



F. Y. B. TECH. (COMMON TO ALL PROGRAMS) SEMESTER I/II (PATTERN 2020)
MODULE-I

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/OR/TW		
	Basic Science Course	TH	3	1	-	20	30	20	30	25	125	4
	Engineering Science Course	TH	2	-	2	20	30	20	30	25	125	3
	Engineering Science Course	TH	2	-	2	20	30	20	30	25	125	3
	Basic Science Course	TH	2	-	2	20	30	20	30	25	125	3
	Basic Science Course	CE	1	1	-	-	-	-	-	25	25	2
	Engineering Science Course	CE	1	-	4	-	-	-	-	50	50	3
	Basic Science Course	CE	1	1	-	-	-	-	-	25	25	2
	Humanity and Social Science Course	CE	1	1	-	-	-	-	-	25	25	2
M1	Induction Program	AU	-	-	-	-	-	-	-	-	-	-
M2	Foreign Language	AU	-	-	-	-	-	-	-	-	-	-
	Total		13	4	10	80	120	80	120	225	625	22

F. Y. B. TECH. (COMMON TO ALL PROGRAMS) SEMESTER I/II (PATTERN 2020)
MODULE-II

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/OR/TW		
	Basic Science Course	TH	3	1	-	20	30	20	30	25	125	4
	Engineering Science Course	TH	2	-	2	20	30	20	30	25	125	3
	Engineering Science Course	TH	2	-	2	20	30	20	30	25	125	3
	Basic Science Course	TH	2	-	2	20	30	20	30	25	125	3
	Basic Science Course	CE	1	1	-	-	-	-	-	25	25	2
	Engineering Science Course	CE	2	1	-	-	-	-	-	50	50	3
	Humanity and Social Science Course	CE	1	1	-	-	-	-	-	25	25	2
	Humanity and Social Science Course	CE	1	1	-	-	-	-	-	25	25	2
M1	Induction Program	AU	-	-	-	-	-	-	-	-	-	-
M2	Foreign Language	AU	-	-	-	-	-	-	-	-	-	-
	Total		14	5	6	80	120	80	120	225	625	22



S.Y. B. TECH. (COMMON TO ALL PROGRAMS), SEMESTER III (PATTERN 2020)

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/OR/TW		
	Basic Science/ Engineering Science Course	TH	3	1/0	0/2	20	30	20	30	25	125	4
	Basic Science /Professional Core Course	TH	3	1/0	0/2	20	30	20	30	25	125	4
	Engineering Science Course	TH	3	1/0	0/2	20	30	20	30	25	125	4
	Professional Core Course	TH	3	1/0	0/2	20	30	20	30	25	125	4
	Professional Core Course	TH	3	-	-	20	30	20	30	-	100	3
	Professional Core Course	CE	2/1	1/0	0/4	-	-	-	-	50	50	3
M2	Mandatory Course	AU	-	-	-	-	-	-	-	-	-	-
	Total		17/16	5/0	0/12	100	150	100	150	150	650	22

S.Y. B. TECH. (COMMON TO ALL PROGRAMS), SEMESTER IV (PATTERN 2020)

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/OR/TW		
	Basic Science/ Engineering Science Course	TH	3	1/0	0/2	20	30	20	30	25	125	4
	Professional Core Course	TH	3	1/0	0/2	20	30	20	30	25	125	4
	Professional Core Course	TH	3	1/0	0/2	20	30	20	30	25	125	4
	Professional Core Course	TH	3	1/0	0/2	20	30	20	30	25	125	4
	Professional Core Course	TH	3	0	0	20	30	20	30	0	100	3
	Professional Core Course	CE	2/1	1/0	0/4	-	-	-	-	50	50	3
M2	Mandatory Course	AU	-	-	-	-	-	-	-	-	-	-
	Total		17/16	5/0	0/12	100	150	100	150	150	650	22



T.Y. B. TECH (COMMON TO ALL PROGRAMS), SEMESTER V (PATTERN 2020)

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/OR/TW		
	Professional Core /Basic Science Course	TH	3	1/0	0/2	20	30	20	30	25	125	4
	Professional Core	TH	3	1/0	0/2	20	30	20	30	25	125	4
	Professional Core	TH	3	1/0	0/2	20	30	20	30	25	125	4
	Professional Core	TH	3	-	-	20	30	20	30	-	100	3
	Professional Elective	TH	3	1/0	0/2	20	30	20	30	25	125	4
	Employability Skills - I	CE	1/0	-	2/4	-	-	-	-	25	25	2
M2	Mandatory Course	AU	-	-	-	-	-	-	-	-	-	-
	Total		16/15	4/0	2/12	100	150	100	150	150	650	21

