NUMERICAL METHODS**	**3**	**2**	**0**	**0**	**4**

PREREQUISITES:
NIL / Course Code – Course Title / Topics

COURSE OBJECTIVES:	
1.	This course aims at providing the necessary basic concepts of a few statistical and numerical methods and give procedures for solving numerically different kinds of problems occurring in engineering and technology.
2.	To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems?
3.	To introduce the basic concepts of solving algebraic and transcendental equations.
4.	To introduce the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines?
5.	To acquaint the knowledge of various techniques and methods of solving ordinary differential equations

UNIT	**TITLE**	**PERIODS**
1	PROBABILITY AND DISTRIBUTIONS	**8+4**
Review of Probability – Axiomatic definition – Baye's theorem – Discrete and continuous random variables – Moments – Moment generating functions – Problems on Binomial, Poisson, Uniform and Normal distributions – Sampling distributions (Student, F, Chi-square definitions only)-Central Limit theorem (Statement only).		
UNIT	**TITLE**	**PERIODS**
2	TESTING OF HYPOTHESIS	**8+4**
Point and interval estimations - Statistical hypothesis-Large sample test based on Normal distribution for single mean and difference of means, single and two variance – Chi square distribution(Goodness of fit and Independence of Attributes).		
UNIT	**TITLE**	**PERIODS**
3	**SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS**	**8+4**
Solution of algebraic and transcendental equations –Fixed point iteration method-Newton Raphson method – Gauss elimination method – Gauss Jordan methods – Iterative methods of Gauss Jacobi and Gauss Seidel – Eigen values of a matrix by power method and Jacobi's method for symmetric matrices.		
UNIT	**TITLE**	**PERIODS**
4	**INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION**	**8+4**
Lagrange's and Newton's divided difference interpolations – Newton's forward and backward difference interpolation – Approximation of derivates using interpolation polynomials –Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules.		
UNIT	**TITLE**	**PERIODS**
5	**NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS**	**8+4**
Single step methods: Taylor's series method – Euler's method – Modified Euler's method – Fourth order Runge-Kutta method for solving first order equations – Multi step methods: Milne's and Adams-Bash forth predictor corrector methods for solving first order equations.		

TOTAL PERIODS:	**60**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Use the probability distribution to study discrete and continuous random variables.
CO2:	Find the acceptability of null hypothesis by applying testing of hypothesis for small and large samples.
CO3:	Solve algebraic, transcendental and simultaneous equations numerically.
CO4:	Use various numerical techniques to differentiate and integrate discrete functions.
CO5:	Find the numerical solutions of ordinary differential equations by using single step and multi step methods.

TEXT BOOKS:	
1.	Grewal. B.S., and Grewal. J.S., "Numerical Methods in Engineering and Science",10th Edition,,Khanna Publishers, New Delhi, 2015.
2.	Johnson. R.A.,Miller,I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, , Asia, 8th edition, 2015.

REFERENCE BOOKS:	
1.	Burden ,R.L and faires , J.D, "Numerical Analysis", 9th Edition, Cengage Learning,2016.
2.	Devore.J.L , "Probability and Statistics for Engineering and the Sciences",Cengage Learning,New Delhi,8th Edition,2014.
3.	Gerald. C.F., and Wheatley. P.O. "Applied Numerical Analysis" Pearson Education, Asia, New Delhi, 2006.
4.	Spiegel. M.R., Schiller. J., and Srinivasan. R.A., "Schaum's Outlines on Probability and Statistics", Tata McGraw Hill Edition, 2004.
5.	Walpole. R.E., Myers. R.H., Myers. S.L., and Ye. K., "Probability and Statistics for Engineers and Scientists", 8th Edition, Pearson Education, Asia, 2007.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEC401T	**MANUFACTURING TECHNOLOGY-II**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES:
NIL / Course Code – Course Title / Topics

COURSE OBJECTIVES:	
1.	To explain the theory of metal cutting with clarity.
2.	To explain the theory of metal cutting with clarity.
3.	To explain working of reciprocating and milling machines
4.	To enable the students to understand working of abrasive and super finishing processes.
5.	To explain the working principles of Non-traditional machining processes with clarity.
6.	To introduce and explain CNC machine tools and part programming fundamentals

UNIT	**TITLE**	**PERIODS**
1	**THEORY OF METAL CUTTING**	**9**
Mechanics of chip formation, single point cutting tool, forces in machining, Types of chip, cutting tools– nomenclature, orthogonal metal cutting, thermal aspects, cutting tool materials, tool wear, tool life, surface finish, cutting fluids and Machinability.		
UNIT	**TITLE**	**PERIODS**
2	**TURNING MACHINES**	**9**
Centre lathe and Capstan & Turret Lathe, semiautomatic – single spindle , automatic screw type – multi spindle- cycle time reduction- specifications, description, Nomenclature of single point cutting tool, operations performed on lathe, lathe accessories & attachments, Work & tool holding methods/devices, Process parameters - Definition of process parameters - cutting speed, feed, DOC & machining time.		
UNIT	**TITLE**	**PERIODS**
3	**SHAPER, BROACHING AND MILLING MACHINES**	**9**
Shaper: Introduction, types, specifications, description, quick return mechanism, Process parameters - Definition of process parameters - cutting speed, feed, DOC & machining time. Broaching Machine: Introduction, types, specifications, description, Types of Broaches & Operations, advantages. Milling Machine: Introduction, Column and Knee type milling machine, specifications, description, attachments, milling cutters, Nomenclature of plain milling cutter & operations performed, Work & tool holding methods/devices, Process parameters - Definition of process parameters - cutting speed, feed, DOC & machining time.		
UNIT	**TITLE**	**PERIODS**
4	**ABRASIVE AND SUPER FINISHING PROCESSES**	**9**

Grinding Machines: Introduction, Classification, working of grinding machines, Grinding wheel (Abrasives & Bond), Selection of Grinding wheel, mounting, glazing & loading, dressing, balancing, Work & tool holding methods/devices, Process parameters - Definition of process parameters - cutting speed, feed, DOC & machining time. Super finishing processes: Lapping, Honing, Super finishing, Polishing & Buffing.

UNIT	TITLE	PERIODS
5	NON-TRADITIONAL MACHINING PROCESSES AND CNC	9

Principles of Non-Traditional Machining Processes - AJM, EDM, CHM, ECM, EDM, LBM and PAM.

NC & CNC fundamentals - Introduction to manual part programming and computer assisted part programming.

Case studies: Mechanics of chip formation in machining cast iron and mild steel ; Selection of suitable lathe for mass production; Helical gear cutting process in milling machine; Apply the method of producing super-finished surface; Write a part program for machining.

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Select the proper cutting tool to machining the various material.
CO2:	Manufacturing of various mechanical components using CNC turning machines .
CO3:	To create a transmission components such as gears used in automobiles.
CO4:	Apply the principles of abrasive machining processes and super finishing processes.
CO5:	Understand the principles of various non-traditional machining processes, principles of CNC and create different part programs

TEXT BOOKS:	
1.	Hajra Choudhury S. K., Nirjhar Roy, “Elements of Work shop Technology, Vol – II Machine Tools”,15th Edition, Media Promoters and Publishers Pvt. Ltd, 2015.
2.	Rao .P.N., “Manufacturing Technology”, Volume-2, Tata McGraw Hill, New Delhi, Fourth Edition, 2018

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEC402T	**STRENGTH OF MATERIALS**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES:
Nil

COURSE OBJECTIVES:	
1.	To develop the fundamental concepts of mechanics of deformable solids.
2.	To apply the transverse loads on beams and draw the shear force bending moment diagrams.
3.	To estimate the effect of structural members subjected to torsional loads.
4.	To analyze the elastic stability of beams and columns.
5.	To perform stress analysis of thin-walled members.

UNIT	**TITLE**	**PERIODS**
1	**STRESS, STRAIN DEFORMATION OF SOLIDS**	**9**
Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of simple and compound bars – Thermal stresses – Strain Energy - Elastic constants – Volumetric strains.		
UNIT	**TITLE**	**PERIODS**
2	**STRESSES IN BEAMS**	**9**
Types of beams - Supports and Loads - Shear Force and Bending Moment in beams – Cantilever, Simply supported and Overhanging beams – Bending Stresses in beams – Applications		
UNIT	**TITLE**	**PERIODS**
3	**TORSION IN SHAFTS & SPRINGS**	**9**
Torsion formulation stresses and deformation in circular and hollows shafts – Stepped shafts– Deflection in shafts fixed at the both ends – Springs – Introduction, Types and Applications: Stresses & Deflection of helical springs - Maximum shear stress in spring section including Wahl Factor.		
UNIT	**TITLE**	**PERIODS**
4	**DEFLECTION OF BEAMS & COLUMNS**	**9**
Double Integration method – Macaulay's method – Area moment method for computation of slopes and deflections in beams - Conjugate beam method. Columns - Euler equation - Slenderness ratio – Rankine's formula for columns.		
UNIT	**TITLE**	**PERIODS**
5	**BI - AXIAL STRESSES**	**9**
Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses and deformation in thin and thick cylinders – spherical shells subjected to internal pressure –Deformation in spherical shells. Stresses on inclined planes – principal stresses and principal planes – Mohr's circle of stress.		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Calculate the stress and strain acting in axial loading
CO2:	Evaluate shear force and bending moment in transverse loading
CO3:	Determine torsion and shear stress in shafts and springs
CO4:	Analyze deflection in beams and columns using appropriate methods
CO5:	Analyze the biaxial stress and strain in cylinders and shells

TEXT BOOKS:	
1.	Beer F. P, Johnston R, “Mechanics of Materials”, McGraw-Hill Book Co, Seventh Edition, 2015.
2.	Egor P. Popov, “Engineering Mechanics of Solids”, Second Edition, Pearson Education Ltd, 2015.

REFERENCE BOOKS:	
1.	Bansal.R.K,“Strength of Materials”, Laxmi publications, Sixth edition, Chennai, 2019.
2.	Hibbeler R.C, Mechanics of materials , (SI Edition) , Pearson Education Ltd, 2018.
3.	Rajput, R.K., “Strength of Materials”, S. Chand Publications, 2015.
4.	Ramamrutham.S, Narayanan.R, “Strength of Materials”, Dhanpat Rai Publishing Company (P) Ltd, Fifth edition, New Delhi, 2017.
5.	Timoshenko S.P, “Elements of Strength of Materials”, Tata McGraw-Hill, Fifth Edition, New Delhi, 2011.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEC403T	**THERMAL ENGINEERING**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES:
191MEC303T - ENGINEERING THERMODYNAMICS

COURSE OBJECTIVES:	
1.	To enable the students to understand the fundamentals of gas power cycles and its application of thermodynamic principles.
2.	To make the students to understand the internal combustion engines and its performance calculations.
3.	To enable the students to analyse the performance of steam nozzle and turbine.
4.	To familiarize the students to calculate the performance of multistage compressor
5.	To elucidate the concepts of various refrigeration and air conditioning processes.
(Use of Standard Steam Table, Mollier chart, Compressibility Chart and Psychrometric Charts are permitted)	

UNIT	**TITLE**	**PERIODS**
1	**GAS POWER CYCLES**	**9**
Otto, Diesel, Dual, Brayton cycles, Calculation of mean effective pressure, and air standard efficiency - Comparison of cycles.		
UNIT	**TITLE**	**PERIODS**
2	**INTERNAL COMBUSTION ENGINES**	**9**
Classification - Components and their function. Valve timing diagram and port timing diagram – actual and theoretical P-V diagram of four stroke and two stroke engines. Simple and complete Carburetor. MPFI, Diesel pump and injector system. Battery and Magneto Ignition System - Principles of Combustion and knocking in SI and CI Engines. Lubrication and Cooling systems. Performance calculation.		
UNIT	**TITLE**	**PERIODS**
3	**STEAM GENERATOR, STEAM NOZZLES AND TURBINES**	**9**
Boilers – Types and comparison – Performance calculations. Flow of steam through nozzles, shapes of nozzles, effect of friction, critical pressure ratio, supersaturated flow. Impulse and Reaction principles, compounding, velocity diagram for simple and multi-stage turbines, speed regulations – Governors.		
UNIT	**TITLE**	**PERIODS**
4	**AIR COMPRESSOR**	**9**
Classification and working principle of various types of compressors, work of compression with and without clearance, Volumetric efficiency, Isothermal efficiency and Isentropic efficiency of reciprocating compressors, Multistage air compressor and inter cooling –work of multistage air compressor.		
UNIT	**TITLE**	**PERIODS**
5	**REFRIGERATION AND AIR CONDITIONING**	**9**
Refrigerants - Vapour compression refrigeration cycle- super heat, sub cooling – Performance calculations - working principle of vapour absorption system, Ammonia –Water, Lithium bromide – water		

systems (Description only). Air conditioning system - Processes, Types and Working Principles - Concept of RSHF, GSHF, ESHF- Cooling Load calculations
Case studies: Study of key parameters such as compression ratio, peak pressure for heavy duty and light duty engines; Study of commercial specification of steam power plant -NLC; Study of commercial specification of an industrial air compressor; Study of specification of an industrial Refrigerator and air conditioner.

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Determine air standard cycles performance parameters using thermodynamic laws
CO2:	Demonstrate the working of IC engines and its auxiliary systems.
CO3:	Evaluate the thermal performance parameters for nozzles and turbines
CO4:	Evaluate the performance of single and multistage compressor using thermodynamic laws
CO5:	Calculate thermal performance parameters for a refrigerator and air - conditioner

TEXT BOOKS:	
1.	Arora.C.P, ”Refrigeration and Air Conditioning”, Third Edition, Tata McGraw-Hill Publishers 2011
2.	Ganesan.V, “Internal Combustion Engines” , Third Edition, Tata McGraw-HillPublishers2013
3.	Paul W.Gill and James H. Smith “Fundamental of Internal Combustion Engines”, Oxford & IBH Publishing Company Pvt. Limited, 2007

TABLES:	
1.	Khurmi, R.S, “Steam Tables with Mollier Diagram”, S.Chand Publishers, 2008
2.	Kothandaraman, C.P, “Refrigeration tables and charts including air conditioning data”, New Age International Publishers, 2014

REFERENCE BOOKS:	
1.	Kothandaraman.C.P.,Domkundwar. S,Domkundwar. A.V., “A course in thermal Engineering", Fifth Edition, DhanpatRai & sons, 2018
2.	Rajput. R. K., “Thermal Engineering” S.Chand Publishers, 2017
3.	Ramalingam. K.K., "Thermal Engineering", SCITECH Publications (India) Pvt. Ltd., 2011
4.	Rudramoorthy.R, “Thermal Engineering “,Tata McGraw-Hill, New Delhi,2017
5.	Sarkar, B.K,”Thermal Engineering”, Tata McGraw-Hill Publishers, 2017

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEC404T	**MECHANICAL MEASUREMENTS AND METROLOGY**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES:
NIL

COURSE OBJECTIVES:	
1.	Understand the importance of measurements in engineering and the factors affecting measurements and to estimate measurement uncertainty.
2.	Apply the working principle and applications of various linear and angular measuring instruments.
3.	Interpret the various tolerance symbols given in engineering drawings to choose the appropriate manufacturing process.
4.	Apply the basic concepts of measurement of transmission elements and measurements of various mechanical parameters
5.	Apply the advances in measurements for quality control in manufacturing Industries

UNIT	**TITLE**	**PERIODS**
1	**FUNDAMENTALS OF MEASUREMENTS**	**6**

Standards - National, Reference, Secondary, and Working Standards, Line and End Statndards, The process of measurement- significance, generalized measuring system Characteristics of measuring instruments: Static characteristics - Precision, Accuracy, Sensitivity, Repeatability, Reproducibility, Linearity, interchangeability, Bias, Calibration, calibration of machine tools Traceability, Confidence level. Errors- Systematic and Random, Uncertainty of Measurement

UNIT	**TITLE**	**PERIODS**
2	**LINEAR, ANGULAR MEASUREMENTS AND GAUGE INSPECTION**	**9**

Linear Measurements: Calipers, Height gauge, Depth gauge, Micrometer, Sine Bar, Bevel protractor, Sprit level, Slip gauges, Comparators: Mechanical, Electrical, Optical, Pneumatic comparators, Tolerancing: Limits and fits, Types of gauges: Snap gauge, Plain plug gauge, ring gauges, Radius gauges, Feeler gauges - Gauge design

UNIT	**TITLE**	**PERIODS**
3	**FORM MEASUREMENT AND ADVANCED METROLOGY**	**12**

Principle, terminology and methods of measuring Straightness, flatness, roundness, Surface Finish, Measurement of screw thread elements – major diameter, minor diameter, effective diameter, pitch, Measurement of gear elements – run out, pitch, profile, lead, backlash, Advanced Metrology: Auto collimator, Laser interferometer, Coordinate measuring machine (CMM), Machine vision for metrology.

UNIT	**TITLE**	**PERIODS**
4	**MEASUREMENT OF MOTION, FORCE AND TORQUE**	**9**

Measurement of motion: Displacement measurement-Resistive, inductive-LVDT, capacitive, piezo electric, hall effect sensor, Speed measurement: optical encoders, tacho generators. Acceleration measurement: Seismic type, Piezo electric type Accelerometers. Measurement of Force and Torque: Strain gauge factor, mechanical strain gauge, electrical strain gauge, platform balance, load cell, cantilever beams, torsion bar dynamometer, servo controller dynamometer, absorption dynamometer.

UNIT	TITLE	PERIODS
5	MEASUREMENT OF FLOW, PRESSURE AND TEMPERATURE	9
Measurement of Flow: Differential Pressure Meters, Rotameters, Turbine Meters, Electromagnetic Flow meters, Ultrasonic Flow meters. Measurement of Pressure: Dead-Weight Tester, Bourdon-tube pressure gauges, Diaphragm and Bellows Gages. Measurement of Temperature: Bimetallic strip, liquid in glass thermometer, Resistance Temperature Detectors, Thermistor, Thermocouples, Pyrometers.		
Case studies: To measure the general maintenance parameters of a gear box used in an automobile.		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Learn knowledge about the importance of measurements in engineering and the factors affecting measuring instruments.
CO2:	Identify the suitable measuring instruments for measuring linear and angular dimensions.
CO3:	Apply the basic concepts for measuring various terminologies in transmission elements.
CO4:	Evaluate the process variables associated with instruments for measuring motion, force and torque
CO5:	Analyze the various parameters associated with various measuring instruments for measuring flow, strain, and temperature.

TEXT BOOKS:	
1.	Jain R.K. “Engineering Metrology”, Khanna Publishers, 2009.
2.	Raghavendra N.V. and Krishnamurthy. L., Engineering Metrology and Measurements, Oxford University Press, 2013.
3.	Venkateshan, S. P., “Mechanical Measurements”, Second edition, John Wiley &Sons, 2015.

REFERENCE BOOKS:	
1.	Galyer, J.F.W. Charles Reginald Shotbolt, “Metrology for Engineers”, Cengage Learning EMEA; 5th revised edition, 1990.
2.	Gupta. I.C., “Engineering Metrology”, Dhanpatrai Publications, 2005.
3.	National Physical Laboratory GuideNo. 40, No. 41, No. 42, No. 43, No. 80, No. 118, No. 130, No. 131. http://www.npl.co.uk. (relevant to syllabus).

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEC411L	**CAD/CAM LABORATORY**	**0**	**0**	**3**	**1**	**2**

COURSE OBJECTIVES:	
1.	To gain practical experience in handling 2D drafting and 3D modeling software systems.
2.	To study the features of CNC Machine Tool.
3.	To expose students to modern control systems (Fanuc, Siemens etc.,)
4.	To know the Explain the working principle and application of a model of various CNC machines like CNC lathe, CNC Vertical Machining centre, CNC EDM and CNC wire-cut and studying of Rapid prototyping.

LIST OF EXPERIMENTS	
1.	**3D GEOMETRIC MODELLING** 1. Introduction of 3D Modeling software Creation of 3D assembly model of following machine elements using 3D Modeling software 2. Flange Coupling 3. Plummer Block 4. Screw Jack 5. Lathe Tailstock 6. Universal Joint 7. Machine Vice 8. Stuffing box 9. Crosshead 10. Safety Valves 11. Non-return valves 12. Connecting rod 13. Piston 14. Crankshaft * Students may also be trained in manual drawing of some of the above components
2.	**MANUAL PART PROGRAMMING** (i) Part Programming - CNC Machining Centre a) Linear Cutting. b) Circular cutting. c) Cutter Radius Compensation. d) Canned Cycle Operations. (ii) Part Programming - CNC Turning Centre a) Straight, Taper and Radius Turning. b) Thread Cutting. c) Rough and Finish Turning Cycle. d) Drilling and Tapping Cycle.
3.	**COMPUTER AIDED PART PROGRAMMING** 1. CL Data and Post process generation using CAM packages. 2. Explain the working principle and application of a model of CAPP in

	Machining and Turning Centre.

TOTAL PERIODS:	**60**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Students can able to create assembly drawings both manually and using standard 2D drafting packages
CO2:	Students can able to create assembly drawings both manually and using standard 3D modeling packages.
CO3:	Apply the knowledge to re-create part drawings, sectional views and assembly drawings as per standards.
CO4:	Write manual part programming
CO5:	Practice CNC Programming

REFERENCES: (OPTIONAL)	
1.	Bhatt N.D and Panchal, V.M. “Machine Drawing”, 48th Edition, Charotar Publishers,2013
2.	Junnarkar,N.D.,“Machine Drawing”, 1st Edition, Pearson Education, 2004
3	Siddeshwar.N, Kanniah.P, Sastri.V.V.S,”Machine Drawing”, published by Tata Mc GrawHill, 2006
4.	Trymbaka Murthy.S, “A Text Book of Computer Aided Machine Drawing”, CBS Publishers, New Delhi, 2007

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEC412L	**MANUFACTURING TECHNOLOGY LABORATORY II**	**0**	**0**	**2**	**0**	**1**

COURSE OBJECTIVES:	
1.	To Study and practice the various operations that can be performed in milling, gear hobbing, gear shaper and grinding machines, and to equipped with practical knowledge required in core industries.

LIST OF EXPERIMENTS	
1.	Milling contours on plates using vertical milling machine
2.	Machining using capstan and Turret lathe
3.	Cutting spur gear using milling machine.
4.	Cutting helical gear using milling machine
5.	Generating gears using gear hobbing machine.
6.	Generating gears using gear shaping machine.
7.	Grinding components using cylindrical grinding machine.
8.	Grinding components using surface grinding machine.
9.	Grinding components using center less grinding machine.
10.	Measurement of cutting forces in Milling Process
11.	Measurement of cutting forces in Turning Process
12.	Tool angle grinding with tool and Cutter Grinder
13.	CNC Part Programming

TOTAL PERIODS:	**30**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Use different machine tools to manufacturing gears
CO2:	Use different machine tools for finishing operations
CO3:	Manufacture tools using tool and cutter grinder
CO4:	Measure cutting forces acting on cutting tools
CO5:	Select appropriate tools, equipment and machines to complete a given job.

REFERENCES: (OPTIONAL)	
1.	Heinrich Gerling, “All about Machine Tools”, Wiley Publishers, 1979.
2.	Hajra Choudhary, “Workshop Technology” Vol. 1 & Vol. 2 15th Edition, Media Promoters Publication-2008
3.	Prashant P. Date, "Introduction to Manufacturing Technologies: Principles & Practice", Jaico

	Publishing House, 2010.
4.	Rao P. N, "Manufacturing Technology", Vol.1 & Vol. 2, 4th Edition, Tata McGraw-Hill, 2013.
5.	Serope Kalpakjian, and Steven R. Schmid, "Manufacturing Engineering and Technology", 5th Edition, Pearson Education, 2015.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEC413L	**MECHANICAL MEASUREMENTS AND METROLOGY LABORATORY**	**0**	**0**	**2**	**0**	**1**

COURSE OBJECTIVES:	
1.	Demonstrating the calibration of simple linear measuring instruments used in manufacturing industries.
2.	Demonstrating the important linear and angular measurements carried out in manufacturing industries.
3.	Demonstrating the measurement of prismatic components using contact and non-contact methods and surface metrology.

LIST OF EXPERIMENTS	
1.	Calibration and use of measuring instruments – Vernier caliper, micrometer, Vernier height gauge – using gauge blocks.
2.	Calibration and use of measuring instruments – depth micrometer, bore gauge, telescopic gauge.
3.	Measurement of angles using bevel protractor and sine bar
4.	Select the best instrument available and measure the angle of a given object.
5.	Inspect, whether the dimensions of the given specimens are within the tolerance limit or not, using Comparators
6.	Measurement of screw thread parameters using Floating carriage micrometer
7.	Measurement of gear tooth thickness using gear tooth vernier caliper
8.	Measurement of features in a prismatic component using Coordinate Measuring Machine (CMM)
9.	Creating CAD models of asymmetric objects using Coordinate Measuring Machine
10.	Measurement of Screw Thread Parameters by Profile projector
11.	Measurement of Cutting Tool Angles by Tool Maker's Micro Scope
12.	Measurement of Surface Roughness using portable surface roughness tester.
13.	Straightness /Flatness Testing using Autocollimator
14.	Measurement of force, torque and temperature

TOTAL PERIODS:	**30**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Select a suitable measuring instrument for measurement of linear and angular dimensions and use the same for carrying out measurements.
CO2:	Calibrate simple linear measuring instruments like Vernier caliper, micrometer, Vernier height gauge, etc. using gauge blocks.
CO3:	Use advanced measuring equipments like coordinate measuring machines, Toolmakers microscope, surface finish measuring equipment to carryout measurements.
CO4:	Measure the gear tooth dimensions, straightness. Flatness and thread parameters.
CO5:	Measure temperature, force, displacement, torque.

REFERENCES:	
1.	Holman J P, “Experimental Methods for Engineers”, Tata McGraw Hill, 2012.
2.	Raghavendra N.V and Krishnamurthy L., “Engineering Metrology and Measurements”, Oxford University Press, 2013.
3.	Rajput R.K., “Mechanical Measurements and Instrumentation”, Kataris & sons Publishers, 2009.

SYLLABUS OF

SEMESTER – V

COURSES

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEC501T	**ENGINEERING MATERIALS AND METALLURGY**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: NIL

COURSE OBJECTIVES:	
1.	To impart knowledge on crystal systems and metallographic process.
2.	To know about the different heat treatment processes.
3.	To design appropriate metals for the required application.
4.	To develop knowledge behavior of materials.
5.	To enhance the knowledge on how the properties of materials are described by testing.

UNIT	**TITLE**	**PERIODS**
1	**CRYSTAL STRUCTURES**	**8**

Unit cells, Crystal systems, Crystallographic planes and directions, BCC, FCC and HCP structures, miller indices, crystal imperfections, point, line, surface and volume defects, Metallography – metallurgical microscope – preparation of specimen, micro & macro examination. Grain size ASTM grain size number, grain size measurement.

UNIT	**TITLE**	**PERIODS**
2	**HEAT TREATMENT**	**10**

Iron – Carbon equilibrium diagram, reactions, phase and microstructure changes – Isothermal transformation diagrams- CCT and TTT diagrams , Heat treatment of steels, Annealing, Normalizing, hardening, Tempering, Austempering, Martempering, hardenability, Jominy end quench test. Surface hardening/Case hardening: Carburizing, Cyaniding, Nitriding, Flame hardening, Induction hardening. Strengthening mechanisms.

UNIT	**TITLE**	**PERIODS**
3	**ENGINEERING MATERIALS AND APPLICATIONS**	**10**

Steels : Effect of alloying elements on steels- classification of steels – Stainless steels- Tool steels-HSLA-Maraging steels; Cast Iron : Grey, White, Malleable, Spheroidal and Alloy cast irons- Properties, Applications, microstructures; Magnesium Alloys, Ni- based super alloys Bearing alloys, Engineering Ceramics- Properties and applications of Al2O3, SiC, Si3N4, PSZ and SAILON. Aerogel, Graphene, Metamaterial , Carbon Nano tubes- Smart materials.

UNIT	**TITLE**	**PERIODS**
4	**BEHAVIOR OF ENGINEERING MATERIALS**	**8**

Dislocations and plastic deformation-slip systems-slip in single crystals-plastic deformation of poly crystalline materials-Deformation by twinning, Fatigue-Fatigue curves-Fatigue tests-Multi axial fatigue-Stress life curve I strain life curve-Strain flow cycle counting-Stress concentration factors-microstructure and surface finish impact on metal fatigue, Creep, Creep curve, Creep tests, Fracture, Ductile fracture, Brittle fracture.

UNIT	**TITLE**	**PERIODS**
5	**TESTING OF MATERIALS**	**9**

Hardness, Brinell hardness test, Rockwell hardness test, Vickers hardness test, Tensile properties of ductile, brittle and polymer materials, Tensile test, Toughness, Impact tests, Wear types of wear- testing, Corrosion- types of corrosion-testing, SEM,TEM,XRD.
Case studies: Case studies on microstructure changes during heat treatment of steels, applications of advanced materials, Failure analysis of automobile and aerospace parts

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Examine the crystal structures and metallographic studies under micro and macro inspection.
CO2:	Identify the exact alloying elements to improve the properties of steels for desired applications.
CO3:	Use the appropriate materials for high temperature applications.
CO4:	Evaluate the failure mechanism of materials under various types of deformation.
CO5:	Analyze the mechanical and tribological properties of material under different testing conditions.

TEXT BOOKS:	
1.	Avner, S.H., “Introduction to Physical Metallurgy”, McGraw Hill Book Company, 2017.
2.	George Dieter, Mechanical Metallurgy, 3rd Edition, Tata McGraw-Hill, Newdelhi, 2013.
3.	Williams D Callister, “Material Science and Engineering” Wiley India Pvt Ltd, Revised Indian Edition 2014

REFERENCE BOOKS:	
1.	Kenneth G.Budinski and Michael K. Budinski, “Engineering Materials”, Prentice Hall of India Private Limited, 2016.
2.	Raghavan.V, “Materials Science and Engineering”, Prentice Hall of India Pvt. Ltd., 2015.
3.	U.C.Jindal : Material Science and Metallurgy, "Engineering Materials and Metallurgy", First Edition, Dorling Kindersley, 2012
4.	Upadhyay. G.S. and Anish Upadhyay, “Materials Science and Engineering”, Viva Books Pvt. Ltd., New Delhi, 2014.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEC502T	**MECHANICS OF MACHINES**	**3**	**2**	**0**	**0**	**4**

PREREQUISITES: 191GES202T – Engineering Mechanics

COURSE OBJECTIVES:	
1.	To understand the principles in the formation of mechanisms and their kinematics.
2.	To understand the construction features of Gears and Gear Trains
3.	To understand the importance of balancing and mechanisms for control
4.	To understand the force-motion relationship in components subjected to external forces and analysis of standard mechanisms.
5.	To understand the importance of vibration and effect of dynamics of undesirable vibrations.

UNIT	**TITLE**	**PERIODS**
1	**KINEMATICS OF MACHINES**	**12**

Mechanisms – Terminology and definitions – kinematics inversions of 4 bar and slide crank chain – kinematics analysis in simple mechanisms – velocity and acceleration polygons – Cam and followers – classifications – displacement diagrams - layout of plate cam profiles – derivatives of followers motion

UNIT	**TITLE**	**PERIODS**
2	**GEARS and GEAR TRAINS**	**12**

Spur gear – law of toothed gearing – involute gearing – Interchangeable gears – Gear tooth action interference and undercutting – nonstandard teeth – gear trains – parallel axis gears trains – epicyclic gear trains.

UNIT	**TITLE**	**PERIODS**
3	**DYNAMIC FORCE ANALYSIS**	**12**

Dynamic force analysis – Inertia force and Inertia torque– D Alembert's principle –Dynamic Analysis in reciprocating engines – Gas forces – Inertia effect of connecting rod– Bearing loads – Crank shaft torque – Turning moment diagrams –Fly Wheels – Flywheels of punching presses-

UNIT	**TITLE**	**PERIODS**
4	**BALANCING AND MECHANISM FOR CONTROL**	**12**

Static and Dynamic balancing – Balancing of revolving and reciprocating masses – Balancing machines - Balancing a single cylinder engine – Balancing of Multi-cylinder inline, V-engines – Partial balancing in engines- Governors and Gyroscopic effects.

UNIT	**TITLE**	**PERIODS**
5	**VIBRATION OF SHAFT**	**12**

Free, forced and damped vibrations of single degree of freedom systems – force transmitted to supports – vibration Isolation – vibration absorption – torsional vibration of shafts – single and multirotor systems – geared shafts – critical speed of shafts.

TOTAL PERIODS:	**60**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Calculate kinematic parameters for simple mechanisms.
CO2:	Determine the geometric and kinematic parameters for gear trains.
CO3:	Estimate the dynamic forces in reciprocating engine components.
CO4:	Determine the balancing mass and position for revolving and reciprocating masses.
CO5:	Determine the characteristics of governors and gyroscope.
CO6:	Calculate the vibration characteristics of mechanical systems with single degree of freedom.

TEXT BOOKS:	
1.	Cleghorn. W. L, “Mechanisms of Machines”, Oxford University Press, 2014.
2.	Khurmi, R.S.,”Theory of Machines”, 14th Edition, S Chand Publications, 2005.
3.	Rattan, S.S, “Theory of Machines”, 4th Edition, Tata McGraw-Hill, 2014.

REFERENCE BOOKS:	
1.	F. B. Sayyad, “Dynamics of Machinery”, McMillan Publishers India Ltd., Tech-Max Educational resources, 2011.
2.	Ghosh. A and Mallick, A.K., “Theory of Mechanisms and Machines", 3rd Edition Affiliated East-West Pvt. Ltd., New Delhi, 2006.
3.	V.Ramamurthi, "Mechanics of Machines", Narosa Publishing House, 2002.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEC503T	**HEAT AND MASS TRANSFER**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: Engineering Thermodynamics, Transforms and Partial Differential Equations

COURSE OBJECTIVES:	
1.	To recognize the mechanisms of heat transfer under steady and transient conditions.
2.	To understand the concepts of heat transfer through extended surfaces.
3.	To learn the thermal analysis and sizing of heat exchangers.
4.	To comprehend the physics of radiation.
5.	To understand the basic concepts of mass transfer.

UNIT	**TITLE**	**PERIODS**
1	**CONDUCTION**	**9**

General Differential equation of Heat Conduction– Cartesian and Polar Coordinates – One Dimensional Steady State Heat Conduction –– plane and Composite Systems – Conduction with Internal Heat Generation – Extended Surfaces – Unsteady Heat Conduction – Lumped Analysis – Semi Infinite and Infinite Solids –Use of Heisler's charts.

UNIT	**TITLE**	**PERIODS**
2	**CONVECTION**	**9**

Free and Forced Convection - Hydrodynamic and Thermal Boundary Layer. Free and Forced Convection during external flow over Plates and Cylinders and Internal flow through tubes.

UNIT	**TITLE**	**PERIODS**
3	**PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS**	**9**

Nusselt's theory of condensation - Regimes of Pool boiling and Flow boiling. Correlations in boiling and condensation. Heat Exchanger Types - Overall Heat Transfer Coefficient – Fouling Factors - Analysis – LMTD method - NTU method.

UNIT	**TITLE**	**PERIODS**
4	**RADIATION**	**9**

Black Body Radiation – Grey body radiation - Shape Factor – Electrical Analogy – Radiation Shields. Radiation through gases.

UNIT	**TITLE**	**PERIODS**
5	**MASS TRANSFER**	**9**

Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state Molecular Diffusion – Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy –Convective Mass Transfer Correlations.

Case studies: heat conduction in rotary drums with L-shaped lifters, Simulation of Convective Flows and Heat Transfer in Air conditioned Spaces, Modeling the outlet temperature in heat exchangers, Analysis of conduction and radiation heat transfer in a 2-d cylindrical medium using the modified discrete ordinate method.

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Apply the heat conduction equations to solve different surface configurations under steady state and transient conditions.
CO2:	Compare free and forced convective heat transfer correlations to solve internal and external flows through/over various surface configurations.
CO3:	Examine the phenomena of boiling and condensation and design the different types of heat exchanger configurations.
CO4:	Construct the various radiation models using basic laws for Radiation between different types of surfaces.
CO5:	Apply diffusive and convective mass transfer equations and correlations to solve problems for different application.

TEXT BOOKS:	
1.	Nag, P.K., "Heat Transfer", Tata McGraw Hill, New Delhi, 2002.
2.	Sachdeva, R.C. “Fundamentals of Engineering Heat & Mass transfer”, New Age International Publishers, 2009.
3.	Yunus A. Cengel, "Heat Transfer A Practical Approach", Tata McGraw Hill, 5th Edition, 2015.

TABLES:	
1.	Kothandaraman, C.P., “Heat and Mass Transfer Data Book”, New Age International Publishers, 2015.
REFERENCE BOOKS:	
1.	Ghoshdastidar, P.S, "Heat Transfer", Oxford, 2004.
2.	Holman, J.P., "Heat and Mass Transfer", Tata McGraw Hill, 2000.
3.	Kothandaraman, C.P., "Fundamentals of Heat and Mass Transfer", New Age International, New Delhi, 1998.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEC511L	**MECHANICS OF MACHINES LABORATORY**	**0**	**0**	**3**	**1**	**2**

COURSE OBJECTIVES:	
1.	To supplement the principles learnt in kinematics and Dynamics of Machinery.
2.	To understand how certain measuring devices are used for dynamic testing

LIST OF EXPERIMENTS	
1.	Study of gear parameters.
2.	Experimental study of velocity ratios of simple, compound, Epicyclic and differential gear trains.
3.	Kinematics of Four Bar, Slider Crank, Crank Rocker, Double crank, Double rocker, Oscillating cylinder Mechanisms.
4.	Kinematics of single and double universal joints.
5.	Determination of Mass moment of inertia of Fly wheel and Axle system.
6.	Determination of Mass Moment of Inertia of axisymmetric bodies using Turn Table apparatus.
7.	Determination of Mass Moment of Inertia using bifilar suspension and compound pendulum.
8.	Motorized gyroscope – Study of gyroscopic effect and couple.
9.	Governor - Determination of range sensitivity, effort etc., for Watts, Porter, Proell governors.
10.	Cams – Cam profile drawing, Motion curves and study of jump phenomenon
11.	Single degree of freedom Spring Mass System – Determination of natural Frequency and verification of Laws of springs – Damping coefficient determination.
12.	Multi degree freedom suspension system – Determination of influence coefficient.
13.	Determination of torsional natural frequency of single and Double Rotor systems. Undamped and Damped Natural frequencies.
14.	Vibration of Equivalent Spring mass system – undamped and damped vibration.
15.	Whirling of shafts – Determination of critical speeds of shafts with concentrated loads.
16	Balancing of rotating masses.
17.	Transverse vibration of Free-Free beam – with and without concentrated masses.
18.	Forced Vibration of Cantilever beam – Mode shapes and natural frequencies.

TOTAL PERIODS:	**60**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Explain gear parameters, kinematics of mechanisms, gyroscopic effect and working of lab equipments
CO2:	Determine mass moment of inertia of mechanical element, governor effort and range sensitivity, natural frequency and damping coefficient, torsional frequency, critical speeds of shafts, balancing mass of rotating and reciprocating masses

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEC512L	**THERMAL ENGINEERING LABORATORY**	**0**	**0**	**4**	**0**	**2**

COURSE OBJECTIVES:

1.	To study the value timing-V diagram and performance of IC Engines.
2.	To study the characteristics of fuels/Lubricates used in IC Engines.
3.	To study the Performance of steam generator/ turbine.
4.	To study the heat transfer phenomena predict the relevant coefficient using implementation.
5.	To study the performance of refrigeration cycle / components.

LIST OF EXPERIMENTS

I.C. ENGINE LAB

1.	Valve Timing and Port Timing diagrams.
2.	Actual p-v diagrams of IC engines.
3.	Performance Test on 4 – stroke Diesel Engine.
4.	Heat Balance Test on 4 – stroke Diesel Engine.
5.	Morse Test on Multi-cylinder Petrol Engine.
6.	Retardation Test on a Diesel Engine.
7.	Determination of Flash Point and Fire Point of various fuels / lubricants.

STEAM LAB

1.	Study on Steam Generators and Turbines.
2.	Performance and Energy Balance Test on a Steam Generator.
3.	Performance and Energy Balance Test on Steam Turbine.

HEAT TRANSFER LAB

1.	Thermal conductivity measurement using guarded plate apparatus.
2.	Thermal conductivity measurement of pipe insulation using lagged pipe apparatus.
3.	Determination of heat transfer coefficient under natural convection from a vertical cylinder.
4.	Determination of heat transfer coefficient under forced convection from a tube.
5.	Determination of Thermal conductivity of composite wall.
6.	Determination of Thermal conductivity of insulating powder.
7.	Heat transfer from pin-fin apparatus (natural & forced convection modes)
8.	Determination of Stefan – Boltzmann constant.
9.	Determination of emissivity of a grey surface.
10.	Effectiveness of Parallel / counter flow heat exchanger.
11.	Performance study of Refrigeration System.
12.	Performance study of Air – Conditioning system.
13.	Performance study of Compressor.
	TOTAL PERIODS: **60**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Conduct tests on heat conduction apparatus and evaluate thermal conductivity of materials.
CO2:	Conduct tests on natural and forced convective heat transfer apparatus and evaluate heat transfer coefficient.
CO3:	Conduct tests on radiative heat transfer apparatus and evaluate Stefan Boltzmann constant and emissivity.
CO4:	Conduct tests to evaluate the performance of parallel/counter flow heat exchanger apparatus and reciprocating air compressor.
CO5:	Conduct tests to evaluate the performance of refrigeration and air-conditioning test rigs.

REFERENCES: (OPTIONAL)	
1.	Kothandaraman, C.P., "Fundamentals of Heat and Mass Transfer", New Age International, New Delhi, 1998.
2.	Yunus A. Cengel, "Heat Transfer A Practical Approach", Tata McGraw Hill, 5th Edition, 2015.
3.	Sachdeva, R.C. “Fundamentals of Engineering Heat & Mass transfer”, New Age International Publishers, 2009.

SYLLABUS OF

SEMESTER – VI

COURSES

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEC601T	**DESIGN OF MACHINE ELEMENTS AND TRANSMISSION SYSTEMS**	**3**	**2**	**0**	**0**	**4**

PREREQUISITES: 191GES202T-Engineering Mechanics,191MEC402T -Strength of Materials

COURSE OBJECTIVES:

1.	To familiarize the various steps involved in the Design Process and to understand the principles involved in evaluating the shape and dimensions of a component to satisfy functional and strength requirements
2.	This course will make acquainted design principles of shaft, keys, Couplings and enable to check strength of fasteners for Rivet, bolts and welding.
3.	To provide knowledge to select and examine the rolling and sliding contact bearings and design of various flexible elements
4.	To impart knowledge in the design of spur gear, helical gear, bevel gear and worm gear.
5.	To impart the knowledge on gears in the design of gear box, clutches and brakes

(Use of PSG Design Data Book is Permitted)

UNIT	TITLE	PERIODS
1	**INTRODUCTION**	**14**

Introduction to the design process - factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers, fits and tolerances – Direct, Bending and torsional stress equations – Impact and shock loading – calculation of principle stresses for various load combinations, eccentric loading – curved beams – crane hook and 'C' frame- Factor of safety - theories of failure – Design based on strength and stiffness – stress concentration – Design for variable loading.

UNIT	TITLE	PERIODS
2	**SHAFTS, COUPLINGS, AND BEARINGS**	**12**

Design of solid and hollow shafts based on strength and rigidity– Keys- Rigid and flexible couplings - Design of Sliding contact bearings **–** Selection of rolling contact bearing – Life of bearing and reliability consideration.

UNIT	TITLE	PERIODS
3	**JOINTS AND SPRINGS**	**12**

Threaded joints – Bolted joints including eccentric loading – Welded joints – Springs – helical and leaf springs.

UNIT	TITLE	PERIODS
4	**GEARS AND FLEXIBLE ELEMENTS**	**12**

Design of gears – tooth terminology - types- Spur, helical and Bevel - Design of Flat belts, Selection of V belts, Selection of hoisting wire ropes and Design of Transmission chains

UNIT	TITLE	PERIODS
5	**GEAR BOXES,CLUTCHES AND BRAKES**	**10**

Geometric progression - Standard step ratio - Ray diagram, kinematics layout -Design of sliding mesh gear box - Design of multi speed gear box for machine tool applications - Constant mesh gear box - Design of plate clutches –-cone clutches - internal expanding rim clutches Band and Block brakes - external shoe brakes – Internal expanding shoe brake.

Case studies: Case study of design of power presses/hydraulic presses. Design of cable car/winches systems considering wind loading.

TOTAL PERIODS:	**60**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Compute stresses in machine members under various loading conditions
CO2:	Design solid and hollow shafts based on strength and rigidity.
CO3:	Design sliding contact and rolling contact bearings.
CO4:	Design bolted joints, welded joints, helical and leaf springs.
CO5:	Design Spur, helical and Bevel gears and flexible transmission elements Flat belts, V belts and ropes.
CO6:	Design sliding mesh gear box gear boxes, multi speed gear box, clutches and brakes

TEXT BOOKS:	
1.	Bhandari V, “Design of Machine Elements”, 4th Edition, Tata McGraw-Hill Book Co, 2016.
2.	Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett “Mechanical Engineering Design”, 9th Edition, Tata McGraw-Hill, 2011.

REFERENCE BOOKS:	
1.	Alfred Hall, Halowenko, A and Laughlin, H., “Machine Design”, Tata McGraw-Hill BookCo.(Schaum’s Outline), 2010
2.	Ansel Ugural, “Mechanical Design – An Integral Approach", 1st Edition, Tata McGraw-Hill Book Co, 2003.
3.	Heine R W, Loper C R and Rosenthal P C, “Principles of Metal Casting”, Tata McGraw Hill Publishing Co. Ltd., New Delhi,2010.
4.	Mikell P. Groover,” Principles of Modern Manufacturing”, SI Version, Wiley & sons Pvt. Ltd, 2013.
5.	Merhyle F. Spotts, Terry E. Shoup and Lee E. Hornberger, “Design of Machine Elements”8th Edition, Printice Hall, 2003.
6.	P.C. Gope, “Machine Design – Fundamental and Application”, PHI learning private ltd, New Delhi,2012.
7.	Prabhu. T.J., “Design of Transmission Elements”, Mani Offset, Chennai, 2000.
8.	Rajput,R.K.”A textbook of manufacturing technology (manufacturing processes)”,Laxmi publications (p) ltd, 2015.
9.	Sundararajamoorthy T. V, Shanmugam. N, “Machine Design”, Anuradha Publications, Chennai, 2003.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEC602T	**FINITE ELEMENT ANALYSIS**	**3**	**2**	**0**	**0**	**4**

PREREQUISITES: NIL

COURSE OBJECTIVES:

1.	To introduce the concepts of Mathematical Modeling of Engineering Problems.
2.	To derive equations in finite element methods for 1D and 2D problems.
3.	Understand the basic finite element formulation techniques.
4.	To learn and apply finite element solutions to structural, thermal, dynamic problem to develop the knowledge and skills needed to effectively evaluate finite element analyses.
5.	To appreciate the use of FEM to a range of Engineering Problems.

UNIT	TITLE	PERIODS
1	**INTRODUCTION TO FEA-1D PROBLEMS**	**12**

Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique Weighted residual mehods (No taper rod problem) – Basic concepts of the Finite Element Method. One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices-Tractions problem.

UNIT	TITLE	PERIODS
2	**ONE-DIMENSIONAL SCALAR PROBLEMS AND EIGEN VALUE PROBLEMS**	**12**

Truss analysis, Solution of bending - heat transfer problem. Longitudinal vibration frequencies and mode shapes. Fourth Order Beam Equation –Transverse deflections and Natural frequencies of beams-Higher order elements.

UNIT	TITLE	PERIODS
3	**TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS**	**12**

Second Order 2D Equations involving Scalar Variable Functions – Variational formulation –Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems - Thermal problems – Torsion of Non circular shafts –Quadrilateral elements – Higher Order Elements.

UNIT	TITLE	PERIODS
4	**TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS**	**12**

Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations - Plate and shell elements.

UNIT	TITLE	PERIODS
5	**ISOPARAMETRIC FORMULATION**	**12**

Natural co-ordinate systems – Isoparametric elements – Shape functions for iso parametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems - Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software.

Case studies: Analysis of structural members, vibratory systems and thermal systems in machines.

TOTAL PERIODS:	**60**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Apply Functional approximation method for solving basic one dimensional structural and thermal boundary value problems for extending it to the grasping of the basics of finite element formulation
CO2:	Apply finite element formulations to solve basic one dimensional structural and thermal Problems in order to extend the application to multi dimensional problem in the future.
CO3:	Apply finite element formulations to solve basic two dimensional scalar Problems for applying to practical structural and thermal problem.
CO4:	Apply finite element method to solve basic two dimensional Vector problems for applying to practical structural problem.
CO5:	Apply finite element method to solve basic one and two dimensional vector variable problems using coordinate transformation on iso-parametric element for solving complex shaped problem

TEXT BOOKS:	
1.	Reddy. J.N., “An Introduction to the Finite Element Method”, 3rd Edition, Tata McGraw-Hill, 2005
2.	Seshu, P, “Text Book of Finite Element Analysis”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.