T.Y. B. TECH (COMMON TO ALL PROGRAMS), SEMESTER VI (PATTERN 2020)

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/OR/TW		
	Professional Core	TH	3	1/0	0/2	20	30	20	30	25	125	4
	Professional Core/ Professional Elective	TH	3	1/0	0/2	20	30	20	30	25	125	4
	Basic Science Course / Professional core	TH	3	1/0	0/2	20	30	20	30	25	125	4
	Professional Core / Professional Elective	TH	3	1/0	0/2	20	30	20	30	25	125	4
	Open Elective (Humanities and Social Science)	TH	3	-	-	20	30	20	30	-	100	3
	Employability Skills -II	CE	1/0	-	2/4	-	-	-	-	25	25	2
M2	Mandatory Course	AU	-	-	-	-	-	-	-	-	-	-
	Total	-	16/ 15	4/0	2/12	100	150	100	150	125	625	21



**FINAL YEAR B. TECH (COMMON TO ALL PROGRAMS), SEMESTER VII
(PATTERN 2020) MODULE I**

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/OR/TW		
	Professional Core/ Professional Elective	TH	3	1/0	0/2	20	30	20	30	25	125	4
	Professional Elective	TH	3	1/0	0/2	20	30	20	30	25	125	4
	Open Elective	TH	3	-	-	20	30	20	30	-	100	3
	Open Elective (Humanities and Social Science)	TH	3	-	-	20	30	20	30	-	100	3
	Intellectual Property Rights (IPR)	CE	2	-	-	-	-	50	-	-	50	2
	Project Work	CE- PR/OR	-	-	8	100	-	-	-	50	150	4
M4	Mandatory Course	AU	-	-	-	-	-	-	-	-	-	-
	Total	-	14	2/0	8/12	180	120	130	120	100	650	20

**FINAL YEAR B. TECH (COMMON TO ALL PROGRAMS), SEMESTER VII
(PATTERN 2020) MODULE II**

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/OR/TW		
	Semester Internship	CE- PR/OR	-	-	20	100	-	-	-	50	150	10
M4	Mandatory Course	AU	-	-	-	-	-	-	-	-	-	-
	Total	-	-	-	20	100	-	-	-	50	150	10



**FINAL YEAR B. TECH (COMMON TO ALL PROGRAMS), SEMESTER VIII
(PATTERN 2020) MODULE III**

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/OR/TW		
	Professional Elective/professional core	TH	3	-	2	20	30	20	30	25	125	4
	Open Elective	TH	3	-	-	20	30	20	30	25	125	3
	Open Elective (Humanities and Social Science)	TH	3	-	-	20	30	20	30	25	125	3
M4	Mandatory Course	AU	-	-	-	-	-	-	-	-	-	-
	Total	-	9	-	2	60	90	60	90	75	375	10

**FINAL YEAR B. TECH (COMMON TO ALL PROGRAMS), SEMESTER VIII
(PATTERN 2020) MODULE IV**

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/OR/TW		
	Semester Internship	CE-PR/OR	-	-	20	100	-	-	-	50	150	10
M4	Mandatory Course	AU	-	-	-	-	-	-	-	-	-	-
	Total	-	-	-	20	100	-	-	-	50	150	10

**FINAL YEAR B. TECH (COMMON TO ALL PROGRAMS), SEMESTER VIII
(PATTERN 2020) MODULE V**

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/OR/TW		
	Professional Core/ Professional Elective	TH	3	1/0	0/2	20	30	20	30	25	125	4
	Professional Elective	TH	3	1/0	0/2	20	30	20	30	25	125	4
	Open Elective	TH	3	-	-	20	30	20	30	-	100	3



	Open Elective (Humanities and Social Science)	TH	3	-	-	20	30	20	30	-	100	3
	Intellectual Property Rights (IPR)	CE	2	-	-	-	-	50	-	-	50	2
	Project Work	CE- PR/OR	-	-	8	100	-	-	-	50	150	4
M4	Mandatory Course	AU	-	-	-	-	-	-	-	-	-	-
	Total	-	14	2/0	8/12	180	120	130	120	100	650	20

NOTE: Students who will register for Module-I in Semester VII have to register either of Module-III or Module IV in Semester VIII. Students who will register for Module-II in Semester VII have to register for Module-V in Semester VIII.

Dean Academics

Director

BansilRamnathAgarwal Charitable Trust's

Vishwakarma Institute of Information Technology, Pune-48

(An Autonomous Institute affiliated to Savitribai Phule Pune University)



**Curriculum for
S. Y. B. Tech.
(Mechanical Engineering)**

**Department of
Mechanical Engineering**

VISION

Excellence in Mechanical Engineering for Global Acceptance

MISSION

- Make spirited mechanical engineers with morals, values and principles for sustainable development of society.
- Strive continuously to impart knowledge and skills of the highest standards.
- Our engineers will respond to the current and future needs of the industry, higher studies as well as research.

Program Educational Objectives:

1. Graduates of the program will become competent engineers suitable for the mechanical engineering based industry and higher education.
2. Graduates of the program will acquire the necessary foundation in fundamental mechanical engineering subjects for development of mathematical and analytical abilities.
3. Graduates of the program will acquire the knowledge and skills in mechanical engineering to provide technological solutions.
4. Graduates of the program will learn managerial, financial and ethical practices such as, project and financial management skills, multidisciplinary approach and soft skills.
5. Graduates of the program will respond to growing demands of society through lifelong learning.

Program Outcomes:

1. Engineering knowledge: Apply knowledge of mathematics, science, and engineering with focus on Mechanical Engineering.
2. Problem analysis: Identify, formulate and analyze a problem using principles of basic sciences and Mechanical Engineering.
3. Design/development of solutions: Design a system, component or process to fulfill desired needs within realistic constraints such as manufacturing, economic, environmental, social, ethical, safety and sustainability.
4. Conduct investigations of complex problems: Design and conduct experiments as well as analyze and interpret data.
5. Modern tool usage: Apply techniques, skills, and modern Mechanical Engineering tools such as CAD, CAM and CAE necessary for engineering practice.
6. The engineer and society: Acquire the broad education necessary to understand the impact of mechanical engineering solutions in the context of global, economic, environmental, cultural, legal and social issues.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. Individual and team work: Function effectively as an individual and as a member of multidisciplinary team.
10. Communication: Communicate effectively with the engineering community and society
11. Project management and finance: Apply project and financial management principles as a leader and team member in a multidisciplinary environment.
12. Life-long learning: Recognize the need and engage in life-long learning

Program Specific Outcomes:

1. Identify, automate and apply manufacturing processes for production of mechanical components considering effective use of man, machines, and material resources.
2. Design, formulate, develop and analyze mechanical components and systems using design engineering principles and modern CAD/CAE tools
3. Specify, analyze, evaluate, audit, design and build thermal and fluid systems using modern engineering tools



S.Y. B. TECH. (MECHANICAL ENGINEERING), SEMESTER III (PATTERN 2020)

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/O R/T W		
ES21201ME	Probability and Statistics	TH	3	1	0	20	30	20	30	25	125	4
MEUA21202	Manufacturing Process	TH	3	0	2	20	30	20	30	25	125	4
MEUA21203	Material Science and Engineering Metallurgy	TH	3	0	2	20	30	20	30	25	125	4
MEUA21204	Thermodynamics	TH	3	0	2	20	30	20	30	25	125	4
ES20205	Universal Human Values 2	TH	2	1	0	20	30	20	30	25	125	3
MEUA21206	Computer Aided Machine Drawing	CE	2	0	2	-	-	-	-	50	50	3
MEUA21207	Data Structure and Algorithm	CE	1		2					50	50	2
M2	Mandatory Course	AU	-	-	-	-	-	-	-	-	-	-
	Total		17	1	12	100	150	100	150	225	725	24

L: 1Hr. = 1 Credit, P: 2 Hrs. = 1 Credit, T : 1 Hr. = 1 Credit, AU: No Credits

CIE: Continuous Internal Evaluation SCE: Skill and Competency Examination

ISE: In-Semester Examination ESE: End Semester Examination

List of Mandatory Courses: Environmental Sciences, Induction training, Indian Constitution, Essence of Indian Traditional Knowledge ?