REFERENCE BOOKS:	
1.	Bhatti Asghar M, "Fundamental Finite Element Analysis and Applications", John Wiley & Sons, 2005 (Indian Reprint 2013)*
2.	Chandrupatla & Belagundu, “Introduction to Finite Elements in Engineering”, 3rd Edition, Prentice Hall College Div, 1990
3.	Logan, D.L., “A first course in Finite Element Method”, Thomson Asia Pvt. Ltd., 2002
4.	Rao, S.S., “The Finite Element Method in Engineering”, 3rd Edition, Butterworth Heinemann, 2004
5.	Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, “Concepts and Applications of Finite Element Analysis”, 4th Edition, Wiley Student Edition, 2002.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEC603T	**AUTOMOBILE ENGINEERING**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: NIL

COURSE OBJECTIVES:	
1.	To understand the construction and working principle of various parts of an automobile
2.	To have the practice for assembling and dismantling of engine auxiliary system
3.	To provide knowledge in various transmission systems.
4.	To gain knowledge in conventional and special steering systems in modern technology
5.	To learn about various principles of suspension systems, safety, braking and stability control

UNIT	**TITLE**	**PERIODS**
1	**VEHICLE STRUCTURE AND ENGINES**	**9**
Classification of automobiles, vehicle construction and different layouts (monocoque, chassis, space frame and body, Vehicle aerodynamics - IC engines –components- functions and materials, variable valve timing		
UNIT	**TITLE**	**PERIODS**
2	**ENGINE AUXILIARY SYSTEMS**	**9**
Electronically controlled gasoline injection system, electronically controlled diesel injection system, Electronic ignition system, Turbo chargers, Engine emission control by three way catalytic converter system, Emission norms (Euro and BS) HVAC systems		
UNIT	**TITLE**	**PERIODS**
3	**TRANSMISSION SYSTEMS**	**9**
Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, Over drive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints ,Differential and rear axle, Hotchkiss Drive and Torque Tube Drive - DSG (dual shift gear box) - Ford intelligent transmission - SAT (satellite aided transmission)		
UNIT	**TITLE**	**PERIODS**
4	**STEERING AND BRAKES SYSTEMS**	**9**
Steering geometry and types of steering gear box - Power Steering, Pneumatic and Hydraulic Braking Systems, Antilock Braking System, electronic brake force distribution and Traction Control.		
UNIT	**TITLE**	**PERIODS**
5	**SUSPENSION SYSTEMS, SAFETY AND STABILITY**	**9**
Types of Front Axle, Types of Suspension Systems, Recent technologies - semi-active suspension, Mercedes magic body suspension. Introduction to safety equipments, air bag, Two wheeler dual disc brake, torque vectoring brake - dynamic chassis control - pro-active chassis control - magneto rheological fluid shock absorbers - Regenerative brakes - Defogger - Electronic limited slip differential		
Demonstration class: [Not for Examination] Practical Training in dismantling and assembling of Engine parts and Transmission Systems should be given to the students.		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:
Upon completion of this course, student will be able to:

CO1:	Select the construction & different layouts of automobile in order to resolve the various forces & moments associated with aerodynamics
CO2:	Select appropriate engines and structures for automobiles based on fundamentals
CO3:	Select suitable engine auxiliary systems for automobiles
CO4:	Select appropriate transmission systems for automobiles
CO5:	Select suitable steering and braking systems for automobiles

TEXT BOOKS:	
1.	Jain K.K. and Asthana .R.B, “Automobile Engineering” Tata McGraw Hill Publishers, New Delhi, 2002
2.	Kirpal Singh, “Automobile Engineering”, Volume 1 & 2, Seventh Edition, Standard Publishers, New Delhi, 1997

REFERENCE BOOKS:	
1.	Heinz Heisler, “Advanced Engine Technology,” SAE International Publications USA, 1998
2.	Joseph Heitner, “Automotive Mechanics,” Second Edition, East-West Press, 1999
3.	Martin W, Stockel and Martin T Stockle , “Automotive Mechanics Fundamentals,” The Good heart – Will Cox Company Inc, USA ,1978
4.	Newton ,Steeds and Garet, “Motor Vehicles”, Butterworth Publishers,1989

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEC611L	**SIMULATION & ANALYSIS LABORATORY**	**0**	**0**	**3**	**1**	**2**

COURSE OBJECTIVES:	
1.	To give exposure to software tools needed to analyse engineering problems.
2.	To expose the students to different applications of simulation and analysis tools.
3.	To model complex geometries and load conditions for the determination of stresses and strains

LIST OF EXPERIMENTS	
1.	Force and stress analysis using link elements in trusses
2.	Stress and deflection analysis in beams with different support conditions
3.	Stress analysis of a flat plate and simple shells
4.	Stress analysis of axi – symmetric components
5.	Thermal stress and heat transfer analysis of plates
6.	Thermal stress analysis of cylindrical shells
7.	Vibration analysis of spring-mass systems
8.	Model analysis of beams
9.	Harmonic, transient and spectrum analysis of simple Systems
10.	Buckling analysis
11.	Application of distributed loads
12.	Non-linear analysis of a cantilever beam
13.	Effect of self-weight on a cantilever beam
14.	MATLAB basics, dealing with matrices, graphing-functions of one variable and two variables
15.	Use of matlab to solve simple problems in vibration
16.	Multibody dynamics mechanism simulation

TOTAL PERIODS:	**60**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Simulate simple problems in vibrations and simple mechanisms using simulation software.
CO2:	Perform analysis of stress, truss/beam and dynamic analysis of mechanical members.
CO3:	Perform two dimensional stress analysis in plate and asymmetric shells.
CO4:	Analyze the temperature distribution in one dimensional heat transfer problems.
CO5:	Analyze different mechanical components using mathematical simulation software.

REFERENCES: (OPTIONAL)	
1.	Esam M. Alawadhi, Finite Element Simulations Using ANSYS, CRC Press, 2016.
2.	Meung K, Finite Element Methods with Programming and Ansys, Lulu Com 2013
3.	Saeed Moaveni, Finite Element Analysis Theory and Applications with Ansys, Pearson Education, 2014.
4.	Stinivasan, K. C. Sambana adn RK Datti, Finite Element Analysis using Ansys 11.0, Paleti PHI Learning Pvt. Ltd, 2010.
5.	S. S. Rao, Finite Element Method in Engineering, Elsevier India, 2017

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191LEH612L	COMMUNICATION SKILLS LABORATORY	0	0	4	0	2

COURSE OBJECTIVES:	
1.	Enhance the Employability and Career Skills of students
2.	Orient the students towards grooming as a professional
3.	Make them Employable Graduates
4.	Develop their confidence and help them attend interviews successfully.

LIST OF TOPICS	
UNIT I	Introduction to Soft Skills-- Hard skills & soft skills - employability and career Skills—Grooming as a professional with values—Time Management—General awareness of Current Affairs
UNIT II	Self-Introduction-organizing the material - Introducing oneself to the audience – introducing the topic – answering questions – individual presentation practice— presenting the visuals effectively – 5 minute presentations
UNIT III	Introduction to Group Discussion— Participating in group discussions – understanding group dynamics - brainstorming the topic -– questioning and clarifying –GD strategies- activities to improve GD skills
UNIT IV	Interview etiquette – dress code – body language – attending job interviews– telephone/skype interview -one to one interview &panel interview – FAQs related to job interviews
UNIT V	Recognizing differences between groups and teams- managing time-managing stress-networking professionally- respecting social protocols-understanding career management-developing a longterm career plan-making career changes

TOTAL PERIODS:	60

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Make effective presentations
CO2:	Participate confidently in Group Discussions

SYLLABUS OF

SEMESTER – VII

COURSES

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEC701T	**MECHATRONICS**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: NIL

COURSE OBJECTIVES:	
1.	To learn the various sensors used to measure various physical parameters.
2.	Understand fundamental operating concepts behind microprocessors and microcontrollers.
3.	Understand commonly used peripheral / interfacing devices
4.	To gain knowledge in writing ladder diagram for various applications
5.	To understand the various mechatronics design processes, essential to understand the emerging field of automation

UNIT	**TITLE**	**PERIODS**
1	**INTRODUCTION**	**9**
Introduction to Mechatronics – Systems – Concepts of Mechatronics approach – Need for Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics. Sensors and Transducers: Static and dynamic Characteristics of Sensor, Potentiometers – LVDT – Capacitance sensors – Strain gauges – Eddy current sensor – Hall effect sensor – Temperature sensors – Light sensors.		
UNIT	**TITLE**	**PERIODS**
2	**MICROPROCESSOR AND MICROCONTROLLER**	**9**
Introduction – Architecture of 8085 – Pin Configuration – Addressing Modes –Instruction set, Timing diagram of 8085 – Concepts of 8051 microcontroller – Block diagram.		
UNIT	**TITLE**	**PERIODS**
3	**PROGRAMMABLE PERIPHERAL INTERFACE**	**9**
Introduction – Architecture of 8255, Keyboard interfacing, LED display –interfacing, ADC and DAC interface, Temperature Control – Stepper Motor Control – Traffic Control interface.		
UNIT	**TITLE**	**PERIODS**
4	**PROGRAMMABLE LOGIC CONTROLLER**	**9**
Introduction – Basic structure – Input and output processing – Programming – Mnemonics – Timers, counters and internal relays – Data handling – Selection of PLC.		
UNIT	**TITLE**	**PERIODS**
5	**ACTUATORS AND MECHATRONIC SYSTEM DESIGN**	**9**
Types of Stepper and Servo motors – Construction – Working Principle – Advantages and Disadvantages. Design process-stages of design process – Traditional and Mechatronics design concepts – Case studies of Mechatronics systems – Pick and place Robot – Engine Management system – Automatic car park barrier.		
Case studies: Design and Analysis of Mechatronics System: A Case Study for Handling Hazardous Gases for Chemical Industry, Mechatronic System Case Study:Thermal Closed - Loop Control System (Not for Exam)		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:
Upon completion of this course, student will be able to:

CO1:	Possess a reasonable level of competence in the use of different sensors/gauges for the measurement of Speed, Vibration, Acceleration Stress and Strain.
CO2:	Demonstrate the architecture of Microprocessor and Microcontroller, Pin Diagram, Addressing Modes of Microprocessor and Microcontroller.
CO3:	Integrate Microprocessors and Microcontrollers with various sensors and actuators using Programmable Peripheral Interface
CO4:	Link the architecture, programming and application of programmable logic controllers to problems and challenges in the areas of Mechatronic engineering.
CO5:	Build the Mechatronics system using the knowledge and skills acquired through the course and also from the given case studies.

TEXT BOOKS:	
1.	Bolton, “Mechatronics”, Prentice Hall, 2008.
2.	Ramesh S Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, 5th Edition, Prentice Hall, 2008.

REFERENCE BOOKS:	
1.	Bradley D.A, Dawson D, Buru N.C and Loader A.J, “Mechatronics”, Chapman and Hall, 1993
2.	Clarence W, de Silva, "Mechatronics" CRC Press, First Indian Re-print, 2013
3.	Devadas Shetty and Richard A. Kolk, “Mechatronics Systems Design”, PWS publishing company, 2007.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEC702T	**POWER PLANT ENGINEERING**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: Thermodynamics, Thermal Engineering, Heat and Mass Transfer

COURSE OBJECTIVES:	
1.	To understand the working of coal power plant
2.	To gain knowledge in various gas powered cycles used in various power plants
3.	To attain overview of nuclear energy based power plants
4.	To suggest various renewable energy sources for power production
5.	To study energy and economic issues of power plants

UNIT	TITLE	PERIODS
1	**COAL BASED THERMAL POWER PLANTS**	**9**
Rankine cycle - improvisations, Layout of modern coal power plant, Super Critical Boilers, FBC Boilers, Turbines, Condensers, Steam & Heat rate, Subsystems of thermal power plants - Fule and ash handling, Draught system, Feed water treatment. Binary Cycles and Cogeneration systems.		
UNIT	**TITLE**	**PERIODS**
2	**DIESEL, GAS TURBINE AND COMBINED CYCLE POWER PLANTS**	**9**
Otto, Diesel, Dual & Brayton Cycle - Analysis & Optimisation. Components of Diesel and Gas Turbine power plants. Combined Cycle Power Plants. Integrated Gasifier based Combined Cycle systems.		
UNIT	**TITLE**	**PERIODS**
3	**NUCLEAR POWER PLANTS**	**9**
Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors: Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANada Deuterium - Uranium reactor (CANDU), Breeder, Gas Cooled and Liquid Metal Cooled Reactors. Safety measures for Nuclear Power plants.		
UNIT	**TITLE**	**PERIODS**
4	**POWER FROM RENEWABLE ENERGY**	**9**
Hydro Electric Power Plants - Classification, Typical Layout and associated components including Turbines. Principle, Construction and working of Wind, Tidal, Solar Photo Voltaic (SPV), Solar Thermal, Geo Thermal, Biogas and Fuel Cell power systems.		
UNIT	**TITLE**	**PERIODS**
5	**ENERGY, ECONOMIC AND ENVIRONMENTAL ISSUES OF POWER PLANTS**	**9**
Present Energy Scenario: World, India and future prospects, Power tariff types, Load distribution parameters, load curve, Comparison of site selection criteria, relative merits & demerits, Capital & Operating Cost of different power plants. Pollution control technologies including Waste Disposal Options for Coal and Nuclear Power Plants.		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:
Upon completion of this course, student will be able to:

CO1:	Evaluate basic components of thermal power plant by calculating the basic variables for plant selection.
CO2:	Evaluate basic components of diesel and gas turbine plant by calculating the basic variables for plant selection.
CO3:	Evaluate the basic variables of nuclear power plant systems for plant selection.
CO4:	Evaluate the basic variables hydraulic and renewable energy systems for plant selection
CO5:	Calculate the operating and fixed cost of the power plants for fixing the unit cost of power.

TEXT BOOKS:	
1.	Domkundwar & Arora Domkundwar "Power Plant Engineering", Eighth edition, ISBN-10: 8177001957, Dhanpat Rai & Co. (P) Limited; 2016
2.	Nag. P.K., "Power Plant Engineering", Third Edition, Tata McGraw - Hill Publishing Company Ltd., 2008.

REFERENCE BOOKS:	
1.	Black & Veatch, Springer, "Power Plant Engineering", 1996.
2.	El-Wakil. M.M., "Power Plant Technology", Tata McGraw - Hill Publishing Company Ltd., 2010.
3.	Godfrey Boyle, "Renewable energy", Open University, Oxford University Press in association with the Open University, 2004.
4.	John W. Twidell & Anthony D.Weir, 'Renewable Energy Resources'.
5.	Thomas C. Elliott, Kao Chen and Robert C. Swanekamp, "Power Plant Engineering", Second Edition, Standard Handbook of McGraw - Hill, 1998.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEC711L	**MECHATRONICS LABORATORY**	**0**	**0**	**3**	**1**	**2**

COURSE OBJECTIVES:	
1.	To focus on the implementation of arithmetic operations using microprocessors and microcontroller.
2.	To know the method of the design, modelling & analysis of basic electrical, hydraulic & pneumatic Systems which enable the students to understand the concept of mechatronics.
3.	To provide knowledge on interfacing.
4.	To provide knowledge about sensors and actuators
5.	To get exposure on working with image processing software

LIST OF EXPERIMENTS	
1.	PROGRAMMING: Assembly language programming of 8085 – Addition - Subtraction – Multiplication - Division - Sorting - Code Conversion.
2.	INTERFACING: Stepper motor interface
3.	INTERFACING: Traffic light interface
4.	INTERFACING: Temperature controller
5.	Speed control of DC motor
6.	Study of various types of Sensors and transducers
7.	Study of hydraulic, pneumatic and electro-pneumatic circuits.
8.	Modelling and analysis of basic hydraulic, pneumatic and electrical circuits using 'AUTOMATION STUDIO' Software.
9.	Study of PLC and its applications.
10.	Study of image processing technique.
11.	Mini project development with processors

TOTAL PERIODS:	**60**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Design mechatronics system with the help of Microprocessor, PLC and other electrical and Electronics Circuits.
CO2:	Use the microprocessor to perform simple programs like addition, subtraction, multiplication, division etc.
CO3:	Use the microprocessor for interfacing for conversion of signals
CO4:	Use transducers to create simple Mechatronics applications using data logging software.
CO5:	Test the simulated output by constructing the fluid power circuits using suitable actuators and valves.

REFERENCES: (OPTIONAL)	
1.	Hakan Gurocak, "Industrial Motion Control", Wiley, 2016

2.	W Bolton, Mechatronics, Pearson Education, Fourth Edition, 2011

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEP711J	**PROJECT WORK PHASE - I**	**0**	**0**	**-**	**4**	**2**

COURSE OBJECTIVES:	
1.	To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
2.	To develop the methodology to solve the identified problem.
3.	To train the students in preparing project reports and to face reviews and viva-voce examination.

SYLLABUS

The student individually works on a specific topic approved by the head of the division under the guidance of a faculty member who is familiar in this area of interest. The student can select any topic which is relevant to the area of engineering design. The topic may be theoretical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.

TOTAL PERIODS:	**60**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Discover potential research areas in the field of Mechanical Engineering.
CO2:	Conduct a survey of several available literature in the preferred field of study
CO3:	Compare and contrast the several existing solutions for research challenge
CO4:	Demonstrate an ability to work in teams and manage the conduct of the research study.
CO5:	Formulate and propose a plan for creating a solution for the research plan identified
CO6:	To report and present the findings of the study conducted in the preferred domain

SYLLABUS OF

SEMESTER – VIII

COURSES

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEP811J	**PROJECT WORK PHASE - II**	**0**	**0**	**-**	**20**	**10**

COURSE OBJECTIVES:	
1.	To solve the identified problem based on the formulated methodology.
2.	To develop skills to analyze and discuss the test results, and make conclusions.

SYLLABUS
The student should continue the phase I work on the selected topic as per the formulated methodology under the same supervisor. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated based on the report submitted and the viva-voce examination by a panel of examiners including one external examiner.

TOTAL PERIODS:	**300**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Apply mathematical knowledge and research based knowledge to solve engineering problems.
CO2:	Use techniques, skills and modern engineering tools necessary for engineering practice and able to manage projects in multidisciplinary environments either as a member or a leader of a team.
CO3:	Apply the engineering knowledge to asses societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering practice.
CO4:	communicate effectively and to present ideas clearly and coherently to specific audience in both the written and oral forms
CO5:	Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task
CO6:	Capable of preparing project reports, facing reviews and vice voce examinations.

SYLLABUS OF

PROFESSIONAL ELECTIVE I

COURSES

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE501T	**THEORY OF METAL FORMING**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: 191MEC501T : Engineering Materials and Metallurgy

COURSE OBJECTIVES:	
1.	To understand the principle, procedure and applications of Bulk Metal Forming and Sheet Metal Forming.
2.	To understand the concepts of forging and rolling of metals
3.	To get exposure on working principle and defects occurred in Extrusion and Drawing of Metals
4.	To understand the principle, procedure and applications of Sheet Metal Forming.
5.	To gain knowledge on recent trends in Metal Forming Processes

UNIT	**TITLE**	**PERIODS**
1	**FUNDAMENTALS OF METAL FORMING**	**9**
State of stress – Components of stress, symmetry of stress tensor, principal stresses – Stress deviator – von-mises, Tresca yield criteria – Octahedral shear stress and shear strain theory – Flow stress determination – Temperature in metal forming – Hot, cold and warm working – strain rate effects –metallurgical structures – residual stresses – Spring back.		
UNIT	**TITLE**	**PERIODS**
2	**FORGING AND ROLLING**	**9**
Principle – classification – equipment – tooling – processes parameters and calculation of forces during forging and rolling processes – Ring compression test - Post forming heat treatment – defects (causes and remedies) – applications – Roll forming.		
UNIT	**TITLE**	**PERIODS**
3	**EXTRUSION AND DRAWING PROCESSES**	**9**
Classification of extrusion processes – tool, equipment and principle of these processes – influence of friction – extrusion force calculation – defects (causes and remedies) – Rod/Wire drawing – tool, equipment and principle of processes – defects – Tube drawing and sinking processes – mannessmann process of seamless pipe manufacturing – Tube bending.		
UNIT	**TITLE**	**PERIODS**
4	**SHEET METAL FORMING PROCESSES**	**9**
Classification – conventional and HERF processes – presses – types and selection of presses – formability studies – FLD, Limiting Draw ratio - processes: Deep drawing, spinning, stretch forming, plate bending, Rubber pad forming, bulging and press brake forming – Explosion forming, electro hydraulic forming, Magnetic pulse forming.		
UNIT	**TITLE**	**PERIODS**
5	**RECENT ADVANCES**	**9**
Super plastic forming – Electro forming – fine blanking – Hydro forming – Peen forming – Laser Forming – Micro forming - P/M forging – Isothermal forging – high speed hot forging – near net shape forming high velocity extrusion – CAD and CAM in forming.		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Identify the effects of stress in metal forming processes.
CO2:	Analyze the Forging and Rolling process for simple applications.
CO3:	Analyze the Extrusion and Drawing process for simple applications.
CO4:	Choose a suitable sheet metal forming technique for a given component.
CO5:	Select advanced techniques for forming processes.

TEXT BOOKS:	
1.	Dieter G.E., “Mechanical Metallurgy”, McGraw Hill, Co., S.I. Edition, 2001
2.	Nagpal G.R. “Metal forming processes”, Khanna publishers, New Delhi, 2004

REFERENCE BOOKS:	
1.	Edward M.Mielink, “Metal working Science Engineering", McGraw Hill, Inc, 2000.
2.	Metal Handbook Vol.14, “Forming and Forging”, Metal Park, Ohio, USA, 1990
3.	Rao, P.N. “Manufacturing Technology”, TMH Ltd., 2003
4.	Serope Kalpakjian, Steven R Schmid, “Manufacturing Process for Engineering Materials”, 4th Edition, Pearson Education, 2003.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE502T	**ADVANCES IN CASTING AND WELDING PROCESSES**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: Manufacturing Technology-I

COURSE OBJECTIVES:	
1.	To elaborate gating system design and metallurgy.
2.	To provide knowledge on Special casting processes
3.	To impart knowledge on Metallurgy of welding
4.	To be acquainted with Special welding processes
5.	To familiarize the students with automation and environmental aspects of welding and casting

UNIT	**TITLE**	**PERIODS**
1	**CASTING DESIGN**	**9**
Introduction - Solidification shrinkage- Pattern allowances- Design of gating System-Design of thin and unequal sections -Rapid solidification processing (RSP) - Melt spinning -Roll quenching - Vibratory solidification -Splat cooling - Thixoforming – Rheocasting - Single crystal growing, Casting defects, inspection, diagnosis and rectification – Case study on casting design		
UNIT	**TITLE**	**PERIODS**
2	**SPECIAL CASTING PROCESSES**	**9**
Evaporative Pattern Casting Process and full mould process – Vaccum sealed moulding - vacuum casting - Magnetic Moulding - Squeeze Casting-types - Plaster mould casting - Ceramic mould casting- Investment casting - Shell Moulding - Continuous casting - Electro slag casting.		
UNIT	**TITLE**	**PERIODS**
3	**WELDING DESIGN**	**9**
Introduction - Fusion zone – Heat flow in welding -Weld solidification --Weldability of steels - Cast iron - Stainless steels, aluminum, copper and titanium alloys - Pre and Post weld heat treatments - Weld joint design- residual stress - Testing of Welding joints -Weld defects – Case study on welding design.		
UNIT	**TITLE**	**PERIODS**
4	**SPECIAL WELDING PROCESSES**	**9**
Principles, Equipment, Types, Advantages and Limitations of High frequency induction welding, Diffusion bonding, Cold pressure welding, Friction welding, Explosive welding, Plasma arc welding, Ultrasonic welding, Electron beam welding and Laser beam welding.		
UNIT	**TITLE**	**PERIODS**
5	**AUTOMATION AND ENVIRONMENTAL ASPECTS OF WELDING AND CASTING**	**9**
Mechanization and automation in foundries: Sand Plant, Material Handling, Mould and Core Making- Pollution control, energy and waste management in foundries. Automated welded joint- Welding robots, Positioners and Manipulators -Microprocessor based control of resistance and arc welding- Arc sensing, Weld Seam Tracking and Vision system Effects of welding fumes on environment		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Use design knowledge to produce quality casting.
CO2:	Select suitable casting process for the given applications
CO3:	Use design knowledge to overcome defects in welding
CO4:	Select suitable welding process for the given applications
CO5:	Implement automation principles with environment consciousness techniques in welding and casting plants

TEXT BOOKS:	
1.	Lal.M. and Khanna.O.P."A Text Books of foundry technology", DhanpatRai& Sons, 2012.
2.	Jain p L, "Principles of Foundry Technology", Tata McGraw Hill, 2009.

REFERENCE BOOKS:	
1.	American Welding Society,"Welding Handbook", Volume 1-5, 9th Edition, 2001.
2.	Dieter Radaj, "Design and Analysis of Fatigue Resistant Welded Structures", Woodhead Publishing, United Kingdom, 1990, ISBN: 978-1855730045
3.	John Campbell, "Complete Casting Handbook: Metal Casting Processes, Metallurgy, Techniques and Design", 2nd edition, Butterworth-Heinemann., United Kingdom, 2015, ISBN: 978-1856178099
4.	Mahi Sahoo and Sam Sahu, "Principles of Metal Casting", McGraw-Hill Education, United States, 3 rd Edition, 2014, ISBN: 978-0071789752.
5.	Robert B. Tuttle, "Foundry Engineering: The Metallurgy and Design of Castings", Create Space Independent Publishing Platform, Amazon, 2012, ISBN: 9781478157434.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE503T	**HYDRAULICS AND PNEUMATICS**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: 191MEC302T – FLUID MECHANICS AND MACHINERY

COURSE OBJECTIVES:	
1.	To enable the students, understand the basics of hydraulics and pneumatics.
2.	To teach students about the utilization of cylinders, accumulators, valves and various electrical and electronic control components.
3.	To provide student with knowledge on the application of fluid power in process, construction and manufacturing Industries.
4.	To develop a measurable degree of competence in the design, construction and operation of fluid power circuits.
5.	Introduce students to fluid power condition monitoring, maintenance and troubleshooting.

UNIT	**TITLE**	**PERIODS**
1	**FLUID POWER PRINICIPLES AND HYDRAULIC PUMPS**	**9**
Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids - Properties of fluids and selection – Basics of Hydraulics – Pascal's Law – Principles of flow - Friction loss – Work, Power and Torque Problems, Sources of Hydraulic power : Pumping Theory– Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary – Fixed and Variable displacement pumps – Problems.		
UNIT	**TITLE**	**PERIODS**
2	**HYDRAULIC ACTUATORS AND CONTROL COMPONENTS**	**9**
Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Hydraulic motors - Control Components: Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications – Accessories: Reservoirs, Pressure Switches – Applications – Fluid Power ANSI Symbols – Problems.		
UNIT	**TITLE**	**PERIODS**
3	**HYDRAULIC CIRCUITS AND SYSTEMS**	**9**
Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double- Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.		
UNIT	**TITLE**	**PERIODS**
4	**PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS**	**9**
Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Problems, Introduction to fluidics and pneumatic logic circuits.		
UNIT	**TITLE**	**PERIODS**
5	**TROUBLE SHOOTING AND APPLICATIONS**	**9**
Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Low-cost Automation – Hydraulic and Pneumatic power packs.		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Select an appropriate hydraulic pump for industrial applications.
CO2:	Choose suitable fluid power elements for simple applications.
CO3:	Design a hydraulic circuit for a given simple industrial applications.
CO4:	Design a pneumatic and electro pneumatic system for simple industrial automation.
CO5:	Troubleshoot fluid power systems and applications.

TEXT BOOKS:	
1.	Anthony Esposito, Fluid Power Systems,: Pearson New International edition, 2013.
2.	James R. Daines, Hydraulics and Pneumatics, 2ndEdition, The Good heart-Willcox Company, Inc., 2013.
3.	W.Bolton, Mechatronics, Electronic control systems in Mechanical and Electrical Engineering, Perason Education, 2013.