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Department of Mechanical Engineering

S.Y. B. TECH. (MECHANICAL ENGINEERING), SEMESTER IV (PATTERN 2020)

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/OR/TW		
MEUA22201	Instrumentation and Control	TH	3	0	2	20	30	20	30	25	125	4
MEUA22202	Applied Thermodynamics	TH	3	0	2	20	30	20	30	25	125	4
MEUA22203	Fluid Mechanics and Machines	TH	3	0	2	20	30	20	30	25	125	4
MEUA22204	Strength of Materials	TH	3	0	2	20	30	20	30	25	125	4
MEUA22205	Manufacturing Technology	TH	3	0	0	20	30	20	30	0	100	3
MEUA22206	Metrology & Quality Control	CE	2	0	2	-	-	-	-	50	50	3
MEUA22207	Data Analytics	CE	1	0	2					50	50	2
M2	Mandatory Course	AU	-	-	-	-	-	-	-	-	-	-
	Total		18	0	12	100	150	100	150	200	700	24

L: 1Hr. = 1 Credit, P: 2 Hrs. = 1 Credit, T : 1 Hr. = 1 Credit, AU: No Credits

CIE: Continuous Internal Evaluation SCE: Skill and Competency Examination

ISE: In-Semester Examination ESE: End Semester Examination

List of Mandatory Courses: Environmental Sciences, Induction training, Indian Constitution, Essence of Indian Traditional Knowledge

BoS Chairman

Dean Academics

Director

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8	MEUA22201	Instrumentation and Control	24
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Department of Mechanical Engineering



Semester - III

VISHWAKARMA
INSTITUTES

VI

Probability and Statistics (ES 21201ME)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits: 4 Lecture (L): 3 hrs./week Tutorial (T): -- 1 hr Practical (P): 0 hrs./week	20	30	20	30	-	25	125

Prerequisite- Engineering Mathematics**Course objectives:**

- 1) Engineers with the ability to analyze the data for a given problem and represent in the mathematical and statistical form.
- 2) Engineers with ability to systematically solve the problems using knowledge of probability, distributions, sampling and formulating hypothesis
- 3) Engineers with the ability to carry out test of hypothesis, and apply the concept of correlation and regression, goodness of fit and distributions

Course Outcomes:

Upon completion of the course, students will be able to

1. Learn the concepts of basic statistics that will be used to summarize data.
2. Apply statistical concepts and probability theory to analyze data for making better decisions.
3. Estimate the population mean with a known and an unknown population standard deviation.
4. Develop both one- and two-tailed null and alternative hypotheses
5. Test a completely randomized design using a one-way and two-way analysis of variance.
6. Calculate the residual, standard error of the estimate, coefficient of multiple determination, and adjusted coefficient of multiple determination of a regression model.

Unit I- Statistical Methods

Introduction, collection, classification and representation of data, various databases related to Mechanical Engineering applications measures of central value (mean, median, mode), measures of dispersion, -Skewness, moment, Kurtosis, range, variance, coefficient of variation

Unit II- Probability Theory

Probability and its terminology, conditional probability, independent events, Bayes 'rule, pdf, cdf, mean and variance of random variable and their properties, covariance, correlation coefficient, probability distributions- Binomial, Poisson, Hypergeometric, Exponential, Normal, and central limit theorem.

Unit III- Sampling Theory

Population, sample, sampling techniques, errors, types of sampling distributions- sample mean, sample proportion and sample variance, point and interval estimates, confidence intervals, student's t distribution, chi-square distribution

Unit IV- Hypothesis Testing

Hypothesis testing- null and alternative hypothesis, type I and II errors, power of a test, approaches for hypothesis testing- p-value, critical value and confidence interval value, test for population mean, proportion and variance- one sample and two sample test, F-distribution.

Unit V- Single Variable Regression

Conceptual overview, one-way (CRD) and two-way ANOVA (RBD), factorial experiment, simple linear regression- model assumptions, parameter estimation (least square method), test for significance

(t and F test), confidence interval for parameters, coefficient of determination.

Unit VI- Multi Variable Regression

Multiple linear regression- model assumptions, parameter estimation (least square method), test for significance (t and F test), confidence interval for parameters, coefficient of determination, Residual analysis, dummy variable, logistic regression, confusion matrix and ROC analysis, curvilinear relationship.

Tutorial- (Any 7)

1. Assignment of central tendency and dispersion.
2. Assignment on Baye's rule and probability distributions.
3. Assignment on sampling distribution.
4. Assignment on testing of hypothesis
5. Assignment on one-way and two-way ANOVA
6. Assignment on factorial experiment
8. Assignment on simple linear and multiple linear regression
8. Assignment on logistic regression and confusion matrix

Text Books:

1. Jay L. Devore, Probability and Statistics for Engineering and the Sciences, 8th Edition, Cengage Learning, 2010.
2. P.V. Sukhatme, Sampling Theory of Surveys with Applications, Indian Society for Agricultural Statistics, New Delhi.
3. Douglas C. Montgomery, George C. Runger, Applied Statistics and Probability for Engineers, Wiley, Year- 2018, ISBN- 1119409535
4. Ken Black, Business Statistics for Contemporary Decision Making, 6th Edition, Wiley

Reference Books :

1. Douglas C. Montgomery, Design and Analysis of Experiments, John Wiley, Year- 2001
2. Douglas C. Montgomery, Elizabeth A. Peck, G. Geoffrey Vining, Introduction to Linear Regression Analysis, Wiley, 2012

Prepared by-Dr. S.C. Chinchankar

BOS Member- Dr. P.P.Hujare

BOS Chairman- Dr. D. N. Kamble

Manufacturing Processes (MEUA21202)

Teaching Scheme	Examination Scheme						
Credits:4	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 3 hrs./week Practical (P): 2 hrs./week Tutorial (T): -- hr.	20	30	20	30	25	-	125

Prerequisite: Physics, Chemistry, Mathematics, Workshop Practices.

Course objectives:

- To familiarize students with major manufacturing processes
- To correlate the material type with the possible fabrication processes
- To describe the operations and tools for major manufacturing processes
- To interpret the knowledge about manufacturing processes, parameters and their effects on performance.

Course Outcomes:

Upon completion of the course, students will be able to

1. Analyze heating, pouring and filling up of mould in casting processes.
2. Analyze bulk deformation processes in terms of power requirement and causes for defects.
3. Explain merits, demerits, applications and calculate energy requirements of various joining and assembly processes.
4. Describe various shaping processes for plastics, polymer matrix composites and rubber in terms of their merits, demerits and applications.
5. Design sheet-metal cutting, bending and drawing processes for various applications.
6. Determine force and energy requirements, machining time, tool life and necessary calculations for thread cutting and taper turning operations.

Unit I–Metal Casting Processes

Typical sand mould (important casting terms), Patterns and cores, Moulds and mould making, Sand testing, Gating system design, Heating and pouring of the molten metal, Analysis of pouring and filling up of mould, Solidification and cooling, Riser design, aspiration effect, Preventing impurities and turbulence in casting, Gating ratios, Effect of friction and velocity distribution, Expandable and permanent moulding processes, casting defects, New technology research and environmental issues.

Unit II - Metal Forming

Bulk deformation processes, Material behavior and temperature in metal forming, Rolling, Forging, Other deformation processes related to Rolling and Forging, Extrusion and Wire drawing, Analysis of Rolling, Forging, Extrusion and Wire drawing, Design for Hot Forging, Environmental Issues - Metal Forming, Forming of Components: Recent Advances (Advanced Forming Technologies).

Unit III - Joining and Assembly processes

Welding: Physics of welding, classification of welding, Features of a fusion welded joint, Power source of welding, Physics and principle of arc welding, resistance welding, oxyfuel gas welding, Other fusion welding processes, Solid state welding FSW, Weld quality, Weldability, Nomenclature and symbol of welding joints, Design considerations in welding, Welding defects and inspection, Brazing, Soldering, Adhesive Bonding,

Mechanical Assembly: Threaded fasteners, rivets and Eyelets, Stitching, stapling and sewing.

Safety in Welding and Allied Processes.

Unit IV- Plastics Processes

Plastics and Composite Standards, Polymer Composites Sustainability: Environmental Perspective, Future Trends and Minimization of Health Risk. Shaping Processes for Plastics: Extrusion, Production of sheet, film, Injection moulding, Compression and transfer moulding, Blow moulding, and thermoforming

Unit V- Sheet Metal Working

Sheet metal working: cutting and bending operations, drawing, Dies and presses for sheet metal processes, Engineering analysis of sheet-metal cutting, bending and drawing, stretch forming, roll bending and forming, Spinning and High-energy rate forming, Environmental aspects of sheet metal forming, Recent trends in sheet metals and their formability in manufacturing automotive panels.

Unit VI – Center Lathe

Lathe, types of lathe, construction of lathe machine, accessories and attachments of lathe, specification of lathe, taper and taper turning, thread cutting, drilling on lathe, cutting speed, feed, depth of cut and machining time.