REFERENCE BOOKS:	
1.	Andrew Parr, Hydraulics and Pneumatics, Butterworth and Heinmann, 2011.
2.	Festo, Basic Pneumatic, Electro pneumatic, Hydraulic text and work books, 2015..
3.	Majumdar S.R., “Oil Hydraulics Systems- Principles and Maintenance”, Tata McGraw-Hill, 2001.
4	John Pippenger and Tyler Hicks, Industrial Hydraullics, McGraw Hill International edition 1980

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE504T	**COMPUTER AIDED DESIGN**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: NIL

COURSE OBJECTIVES:	
1.	To provide an overview of how computers are being used in mechanical component design
2.	To understand the various geometric modeling concepts.
3.	To identify the common visual realism algorithms
4.	To impart the knowledge on parts assembly logics and consideration factors
5.	To study the available data exchange formats for CAD model transportation

UNIT	TITLE	PERIODS
1	**FUNDAMENTALS OF COMPUTER GRAPHICS**	**9**
Product cycle- Design process- sequential and concurrent engineering- Computer aided design – CAD system architecture- Computer graphics – co-ordinate systems- 2D and 3D transformations- homogeneous coordinates - Line drawing -Clipping- viewing transformation		
UNIT	**TITLE**	**PERIODS**
2	**GEOMETRIC MODELLING**	**9**
Representation of curves- Hermite curve- Bezier curve- B-spline curves-rational curves-Techniques for surface modeling – surface patch- Coons and bicubic patches- Bezier and B-spline surfaces. Solid modeling techniques- CSG and B-rep		
UNIT	**TITLE**	**PERIODS**
3	**VISUAL REALISM**	**9**
Hidden – Line-Surface-Solid removal algorithms – shading – colouring – computer animation		
UNIT	**TITLE**	**PERIODS**
4	**ASSEMBLY OF PARTS**	**9**
Assembly modelling – interferences of positions and orientation – tolerance analysis-mass property calculations – mechanism simulation and interference checking.		
UNIT	**TITLE**	**PERIODS**
5	**CAD STANDARDS**	**9**
Standards for computer graphics- Graphical Kernel System (GKS) - standards for exchange images- Open Graphics Library (OpenGL) - Data exchange standards - IGES, STEP, CALS etc. - communication standards.		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Interpret the 2D and 3D transformation methods used in computer graphics
CO2:	Create complex parts using surface and solid modeling techniques

CO3:	Apply the concepts of colour and shading models for product visualization
CO4:	Perform dimensional and mass property analysis using a coordinate system
CO5:	Use the different types of Standard systems used in CAD.

TEXT BOOKS:	
1.	Ibrahim Zeid, R Sivasubramanian, CAD/CAM, Theory and Practice, Second edition, Tata McGraw-Hill Publishing Co.2017
2	Srinivas, J, CAD/CAM Principles and applications, Oxford University Press, 2017

REFERENCE BOOKS:	
1.	Chris McMahon and Jimmie Browne “CAD/CAM Principles", "Practice and Manufacturing management “Second Edition, Pearson Education, 1999.
2.	Ibrahim Zeid, Mastering CAD/CAM, Tata McGraw-Hill Publishing Co.2017
3.	Foley, Wan Dam, Feiner and Hughes - "Computer graphics principles & practice" Pearson Education - 2003.
4.	William M Neumann and Robert F.Sproul “Principles of Computer Graphics”, McGraw Hill Book Co. Singapore, 1989.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE505T	**REFRIGERATION AND AIR CONDITIONING**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: 191MEC403T – Thermal Engineering

COURSE OBJECTIVES:	
1.	To understand the underlying principles of operations in different Refrigeration & Air conditioning systems and components.
2.	To gain knowledge in vapor compression refrigeration system and components associated with it.
3.	To provide knowledge in various non conventional refrigeration systems.
4.	To gain knowledge in psychrometric processes and properties.
5.	To provide knowledge on design aspects of Refrigeration & Air conditioning systems

UNIT	**TITLE**	**PERIODS**
1	**INTRODUCTION**	**9**
Introduction to Refrigeration - Unit of Refrigeration and C.O.P.– Ideal cycles -Block diagram of refrigerator & heat pump. Refrigerants Desirable properties – Classification - Nomenclature - ODP & GWP.		
UNIT	**TITLE**	**PERIODS**
2	**VAPOUR COMPRESSION REFRIGERATION SYSTEM**	**9**
Vapor compression cycle: p-h and T-s diagrams - deviations from theoretical cycle – subcooling and super heating- effects of condenser and evaporator pressure on COP- multipressure system - low temperature refrigeration - Cascade systems – problems. Equipments: Type of Compressors, Condensers, Expansion devices, Evaporators.		
UNIT	**TITLE**	**PERIODS**
3	**OTHER REFRIGERATION SYSTEMS**	**9**
Working principles of Vapour absorption systems and adsorption cooling systems – Steam jet refrigeration- Thermoelectric refrigeration- Air refrigeration - Magnetic - Vortex and Pulse tube refrigeration systems. Three fluid system (Electrolux refrigeration), comparison between VCR and VAR.		
UNIT	**TITLE**	**PERIODS**
4	**PSYCHROMETRIC PROPERTIES AND PROCESSES**	**9**
Properties of moist air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temperature Thermodynamic wet bulb temperature, Psychrometric chart; Psychrometric of air-conditioning processes, mixing of air streams.		
UNIT	**TITLE**	**PERIODS**
5	**AIR CONDITIONING SYSTEMS AND LOAD ESTIMATION**	**9**
Air conditioning loads: Outside and inside design conditions; Heat transfer through structure, Solar radiation, Electrical appliances, Infiltration and ventilation, internal heat load; Apparatus selection; fresh air load, human comfort & IAQ principles, effective temperature & chart, calculation of summer & winter air conditioning load; Classifications, Layout of plants Classification of ductsflow through duct, pressure losses in duct (friction losses, dynamic losses), methods of duct system design cooling and adiabatic mixing. Simple Applications		
Case studies: Design And Analysis of Solar Electrolux Vapour Absorption Refrigeration System. Air Conditioning of Classrooms in Schools & Training Centers. Low Power Vapour Compression Refrigeration System.		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Elucidate the principles of Refrigeration and calculation of basic performance parameters.
CO2:	Analyze the performance of vapour compression refrigeration system by calculating the performance parameters.
CO3:	Enumerate the functioning and features of non conventional refrigeration systems
CO4:	Estimate the psychometric properties of gas mixtures, moist air for basic processes.
CO5:	Design HVAC system for a given simple building layout.

TEXT BOOKS:	
1.	Arora, C.P., "Refrigeration and Air Conditioning", 3rd edition, McGraw Hill, New Delhi, 2010
2.	Khurmi R.S, Gupta J.K, “A Textbook of Refrigeration and Air Conditioning” , S Chand Publishing.

REFERENCE BOOKS:	
1.	ASHRAE Hand book, Fundamentals, 2010.
2.	Jones W.P., "Air conditioning engineering", 5th edition, Elsevier Butterworth-Heinemann, 2007
3.	Roy J. Dossat, "Principles of Refrigeration", 4 th edition, Pearson Education Asia, 2009.
4.	Stoecker, W.F. and Jones J. W., "Refrigeration and Air Conditioning", McGraw Hill, New Delhi, 1986.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE506T	**CRYOGENIC ENGINEERING**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: Engineering Thermodynamics, Thermal Engineering

COURSE OBJECTIVES:	
1.	To provide introductory knowledge of cryogenic Engineering
2.	To impart knowledge in liquefaction, separation of cryogenics gases and working of cryocoolers
3.	To provide knowledge in separation of cryogenic gases.
4.	To gain knowledge in different types of refrigerators.
5.	To provide awareness on handling of various cryogenic systems.

UNIT	**TITLE**	**PERIODS**
1	**INTRODUCTION**	**8**
Insight on Cryogenics, Properties of Cryogenic fluids, Material properties at Cryogenic Temperatures. Applications of Cryogenics in Space Programs, Superconductivity, Cryo Metallurgy, Medical applications.		
UNIT	**TITLE**	**PERIODS**
2	**LIQUEFACTION CYCLES**	**10**
Carnot Liquefaction Cycle, F.O.M. and Yield of Liquefaction Cycles. Inversion Curve - Joule Thomson Effect. Linde Hampson Cycle, Precooled Linde Hampson Cycle, Claudes Cycle Dual Cycle, Ortho- Para hydrogen conversion, Eollins cycle, Simpson cycle, Critical Components in Liquefaction Systems.		
UNIT	**TITLE**	**PERIODS**
3	**SEPARATION OF CRYOGENIC GASES**	**9**
Binary Mixtures, T-C and H-C Diagrams, Principle of Rectification, Rectification Column Analysis - McCabe Thiele Method. Adsorption Systems for purification		
UNIT	**TITLE**	**PERIODS**
4	**CRYOGENIC REFRIGERATORS**	**8**
J.T.Cryocoolers, Stirling Cycle Refrigerators, G.M.Cryocoolers, Pulse Tube Refrigerators Regenerators used in Cryogenic Refrigerators, Dilution refrigerators, Magnetic Refrigerators		
UNIT	**TITLE**	**PERIODS**
5	**HANDLING OF CRYOGENS**	**10**
Cryogenic Dewar, Cryogenic Transfer Lines. Insulations used in Cryogenic Systems, Instrumentation to measure Flow, Level and Temperature		
Case studies: Material selection of cryogenic pressure vessel in industry. Study of chandrayaan 2 by GSLV-MKIII launch vehicle system.		
	TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Calculate cryogenic properties of fluid and materials.
CO2:	Select cycle for gas liquefaction
CO3:	Correlate the separation techniques of cryogenic gases and sketch phase diagrams.
CO4:	Select cryogenic cooling equipment for particular applications

CO5:	Implement safety procedures while handling cryogens

TEXT BOOKS:	
1.	Randall F. Barron, Cryogenic Systems, McGraw-Hill, 1985
2.	Scott R.B., Cryogenic Engineering, Van No strand and Co., 1962
3.	Venkatarathnam G, Cryogenic Mixed Refrigerant Processes, Springer Publication, 2010.

REFERENCE BOOKS:	
1.	Herald Weinstock, Cryogenic Technology, Boston Technical Publishers, inc., 1969
2.	J.G.Weisend, Hand Book of Cryogenic Engineering —II, Taylor and Francis, 1998.
3.	Klaus D. Timmerhaus and Thomas M. Flynn, Cryogenic Process Engineering, Plenum Press, New York, 1989
4.	Robert W. Vance, Cryogenic Technology, John wiley & Sons, Inc., New York, London

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE507T	**PROFESSIONAL ETHICS IN ENGINEERING**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: NIL

COURSE OBJECTIVES:	
1.	To identify the core values that shape the ethical behavior of an engineer
2.	To utilize opportunities to explore one's own values in ethical issues
3.	To become aware of ethical concerns and conflicts
4.	To enhance familiarity with codes of conduct
5.	To increase the ability to recognize and resolve ethical dilemmas

UNIT	**TITLE**	**PERIODS**
1	**HUMAN VALUES**	**9**
Morals and Ethics - Honesty - Integrity - Values - Work Ethic - Civic Virtue - Respect for Others – Living Peacefully - Caring and Sharing - Self-Confidence - Courage - Co-operation - Commitment - Empathy		
UNIT	**TITLE**	**PERIODS**
2	**ENGINEERINGETHICS AND PROFESSIONALISM**	**9**
Scope of Engineering Ethics- Variety of moral issues - Types of inquiry - Accepting and sharing responsibility - Ethical dilemmas - Moral autonomy - Kohlbergs and Gilligan's theory - Consensus and controversy - Profession and Professionalism - Models of Professional Roles - Right action theories - Senses of corporate responsibility - Codes of ethics: Importance – justification - Limitation - Abuse.		
UNIT	**TITLE**	**PERIODS**
3	**ENGINEER'S AS SOCIAL EXPERIMENTATION & RESPONSIBILITY FOR SAFETY**	**9**
Engineering as Experimentation –Engineers as responsible Experimenters –Research Ethics -Codes of Ethics -Industrial Standards -A Balanced Outlook on Law - Cautious Optimism - Safety and Risk – Assessment of Safety and Risk –Risk Analysis –Reducing Risk –The Government Regulator's Approach to Risk -l Case Studies Chernobyl and Bhopal Gas Tragedy		
UNIT	**TITLE**	**PERIODS**
4	**RESPONSIBILITIES AND RIGHTS**	**9**
Fundamental Rights - Responsibilities and duties of Indian Citizen - Team work- Ethical corporate Climate - Collegiality and Loyalty –Respect for Authority –Collective Bargaining –Confidentiality –Conflicts of Interest – Occupational Crime –Professional Rights –Employee Rights –Intellectual Property Rights (IPR) - Discrimination		
UNIT	**TITLE**	**PERIODS**
5	**GLOBAL ISSUES**	**9**
Multinational Corporations –Business Ethics -Environmental Ethics –Computer Ethics -Role in Technological Development –Weapons Development –Engineers as Managers –Consulting Engineers – Engineers as Expert Witnesses and Advisors –Honesty –Moral Leadership –Sample Code of Conduct		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:
Upon completion of this course, student will be able to:

CO1:	Apply Ethical Theories and Human Values in Engineering.
CO2:	Understand the Responsibility and Professionalism.
CO3:	Evaluate social experimentation with engineering approaches for Safety.
CO4:	Create Confidence in their approaches and claim their rights.
CO5:	Create moral leadership with the knowledge in global practices.

TEXT BOOKS:	
1.	Charles E Harris, Michael S Pritchard and Michael J Rabins, "Engineering EthicsConcepts and Cases", Cengage Learning., Belmont, 2009, ISBN-13: 978-0-495-50279-1 ISBN-10: 0-495-50279-0
2.	Mike Martin and Roland Schinzinger, "Introduction To Engineering Ethics", 2nd Edition McGraw Hill., New York, 2010, ISBN 978-0-07-248311-6—ISBN 0-07-248311-3

REFERENCE BOOKS:	
1.	Charles D Fleddermann, "Engineering Ethics", 4thedition, Prentice Hall., New Mexico, Newjersey, 1999, ISBN-13: 978-0-13-214521-3 , ISBN-10: 0-13-214521-9
2.	David Ermann and Michele S Shauf, "Computers, Ethics and Society", Oxford University Press,United Kingdom, 2002,ISBN: 9780195143027.
3.	Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", 1st edition, Oxford University Press, United Kingdom, 2000, ISBN-13:978-0195134889, ISBN-10:0195134885
4.	John R Boatright, "Ethics and the Conduct of Business",8theditionPearson Education, Boston,2017,ISBN-10:9789352862306, ISBN-13:978-9352862306
5.	Prof. (Col) P S Bajaj and Dr. Raj Agrawal, "Business Ethics –An Indian Perspective", Wiley, 2004,ISBN-10:8177221671ISBN-13:9788177221671.

SYLLABUS OF

PROFESSIONAL ELECTIVE II

COURSES

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE601T	**GAS DYNAMICS AND JET PROPULSION**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: 191MEC303T - Engineering Thermodynamics**,** 191MEC403T - Thermal Engineering

COURSE OBJECTIVES:	
1.	To understand the basics of compressible fluids and flow through variable ducts
2.	To understand the flow through constant area ducts
3.	To understand the phenomenon of shock waves and its effect on flow
4.	To gain basic knowledge about jet propulsion
5.	To gain basic knowledge about Rocket propulsion

UNIT	**TITLE**	**PERIODS**
1	**BASIC CONCEPTS AND ISENTROPIC FLOWS**	**9**
Energy and momentum equations of compressible fluid flows - Stagnation states, Mach waves and Mach cone - Effect of Mach number on compressibility - Isentropic flow through variable ducts - Nozzle and Diffusers.		
UNIT	**TITLE**	**PERIODS**
2	**FLOW THROUGH DUCTS**	**9**
Flow through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) - variation of flow properties.		
UNIT	**TITLE**	**PERIODS**
3	**NORMAL AND OBLIQUE SHOCKS**	**9**
Governing equations - Variation of flow parameters across the normal and oblique shocks - Prandtl - Meyer relations - Applications.		
UNIT	**TITLE**	**PERIODS**
4	**JET PROPULSION**	**9**
Theory of jet propulsion - Thrust equation - Thrust power and propulsive efficiency - Operating principle, cycle analysis and use of stagnation state performance of ram jet, turbojet, turbofan and turbo prop engines.		
UNIT	**TITLE**	**PERIODS**
5	**SPACE PROPULSION**	**9**
Types of rocket engines - Propellants - feeding systems - Ignition and combustion - Theory of rocket propulsion - Performance study - Staging - Terminal and characteristic velocity - Applications - space flights.		
Case studies: Study of specifications of Rockets - PSLV, GSLV		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Calculate stagnation and flow properties for isentropic compressible flow through constant area duct
CO2:	Calculate the stagnation and flow properties for constant area duct with heat transfer and friction
CO3:	Calculate the stagnation and flow properties in a normal, oblique shock waves
CO4:	Calculate the propulsion parameters in aircraft engine

CO5:	Calculate the propulsion parameters in rocket vehicles.

TEXT BOOKS:	
1.	Anderson, J.D., "Modern Compressible flow", 3rd Edition, McGraw Hill, 2012.
2.	Cohen. H., G.E.C. Rogers and Saravanamutto, "Gas Turbine Theory", 5th Edition, Longman Group Ltd., 2013
3.	Yahya, S.M., "Fundamentals of Compressible Flow", 6th Edition, New Age International (P) Limited, New Delhi, 2018.

TABLES:	
1.	Yahya, S.M., “Gas Tables”, New Age International Publishers, 2018.

REFERENCE BOOKS:	
1.	Ganesan. V., "Gas Turbines", Tata McGraw Hill Publishing Co., New Delhi, 2010.
2.	Shapiro. A.H., "Dynamics and Thermodynamics of Compressible fluid flow", John wiley, New York, 1953.
3.	Sutton. G.P., "Rocket Propulsion Elements", John Wiley, New York, 2010.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE602T	**ENERGY CONSERVATION AND MANAGEMENT**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: Thermal Engineering

COURSE OBJECTIVES:	
1	Understand and analyze the energy data of industries
2	Carryout energy accounting and balancing
3	Conduct energy audit and suggest methodologies for energy savings and
4	Utilize the available resources in optimal ways
5.	To learn Energy Conservation practices using Economics principles and Strategies.

UNIT	**TITLE**	**PERIODS**
1	**INTRODUCTION**	**8**
Energy - Power – Past & Present scenario of World; National Energy consumption Data – Environmental aspects associated with energy utilization –Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing.		
UNIT	**TITLE**	**PERIODS**
2	**ELECTRICAL SYSTEMS**	**12**
Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination.		
UNIT	**TITLE**	**PERIODS**
3	**THERMAL SYSTEMS**	**12**
Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and encon measures. Energy Efficiency of turbines, compressors and pumps, specific energy consumption, parameters affecting specific energy consumption, flexi targeting technique. Cogeneration: types and schemes, case study , Steam: Distribution &U sage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories,The Energy efficiency home.		
UNIT	**TITLE**	**PERIODS**
4	**ENERGY CONSERVATION IN MAJOR UTILITIES**	**8**
Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems – Cooling Towers – D.G. sets. Energy Audits and Improvements for Commercial Buildings		
UNIT	**TITLE**	**PERIODS**
5	**ECONOMICS**	**5**
Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept, Energy conservation in vehicles, energy conservation in buildings, Power quality issues related to Energy Efficient Technologies, Energy Conservation Practice – Case Studies		
Case studies: Energy saving measures/ projects, Heat Ventilating and Air-Conditioning (HVAC) -Energy Conservation Practice		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Demonstrate the energy auditing methods, barriers with the help of energy auditing instruments
CO2:	Evaluate the energy efficiencies of electrical systems through energy audit
CO3:	Evaluate the energy efficiencies of thermal systems through energy audit
CO4:	Infer the areas where energy conservation is possible for improvements in commercial buildings
CO5:	Evaluate the energy economic strategies of vehicles and buildings
CO6:	Estimate the energy utilization and conservation in buildings and vehicles

TEXT BOOKS:	
1.	Ian M. Shapiro, “Energy Audits and Improvements for Commercial Buildings”Wiley,2011
2.	K. V. Sharma., P. Venkataseshaiah, “Energy Management and Conservation”I K International Publishing, 2011.
3.	S. S. Thipse. “Energy Conservation and Management”,Alpha Science International, 2014.

REFERENCE BOOKS:	
1.	Callaghn, P.W. “Design and Management for Energy Conservation”, Pergamon Press, Oxford, 1981.
2.	Patrick Waterfield.” The ENERGY EFFICIENT HOME: A Complete Guide “2011.
3.	Witte. L.C., P.S. Schmidt, D.R. Brown, “Industrial Energy Management and Utilisation” Hemisphere Publ, Washington, 1988.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE603T	**VIBRATION AND NOISE CONTROL**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: 191MEC502T - MECHANICS OF MACHINES

COURSE OBJECTIVES:

1.	To familiarize with fundamentals of vibration noise
2.	To understand different noise propagation
3.	To gain knowledge on noise measurement and its instrumentation techniques
4.	To apply various noise control techniques
5.	To understand various vibration control strategies

UNIT	TITLE	PERIODS
1	**INTRODUCTION TO VIBRATION NOISE**	**9**
Definition, basic attributes of sound (wavelength, period, frequency velocity, speed, pressure, power and sound intensity), units (decibel, dB (A) and SPL), Wave analysis of structures and spaces.		
UNIT	**TITLE**	**PERIODS**
2	**ENVIRONMENTAL NOISE PROPAGATION**	**9**
Sources, distance from source, atmospheric absorption, wind, temperature, wind and temperature gradient, obstacles such as barriers and buildings, ground absorption, reflections, humidity.		
UNIT	**TITLE**	**PERIODS**
3	**NOISE MEASUREMENT AND INSTRUMENTAION**	**9**
Noise measurement and control instrumentation, Leq and various noise metrics for aircraft and industrial noises. Noise Level indicators, Noise severity criteria, Various types of acoustic testing chambers.		
UNIT	**TITLE**	**PERIODS**
4	**NOISE CONTROL**	**9**
Importance of reverberations time. Design of absorption systems for required reverberation time. Noise isolation design. Noise absorber design. Acoustic Design of Buildings Common strategies for reducing environmental noise exposure.		
UNIT	**TITLE**	**PERIODS**
5	**VIBRATION CONTROL STRATEGIES**	**9**
Review of Vibration control measures, design of a Vibration Absorbers, unconstrained and constrained layer damping treatment, add on dampers, and stiffeners. Design of Isolators in machine foundations, Role of materials damping. Introduction to Active Vibration Control.		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO1:	Analyze different attributes of vibration and wave analysis of structure.
CO2:	Analyze the noise propagation mechanism in buildings.
CO3:	Apply acoustic testing methods to measure industrial vibration and noise

CO4:	Design noise absorption systems for reducing environmental noise exposure
CO5:	Develop test strategies of noise propagation

TEXT BOOKS:	
1.	Grover. G.T., “Mechanical Vibrations”, Nem Chand and Bros., 2009
2.	Singiresu S.Rao, “Mechanical Vibrations”, 6th Edition, Pearson Education, 2016.

REFERENCE BOOKS:	
1.	Balakumar Balachandran and Edward B. Magrab, “Fundamentals of Vibrations”,1st Editon, Cengage Learning, 2009
2.	Bernard Challen and Rodica Baranescu - “Diesel Engine Reference Book”, Second Edition, SAE International, 1999
3.	Colin Hansen , Scott Snyder , Laura Brooks, Active Control of Noise and Vibration, Second Edition, Volume 1, CRC Press, 2012
4.	Kewal Pujara, Vibration and Noise for Engineers, Dhanpat Rai & co, 2018

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE604T	**INDUSTRIAL TRIBOLOGY**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: 191PYB203T- Material Science

COURSE OBJECTIVES:	
1.	To familiarize the knowledge on surface engineering and surface modification methods that will come in handy to solve the industrial problems.
2.	To impart knowledge in the friction and wear aspects of machine components.
3.	To gain knowledge in the lubrication aspects of machine components.
4.	To provide the knowledge on to apply and solve the industrial problems that arise related to Corrosion of surfaces.
5.	To understand the material properties which influence the tribological characteristics of surfaces.

UNIT	**TITLE**	**PERIODS**
1	**SURFACE INTERACTION AND FRICTION**	**8**
Topography of Surfaces – Surface features – Properties and measurement – Surface interaction – Adhesive Theory of Sliding Friction – Rolling Friction – Friction properties of metallic and non-metallic materials.		
UNIT	**TITLE**	**PERIODS**
2	**WEAR CHARACTERISTICS**	**9**
Introduction – Abrasive wear, Erosive, Cavitation, Adhesion, Fatigue wear and Fretting Wear-Laws of wear – Theoretical wear models – Wear of metals and non metals – International standards in friction and wear measurements.		
UNIT	**TITLE**	**PERIODS**
3	**LUBRICANTS AND LUBRICATION REGIMES**	**8**
Lubricants and their physical properties – Viscosity and other properties of oils – Additives and selection of Lubricants – Lubricant standards ISO, SAE, AGMA, BIS standards – Lubrication Regimes – Solid Lubrication – Hydrodynamic lubrication – Hydrostatic lubrication – Gas lubrication.		
UNIT	**TITLE**	**PERIODS**
4	**CORROSION**	**10**
Introduction – Principle of corrosion – Classification of corrosion – Types of corrosion – Factors influencing corrosion – Testing of corrosion – In-service monitoring, Simulated service, Laboratory testing – Evaluation of corrosion – Prevention of Corrosion – Material selection, Alteration of environment, Cathodic and Anodic Protection.		
UNIT	**TITLE**	**PERIODS**
5	**SURFACE TREATMENTS**	**10**
Introduction – Surface properties, Superficial layer – Changing surface metallurgy – Wear resistant coatings and Surface treatments – Techniques – PVD – CVD – Physical CVD – Ion implantation – Thermal spraying – Laser surface hardening and alloying, Applications of coatings and surface treatments in wear and friction control –New trends in coating technology – DLC – CNC – Thick coatings – Nano-engineered coatings – Corrosion resistant coatings.		
Case studies: Case study of wear and corrosion resistant coatings on industrial applications, Case study of Nano coatings on industrial applications,		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Examine the surface features and frictional properties of Metallic and Non Metallic Materials
CO2:	Appreciate the various modes of wear and the wear-mechanisms.
CO3:	Select suitable lubricants and lubrication regimes for different operating conditions in industrial applications.
CO4:	Test the corrosion properties of metals
CO5:	Apply surface coatings on materials to control wear and corrosion

TEXT BOOKS:	
1.	Basu.S.K, Sengupta.S.N and Ahuja.B.B, ”Fundamentals of Tribology” Prentice – Hall of India Pvt Ltd , New Delhi, 2005.
2.	Cameron, A. “Basic Lubrication Theory”, Ellis Herward Ltd., UK, 1981.
3.	Fontana G., “Corrosion Engineering”, McGraw Hill, 1985.
4.	Halling, J, “Principles of Tribology”, Macmillian – 1984.
5.	Rabinowicz. E, “Friction and Wear of materials”, John Willey &Sons ,UK,1995.
6.	Stachowiak.G.W and Batchelor.A.W, “Engineering Tribology”, Butterworth - Heinemann, UK, 2005.
7.	Williams J.A. “Engineering Tribology”, Oxford Univ. Press, 1994.

REFERENCE BOOKS:	
1.	Avraham Harnoy, “Bearing Design in Machinery: Engineering Tribology and Lubrication”, Dekker 2007.
2.	Giovanni Straffelini, “Friction and Wear: Methodologies for Design and Control”, Springer 2015
3.	Michael Khonsari.M, “Applied Tribology: Bearing Design and Lubrication”, Wiley Blackwell; 2nd Revised edition, 2008.
4.	Stolarsk.T.A, “Tribology in Machine Design, Butterworth”, – Heinemann, UK, 2013.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE605T	**QUALITY CONTROL AND RELIABILITY ENGINEERING**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: Statistical Quality Control

COURSE OBJECTIVES:	
1.	To introduce the concepts of SQC
2.	To understand the process control for Defects and Defectives
3.	To understand process control and acceptance sampling procedure and their application.
4.	To understand the concept of Life Testing & Reliability
5.	To learn the concept of product development and product life cycle

UNIT	**TITLE**	**PERIODS**
1	**INTRODUCTION AND PROCESS CONTROL FOR VARIABLES**	**9**
Introduction, definition of quality, basic concept of quality, definition of SQC, benefits and limitation of SQC, Quality assurance, Quality control: Quality cost-Variation in process causes of variation – Theory of control chart- uses of control chart –X chart, R chart and chart - process capability – process capability studies and simple problems. Six sigma concepts. Seven quality control tools		
UNIT	**TITLE**	**PERIODS**
2	**PROCESS CONTROL FOR ATTRIBUTES**	**9**
Control chart for attributes –control chart for non conforming– p chart and np chart – control chart for nonconformities– C and U charts, State of control and process out of control identification in charts, pattern study.		
UNIT	**TITLE**	**PERIODS**
3	**ACCEPTANCE SAMPLING**	**9**
Lot by lot sampling – types – probability of acceptance in single, sampling techniques – O.C. curves – producer's Risk and consumer's Risk. AQL, LTPD, AOQL concepts-standard sampling plans for AQL and LTPD- uses of standard sampling plans.		
UNIT	**TITLE**	**PERIODS**
4	**LIFE TESTING – RELIABILITY**	**9**
Life testing – Objective – failure data analysis, Mean failure rate, mean time to failure, mean time between failure, hazard rate – Weibull model, system reliability, series, parallel and mixed configuration – simple problems. Maintainability and availability – simple problems. Acceptance sampling based on reliability test – O.C Curves.		
UNIT	**TITLE**	**PERIODS**
5	**QUALITY AND RELIABILITY**	**9**
Reliability improvements – techniques- use of Pareto analysis – design for reliability – redundancy unit and standby redundancy – Optimization in reliability – Product design – Product analysis – Product development– Product life cycles.		
Case Study: Problem solving through R-programming/ Mini TAB		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, Student will be able to:	
CO1:	Employ various statistical methods to monitor quality of the process.
CO2:	Use of control charts for attributes to Analyze product quality.

CO3:	Determine the quality of a batch of products by using sampling techniques.
CO4:	Estimating the expected durability of a product over a period of time.
CO5:	Predict how well a product performs its proper functions.

TEXT BOOKS:	
1.	Douglus C. Montgomery, “Introduction to Statistical Quality Control”, Wiley-India, Seventh Edition, 2013.
2.	Srinath. L.S., “Reliability Engineering”, Affiliated East west press, 2008.

REFERENCE BOOKS:	
1.	AmitavaMitra, “Fundamentals of Quality Control and Improvement”, Wiley, Third Edition, 2008.
2.	Charles E.Ebeling, “An Introduction to Reliability and Maintainability Engineering”, TMH, 2007
3.	Connor, P.D.T.O., “Practical Reliability Engineering”, John Wiley, 2012
4.	Dale H. Besterfield, Quality Control, Pearson Education Asia, EightEdition, 2008
5.	Eugene L. Grant and Richard S. Leaven Worth, “Statistical Quality Control”, McGraw-Hill Education, Seventh Edition, 2000.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE606T	**NANO TECHNOLOGY**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: NIL

COURSE OBJECTIVES:	
1.	To learn fundamental principles behind nanotechnology and nano materials and their vital role in novel sensing properties and applications.
2.	To provide interesting interdisciplinary scientific and engineering knowledge at the nanoscale.
3.	To understand the fabrication, characterization, and manipulation of nano materials.
4.	To understand the fabrication, characterization, and manipulation of nano sensors, and how they can be exploited for new applications.
5.	To apply their knowledge of nanotechnology and nano sensors to a topic of personal interest in this course.

UNIT	**TITLE**	**PERIODS**
1	**INTRODUCTION TO NANO MATERIALS**	**9**

Crystal Systems – Unit Cells – Bravias Lattices – Crystallographic Planes – Miller Indices – Space Groups – Crystalline and Amorphous Materials Bonds in the Materials: Metallic, Ionic- Covalent and Van-der-Waals Bonds – Crystal Defects – Basics of Nanoscience and Nanotechnology – Scientific Revolutions – Nano sized Effects – Surface to Volume Ratio – Energy at the Nanoscale - Quantum Confinement Effects – Classifications of Nano systems - 1D- 2D- 3D Nanomaterials – Size Dependent Properties of Nanomaterials.

UNIT	**TITLE**	**PERIODS**
2	**PREPARATION OF NANOMATERIALS**	**9**

Basics of material preparation: Bottom-up Synthesis-Top-down Approach: Mechanical methods: Mechanical Milling Planetary- Attritor- Tumbler and Uniball – Milling parameters: Ballto-Powder ratio- Speed- Medium and Atmosphere – Mechanochemical reactions – Mechanical alloying – Mechanical Milling; Amorphization and Crystallization by Milling process. Chemical methods: Sol gel process Colloidal precipitation.

UNIT	**TITLE**	**PERIODS**
3	**CHARACTERIZATION OF NANO MATERIALS**	**9**

Characterization of electrical- optical- mechanical and magnetic properties of nanomaterials. Electrical conductivity and permittivity- magnetic permeability- Structural characterization: X-ray diffraction- Electron microscopy. Surface characterization: scanning electron microscopy- atomic force microscopy- Tunneling electron microscopy- XPS. Characterization of thin films-optical and electronic properties.

UNIT	**TITLE**	**PERIODS**
4	**CARBON NANO STRUCTURES**	**9**

Carbon nanotubes (CNT): Single walled carbon nanotubes, Multi-walled carbon nanotubes – Carbon dots – Carbon Nano cones – Carbon Nano horns – Nano diamond – Stability of carbon phases at Nano level: Phase diagram. Properties of carbon nano structures- Mechanical strength, Electrical conductivity Applications- energy storage devices, Quantum computers.

UNIT	**TITLE**	**PERIODS**
5	**SENSOR APPLICATIONS**	**9**

Inorganic Nanotechnology Enabled Sensors - Nanotechnology Enabled Mechanical Sensors - Thermal energy sensors - temperature sensors - Electromagnetic sensors- electrical resistance sensors- electrical current sensors- electrical voltage sensors- electrical power sensors - liquid flow sensors- position sensors -

chemical sensors - radiation sensors – organic nanotechnology enabled sensors.
Case Studies: Nanotechnology in concrete materials, the current application of nanotechnology in food and agriculture. Nanotechnology in Textile industries

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Infer fundamental principles of nano-technology and its applications.
CO2:	Select an appropriate method for preparation of nanomaterials.
CO3:	Analyze nanomaterials using various characterization methods.
CO4:	Design functional nanomaterials using carbon nano tubes.
CO5:	Identify the suitable nano sensors for various applications

TEXT BOOKS:	
1.	A.S. Edelstein and R.C. Cammearata, eds., “Nanomaterials: Synthesis, Properties and Applications”, Institute of Physics Publishing, Bristol and Philadelphia, 1996.
2.	N John Dinardo, “Nanoscale Characterization of surfaces & Interfaces”, 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000.

REFERENCE BOOKS:	
1.	Akhlesh Lakhtakia, “The Hand Book of Nano Technology, Nanometer Structure, Theory, Modeling and Simulations”. Prentice-Hall of India (P) Ltd, New Delhi, 2007.
2.	G Timp, “Nanotechnology”, AIP press/Springer, 1999.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE607T	**ENGINEERING ECONOMICS AND FINANCIAL ACCOUNTS**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: Nil

COURSE OBJECTIVES:	
1.	To introduce the concept of Economics and cost Analysis to engineering and take economically sound decision
2.	To Introduce the concept of Good working condition at the lowest cost
3.	To Introduce the concept of Work Management
4.	To Introduce the concept of operational performance and Economics position of an enterprise
5.	To introduce Economic Theory in Engineering Practices

UNIT	**TITLE**	**PERIODS**
1	**FINANCIAL ACCOUNTING**	**12**
Accounting principles –preparation and interpretation of profit and loss statement –balance sheet –Fixed assets –current assets –depreciation –depreciation methods		
UNIT	**TITLE**	**PERIODS**
2	**PROFIT VOLUME ANALYSIS**	**10**
Cost volume profit relationship –relevant costs in decision making –profit management analysis –break even analysis –margin of safety –angle of incidence and multi product break even analysis Effect of changes in volume, selling price, fixed cost and variable cost.		
UNIT	**TITLE**	**PERIODS**
3	**WORKING CAPITAL MANAGEMENT**	**8**
Current assets and liability decisions –Estimation of working capital requirements –Management of accounts receivable –Inventory –Cash –Inventory valuation methods.		
UNIT	**TITLE**	**PERIODS**
4	**CAPITAL BUDGETING**	**7**
Significance of capital budgeting –payback period –present value method –Accounting rate of return method		
UNIT	**TITLE**	**PERIODS**
5	**ENGINEERING ECONOMICS**	**8**
Economics –Engineering economics –Demand analysis –Laws of demand –Production and cost –Pricing methods –Cost volume profit analysis.		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Prepare and interpret financial statements.
CO2:	Perform Profit analysis.
CO3:	Estimating the working capital management.
CO4:	Manage the capital budgeting.

CO5:	Understand the principles of Engineering Economics.

TEXT BOOKS:	
1.	R.Kesavan, C. Elanchezian and T.Sundar Selwyn –Engineering Economics and Financial Accounting, Laxmi Publications 2005.
2.	Panneer Selvam, R, “Engineering Economics”, Prentice Hall of India Ltd, New Delhi, 2001.

REFERENCE BOOKS:	
1.	C.James, Vanhorn, Fundamentals of Financial Management PHI 1996.
2.	Charles T.Homgren, Cost Accounting, PHI 1985
3.	S.N.Maheswaran, Management Accounting and Financial Control, Sultan Chand, 1992.

SYLLABUS OF

PROFESSIONAL ELECTIVE III

COURSES

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE701T	**NON CONVENTIONAL ENERGY SOURCES**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: NIL

COURSE OBJECTIVES:

1.	To understand the availability of various energy resources
2.	To attain the knowledge in solar energy and its applications
3.	To provide knowledge in various wind energy systems.
4.	To gain knowledge in designing and modeling bio energy plants.
5.	To learn about various other renewable energy resources.

UNIT	TITLE	PERIODS
UNIT 1	**INTRODUCTION**	**9**

World Energy Use – Reserves of Energy Resources – Environmental Aspects of Energy Utilization – Renewable Energy Scenario in Tamil Nadu, India and around the World – Potentials - Achievements / Applications – Economics of renewable energy systems

UNIT	TITLE	PERIODS
UNIT 2	**SOLAR ENERGY**	**9**

Solar Radiation – Measurements of Solar Radiation - Flat Plate and Concentrating Collectors – Solar direct Thermal Applications – Solar thermal Power Generation - Fundamentals of Solar Photo Voltaic Conversion – Solar Cells – Solar PV Power Generation – Advancement of Solar PV materials - Principles and efficiencies

UNIT	TITLE	PERIODS
UNIT 3	**WIND ENERGY**	**9**

Wind Data and Energy Estimation – Types of Wind Energy Systems – Performance – Site Selection - Construction and Material selection – Details of Wind Turbine Generator – Test and Measurement - Safety, Environmental and Economic Aspects

UNIT	TITLE	PERIODS
UNIT 4	**BIO - ENERGY**	**9**

Biomass direct combustion – Biomass Gasifiers – Biogas plants – Digesters – Ethanol production – Bio diesel – Cogeneration - Biomass Applications - International Issues, Regulations and Economics

UNIT	TITLE	PERIODS
UNIT 5	**OTHER RENEWABLE ENERGY SOURCES**	**9**

Tidal energy – Wave Energy – Open and Closed OTEC Cycles – Small Hydro-Geothermal Energy – Hydrogen and Storage - Fuel Cell Systems – Hybrid Systems

TOTAL PERIODS:	**45**

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO1:	Report on present scenario of renewable energy system highlighting the environmental aspects of energy consumption.
CO2:	Select the correct solar energy system for energy harvesting by learning its performance.

CO3:	Select the suitable wind energy system for a particular site by considering safety, environmental and economic aspects.
CO4:	Choose suitable method to device energy from biomass considering social, economic and safety issues.
CO5:	Derive energy from non-conventional energy sources without damaging the environment.

TEXT BOOKS:	
1.	Rai. G.D., "Non Conventional Energy Sources", Khanna Publishers, New Delhi, 2011
2.	Twidell, J.W. & Weir, A., "Renewable Energy Sources", EFN Spon Ltd., UK, 2006

REFERENCE BOOKS:	
1.	David M. Mousdale – "Introduction to Biofuels", CRC Press, Taylor & Francis Group, USA 201
2.	Freris. L.L., "Wind Energy Conversion Systems", Prentice Hall, UK, 1990
3.	Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 1996
4.	Johnson Gary, L. "Wind Energy Systems", Prentice Hall, New York, 1985
5.	Sukhatme. S.P., "Solar Energy", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997
6.	Tiwari. G.N., Solar Energy – "Fundamentals Design, Modelling & Applications", Narosa Publishing House, New Delhi, 2002

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE702T	**COMPUTATIONAL FLUID DYNAMICS**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: Fluid Mechanics, Finite Element Analysis and Heat and Mass Transfer

COURSE OBJECTIVES:	
1	To introduce Governing Equations of viscous fluid flows
2	To introduce numerical modeling and its role in the field of fluid flow and heat transfer
3	To enable the students to understand discretization methods, solution procedures and turbulence modeling.
4	To create confidence to solve complex problems in the field of fluid flow and heat transfer by using high speed computers.
5.	To understand advances in numerical methods and techniques and advances in computational models.

UNIT	**TITLE**	**PERIODS**
1	**GOVERNING EQUATIONS AND BOUNDARY CONDITIONS**	**8**

Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Chemical species transport – Physical boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations – Mathematical behavior of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations.

UNIT	**TITLE**	**PERIODS**
2	**FINITE VOLUME METHODS FOR DIFFUSION**	**9**

Introduction to finite difference equations – FVM – General Methods for first and second order accuracy – Finite volume formulation for steady state One, Two and Three -dimensional diffusion problems –Parabolic equations – Explicit and Implicit schemes – Example problems on elliptic and parabolic equations – Use of Finite Volume methods.

UNIT	**TITLE**	**PERIODS**
3	**FINITE VOLUME METHOD FOR CONVECTION DIFFUSION**	**10**

Steady one-dimensional convection and diffusion – Central, upwind differencing schemes properties of discretization schemes – Conservativeness, Boundedness, Transportiveness, Hybrid, Power-law, QUICK Schemes.

UNIT	**TITLE**	**PERIODS**
4	**FLOW FIELD ANALYSIS**	**9**

Finite volume methods -Representation of the pressure gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants – PISO Algorithms.CFD solution analysis-Essentials.

UNIT	**TITLE**	**PERIODS**
5	**TURBULENCE MODELS AND MESH GENERATION**	**9**

Turbulence models, mixing length model, Two equation (k-?) models – High and low Reynolds number models – Structured Grid generation – Unstructured Grid generation – Mesh refinement – Adaptive mesh – Software tools. Advances in numerical methods and techniques, Advances in computational models.

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able :	
CO1:	Formulate the problems of fluid flow and heat transfer by selecting the correct governing equation and boundary conditions
CO2:	Discretize and solve the steady state and transient diffusion equation by finite volume method
CO3:	Discretize and solve the steady state convection- diffusion equation by finite volume method
CO4:	Discretize incompressible 2D flow equation by finite volume method.
CO5:	Include the effect of turbulence in the flow algorithm by selecting the correct turbulence model for the flow problem
CO6:	Select structured and unstructured meshes for a given fluid flow problem

TEXT BOOKS:	
1.	Versteeg, H.K., and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The finite volume Method", Pearson Education Ltd., Second Edition, 2007.
2.	Müller, J.D. “Essentials of computational fluid dynamics”. CRC Press, 2015.
3.	Tu, J., Yeoh, G.H. and Liu, C., “Computational fluid dynamics: a practical approach” , Butterworth-Heinemann,2018.

REFERENCE BOOKS:	
1.	Chung, T.J. "Computational Fluid Dynamics", Cambridge University, Press, 2002.
2.	Ghoshdastidar P.S., "Heat Transfer", Oxford University Press, 2005
3.	Anil W. Date "Introduction to Computational Fluid Dynamics" Cambridge University Press, 2005.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE703T	**INDUSTRIAL ROBOTICS**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: NIL

COURSE OBJECTIVES:	
1.	To gain knowledge in the basic principles and information on robotics, robot configurations and robot motions.
2.	To learn major robot control components and operations required to automate a process or an activity
3.	To familiar with appropriate sensor and machine vision system for a given application.
4.	To learn the programming techniques for various robotic applications.
5.	To understand the robots in various industrial sectors and summarize the need and application of robots in different sectors.

UNIT	**TITLE**	**PERIODS**
1	**INTRODUCTION**	**9**
Definition of a Robot - Basic Concepts –Application- Robot configurations - Types of Robot drives - Basic robot motions - Point to point control - Continuous path control.		
UNIT	**TITLE**	**PERIODS**
2	**COMPONENTS AND OPERATIONS**	**10**
Basic control system concepts - control system analysis - robot actuation and feedback, Manipulators - director and inverse kinematics, Coordinate transformation - Brief Robot dynamics - Types of Robot end effectors - Grippers - Tools as end effectors		
UNIT	**TITLE**	**PERIODS**
3	**SENSING AND MACHINE VISION**	**7**
Range sensing - Proximity sensing - Touch sensing - Force and Torque sensing. Introduction to Machine vision - Sensing and digitizing - Image processing and analysis.		
UNIT	**TITLE**	**PERIODS**
4	**ROBOT PROGRAMMING**	**9**
Methods - languages - Capabilities and limitation - Artificial intelligence - Knowledge representation - Search techniques - AI and Robotics.		
UNIT	**TITLE**	**PERIODS**
5	**INDUSTRIAL APPLICATIONS AND ECONOMICS**	**9**
Application of robots in machining - Welding - Assembly - Material handling - Loading and unloading - CIM - Hostile and remote environments – Safety Considerations for Robot Operations- Economic Analysis of Robots.		
Case Studies: Collaborative robot system, Agricultural robotics.		
	TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Articulate the basic concepts of Robots, Robot drives and controls.

CO2:	Apply inverse kinematics and robot dynamics for basic control system and its components.
CO3:	Interpret images acquired through various sensors using machine vision techniques.
CO4:	Create programs for Robots using the AI concepts of Knowledge representation and Search techniques
CO5:	Apply Robots for various industrial applications.

TEXT BOOKS:	
1.	Groover M.P., “Industrial Robotics -Technology, Programming and Applications”, McGraw Hill Education, 2017.
2.	Klafter R.D., Chmielewski T.A and Negin M., “Robotic Engineering - An Integrated Approach”,Prentice Hall, 2003.

REFERENCE BOOKS:	
1.	Craig J.J., “Introduction to Robotics Mechanics and Control”, Pearson Education, 2008.
2.	Deb S.R., “Robotics Technology and Flexible Automation” Tata McGraw Hill Book Co., 2013.
3.	Fu.K.S.,Gonzalz R.C. and Lee C.S.G., “Robotics Control, Sensing, Vision and Intelligence”, McGraw Hill Book Co., 1987.
4.	Janakiraman P.A., “Robotics and Image Processing”, Tata McGraw Hill, 1995.
5.	Koren Y., “Robotics for Engineers", Mc Graw Hill Book Co., 1992.
6.	Ray Asfahl. C., “Robots and Manufacturing Automation”, John Wiley & Sons Inc.,1985

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE704T	**MECHANICS OF COMPOSITE MATERIALS**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: Strength of materials

COURSE OBJECTIVES:	
1.	To gain knowledge on Composite structures
2.	To familiarized with composite structural design and joints
3.	To understand design basics
4.	To learn elastic properties of lamina
5.	To obtain knowledge on analysis of laminated composites

UNIT	**TITLE**	**PERIODS**
1	**INTRODUCTION TO COMPOSITE STRUCTURES**	**9**
Types of composites, Engineering applications, Manufacturing process, materials selection and design requirements		
UNIT	**TITLE**	**PERIODS**
2	**COMPOSITES LAMINATES**	**9**
Lamina, Laminate: The basic building block of a composite material, Laminate joints, optimization concepts		
UNIT	**TITLE**	**PERIODS**
3	**ANALYSIS OF COMPOSITE STRENGTH AND STIFFNESS**	**9**
Properties of typical composite materials. Volume and Weight Fractions. Longitudinal Strength and Stiffness. Transverse Modulus. In-plane shear Modulus. Poisson's ratio		
UNIT	**TITLE**	**PERIODS**
4	**ELASTIC PROPERTIES OF THE UNIDIRECTIONAL LAMINA**	**9**
Stress-strain relationships. Engineering Constants. Stress strain relations of a Thin Lamina. Examples		
UNIT	**TITLE**	**PERIODS**
5	**ANALYSIS OF LAMINATED COMPOSITES**	**9**
Laminates, Basic Assumptions, Strain-Displacement Relationship, inter laminar stresses, weak bonding, de bonding, Stress-Strain Relationships, Equilibrium Equations, Laminate Stiffness, Determination of Lamina Stresses and Strains, Types of Laminate Configuration, Balanced Laminate, Anti-symmetric Laminate, Introduction to asymmetric stress tensor analysis, examples		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Explain the engineering applications of composite materials
CO2:	Apply fundamental concepts to fabricate composite structures
CO3:	Analyze the strength and stiffness of composite laminates
CO4:	Determine the Elastic Properties of unidirectional Laminated composites

CO5:	Apply classical laminate theory to predict strength of a given composite laminate

TEXT BOOKS:	
1.	Isaac M. Daniel, Ori Ishai, Engineering Mechanics of Composite Materials, Second edition Oxford University Press, 2006, First Indian Edition – 2007
2.	Robert M johns, Mechanics of Composite Materials, CRC Press, 2003

REFERENCE BOOKS:	
1.	Chawla Krishnan K, Composite Materials Science & engineering, Springer, Third edition 2012.
2.	Christophe Bout ,Mechanics of Aeronautical composite materials ,Wiley 2013
3.	Madhujit Mukhop, Mechanics of FRP Composite Materials & Structure, Universities Press 2004.

Course Code	Course Title	Periods per week				Credits
		L	T	P	C	
191MEE705T	**MAINTENANCE ENGINEERING**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: NIL

COURSE OBJECTIVES:	
1.	To enable the student to understand the principles, functions and practices adapted in industry for the successful management of maintenance activities.
2.	To explain the different maintenance categories like Preventive maintenance, condition monitoring and repair of machine elements.
3.	To illustrate some of the simple instruments used for condition monitoring in industry.
4.	To gain knowledge in repair methods for basic machine elements.
5.	To gain knowledge in repair methods for special machines line material handling equipment.

UNIT	**TITLE**	**PERIODS**
1	**PRINCIPLES AND PRACTICES OF MAINTENANCE PLANNING**	**9**
Basic Principles of maintenance planning – Objectives and principles of planned maintenance activity – Importance and benefits of sound Maintenance systems – Reliability and machine availability – MTBF, MTTR and MWT – Factors of availability – Maintenance organization – Maintenance economics.		
UNIT	**TITLE**	**PERIODS**
2	**MAINTENANCE POLICIES – PREVENTIVE MAINTENANCE**	**9**
Maintenance categories – Comparative merits of each category – Preventive maintenance, maintenance schedules, repairs cycle - Principles and methods of lubrication – TPM.		
UNIT	**TITLE**	**PERIODS**
3	**CONDITION MONITORING**	**9**
Condition Monitoring – Cost comparison with and without CM – On-load testing and offload testing – Methods and instruments for CM – Temperature sensitive tapes – Pistol thermometers – wear-debris analysis		
UNIT	**TITLE**	**PERIODS**
4	**REPAIR METHODS FOR BASIC MACHINE ELEMENTS**	**9**
Repair methods for beds, slide ways, spindles, gears, lead screws and bearings – Failure analysis – Failures and their development – Logical fault location methods – Sequential fault location.		
UNIT	**TITLE**	**PERIODS**
5	**REPAIR METHODS FOR MATERIAL HANDLING EQUIPMENT**	**9**
Repair methods for Material handling equipment - Equipment records –Job order systems -Use of computers in maintenance.		
Case studies: Maintenance of hydraulic pumps used in an excavator. Maintenance check and problem identification in Special machines laboratory.		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Implement the maintenance function and different practices in industries for the successful management of maintenance activities
CO2:	Compare different maintenance categories like Preventive maintenance & Lubrication Methods.