List of Practical:

1. Design of pattern, pattern making, moulding and casting.
2. Job of assembly, consisting of at least three components with tolerance involving use of machine tools or processes.
3. Spur Gear cutting in milling machine on a work piece
4. Demonstration about following processes
A) Sheet metal working Processes: Introduction, hand press, different dies such as simple die, compound die, progressive die and its application. Demonstration of one utility job.
B) Plastic Injection Moulding: Introduction, principle, equipment & operation and video on one utility job.
C) Welding Processes: Arc Welding, Resistance Welding, Soldering and Brazing

Text Books:

1. Hajara Choudhari, Bose S.K. – Elements of workshop Technology Vol. I &II, Asian Publishing House, ISBN0713136227
2. M.P Grover – Fundamentals of modern manufacturing: Materials and systems, John Wiley & Sons, Inc, New Jersey, 2010, ISBN978-0470-467008.
3. R. K. Jain, Production Technology, Khanna Publishers, 16th Edition, 2003
4. R.K. Rajput – Manufacturing Technology, Laxmi Publications (P)Ltd.

Reference Books:

1. B. Ravi – Metal Casting – Computer Aided design and analysis- Prentice Hall of India ISBN: 8120327268, 9788120327269.
2. Reikher – Casting: An analytical approach – Springer ISBN9781846288494.
3. Materials and Processes in Manufacturing, DeGarmo, Black, and Kohser, John Wiley & Sons, Inc, New York, 2011.
4. Kalpakjian and Schmid - Manufacturing Engineering and Technology, Prentice Hall, New Jersey, 2013

Course Coordinator: Mr. M. G. Gadge

BoS Member: Dr. S. S. Chinchankar

BoS Chairman: Dr. D N. Kamble

Material Science and Engineering Metallurgy (MEUA21203)

Teaching Scheme	Examination Scheme						
Credits:4 Lecture (L): 3hrs./week Tutorial (T): -- hr. Practical (P): -- 2 hrs./week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	25	-	125
Prerequisite: Mathematics, Physics and Chemistry							
Course objectives: <ul style="list-style-type: none"> To Describe importance of crystal structure Importance phase diagram and co-relation of different phases with different mechanical properties. Perform various heat treatments tests for material properties and characterization of industrial samples 							
Course Outcomes: Upon completion of the course, students will be able to <ol style="list-style-type: none"> Define the basics of crystal structure and structure of metal Compare deformation in different metals and understand importance of NDT. Define importance of equilibrium diagram with reference to Metallurgy and Mechanical Engineering Understand importance of Iron Carbon equilibrium diagram and classify different types of steels Justify the difference between alloy steels and cast iron based on Iron Carbon equilibrium diagram. Explain proper heat treatments and their importance in steels 							
Unit I : Structure of Materials							
Crystal Structure: Unit cells, Metallic crystal structures, Miller direction and calculations Imperfection in solids: like Point, line defects; dislocation plastic of single crystal and calculation, deformation mechanisms like twinning and slip, Annealing and its stages.							
Unit II: Mechanical Testing							
Study of destructive testing, Tensile test, engineering stress-strain curve, true stress-strain curve, types of stress-strain curves, Numerical based on Evolution of properties, compression test, different hardness tests-Vickers, Rockwell, Brinell, Poldi, Micro Hardness Test, Impact test, Introduction to different Non-destructive test and its uses. importance.							
Unit III: Metallography and Equilibrium Diagrams							
Microscopy, macroscopy. Importance of Equilibrium diagram with basic terms. Hume Rothery's rule of solid solubility allotropy and polymorphism, eutectic system and Partial eutectic system.							
Unit IV: Iron-Carbon Equilibrium Diagram							
Iron-iron carbide equilibrium diagram, non-equilibrium cooling of steels, Classification and application of plain carbon steels specification of steels,							
Unit V: Alloy Steels and Cast Irons and Introductions Nonferrous metals							

Introduction to cast Iron and its basic types, Effect of different alloying elements on IC diagram, Introduction to tool steel, transformation products of austenite, time temperature transformation diagrams, critical cooling rate, Basics Introduction to nonferrous materials (Basics of Brasses and Bronzes).

Unit VI: Heat- Treatment of Steels

Heat treatment of steels like Annealing, normalizing, hardening & tempering, retention of austenite: effects of retained austenite, elimination of retained austenite, introduction to case hardening processes.