CO3:	Use condition monitoring for effective maintenance of machines.
CO4:	Examine appropriate repair methods and fault analysis of basic machine elements.
CO5:	Adopt appropriate repair methodology for material handling equipments.

TEXT BOOKS:	
1.	Srivastava S.K., “Industrial Maintenance Management”, S. Chand and Co., 1981
2.	Venkataraman .K “Maintancence Engineering and Management”, PHI Learning, Pvt. Ltd., 2007

REFERENCE BOOKS:	
1.	Bhattacharya S.N., “Installation, Servicing and Maintenance”, S. Chand and Co., 1995
2.	Garg M.R., “Industrial Maintenance”, S. Chand & Co., 1986.
3.	White E.N., “Maintenance Planning”, I Documentation, Gower Press, 1979.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE706T	**OPERATIONS RESEARCH**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: NIL

COURSE OBJECTIVES:	
1.	To understand the various model formations and their industrial applications.
2.	To understand the various models of transportation and assignment problems.
3.	To evaluate the critical path and duration of project & process.
4.	To understand about replacement methods with sequencing.
5.	To understand the concept of Inventory control and queuing theory.

UNIT	**TITLE**	**PERIODS**
1	**LINEAR MODEL**	**9**
The phases of OR study – Formation of an L.P model – Graphical solution – Simplex algorithm – Artificial variables technique (Big M method, two phase method), Duality in simplex.		
UNIT	**TITLE**	**PERIODS**
2	**TRANSPORTATION AND ASSIGNMENT PROBLEM**	**9**
Transportation model – Initial solution by North West corner method – Least Cost method – VAM. Optimality test – MODI method and stepping stone method. Assignment model – Formulation – Balanced and unbalanced assignment problems.		
UNIT	**TITLE**	**PERIODS**
3	**PROJECT MANAGEMENT BY PERT & CPM**	**9**
Basic terminologies – Constructing a project network – Scheduling computations – PERT - CPM – Resource smoothening, Resource leveling, PERT Cost.		
UNIT	**TITLE**	**PERIODS**
4	**REPLACEMENT AND SEQUENCING MODELS**	**9**
Replacement policies - Replacement of items that deteriorate with time (value of money not changing with time) – Replacement of items that deteriorate with time (Value of money changing with time) – Replacement of items that fail suddenly (individual and group replacement policies). Sequencing models- n job on 2 machines – n jobs on 3 machines – n jobs on m machines, Traveling salesman problem.		
UNIT	**TITLE**	**PERIODS**
5	**INVENTORY AND QUEUING THEORY**	**9**
Variables in inventory problems, EOQ, deterministic inventory models, order quantity with price break, techniques in inventory management. Selective inventory control, Safety stock calculations, Queuing system and its structure – Kendall's notation – Common queuing models - M/M/1:FCFS/8/8 - M/M/1: FCFS/n/8 - M/M/C: FCFS/8/8 .		
	TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Apply linear programming model for optimizing various industrial process.
CO2:	Analyze the various methods under transportation model for evolving the optimal results.
CO3:	Apply the concepts of PERT and CPM for decision making in managing projects.

CO4:	Analyze the various replacement and sequencing models for arriving at optimal decision.
CO5:	Apply appropriate inventory and queuing theories in domain specific situations.

TEXT BOOKS:	
1.	Hira and Gupta “Problems in Operations Research”, S.Chand and Co.2008
2.	Taha H.A, “Operation Research”, Pearson Education sixth edition, 2003

REFERENCE BOOKS:	
1.	Budnick F.S., “Principles of Operations Research for Management”, Richard D Irwin, 1990.
2.	Shennoy G.V. and Srivastava U.K., “Operation Research for Management”, Wiley Eastern, 1994.
3.	Tulsian and Pasdey V., “Quantitative Techniques”, Pearson Asia, 2002.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE707T	**MECHANICAL, ELECTRICAL AND PLUMBING (MEP)**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: NIL

COURSE OBJECTIVES:	
1.	To know about MEP services and its importance.
2.	To get the knowledge in the area of HVAC.
3.	To provide knowledge in various electrical distribution, loads and its applications.
4.	To gain knowledge in Plumbing Systems.
5.	To learn about the fire protection and HVAC software's.

UNIT	**TITLE**	**PERIODS**
1	**INTRODUCTION TO MEP SERVICES**	**9**
What is MEP? – Basics - different systems used in MEP - Applications of MEP services-Electrical basics-DG set-UPS systems		
UNIT	**TITLE**	**PERIODS**
2	**INTRODUCTION TO MEP-ELECTRICAL SERVICES**	**9**
General - Codes & Standards to be followed - Electrical equipment's and its application used in the installation - Means of electrical distribution for installation - Major electrical loads used in the installation - Electrical design calculations - Various design stages & Sequence of electrical design procedure.		
UNIT	**TITLE**	**PERIODS**
3	**HVAC**	**9**
Introduction to HVAC - Basic Components of Air-Conditioning and Refrigeration machines - Classification of Air-Conditioning System - Categories of Air Conditioning - Study of Psychometric Charts - Load Calculation - Air Distribution System - Static Pressure Calculation.		
UNIT	**TITLE**	**PERIODS**
4	**HVAC SOFTWARE'S AND FIRE PROTECTION**	**9**
Ventilation systems - Fire Protection (Awareness) - HVAC software's - Introduction to BIM and Revit MEP basics - Improving Employability Skills		
UNIT	**TITLE**	**PERIODS**
5	**PLUMBING**	**9**
Plumbing Systems - Design of Domestic Water Supply and Distribution System - Design of Sanitary Drainage System - Drawings – Plumbing Layouts - The Other aspects		
Case studies: Apply MEP services to your home, work place and classroom.		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:
Upon completion of this course, student will be able to:

CO1:	Classify the various MEP services
CO2:	Selection of Diesel generator and UPS for given site after understanding the basics
CO3:	Design and selection of HVAC components for given site after understanding the fundamentals
CO4:	Design of ventilation, fire protection for a given site
CO5:	Design a plumbing system for a given site

TEXT BOOKS:	
1.	Indian Plumbing Code, 2018
2.	MEP Data book , Sidney Levy, McGraw-Hill Education,2000

SYLLABUS OF

PROFESSIONAL ELECTIVE IV

COURSES

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE711T	**PROCESS PLANNING AND COST ESTIMATION**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: NIL

COURSE OBJECTIVES:	
1.	To understand the Selection of process, equipment and tools for various industrial products.
2.	To study and prepare process planning activity chart.
3.	To understand the concept of cost estimation.
4.	To know the compute job order cost for different types of shop floor.
5.	To develop the knowledge in calculating machining time for various machining operations.

UNIT	**TITLE**	**PERIODS**
1	**INTRODUCTION TO PROCESS PLANNING**	**9**
Introduction- methods of process planning-Drawing interpretation-Material evaluation – steps in process selection-.Production equipment and tooling selection		
UNIT	**TITLE**	**PERIODS**
2	**PROCESS PLANNING ACTIVITIES**	**9**
Process parameters calculation for various production processes-Selection jigs and fixtures election of quality assurance methods – Set of documents for process planning-Economics of process planning- case studies		
UNIT	**TITLE**	**PERIODS**
3	**INTRODUCTION TO COST ESTIMATION**	**9**
Importance of costing and estimation –methods of costing-elements of cost estimation –Types of estimates – Estimating procedure- Estimation labor cost, material cost- allocation of over head charges- Calculation of depreciation cost		
UNIT	**TITLE**	**PERIODS**
4	**PRODUCTION COST ESTIMATION**	**9**
Estimation of Different Types of Jobs – Estimation of Forging Shop, Estimation of Welding Shop, Estimation of Foundry Shop		
UNIT	**TITLE**	**PERIODS**
5	**MACHINING TIME CALCULATION**	**9**
Estimation of Machining Time – Importance of Machine Time Calculation- Calculation of Machining Time for Different Lathe Operations ,Drilling and Boring – Machining Time Calculation for Milling, Shaping and Planning -Machining Time Calculation for Grinding.		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Select the production tools and equipments for various Industrial Products.
CO2:	Calculate the process parameters and planning activities for various production processes.

CO3:	Evaluate the various elements of costing and estimation
CO4:	Calculate the cost estimation for various production process in Shop Floors.
CO5:	Estimate the machining time for various manufacturing operations.

TEXT BOOKS:	
1.	Peter scalon, “Process planning, Design/Manufacture Interface”, Elsevier science technology Books, Dec 2002.
2.	Sinha B.P, “Mechanical Estimating and Costing”, Tata-McGraw Hill publishing co, 1995.

REFERENCE BOOKS:	
1.	Chitale A.V. and Gupta R.C., “Product Design and Manufacturing”, 2nd Edition, PHI, 2002.
2.	K.C. Jain & L.N. Aggarwal, “Production Planning Control and Industrial Management”, Khanna Publishers 1990.
3.	Mikell P. Groover, “Automation, Production, Systems and Computer Integrated Manufacturing”, Pearson Education 2001.
4	Ostwalal P.F. and Munez J., “Manufacturing Processes and systems”, 9th Edition, John Wiley, 1998.
5	R Kesavan, C . Elanchezhian,B.Vijaya Ramnath, “Process Planning and Cost Estimation”, New Age International Publishers, 2019.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE712T	**COMPUTER INTEGRATED MANUFACTURING SYSTEMS**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: NIL

COURSE OBJECTIVES:	
1.	To understand the application of computers in various aspects of Manufacturing viz., Design, Proper planning, Manufacturing cost, Layout & Material Handling system.
2.	To provide knowledge on Group Technology and Computer Aided Process Planning
3.	To impart knowledge on Shop Floor Control and Flexible Manufacturing Systems
4.	To learn the various CIM implementation and data communication techniques.
5.	To provide knowledge on the concept of Manufacturing automation protocol, Technical office protocol and database terminology.

UNIT	**TITLE**	**PERIODS**
1	**INTRODUCTION**	**9**

Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control- Introduction to CAD/CAM – Concurrent Engineering-CIM concepts – Computerised elements of CIM system – Types of production - Manufacturing models and Metrics – Mathematical models of Production Performance – Simple problems – Manufacturing Control – Simple Problems – Basic Elements of an Automated system – Levels of Automation – Lean Production and Just-In-Time Production.

UNIT	**TITLE**	**PERIODS**
2	**PRODUCION PLANNING AND CONTROL & COMPUTERISED PROCESS PLANING**	**9**

Process planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer Aided Process Planning – Aggregate Production Planning and the Master Production Schedule – Material Requirement planning – Capacity Planning- Control Systems-Shop Floor Control-Inventory Control
– Brief on Manufacturing Resource Planning-II (MRP-II) & Enterprise Resource Planning (ERP) - Simple Problems.

UNIT	**TITLE**	**PERIODS**
3	**CELLULAR MANUFACTURING**	**9**

Group Technology (GT), Part Families – Parts Classification and coding – Simple Problems in Opitz Part Coding system – Production flow Analysis – Cellular Manufacturing – Composite part concept
– Machine cell design and layout – Quantitative analysis in Cellular Manufacturing – Rank Order Clustering Method - Arranging Machines in a GT cell – Hollier Method – Simple Problems.

UNIT	**TITLE**	**PERIODS**
4	**FLEXIBLE MANUFACTURING SYSTEM (FMS) AND AUTOMATED GUIDED VEHICLE SYSTEM (AGVS)**	**9**

Types of Flexibility - FMS – FMS Components – FMS Application & Benefits – FMS Planning and Control – Quantitative analysis in FMS – Simple Problems. Automated Guided Vehicle System (AGVS) – AGVS Application – Vehicle Guidance technology – Vehicle Management & Safety.

UNIT	**TITLE**	**PERIODS**
5	**INDUSTRIAL ROBOTICS**	**9**

Robot Anatomy and Related Attributes – Classification of Robots- Robot Control systems – End Effectors – Sensors in Robotics – Robot Accuracy and Repeatability - Industrial Robot Applications– Robot Part Programming – Robot Accuracy and Repeatability – Simple Problems.

Case Study: Lights-out manufacturing – Zero Down Time

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Understand the basic concepts of CAD, CAM and computer integrated manufacturing Systems
CO2:	Summarize the production planning and control and computerized process planning
CO3:	Compare the different coding systems used in group technology and solve simple problems
CO4:	Interpret the concepts of flexible manufacturing system (FMS) and automated guided vehicle (AGV) system
CO5:	Analyze and select suitable robots for various Industrial applications based on their anatomy and attributes.

TEXT BOOKS:	
1.	Mikell.P.Groover “Automation, Production Systems and Computer Integrated Manufacturing”, Prentice Hall of India, 2008
2.	Radhakrishnan P, Subramanyan S.and Raju V., “CAD/CAM/CIM”, 2nd Edition, New Age International (P) Ltd, New Delhi, 2000.

REFERENCE BOOKS:	
1.	Gideon Halevi and Roland Weill, “Principles of Process Planning – A Logical Approach” Chapman & Hall, London, 1995.
2.	Kant Vajpayee S, “Principles of Computer Integrated Manufacturing”, Prentice Hall India.
3.	Rao. P, N Tewari &T.K. Kundra, “Computer Aided Manufacturing”, Tata McGraw Hill Publishing Company, 2000.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE713T	**BUILDING AUTOMATION SYSTEMS**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: ELECTRICAL AND AIR CONDITIONING

COURSE OBJECTIVES:

1.	To enlighten the concept of Building Management System (BMS) and Automation.
2.	To familiarize with various transducers and sensors in BMS.
3.	To familiarize various controls in building automation system
4.	To expose on Control panel and Communication.
5.	To introduce Fire Alarm System (FAS) and security system such as CCTV.

UNIT	TITLE	PERIODS
1	**INTRODUCTION TO BUILDING MANAGEMENT SYSTEM AND AUTOMATION**	**9**

Concept and application of Building Management System (BMS) and Automation, requirements and design considerations and its effect on functional efficiency of building automation system, architecture and components of BMS. Systems used in building automation system. Building heating and cooling system. Chiller, DX plant, Air handling unit, Fan coil unit, CAV and VAV System, Ventilation system, Lighting system, Water distribution, Plumbing System, Fire fighting System, Lift, HVAC Control Panel, Electrical distribution System. MCC Panel components

UNIT	TITLE	PERIODS
2	**SENSORS IN BAS**	**9**

Temperature Sensors: RTD, Thermistor, Thermocouple, Bimetallic strip - Pressure Sensors: Diaphragm type, piezoelectric sensors – Different types of mounting of pressure sensors in duct, rooms and pipes – Air flow sensor: Anemometer, velocity pressure sensors – Flow sensors: Turbine flow meter, Orifice, Venturi, Pitot tube, ultrasonic flow meter – Different types of mounting for air & water flow meters. . Humidity sensors - Gas / air quality sensors - Electrical current monitoring sensors-Smoke sensors-Motion / occupancy sensors, Contact sensors .

UNIT	TITLE	PERIODS
3	**CONTROL AND AUTOMATION**	**9**

Types of Control- open and closed loop control. On off control, Proportional, Integral, Derivative controller, PID control, Digital control, DDC system, Adaptive control, Optimal controls – AHU and Chiller Control; Optimization algorithms for chillers

UNIT	TITLE	PERIODS
4	**NETWORKING AND COMMUNICATION**	**9**

Communication Basics, Networks, systems- LAN networks. BAS communication Standards, BACNet, Modbus, LON- Wireless sensor. Internet technologies.

UNIT	TITLE	PERIODS
5	**LIGHTING,FAS, SECURITY SYSTEMS & ENERGY MANAGEMENT**	**9**

Fire, Fire modes – Fire Alarm Systems components: Field components, panel components – FAS Architectures – Access Components, Access control system Design - CCTV camera types and operation – camera selection criteria – CCTV Applications. Energy Savings concept & methods, lightning control, Building Efficiency improvement, Green Building (LEED) Concept & Examples.

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Demonstrate the ability to identify various components of building automation systems
CO2:	Select the correct type of sensor for a building automation systems
CO3:	Choose various types of controls and optimization algorithms for cooling system
CO4:	Derive the control panel and communication system for building automation systems
CO5:	Derive the lighting , fire alarm system and security system for building automation systems
CO6:	Implement the green building concepts for improving the building efficiency

TEXT BOOKS:	
1.	Bela G. Liptak, Process control – Instrument Engineers Handbook Chilton book co.
2.	Reinhold A. Carlson and Robert A. Di Giandomenico, Understanding Building Automation Systems (Direct Digital Control, Energy Management, Life safety, Security, Access Control, Lightning, Building Management Programs) (Hardcover),., 1991
3.	Shengwei Wang - Intelligent Buildings and Building Automation- Spon Press
4.	WaiLok Chan, Intelligent Building Systems by Albert Ting-Pat So, Kluwer Academic publisher, 3rd ed., 2012.

REFERENCE BOOKS:	
1.	Building Control Systems, Application Guide (CIBSE Guide), CIBSE, 2000.
2.	Jim Sinopoli, Butterworth-Heinemann,Smart Buildings by imprint of Elsevier, 2nd ed., 2010.
3.	Robert Gagnon, Design of Special Hazards and Fire Alarm Systems, 2007.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE714T	**WASTE HEAT RECOVERY SYSTEMS AND COGENERATION**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: NIL

COURSE OBJECTIVES:

1.	To understand the underlying principles of Co-Generation.
2.	To gain knowledge in techno economics of Cogeneration and its application.
3.	To provide knowledge in waste heat recovery.
4.	To gain knowledge in various waste heat recovery systems.
5.	To gain knowledge in techno economics of Cogeneration and its application.

UNIT	TITLE	PERIODS
1	**CO-GENERATION**	**9**
Introduction-principles of thermodynamics, combined cycles, topping, bottoming, organic rankine cycles, advantages of cogeneration technology		
UNIT	**TITLE**	**PERIODS**
2	**APPLICATION AND TECHNO ECONOMICS OF COGENERATION**	**9**
Cogeneration application in various industries like cement, sugar mill, paper mill etc. Sizing of waste heat boilers-performance calculations, part load characteristics, selection of co-generational technologies-financial considerations- operating and investments-costs of co-generation		
UNIT	**TITLE**	**PERIODS**
3	**WASTE HEAT RECOVERY**	**9**
Introduction-principles of thermodynamics and second law- sources of waste heat recovery-diesel engines and power plant.		
UNIT	**TITLE**	**PERIODS**
4	**WASTE HEAT RECOVERY SYSTEMS**	**9**
Recuperators, regenerators, economizers plate heat exchangers. Waste heat boilers-classification, location, service conditions and design considerations. Unfired combined cycle, supplementary fired combined cycle, fired combined cycle.		
UNIT	**TITLE**	**PERIODS**
5	**APPLICATIONS AND TECHNO ECONOMICS OF WASTE HEAT RECOVERY**	**9**
Applications in industries-fluidized bed heat exchangers, heat pipe exchangers-heat pumps and thermic fluid heaters. Selection of waste heat recovery technologies-financial considerations, operations and investment costs of waste heat recovery		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:

Upon completion of this course, student will be able to:

CO1:	Demonstrate the ability to select cogeneration systems.

CO2:	Calculate the thermodynamic parameter for a waste heat recovery system.
CO3:	Size cogeneration system for cement, sugar and paper industries by considering economic issues.
CO4:	Size components of heat recovery system with and without supplementary firing.
CO5:	Recover waste heat in FBC, heat pipe, heat pumps and thermic fluid heaters.

TEXT BOOKS:	
1.	Charles H Butler, “Co-generation”, Mc Graw Hill, New York,1984
2.	Horlock J H, “Co-generation-Heat and Power, Thermodynamics and Economics”, Oxford,UK, 1987.
3.	“Institute of Fuel, London, Waste Recovery”, Chapman and Hall Publishers, London,UK,1963.
4.	Sengupta Subrata, Lee SS EDS, “Waste Heat Utilization and Management”,Washington,USA,1983

REFERENCE BOOKS:	
1.	Robert Noyes, “Cogeneration of Steam and Electric Power, Energy Technology Review”, Vol:29, Noyes Data corporation, 1978.
2.	Stecher P G “Industrial and Institutional Waste Heat Recovery Energy, Technology Review”, No:37, Noyes Data Corporation 1978

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE715T	**DESIGN FOR SHEET METAL MANUFACTURING**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: 191MEC301T – Manufacturing Technology - I

COURSE OBJECTIVES:	
1.	To know about the basics of design for manufacturing and assembly.
2.	To select of material, manufacturing process and mechanism for a product.
3.	To provide knowledge in various sheet metal forming processes and its applications.
4.	To gain knowledge in advanced sheet metal forming processes and special forming.
5.	To learn about sheet metal joining and design for the environment.

UNIT	**TITLE**	**PERIODS**
1	**INTRODUCTION**	**9**
General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances Geometric tolerances - Assembly limits -Datum features.		
UNIT	**TITLE**	**PERIODS**
2	**FACTORS INFLUENCING FORM DESIGN**	**9**
Working principle, Material, Manufacture, Design- Possible solutions - Materials choice - Influence of materials on form design - Sheet metal characteristics - Knowledge and Skills required to Design effectively		
UNIT	**TITLE**	**PERIODS**
3	**DESIGN FOR SHEET METAL FORMING PROCESSES**	**9**
Theory of plastic deformation - Stress- Strain Curve - Plastic Elongation in Testing, Formability of sheet metal - Formability Test methods, Major and Minor Axis of deformation, Major Strain and Minor Strain, Sheet metal operations – Shearing, Bending, Spring-back, Wrinkling and Deep Drawing.		
UNIT	**TITLE**	**PERIODS**
4	**OTHER SHEET METAL OPERATIONS**	**9**
Hydro forming - Tube Hydro forming - Rubber pad forming – Metal spinning – Explosive forming – Magnetic pulse forming – Super plastic forming-Electro hydraulic forming - Stretch Forming - Tube Bending - Roll Forming - Embossing and Coining.		
UNIT	**TITLE**	**PERIODS**
5	**SHEET METAL JOINING AND DESIGN FOR THE ENVIRONMENT**	**9**
Welding, Fasteners, Fasteners vs. Welding, Environmental objectives – Global issues – Regional and local issues – Basic DFE methods - Lifecycle assessment.		
Case studies: Manufacturing of body parts for automobile industries. Different methods of sheet metal joining for cars. Fabrication of LPG cylinders.		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:
Upon completion of this course, student will be able to:

CO1:	Apply design principles for manufacturability and assembly
CO2:	Evaluate various factors influencing form design for sheet metal manufacturing
CO3:	Design for sheet metal forming processes
CO4:	Analyze the advanced sheet metal forming processes and special forming.
CO5:	Design for sheet metal joining operations with environmental considerations

TEXT BOOKS:	
1.	Harrypeck, "Design for Manufacture", Pitman, 1973.
2.	Robert Matousek "Engineering Design" Springer; 1963
3.	Serope Kalpakjian and Stephen Schmid,"Manufacturing, Engineering and Technology", SI 6th Edition -", Pearson Education, 2010.

REFERENCE BOOKS:	
1.	James Bralla, "Design for Manufacture handbook", McGraw hill, 1999.
2.	Joseph Fiksel,"Design for the Environment", McGraw-Hill Professional; 2 edition, 2011.
3.	Rajput,R.K."A textbook of manufacturing technology (manufacturing processes)", Laxmi publications (p) ltd, 2015.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE716T	**VEHICLE DESIGN ENGINEERING**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: 191MEC502T - MECHANICS OF MACHINES

COURSE OBJECTIVES:	
1.	To gain knowledge on Vehicle design and FMEA
2.	To familiarized with selection of engine and transmission
3.	To analyze force acting in crank mechanism
4.	To analyze vehicle vibrations
5.	To obtain knowledge on Standards, tests and norms for an automotive part/system

UNIT	**TITLE**	**PERIODS**
1	**TRANSLATION OF CUSTOMER'S VOICE INTO ENGINEERING REQUIREMENTS**	**9**

–Different phases of new product development, QFD, HoQ for converting customer voice into technical specifications, Casestudies–HoQfor cars/motorcycles, any part/subsystem. Failure Mode and Effects Analysis(FMEA), Failure analysis technique- FTA, kepner-trio, problem analysis etc. Kano status and athe import in design from conception to launch. Scrum techniques in NPD- Bench marking competitor evaluation

UNIT	**TITLE**	**PERIODS**
2	**SELECTION OF ENGINE AND TRANSMISSION FOR AN AUTOMOBILE**	**9**

Merits and demerits of different vehicle layouts. Chassis frame design, Engine selection criteria, Matching engine and transmission, Transmission selection - over gearing and under gearing, Vehicle dynamics -ride and handling, vehicle stability, roll over protection, pedestrian protection- safety systems

UNIT	**TITLE**	**PERIODS**
3	**FORCES ACTING IN CRANK MECHANISM**	**9**

Instantaneous piston velocity and acceleration, instantaneous connecting rod velocity and acceleration, Plotting P-Θ, P-v diagrams, side thrust, resultant force, turning moment of single cylinder and multi-cylinder engines, various forces acting in crank mechanism.

UNIT	**TITLE**	**PERIODS**
4	**VEHICLE VIBRATION**	**9**

Load distribution, spring stiffness at front and rear, vertical springs, inclined springs, springs in series, parallel springs, equivalent stiffness, Quarter car model and half car model, single and two degree of freedom systems - free and forced vibrations, damped and undamped vibrations, frequency, mode shapes, critical velocity, Transmissibility ratio, combined pitch and bounce, pitch centre and bounce centre

UNIT	**TITLE**	**PERIODS**
5	**STANDARDS, TESTS AND NORMS FOR AN AUTOMOTIVE PART/SYSTEM**	**9**

Global material/design/regulatory & automotive standards for automobile industry - Working environment of part / sub system / vehicle in usage & handling by various stake holders – Tests & test conditions to verify part against all failure modes - case studies, Emission norms. Reliability and durability of vehicles.