List of Practical:

Any 8

1. Study and trial on Tensile test.
2. Study and trial on compression test.
3. Study and trial on Brinell hardness test
4. Study and trial on Vickers hardness test
5. Study and trial on impact test
6. Study and performance on magnetic particle & dye penetrant test
7. Study of metallurgical microscope, Study & demonstration of specimen preparation for microscopic examination
8. Study and trial on Jominy end hardenability test
9. Study and drawing of microstructure of steels and cast Iron.(min 2)
10. Heat treatment of plain carbon steel and determination of relative hardness

Text Books:

1. Dr. V.D. Kodgire & S. V. Kodgire, "Material Science & Metallurgy For Engineers", Everest Publication 2008 , ISBN 81-86314-00-8.
2. K. Bhargava, C.P. Sharma "Mechanical Behavior & Testing Of Materials", P H I Learning Private Ltd., ISBN: 978-81-203-4250-7

Reference Books :

1. Donald R. Askl and, Phule P. P., "Science and engineering of materials", Thomson Learning 2003. ISBN: 0534553966.
2. Callister W. D, "Materials Science and Engineering", John Wiley, ISBN 9780470419977
3. Higgins R. A., "Engineering Metallurgy", Viva books Pvt. Ltd., 2000, ISBN 0340568305.
4. Raghvan V. "Material Science & Engg.", Prentice Hall of India , New Delhi. 2003
5. Avner, S.H. Introduction to Physical Metallurgy, Tata McGraw-Hill, 1997. ISBN 10: 0074630067

Course Coordinator: Mrs. Sampada Dravid

BoS Member: Dr. S. S. Chinchankar

BoS Chairman: Dr .D N. Kamble

Thermodynamics (MEUA21204)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits:4 Lecture (L): 3hrs./week Tutorial (T): -- hr. Practical (P): 2 hrs./week	20	30	20	30	25	-	125

Prerequisite: Engineering Mathematics, Engineering Physics and Chemistry

Course Objectives:

- To understand applications of thermodynamics laws to various energy conversion devices.
- To evaluate the changes in properties of substances in various processes.

Course Outcomes:

Upon completion of the course, students will be able to

1. Apply the first law of thermodynamics to analyze thermodynamic devices and ideal gas processes.
2. Explain second law of thermodynamics and concepts of reversibility and irreversibility.
3. Determine entropy change during processes for predicting the available energy/ unavailable energy.
4. Evaluate various properties of steam using the steam table.
5. Estimate performance parameters of various thermodynamic cycles.
6. Analyze the performance of steam generator.

Unit I : First Law of Thermodynamics

Review of basic terms and definitions, Microscopic and Macroscopic approach, Thermodynamic processes, throttling process, Thermodynamic equilibrium, Point and path function, Heat and work, Perfect gas laws, PMM I, Applications of first law to non-flow processes (Constant Pressure, Constant Volume, Isothermal, Adiabatic, and Polytropic). Calculations of heat transfer, work done, internal energy, enthalpy.

Applications of first law to flow Processes SFEE (Pump, compressor, turbine, boiler, nozzle)

Unit II: Second Law of Thermodynamics

Limitations of First law, Clausius and Kelvin Plank Statement and their equivalence, PMM II, Reversibility and irreversibility, Causes and Conditions of reversibility, Carnot cycle for heat engine, heat pump and refrigerator, Carnot theorem, Clausius inequality.

Unit III: Entropy and Availability

Concept of entropy, entropy changes for an ideal gas during reversible process, entropy of isolated system, principle of entropy increase, Definition of Isentropic efficiency for compressors, turbines. and nozzles.

Available and unavailable energy, Availability function for systems and Control volumes undergoing different processes, Lost work.

Unit IV: Properties of Steam

Definition of pure substance, Formation of steam, Phase changes, Properties of steam, Use of Steam Tables, Study of P-V, T-S and Mollier diagram for steam, Dryness fraction and its determination, Study of steam calorimeters (Barrel, Separating, Throttling and combined) Non-flow and Steady flow vapour processes, Change of properties, Work and heat transfer.

Unit V: Gas and Vapour Power Cycle:

Air standard Otto, Diesel and Dual cycles, Air standard Brayton cycle, Basic Rankine cycle , Reversed Carnot Cycle, Vapor compression refrigeration cycles.

Unit VI: Boiler

Classification of boiler, Boiler mounting and accessories, Boiler draught (natural and artificial draught) Boiler performance calculations-Equivalent evaporation, Boiler efficiency Energy balance. IBR Act.