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Incorporate customer requirements in new product development using FMEA and benchmarking techniques
CO2:	Select engine and matching transmission for better vehicle dynamics.
CO3:	Evaluate the forces acting in crank mechanism of engines.
CO4:	Analyze the load distribution and vibrations in vehicles.
CO5:	Deduce the automotive standards and norms for various working environments.

TEXT BOOKS:	
1.	N.K.Giri, “Automobile Mechanics”, 8thEdition, Khanna Publishers, Delhi,2013.
2.	Kirpal Singh, “Automobile Engineering”, Volume-1&2, 13thEdition, Standard Publishers Distributers, Delhi,2017.
3.	Thomas D.Gillespie, “Fundamentals of vehicle dynamics” Premiere Series Books, 1992.

REFERENCE BOOKS:	
1.	Harald Naunheimer, Bernd Bertsche, Joachim Ryborz, Wolfgang Novak, “Automotive Transmissions - Fundamentals, Selection, Design and Application”, in Collaboration with Peter Fietkau, Second Edition, Springer,2010
2.	G. K. Grover, “Mechanical Vibrations”, 8thEdition, Nem Chand & Bros, Rooekee, U.K., India, 2009.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE717T	**IOT FOR MECHANICAL ENGINEERING**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: NIL

COURSE OBJECTIVES:	
1.	To gain a basic knowledge of IoT and its application in Mechanical Engineering.
2.	To present a problem oriented in depth knowledge of IoT & Smart Manufacturing
3.	To address the underlying concepts and methods behind Database Management.
4.	To address various problems related to IoT enabled Industries.
5	To understand the concepts of security and privacy issues related to IoT.

UNIT	**TITLE**	**PERIODS**
1	**THE INTERNET OF THINGS: AN OVERVIEW**	**9**
The Internet of Things: An overview; Design Principles for Connected Devices; Internet Principles. Thinking about Prototyping – Costs versus ease of prototyping, prototyping and Production, open source versus Closed Source. Prototyping Embedded devices – Electronics, Embedded Computing Basics, Arduino/ Raspberry Pi/ BeagleBone Black/ etc., Electric Imp and other notable platforms Prototyping of Physical Design. Prototyping online Components – Getting Started with an API, Writing a New API.		
UNIT	**TITLE**	**PERIODS**
2	**DATABASE MANAGEMENT**	**9**
Real Time Reactions, Other Protocols. Techniques for Writing Embedded Code – Memory Management, Performance and Battery Life, Libraries and debugging. Automatic Storage Management in a Cloud World – Introduction to Cloud, Relational Databases in the Cloud, Automatic Storage Management in the Cloud. Smart Connected System Design Case Study.		
UNIT	**TITLE**	**PERIODS**
3	**IOT AND ITS SECURITY**	**9**
Internet of Things Privacy, Security and Governance Introduction, Overview of Governance, Privacy and Security Issues, Contribution from FP7 Projects, Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach. Data Aggregation for the IoT in Smart Cities, Security.		
UNIT	**TITLE**	**PERIODS**
4	**SMART MANUFACTURING**	**9**
Introduction to Smart Manufacturing: What is “smart manufacturing” really and how does it differ from conventional/legacy manufacturing-Smart Manufacturing Processes- Three Dimensions: (1) Demand Driven and Integrated Supply Chains;(2) Dynamically Optimized Manufacturing Enterprises (plant + enterprise operations);(3) Real Time, Sustainable Resource Management (intelligent energy demand management, production energy optimization and reduction of GHG), Smart Applications: Online Predictive Modeling, Monitoring and Intelligent Control of Machining/Manufacturing .		
UNIT	**TITLE**	**PERIODS**
5	**SMART SUPPLY CHAIN MANAGEMENT**	**9**
Logistics/Supply Chain Processes, Smart Transportation - Digital Tools, Product Representation and Exchange Technologies and Standards, Agile (Additive) Manufacturing Systems and Standards. Mass		

Customization, Smart Machine Tools, Robotics and Automation (perception, manipulation, mobility, autonomy), Smart Perception – Sensor networks and Devices. Smart warehouse Management of processes and facilities.
Case studies: Improving Intelligent Decision Making under uncertainty Assisted/Augmented Production, Assisted/Augmented Assembly, Assisted/Augmented Quality, Assisted/Augmented Maintenance, Assisted/Augmented Warehouse Operations and Assisted Training.

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, Students will be able to	
CO1:	Apply concept of IoT and its application in Mechanical Engineering.
CO2:	Select the appropriate methods in Database Management.
CO3:	Classify the problems related to IoT enabled Industries.
CO4:	Apply the concepts of security and privacy issues related to IoT.
CO5:	Apply the supply chain management concept in Industrial automation

TEXT BOOKS:	
1.	A. McEwen and H. Cassimally, Designing the Internet of Things, 1st edition, Wiley, 2013, ISBN-10: 111843062X.
2.	N. Vengurlekar and P. Bagal, Database Cloud Storage: The Essential Guide to Oracle Automatic Storage Management, 1st edition, McGraw-Hill Education, 2013, ISBN-10: 0071790152.

REFERENCE BOOKS:	
1.	M. Kuniavsky, Smart Things: Ubiquitous Computing User Experience Design, 1st edition, Morgan Kaufmann, 2010, ISBN-10: 0123748992.

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COURSES

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE801T	**NON DESTRUCTIVE TESTING**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: NIL

COURSE OBJECTIVES:	
1.	To learn principle, methods for various Non Destructive Evaluation and Testing methods.
2.	To gain knowledge in various Surface evaluation methods for Manufacturing sectors with suitable applications.
3.	To gain knowledge in advanced Non Destructive material testing methods in different Manufacturing technologies and its applications.
4.	To learn the recent developments involved in different materials testing methods.
5.	To learn about modern technologies used in material testing process in theory and their industrial applications

UNIT	**TITLE**	**PERIODS**
1	**OVERVIEW OF NDT**	**9**
NDT Versus Mechanical testing, Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterization. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT, Visual inspection – Unaided and aided.		
UNIT	**TITLE**	**PERIODS**
2	**SURFACE NDE METHODS**	**9**
Liquid Penetrant Testing - Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection materials Magnetisation methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.		
UNIT	**TITLE**	**PERIODS**
3	**THERMOGRAPHY AND EDDY CURRENT TESTING (ET)**	**9**
Thermography- Principles, Contact and non contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation - infrared radiation and infrared detectors, Instrumentations and methods, applications. Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.		
UNIT	**TITLE**	**PERIODS**
4	**ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION (AE)**	**9**
Ultrasonic Testing-Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction. Acoustic Emission Technique – Principle, AE parameters, Applications		
UNIT	**TITLE**	**PERIODS**
5	**RADIOGRAPHY (RT)**	**9**
Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films - graininess, density, speed, contrast, characteristic curves, Penetrameters, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Computed Radiography, Computed Tomography		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon the completion of this course the students will be able to :	
CO1:	Apply the various Non Destructive testing methods for quality inspection
CO2:	Analyze the surface defects using liquid penetrant and magnetic particle testing methods for industrial components
CO3:	Develop advanced engineering testing methods for defect detections
CO4:	Identify the defects of industrial components by Ultrasonic testing and Acoustic emission.
CO5:	Apply the Radiography testing to detect the defects with precautionary measure.

TEXT BOOKS:	
1.	Baldev Raj, T.Jayakumar, M.Thavasimuthu “Practical Non-Destructive Testing”, Narosa Publishing House, 2014.
2.	Ravi Prakash, “Non-Destructive Testing Techniques”, 1st revised edition, New Age International Publishers, 2010

REFERENCE BOOKS:	
1.	ASM Metals Handbook, ”Non-Destructive Evaluation and Quality Control”, American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
2.	ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook,Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing
3.	Charles, J. Hellier,“ Handbook of Nondestructive evaluation”, McGraw Hill, New York 2001.
4.	Paul E Mix, “Introduction to Non-destructive testing: a training guide”, Wiley, 2nd Edition New Jersey, 2005

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE802T	**SUPPLY CHAIN MANAGEMENT AND LOGISTICS**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: NIL

COURSE OBJECTIVES:	
1.	To provide an insight on the fundamentals of supply chain networks, tools and techniques
2.	To address the sourcing and analysis and strategic building concepts and methods behind Supply chain management and Logistics.
3.	To understand the role of Logistics in Supply chain management.
4.	To educate the importance of Information technology in Supply chain management.
5.	To understand the concept of network design in supply chain.

UNIT	**TITLE**	**PERIODS**
1	**INTRODUCTION**	**9**
Role of Logistics and Supply chain Management: Scope and Importance- Evolution of Supply Chain - Decision Phases in Supply Chain - Competitive and Supply chain Strategies – Drivers of Supply Chain Performance and Obstacles-Implementation.		
UNIT	**TITLE**	**PERIODS**
2	**SUPPLY CHAIN NETWORK DESIGN**	**9**
Role of Distribution in Supply Chain – Factors influencing Distribution network design – Design options for Distribution Network Distribution Network in Practice-Role of network Design in Supply Chain – Framework for network Decisions		
UNIT	**TITLE**	**PERIODS**
3	**LOGISTICS IN SUPPLY CHAIN**	**9**
Role of transportation in supply chain – factors affecting transportations decision – Routing and scheduling in transportation- Risk Pooling and postponement strategy, inventory management.		
UNIT	**TITLE**	**PERIODS**
4	**SOURCING AND COORDINATION IN SUPPLY CHAIN**	**9**
Role of sourcing supply chain supplier selection assessment and contracts- Design collaboration - sourcing planning and analysis - supply chain co-ordination - Bull whip effect – Effect of lack of co-ordination in supply chain and obstacles – Building strategic partnerships and trust within a supply chain. Beer game strategy – Case Study		
UNIT	**TITLE**	**PERIODS**
5	**SUPPLY CHAIN AND INFORMATION TECHNOLOGY**	**9**
The role IT in supply chain- The supply chain IT frame work Customer Relationship Management – Internal supply chain management – supplier relationship management – future of IT in supply chain –E-Business in supply chain.		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:
Upon completion of this course, Students will be able to;

CO1:	Apply various decisions phases and strategies for improving supply chain performance of an organization.
CO2:	Construct suitable network design for increasing Supply chain performance.
CO3:	Develop suitable logistics network design for Transportation in Supply chain.
CO4:	Choose appropriate sourcing and coordination contracts with supplier for building strategic partnerships and trust within a supply chain.
CO5:	Integrate IT tools in current trends with Internal and supplier relationship management.

TEXT BOOKS:	
1.	Janat Shah ,Supply Chain Management 2/e: Text and Cases ,Pearson Education,2016.
2.	Sunil Chopra, Peter Meindl and Kalra, “Supply Chain Management, Strategy, Planning, and operation”, Pearson Education, 2010.

REFERENCE BOOKS:	
1.	David J.Bloomberg , Stephen Lemay and Joe B.Hanna, “Logistics”, PHI 2002.
2.	David Simchi-Levi and Philip Kaminsky and Edith Simchi-Levi,Designing And Managing the Supply Chain: Concepts, Strategies and Case studies | 3rd Edition,2008.
3.	James B.Ayers, “Handbook of Supply chain management”, St.Lucle press, 2000.
4.	Jeremy F.Shapiro, “Modeling the supply chain”, Thomson Duxbury, 2002.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE803T	**OPTIMIZATION OF MECHANICAL SYSTEMS**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: NIL

COURSE OBJECTIVES:

1.	To learn about principles of optimization in engineering.
2.	To gain knowledge in various concept of optimization.
3.	To familiarize multi objective optimization and its tools.
4.	To gain knowledge in static structural design application.
5.	To learn about dynamic design applications of optimization.

UNIT	TITLE	PERIODS
1	**INTRODUCTION**	**9**
Introduction - General characteristics of mechanical elements, adequate and optimum design, principles of optimization, Formulation of objective function, design constraints-classification of optimization problem. - Single variable unconstraint optimization – Golden section and Brent's method.		
UNIT	**TITLE**	**PERIODS**
2	**OPTIMIZATION METHODS**	**9**
Optimization with Equality and Inequality constraints-Direct methods-Indirect methods using penalty functions, Lagrange's multipliers, Geometric Programming and Stochastic Programming		
UNIT	**TITLE**	**PERIODS**
3	**MULTI OBJECTIVE OPTIMIZATION**	**9**
Multi variable unconstraint optimization- Conjugate gradient with line minimization – Quasi Newton Method with line search. Multi objective optimization, - Goal attainment- Introduction to Genetic algorithms and Simulated Annealing techniques.		
UNIT	**TITLE**	**PERIODS**
4	**STATIC APPLICATIONS IN OPTIMIZATION**	**9**
Structural applications-Design of simple truss members. Design applications-Design of simple axial, Transverse loaded members for minimum cost, maximum weight-Design of shafts and Torsionally loaded members-Design of Springs		
UNIT	**TITLE**	**PERIODS**
5	**DYNAMIC APPLICATIONS IN OPTIMIZATION**	**9**
Dynamic applications-Optimum design of single, two degree of freedom systems, Vibration absorbers. Application in Mechanisms-Optimum design of Simple linkage mechanisms		
Case studies: Usage of Matlab for single, multi objective problems with optimization toolbox.		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:

Upon completion of this course, student will be able to :

CO1:	Formulate unconstrained optimization techniques in engineering design application.

CO2:	Formulate constrained optimization techniques for various applications.
CO3:	Implement multi objective optimization techniques to real world design problems.
CO4:	Design machine elements subjected to various loading conditions.
CO5:	Perform vibration analysis in machine elements.

TEXT BOOKS:	
1.	Johnson Ray,C., Optimum Design of mechanical elements, Wiley, John & Sons, 1990.

REFERENCE BOOKS:	
1.	Goldberg,D.E., Genetic algorithms ion search, Optimization and Machine, Barnen, Addison-Wesley, New York,1989
2.	Kalyanamoy Deb, Optimization for Engineering Design algorithms and Examples, Prentice Hall of India Pvt., 1995

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE804T	**INTEGRATED PRODUCT DEVELOPMENT**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES:
NIL

COURSE OBJECTIVES:	
1.	To learn various needs for IPPD, analysis of customer requirements, organization process management.
2.	To gain knowledge in generating, selecting and testing various concept.
3.	To provide knowledge in various types of product architecture processes and its applications.
4.	To gain knowledge in industrial design, and robust design.
5.	To learn about various cost-effective design processes and benefits of prototyping.

UNIT	**TITLE**	**PERIODS**
1	**INTRODUCTION**	**9**
Need for IPPD-Strategic importance of Product development - integration of customer, designer, material supplier and process planner, Competitor and customer - behavior analysis. Understanding customer-promoting customer understanding-involve customer in development and managing requirements - Organization process management and improvement.		
UNIT	**TITLE**	**PERIODS**
2	**CONCEPT GENERATION, SELECTION AND TESTING**	**9**
Plan and establish product specifications. Task - Structured approaches - clarification - search-externally and internally-Explore systematically - reflect on the solutions and processes - concept selection - methodology - benefits. Implications - Product change - variety - component standardization - product performance - manufacturability – Concept Testing Methodologies.		
UNIT	**TITLE**	**PERIODS**
3	**PRODUCT ARCHITECTURE**	**9**
Product development management - establishing the architecture - creation - clustering - geometric layout development - Fundamental and incidental interactions - related system level design issues - secondary systems -architecture of the chunks - creating detailed interface specifications-Portfolio Architecture.		
UNIT	**TITLE**	**PERIODS**
4	**INDUSTRIAL DESIGN**	**9**
Integrate process design - Managing costs - Robust design - Integrating CAE, CAD, CAM tools – Simulating product performance and manufacturing processes electronically - Need for industrial design-impact – design process - investigation of customer needs - conceptualization - refinement - management of the industrial design process - technology driven products - user - driven products - assessing the quality of industrial design.		
UNIT	**TITLE**	**PERIODS**
5	**DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT**	**9**
Definition - Estimation of Manufacturing cost-reducing the component costs and assembly costs – Minimize system complexity - Prototype basics - Principles of prototyping - Planning for prototypes - Economic Analysis - Understanding and representing tasks-baseline project planning - accelerating the project-project execution.		
Case studies: Conduct a brief analysis for better understanding of successful products and the processes behind their design, development and implementation. (For example: Sony television, Apple iPhone, Stanley		

hand drill. Etc..)

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Apply fundamental knowledge to meet customer requirements for product development.
CO2:	Demonstrate the idea of structured approach to concept generation, selection and testing of new product.
CO3:	Interpret the product development management and product architecture process.
CO4:	Apply the design principles for assessing the quality of industrial design.
CO5:	Categorize various aspects of design for manufacturing.

TEXT BOOKS:	
1.	Karl T.Ulrich and Steven D.Eppinger, Product Design and Development, McGraw –Hill International Edns.1999

REFERENCE BOOKS:	
2.	Stephen Rosenthal, Effective Product Design and Development, Business One Orwin, Homewood, 1992,ISBN, 1-55623-603-4
3.	Stuart Pugh, Tool Design – Integrated Methods for successful Product Engineering, Addison Wesley Publishing, Neyourk,NY,1991, ISBN 0-202-41639-5.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE805T	**DESIGN OF HEAT EXCHANGERS**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES:191MEC503T **-** Heat and Mass Transfer,191MEC404T - Thermal Engineering

COURSE OBJECTIVES:	
1.	To understand the different types of Heat exchangers and their classifications.
2.	To gain knowledge in design process of heat exchangers.
3.	To provide knowledge in the importance of stress analysis in heat exchanger design.
4.	To understand the compact and plate heat exchangers and its applications.
5.	To provide knowledge on design aspects of condenser and cooling towers.

UNIT	**TITLE**	**PERIODS**
1	**INTRODUCTION**	**9**
Types of heat exchangers, shell and tube heat exchangers – regenerators and recuperates - Temperature distribution and its implications - Parts description, Classification as per Tubular Exchanger Manufacturers Association (TEMA)		
UNIT	**TITLE**	**PERIODS**
2	**PROCESS DESIGN OF HEAT EXCHANGERS**	**9**
Heat transfer correlations, Overall heat transfer coefficient, analysis of heat exchangers – LMTD and effectiveness method. Sizing of finned tube heat exchangers, U tube heat exchangers, Design of shell and tube heat exchangers, fouling factors, pressure drop calculations.		
UNIT	**TITLE**	**PERIODS**
3	**STRESS ANALYSIS**	**9**
Stress in tubes – header sheets and pressure vessels – thermal stresses, shear stresses - types of failures, buckling of tubes, flow induced vibration.		
UNIT	**TITLE**	**PERIODS**
4	**COMPACT AND PLATE HEAT EXCHANGER**	**9**
Types- Merits and Demerits- Design of compact heat exchangers, plate heat exchangers, performance influencing parameters, limitations.		
UNIT	**TITLE**	**PERIODS**
5	**CONDENSERS AND COOLING TOWERS**	**9**
Design of surface and evaporative condensers – cooling tower – performance characteristics.		
Case studies: Design And Analysis Of Solar Electrolux Vapour Absorption Refrigeration System. Air Conditioning of Classrooms in Schools & Training Centers. Low Power Vapour Compression Refrigeration System. Manufacturing process for water tanks and polythene bags.		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Evaluate and select different types of Heat exchangers for specific applications of thermal

	equipments
CO2:	Size the heat exchangers for a given heat load and pressure drop for the design of thermal equipments
CO3:	Size the heat exchangers based on mechanical stress requirement for the design of thermal equipments
CO4:	Size the compact heat exchangers for a given heat load and pressure drop for the design of thermal equipments
CO5:	Size the condensers and cooling tower for the design of thermal equipments

TEXT BOOKS:	
1.	SadikKakac and Hongtan Liu, "Heat Exchangers Selection", Rating and Thermal Design, CRC Press, 2002.
2.	Shah,R. K., Dušan P. Sekulić, "Fundamentals of heat exchanger design", John Wiley & Sons, 2003.

REFERENCE BOOKS:	
1.	John E. Hesselgreaves, "Compact heat exchangers: selection, design, and operation", Elsevier science Ltd, 2001.
2.	Kuppan. T., "Heat exchanger design hand book", New York : Marcel Dekker, 2000.
3.	Robert W. Serth, "Process heat transfer principles and applications", Academic press, Elsevier, 2007.
4.	Sarit Kumar Das, "Process heat transfer", Alpha Science International, 2005

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE806T	**ELECTRIC AND HYBRID VEHICLES**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: 191MEC603T - Automobile Engineering

COURSE OBJECTIVES:	
1.	To understand the fundamentals of electric vehicles.
2.	To learn about the concepts of hybrid vehicles.
3.	To understand the electric propulsion systems.
4.	To gain knowledge about energy storage devices.
5.	To gain knowledge about fuel cell and solar power.

UNIT	**TITLE**	**PERIODS**
1	**ELECTRIC VEHICLES**	**9**
Architecture of an electric vehicle, essentials and performance of electric vehicles – Traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption, advantage and limitations.		
UNIT	**TITLE**	**PERIODS**
2	**HYBRID VEHICLES**	**9**
Hybrid electric drive trains - Concepts, architecture, design, control strategies, merits and demerits.		
UNIT	**TITLE**	**PERIODS**
3	**ELECTRIC PROPULSION SYSTEMS**	**9**
DC motor drives, induction motor drives, permanent magnet motor drives and switched reluctance motor drives.		
UNIT	**TITLE**	**PERIODS**
4	**ENERGY STORAGE DEVICES**	**9**
Electrochemical batteries – Reactions, thermodynamic voltage, lead-acid batteries, nickel based batteries, lithium based batteries, flywheel and ultra-capacitors, Battery management systems.		
UNIT	**TITLE**	**PERIODS**
5	**HYBRID SOLAR VEHICELS**	**9**
Fuel cell thermodynamics, operating principle, fuel cell technologies, fuel reforming, hydrogen production and storage. Photovoltaic cell, maximum power point tracking, solar powered accessories, hybrid solar vehicles.		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Select the capacity of the electric vehicle traction motor based on performance characteristics
CO2:	Design the drive train for electric vehicles
CO3:	Select the motor drives for an electric vehicles.

CO4:	Select the battery storage device and storage management system for electric vehicles
CO5:	Incorporate the hybrid and solar technologies in electric vehicles.

TEXT BOOKS:	
1.	Iqbal Husain, “Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2011.
2.	Mehrdad Ehsani, Yimin Gao, sebastian E. Gay and Ali Emadi, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design”, CRC Press, 2009.

REFERENCE BOOKS:	
1.	Aulice Scibioh M. and Viswanathan B., “Fuel Cells – Principles and Applications”, University Press, India, 2006.
2.	Barbir F., “PEM Fuel Cells: Theory and Practice” Elsevier, Burlington, 2005.
3.	James Larminie and John Loury, “Electric Vehicle Technology-Explained”, John Wiley & Sons Ltd., 2003.
4.	Seref Soylu “Electric Vehicles - The Benefits and Barriers”, InTech Publishers, Croatia, 2011.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE807T	**INDUSTRIAL SAFETY ENGINEERING**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: NIL

COURSE OBJECTIVES:	
1.	To know the safety rules and regulations, standards and codes.
2.	To study various mechanical machines and their safety importance
3.	To understand the principles of machine guarding and operation of protective devices.
4.	To know the working principle of mechanical engineering processes such as metal forming and joining process and their safety risks
5.	Developing the knowledge related to health and welfare measures in engineering industry.

UNIT	**TITLE**	**PERIODS**
1	**SAFETY IN METAL WORKING MACHINERY AND WOOD WORKING MACHINES**	**9**

General safety rules – principles, maintenance, Inspections of turning machines, boring machines, milling machine, planning machine and grinding machines – CNC machines – Wood working machinery – types, safety principles, electrical guards, work area, material handling, inspection, standards and codes - saws, types, hazards.

UNIT	**TITLE**	**PERIODS**
2	**PRINCIPLES OF MACHINE GUARDING**	**9**

Guarding during maintenance, Zero Mechanical State (ZMS), Definition, Policy for ZMS – guarding of hazards – point of operation protective devices, machine guarding, types, fixed guard, interlock guard, automatic guard, trip guard, electron eye, positional control guard, fixed guard fencing – guard construction – guard opening. Selection and suitability: lathe – drilling – boring – milling – grinding –shaping – sawing – shearing presses – forge hammer – flywheels – shafts – couplings – gears –sprockets wheels and chains – pulleys and belts – authorized entry to hazardous installations – benefits of good guarding systems.

UNIT	**TITLE**	**PERIODS**
3	**SAFETY IN WELDING AND GAS CUTTING**	**9**

Gas welding and oxygen cutting, resistances welding, arc welding and cutting, common hazards, personal protective equipment, training, safety precautions in brazing, soldering and metalizing – explosive welding, selection, care and maintenance of the associated equipment and instruments – safety in generation, distribution and handling of industrial gases – colour coding – flashback arrestor – leak detection – pipe line safety – storage and handling of gas cylinders.

UNIT	**TITLE**	**PERIODS**
4	**SAFETY IN COLD FORMING AND HOT WORKING OF METALS**	**9**

Cold working, power presses, point of operation safe guarding, auxiliary mechanisms, feeding and cutting mechanism, hand or foot – operated presses, power press electric controls, power press set up and die removal, inspection and maintenance – metal sheers – press brakes.

UNIT	**TITLE**	**PERIODS**
5	**SAFETY IN FINISHING, INSPECTION AND TESTING**	**9**

Heat treatment operations, electro plating, paint shops, sand and shot blasting, safety in inspection and testing, dynamic balancing, hydro testing, valves, boiler drums and headers, pressure vessels, air leak test, steam

testing, safety in radiography, personal monitoring devices, radiation hazards, engineering and administrative controls, Indian Boilers Regulation.

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Implement safety rules, standards and codes in manufacturing engineering
CO2:	Select an appropriate machine guarding techniques for rotating machinery
CO3:	Adopt safety procedures in metal joining industry
CO4:	Summarize the safety concepts of cold and hot working of metals
CO5:	Articulate finishing and post manufacturing safety techniques as per standards

TEXT BOOKS:	
1.	John V. Grimaldi and Rollin H. Simonds “Safety Management “by All India Travelers Book seller, New Delhi, 1989.

REFERENCE BOOKS:	
1.	Charles D. Reese, Occupational Health and Safety Management, CRC Press, 2003
2.	Health and Safety in welding and Allied processes, welding Institute, UK, High Tech. Publishing Ltd., London, 1989.
3.	Philip E. Hagan, John Franklin Montgomery, James T. O'Reilly, Accident Prevention Manual – NSC, Chicago, 2009.
4.	Safety in Industry” N.V. Krishnan Jaico Publishery House, 1996.
5.	Singh, U.K and Dewan, J.M., Safety, Security And Risk Management, APH publishing company, New Delhi, 1996.

SYLLABUS OF

PROFESSIONAL ELECTIVE VI

COURSES

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE811T	**MECHANICAL BEHAVIOUR OF MATERIALS**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: NIL

COURSE OBJECTIVES:

1.	To gain knowledge in various Strengthening Mechanisms of Metals and Non Metals
2.	To familiarize on Fracture mechanics and factors influencing the Facture of materials
3.	To get exposure on Fatigue testing and Fatigue behavior of materials, Expose failure mechanisms due to fatigue
4.	To study about the creep and effect of creep on materials, Expose failure mechanisms due to creep
5.	To gain knowledge on selection of materials for various applications

UNIT	TITLE	PERIODS
1	**STRENGTHENING MECHANISMS**	**9**

Cold working, grain size strengthening. Solid solution strengthening. martensitic strengthening, precipitation strengthening, dispersion strengthening, fiber strengthening, examples of above strengthening mechanisms from ferrous and non-ferrous systems, simple problems. Yield point phenomenon, strain aging and dynamic strain aging

UNIT	TITLE	PERIODS
2	**FRACTURE AND FRACTURE MECHANICS**	**9**

Types of fracture, basic mechanism of ductile and brittle fracture, Griffith's theory of brittle fracture, Orowan's modification. Izod and Charpy Impacts tests, Ductile to Brittle Transition Temperature (DBTT), Factors affecting DBTT, determination of DBTT. Fracture mechanics-introduction, modes of fracture, stress intensity factor, strain energy release rate, fracture toughness and determination of K_{IC}, introduction to COD, J integral.

UNIT	TITLE	PERIODS
3	**FATIGUE BEHAVIOUR AND TESTING**	**9**

Fatigue: Stress cycles, S-N curves, effect of mean stress, factors affecting fatigue, structural changes accompanying fatigue, cumulative damage, HCF / LCF, thermo mechanical fatigue, application of fracture mechanics to fatigue crack propagation, fatigue testing machines.

UNIT	TITLE	PERIODS
4	**CREEP BEHAVIOUR AND TESTING**	**9**

Creep curve, stages in creep curve and explanation, structural changes during creep, creep mechanisms, metallurgical factors affecting creep, high temperature alloys, stress rupture testing, creep testing machines, parametetric methods of extrapolation. Deformation Mechanism Maps according to Frost/Ashby

UNIT	TITLE	PERIODS
5	**SELECTION OF MATERIALS**	**9**

Motivation for selection, cost basis and service requirements – Selection for mechanical properties, strength, toughness, fatigue and creep – Selection for surface durability corrosion and wear resistance – Relationship between materials selection and processing – Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications – Computer aided materials selection.

Case studies: Analysis on failure of materials on welding joints, marine and aerospace applications

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
After completing this course, students will be able to :	
CO1:	Analyze various strengthening mechanisms for Ferrous and Non ferrous metals
CO2:	Explore the fracture mechanics of Ductile and Brittle materials.
CO3:	Examine the Fatigue behavior of materials.
CO4:	Evaluate the safe use of materials for simple engineering applications at high temperature
CO5:	Select suitable materials for real time engineering applications

TEXT BOOKS:	
1.	Davis. H. E., Troxell G.E., Hauck.G. E. W., “The Testing of Engineering Materials”, McGraw-Hill, 1982.
2.	Dieter, G.E., “Mechanical Metallurgy”, McGraw-Hill, SI Edition, 1995

REFERENCE BOOKS:	
1.	Ashby M.F., materials selection in Mechanical Design 2nd Edition, Butter worth 1999.
2.	Hayden, H. W. W. G. G. Moffatt, J. Moffatt and J. Wulff, The Structure and Properties of Materials, Vol.III, Mechanical Behavior, John Wiley & Sons, New York, 1965.
3.	Honey combe R. W. K., “Plastic Deformation of Materials”, Edward Arnold Publishers, 1984.
4.	Wulff, The Structure and Properties of Materials, Vol. III “Mechanical Behavior of Materials”, John Wiley and Sons, New York, USA, 1983.
5.	Suryanarayana, A. V. K., “Testing of Metallic Materials”, Prentice Hall India, New Delhi, 1979.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE812T	**DESIGN OF EXPERIMENTS**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: NIL

COURSE OBJECTIVES:	
1.	To demonstrate knowledge and understanding of Classical Design of Experiments (DOE)
2.	To demonstrate knowledge and understanding of Single factor experiments
3.	To develop and understand the various factorial design.
4.	To develop competency for analysing the data to determine the optimal process Parameters that optimize the process.
5.	To develop skills to design and conduct experiments using DOE and Taguchi's approach

UNIT	**TITLE**	**PERIODS**
1	**FUNDAMENTALS OF EXPERIMENTAL DESIGNS**	**9**

Hypothesis testing – Single mean, two means, dependant/ correlated samples – Confidence intervals, Experimentation – Need, Conventional test strategies, Analysis of variance, F-test, terminology, Basic principles of design, Steps in experimentation – choice of sample size – Normal and half normal probability plot – Simple linear and multiple linear regression, testing using Analysis of variance.

UNIT	**TITLE**	**PERIODS**
2	**SINGLE FACTOR EXPERIMENTS**	**9**

Completely Randomized Design- Effect of coding the observations - Model adequacy checking - Estimation of model parameters, Residuals analysis- Treatment comparison methods- Duncan's multiple range test, Newman-Keuel's test, Fisher's LSD test, Tukey's test - Testing using contrasts - Randomized Block Design – Latin Square Design - Graeco Latin Square Design – Applications.

UNIT	**TITLE**	**PERIODS**
3	**FACTORIAL DESIGNS**	**9**

Main and Interaction effects - Two and three factor full factorial designs - Fixed effects and random effects model - Rule for sum of squares and Expected Mean Squares - 2K Design with two and three factors - Yate's Algorithm - fitting regression model - Randomized Block Factorial Design - Practical applications.

UNIT	**TITLE**	**PERIODS**
4	**SPECIAL EXPERIMENTAL DESIGNS**	**9**

Blocking and confounding in 2K Designs - Blocking in replicated design - 2K Factorial Design in two blocks - Complete and partial confounding - Confounding 2K Fractional Factorial Designs - One-half fraction of 2K Design in four blocks - Two level Design, design resolution, Construction of one-half fraction with highest design resolution, One-quarter fraction of 2K Design - Introduction to response surface methods, central composite design.

UNIT	**TITLE**	**PERIODS**
5	**TAGUCHI METHODS**	**9**

Design of experiments using Orthogonal Arrays, Data analysis from Orthogonal experiments - Response Graph Method, ANOVA - Attribute data analysis - Robust design - Noise factors, Signal to noise ratios, Inner/outer OA design - case studies.

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Perform research experimental designs using fundamental statistical techniques
CO2:	Apply the concept of single factor experimental design.
CO3:	Demonstrate the application of various factorial designs.
CO4:	Describe the special experimental design for process performance and Robustness.
CO5:	Apply Taguchi approach to evaluate quality.

TEXT BOOKS:	
1.	Douglas C. Montgomery, “Design and Analysis of Experiments”, John Wiley & sons, 2012.

REFERENCE BOOKS:	
1.	Box, G. E., Hunter,W.G., Hunter, J.S., Hunter,W.G., “Statistics for Experimenters: Design, Innovation, and Discovery”, 2nd Edition, Wiley, 2005
2.	Krishnaiah K, and Shahabudeen P, “Applied Design of Experiments and Taguchi Methods”, PHI, India, 2011.
3.	Phillip J. Ross, “Taguchi Techniques for Quality Engineering”, Tata McGraw-Hill, India, 2005

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE813T	**ADDITIVE MANUFACTURING**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: NIL

COURSE OBJECTIVES:	
1.	To learn principle, methods for Additive Manufacturing technologies
2.	To gain knowledge in various possibilities and Design process for Additive Manufacturing with suitable applications.
3.	To provide knowledge in environmental effects of Additive Manufacturing technologies and its applications.
4.	To gain knowledge familiar with the characteristics of the different materials those are used in Additive Manufacturing technologies.
5.	To learn about modern developments and case studies Additive Manufacturing process.

UNIT	**TITLE**	**PERIODS**
1	**INTRODUCTION**	**9**
Overview – Need - Development of Additive Manufacturing Technology -Principle – AM Process Chain-Classification –Rapid Prototyping- Rapid Tooling – Rapid Manufacturing – Applications Benefits –Case studies – Reverse Engineering		
UNIT	**TITLE**	**PERIODS**
2	**DESIGN FOR ADDITIVE MANUFACTURING**	**9**
Design tools: Data processing - CAD model preparation – Part orientation and support structure generation – Model slicing –Tool path generation- Design for Additive Manufacturing: Concepts and objectives- AM unique capabilities – DFAM for part quality improvement- Customized design and fabrication for medical applications.		
UNIT	**TITLE**	**PERIODS**
3	**PHOTOPOLYMERIZATION AND POWDER BED FUSION PROCESSES**	**9**
Photo polymerization: SLA-Photo curable materials – Process - Advantages and Applications. Powder Bed Fusion: SLS-Process description – powder fusion mechanism – Process Parameters – Typical Materials and Application- Electron Beam Melting.		
UNIT	**TITLE**	**PERIODS**
4	**EXTRUSION BASED AND SHEET LAMINATION PROCESSES**	**9**
Extrusion Based System: FDM-Introduction – Basic Principle – Materials – Applications and Limitations – Bio extrusion. Sheet Lamination Process: LOM- Gluing or Adhesive bonding – Thermal bonding.		
UNIT	**TITLE**	**PERIODS**
5	**PRINTING PROCESSES AND BEAM DEPOSITION PROCESSES**	**9**
Droplet formation technologies – Continuous mode – Drop on Demand mode – Three Dimensional Printing – Advantages – Bio plotter - Beam Deposition Process: LENS- Process description – Material delivery – Process parameters – Materials – Benefits – Applications.		
Case Study: Customized implants and prosthesis		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:

Upon completion of this course, student will be able to:	
CO1:	Demonstrate a basic technical understanding of the physical principles, materials, and operation of the types of AM processes.
CO2:	Apply CAD tools for design and prototyping
CO3:	Select an appropriate powder fusion process for industrial applications
CO4:	Identify characteristics of parts that are fabricated by extrusion and lamination process
CO5:	Analyze the process parameters in beam deposition method

TEXT BOOKS:	
1.	Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third edition, World Scientific Publishers, 2010.
2.	Ian Gibson, David W.Rosen, Brent Stucker "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing" Springer , 2010.
3.	Serope Kalpakjian and Stephen Schmid,"Manufacturing, Engineering and Technology", SI 6th Edition -", Pearson Education, 2010.

REFERENCE BOOKS:	
1.	Andreas Gebhardt "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing" Hanser Gardner Publication 2011.
2.	Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.
3.	Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007.
4.	Tom Page "Design for Additive Manufacturing" LAP Lambert Academic Publishing, 2012.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE814T	**MANUFACTURING OF COMPOSITES**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: NIL

COURSE OBJECTIVES:	
1.	To enrich the knowledge in reinforcement and matrix materials.
2.	To impart knowledge on processing of polymer matrix composite materials.
3.	To impart knowledge on processing of metal matrix composite materials.
4.	To impart knowledge on processing of ceramic matrix composite materials.
5.	To provide knowledge on advanced composite materials.

UNIT	**TITLE**	**PERIODS**
1	**INTRODUCTION TO COMPOSITES**	**9**

Fundamentals of composites, characteristics, Applications of composites, Reinforcements - glass fibers, boron fibers, carbon fibers, organic fibers, aramid fibers, ceramic fibers, oxide and non-oxide fibers, Forms of reinforcements - Roving, Woven fabrics, Non-woven, random mats, whiskers, Rule of mixtures, Matrix materials - Polymers - Thermosetting resins, thermoplastic resins .

UNIT	**TITLE**	**PERIODS**
2	**PROCESSING OF POLYMER MATRIX COMPOSITES**	**9**

Processing of polymer matrix composites: hand layup, spray, filament winding, Pultrusion, resin transfer moulding, autoclave moulding - bag moulding, compression moulding– thermoplastic matrix composites – film stacking, diaphragm forming, thermoplastic tape laying, injection moulding – interfaces in PMCs - structure, properties and application of PMCs –recycling of PMCs.

UNIT	**TITLE**	**PERIODS**
3	**PROCESSING OF METAL MATRIX COMPOSITES**	**9**

Metallic matrices: Aluminium, titanium, magnesium, copper alloys – processing of MMCs: liquid state, Solid state, in situ fabrication techniques – diffusion bonding – powder metallurgy techniques interfaces in MMCs – mechanical properties – machining of MMCs – Applications. Introduction to Nano composites.

UNIT	**TITLE**	**PERIODS**
4	**PROCESSING OF CERAMIC MATRIX COMPOSITES**	**9**

Processing of CMCs: cold pressing, sintering, reaction bonding, liquid infiltration, lanxide process – in situ chemical reaction techniques: chemical vapour deposition, chemical vapour impregnation, sol gel – interfaces in CMCs – mechanical properties and applications of CMCs.

UNIT	**TITLE**	**PERIODS**
5	**ADVANCES IN COMPOSITE MATERIALS**	**9**

Carbon fiber composites - properties, chemical vapour deposition - oxidative etching, liquid phase oxidation carbon/carbon composites - properties and applications of C/C Composites, future scope of c-c composites, Bio composites, multi-filament superconducting composites.

Case studies: Advanced Composite Materials for Civil Engineering and Architectural Applications, Polymer Matrix Composites in Automobiles.

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Select an appropriate constituent material for manufacturing of polymer composites.
CO2:	Identify suitable processing methods for Polymer Matrix Composites.
CO3:	Identify suitable processing methods for Metal Matrix Composites
CO4:	Select the suitable fabrication process for Ceramic Matrix Composites.
CO5:	Analyze the advanced composite materials for suitable applications.

TEXT BOOKS:	
1.	B.D. Agarwal and L.J. Broutman, Analysis and Performance of Fiber Composites, John Wiley and Sons, New York, 2000.
2.	Krishnan K Chawla, Composite Materials: Science and Engineering, International Edition, Springer, 2012
3.	Mallick P.K., Fiber Reinforced Composites: Materials, Manufacturing and Design, CRC press, New Delhi, 2010

REFERENCE BOOKS:	
1.	Isaac M. Daniel, Ori Isha, Engineering Mechanics of Composite Materials, Oxford University Press, 2005.
2.	Mallick, P.K. and Newman.S. Composite Materials Technology, Hanser Publishers, 2003.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE815T	**SOLAR ENGINEERING**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: NIL

COURSE OBJECTIVES:	
1.	To recognize the basic physics about solar engineering, origin and related devices used to collect solar energy.
2.	To gain knowledge about the concept of various laws related to solar engineering.
3.	To outline the basic idea of solar energy collection.
4.	To understand the physics of solar cell.
5.	To learn about various energy storage methods.

UNIT	**TITLE**	**PERIODS**
1	**INTRODUCTION TO SOLAR ENERGY**	**10**

Basics of solar energy - Brief history of solar energy utilization - Various approaches of utilizing solar energy - Blackbody radiation- Relation between radiation field energy density and radiation spectrum - Planck's formula in energy unit - Maximum spectral density - Planck's formula in wavelength unit - Wien displacement law - Stefan - Boltzmann law - Photoelectric effect - Einstein's theory of photons - Einstein's derivation of the black-body formula.

UNIT	**TITLE**	**PERIODS**
2	**SOLAR TRACKING & ATMOSPHERIC INTERACTION**	**10**

Basic parameters of the Sun - Measurement of the solar constant - The structure of the Sun – The origin of solar energy - Rotation and orbital motion of the Earth around the Sun - Solar time, sidereal time, universal standard time, local standard time - Equation of time - Intensity of sunlight on an arbitrary surface at any time - Interaction with the atmosphere - Absorption of the molecules – Air mass - Rayleigh scattering - Direct and scattered sunlight.

UNIT	**TITLE**	**PERIODS**
3	**SOLAR CELLS**	**9**

Formation of a PN – junction - Space charge and internal field - Quasi - Fermi levels - The Shockley diode equation - Structure of a solar cell - The solar cell equation - Fill factor and maximum power - Various electron - hole-pair recombination mechanisms - Crystalline silicon solar cells - Thin film solar cells: CIGS, Cite and a – silicon - Tandem solar cells - Dye - sensitized solar cells - Organic solar cells**.**

UNIT	**TITLE**	**PERIODS**
4	**CONCENTRATION OF SOLAR ENERGY**	**8**

Three types of imaging optics: trough or linear collectors, central receiver with heliostats, and parabolic dish concentrator with on - axis tracking- Solar thermal electricity using Stirling engine or Ranking engine - Solar photovoltaic's with concentration.

UNIT	**TITLE**	**PERIODS**
5	**ENERGY STORAGE**	**8**

Necessity of storage for solar energy- Chemical energy storage - Thermal energy storage – Thermal Flywheels - Compressed air- Rechargeable batteries**.**

Case studies: Basic research needs for solar energy utilization-Solar panels at Boston College-International Energy Agency's concentrating solar power technologies for climate change mitigation-Battery storage of

Alaska island- off-grid frequency response.

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Calculate basic solar parameter
CO2:	Calculate the solar radiation at various intervals of time for a particular location
CO3:	Calculate the solar cell requirement for given load and particular location and to select suitable type
CO4:	Design concentrating collectors for given solar application
CO5:	Design storage system for a given solar application

TEXT BOOKS:	
1.	Rai, G.D., Solar Energy Utilization, Khanna Publishers, N. Delhi, 2010.
2.	Streetman B.G. and S. Banerjee, Solid State Electronic Devices, Sixth Edition, Prentice Hall, 2006.
3.	Sukhatme S.P., Solar Energy, Tata McGraw Hills P Co., 3rd Edition, 2008.

REFERENCE BOOKS:	
1.	Duffie, J.A., and Beckman, W.A. Solar Energy Thermal Process, John Wiley and Sons, New York, Jui Sheng Hsieh, Solar Energy Engineering, Prentice-Hall, 2007.
2.	M. Stix, The Sun, An Introduction, Second Edition, Springer 2002.
3.	Nelson, The Physics of Solar Cells. Imperial College Press, 2003.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE816T	**NUCLEAR ENGINEERING**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: NIL

COURSE OBJECTIVES:	
1.	To recognize the basic fundamental laws of nuclear engineering
2.	To gain knowledge about nuclear fission and fusion reactor
3.	To familiarize about the industrial radiation instruments
4.	To understand the physics of nuclear energy systems
5.	To learn about various radiation safety methods.

UNIT	**TITLE**	**PERIODS**
1	**BASIC NUCLEAR PHYSICS**	**10**
General Properties of Nuclei -Binding Energy, Statistics, Mass Formula-Nuclear Structure - Free Fermi Gas Model, Shell Models, Collective Models- Nuclear Reactions -Formal Theory, Optical Model, Direct Reactions, Compound Nuclear Reactions, Statistical Model.		
UNIT	**TITLE**	**PERIODS**
2	**NUCLEAR REACTOR THEORY**	**9**
Neutron Physics of Fission and Fusion Reaction-Neutron Transport- Multigroup Diffusion Theory- Nuclear Reactor Kinetics- Fuel Burnup-Fusion Reactions and Reactors.		
UNIT	**TITLE**	**PERIODS**
3	**NUCLEAR CHEMISTRY AND RADIATION SCIENCE**	**9**
Radioactive Disintegration-Physical and Chemical Effects of Radiation on Atoms and Molecules- Radiation Detection and Application- Industrial Use of Radiation Instruments- Application of Particle Accelerators.		
UNIT	**TITLE**	**PERIODS**
4	**NUCLEAR ENERGY SYSTEMS**	**9**
Principles of Nuclear Reactor Design-Light Water Reactor Power Plant-Fast Breeder Reactor Plant-Fundamentals of Fusion Reactors- Fusion Reactor Design.		
UNIT	**TITLE**	**PERIODS**
5	**NUCLEAR REACTOR SAFETY**	**8**
Safety Characteristics of LWR and FBR- Safety Culture- Nuclear Reactor Accidents- Safety Improvements and Advanced Nuclear Reactors.		
Case studies: Feasibility of small and medium nuclear power plants in Egypt by IAEA- Radiation contamination caused by transportation accident-Investigation of fusion and fast breeder reactors by IIASA-Chernobyl nuclear disaster.		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Calculate basic properties in nuclear physics

CO2:	Calculate the energy generated in fission and fusion
CO3:	Analyze the radiation effects in nuclear chemistry and measure radiation with instruments
CO4:	Design the nuclear reactor and apply their functions in different power plant
CO5:	Emphasis the safety precautions in a nuclear reactor and prevention of accidents

TEXT BOOKS:	
1.	Glasstone S. & Sesonske A., Nuclear Reactor Engineering Reactor Systems Engineering, Vol. II, CBS Publication, Fourth Edition, 2004.
2.	R. K. Singhal, Nuclear Reactors, New Age International Pvt Ltd Publishers, First Edition, 2014.
3.	Vaidyanathan G., Nuclear Reactor Engineering (Principles and Concepts), S. Chand Publishing, 2013.

REFERENCE BOOKS:	
1.	J. Kenneth Shultis, Richard E. Faw, Fundamentals of Nuclear Science and Engineering, Third Edition, CRC Press 2016.
2.	Kenneth D. Kok, Nuclear Engineering Handbook, First Edition, CRC press 2016.
3.	Yoshiaki Oka, Nuclear Reactor Design. Springer Japan, 2014.

Course Code	Course Title	Periods per week				Credits
		L	T	P	R	
191MEE817T	**ENTREPRENEURSHIP DEVELOPMENT**	**3**	**0**	**0**	**0**	**3**

PREREQUISITES: NIL

COURSE OBJECTIVES:	
1.	To learn basic concepts of entrepreneurship in economic development of the country.
2.	To develop motivation in students and to impart basic entrepreneurial skills.
3.	To provide knowledge about the sources of information on promotion and problems faced by small enterprises.
4.	To gain knowledge in various sources of finance support, types of term loans, project execution techniques, taxation.
5.	To learn about government policies on promoting small enterprises, strategies used for growth of small enterprises.

UNIT	**TITLE**	**PERIODS**
1	**ENTREPRENEURSHIP**	**9**
Entrepreneur – Types of Entrepreneurs – Difference between Entrepreneur and Intrapreneur Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth.		
UNIT	**TITLE**	**PERIODS**
2	**MOTIVATION**	**9**
Major Motives Influencing an Entrepreneur – Achievement Motivation Training, Self-Rating, Business Games, Thematic Apperception Test – Stress Management, Entrepreneurship Development Programs – Need, Objectives.		
UNIT	**TITLE**	**PERIODS**
3	**BUSINESS**	**9**
Small Enterprises – Definition, Classification – Characteristics, Ownership Structures – Project Formulation – Steps involved in setting up a Business – identifying, selecting a Good Business opportunity, Market Survey and Research, Techno Economic Feasibility Assessment – Preparation of Preliminary Project Reports – Project Appraisal – Sources of Information – Classification of Needs and Agencies.		
UNIT	**TITLE**	**PERIODS**
4	**FINANCING AND ACCOUNTING**	**9**
Need – Sources of Finance, Term Loans, Capital Structure, Financial Institution, and Management of working Capital, Costing, Break Even Analysis, and Taxation – Income Tax, Excise Duty – Sales Tax.		
UNIT	**TITLE**	**PERIODS**
5	**SUPPORT TO ENTREPRENEURS**	**9**
Sickness in small Business – Concept, Magnitude, Causes and Consequences, Corrective Measures - Business Incubators – Government Policy for Small Scale Enterprises – Growth Strategies in small industry – Expansion, Diversification, Joint Venture, Merger and Sub Contracting.		
Case studies: A Case Study of Big Bazaar, A Case Study Alibaba, A Case Study of Coffee Day. - A SWOT analysis.		

TOTAL PERIODS:	**45**

COURSE OUTCOMES:	
Upon completion of this course, student will be able to:	
CO1:	Understand the concept of entrepreneurship and its role on economic growth for becoming an entrepreneur.
CO2:	Demonstrate various types of motivation techniques to develop an entrepreneurship.
CO3:	Prepare a project report to start SSI unit.
CO4:	Make finance and accounting calculations needed for a business unit.
CO5:	Appreciate the support to entrepreneurs by understanding the Government policies.

TEXT BOOKS:	
1.	Donald F Kuratko, “Entrepreneurship – Theory, Process and Practice”, 9th Edition, Cengage Learning, 2014.
2.	Khanka. S.S., “Entrepreneurial Development” S.Chand & Co. Ltd., Ram Nagar, New Delhi, 2013.

REFERENCE BOOKS:	
1.	EDII “Faulty and External Experts – A Hand Book for New Entrepreneurs Publishers: Entrepreneurship Development”, Institute of India, Ahmadabad, 1986.
2.	Hisrich R D, Peters M P, “Entrepreneurship” 8th Edition, Tata McGraw-Hill, 2013.
3.	Rajeev Roy, "Entrepreneurship" 2nd Edition, Oxford University Press, 2011.