List of Practical:

Any 8 (Expt. 9 compulsory)

1. Validation of first law of thermodynamics using Joules experiment.
2. Determination of energy interaction in any thermal system using SFEE.
3. Determination of thermal efficiency of heat engine.
4. Determination of theoretical COP of vapor compression cycle.
5. Determination of dryness fraction of steam using any one of calorimeter.
6. Demonstration of Boiler mountings
7. Demonstration of Boiler accessories.
8. Performance test on Boiler and its heat balance sheet analysis.
9. Performance estimation of any thermal system using any suitable software.
10. Industrial visit to any processing unit having boiler.

Text Books:

1. P. K. Nag, Engineering Thermodynamics, Tata McGraw Hill Publications, ISBN-13: 978-1-25-906256-8
2. R. K. Rajput, Engineering Thermodynamics, EVSS Thermo Laxmi Publications, ISBN: 978-81-318-0058-4
3. M M Rathod, Thermal Engineering, Tata McGraw Hill Publications, ISBN(13)978-0-07-068113-2

Reference Books :

1. Y. Cengel & Boles: Thermodynamics – An Engineering Approach, Tata McGraw Hill Publications, ISBN 13:9780072884951
2. P. L Ballany: Thermal Engineering, Khanna Publishers, ISBN-13: 978-81-7409-031-2
3. C.P. Arora: Engineering Thermodynamics, Tata McGraw Hill Publications, ISBN - 9780074620144

Prepared By: Mr. C.R. Ramtirthkar

BOS Member: Dr. S.S. Kore

BOS Chairman: Dr. D.N. Kamble

Universal Human Values 2 (ES20205)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits:3 Lecture (L): --2 Practical (P): -- Tutorial (T): --1 1hrs./week	20	30	20	30	-	25	125

Prerequisite: Universal Human Values – I**Course objectives:**

- Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
- Understanding of the harmony in the human being, family, society and nature/existence. Strengthening of self-reflection.
- Development of commitment and courage to act.

Course Outcomes:

Upon completion of the course, students will be able to

1. Become more aware of themselves, and their surroundings family, society, nature.
2. Become more responsible in life and handle problems with sustainable solutions.
3. Have better critical ability and become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
4. Apply what they have learnt to their own self in different day-to-day settings in real life.

Unit I–Introduction - Need, Basic Guidelines, Content and Process for Value Education

Purpose and motivation for the course,

Self-Exploration–what is it? - Its content and process; ‘Natural Acceptance’ and Experiential Validation- as the process for self-exploration,

Continuous Happiness and Prosperity- A look at basic Human Aspirations,

Right understanding, Relationship and Physical Facility- the basic requirements for fulfillment of aspirations of every human being with their correct priority,

Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario,

Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Unit II –Understanding Harmony in the Human Being - Harmony in Myself!

Understanding human being as a co-existence of the sentient ‘I’ and the material ‘Body’,

Understanding the needs of Self (‘I’) and ‘Body’ - happiness and physical facility,

Understanding the Body as an instrument of ‘I’ (I being the doer, seer and enjoyer),

Understanding the characteristics and activities of ‘I’ and harmony in ‘I’,

Understanding the harmony of I with the Body, correct appraisal of Physical needs, meaning of Prosperity in detail.

Unit III –Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship

Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfillment to ensure mutual happiness, Trust and Respect as the foundational values of relationship

Understanding the meaning of Trust; Difference between intention and Competence, Understanding the meaning of Respect, Difference between respect and Differentiation; the other salient values in relationship,

Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals, Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Unit IV- Understanding Harmony in the Nature and Existence - Whole existence as Coexistence with Implications of the Holistic Understanding of Harmony on Professional Ethics

Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature, Exploring the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence, Exploring Co-existence in Existence, Discussion on the conduct as an engineer or scientist.

List of Tutorial: (Any 7 tutorials can be taken)

1. Practice session to discuss natural acceptance in human being.
2. Practice session to discuss the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.
3. Practice session to discuss the role others have played in making material goods available to me.
Identifying from one's own life.
4. Practice session to differentiate between prosperity and accumulation.
5. Practice session to discuss program for ensuring health vs dealing with disease.
6. Practice session to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc.
7. Practice session to reflect on Gratitude as a universal value in relationships. Discuss with scenarios.
8. Practice session to reflect on Gratitude Elicit examples from students' lives.
9. Practice session to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.
10. Case Study session e.g. to discuss the conduct as an engineer or scientist etc.

Prepared By: Mr. N. B. Kate

BOS Member: Dr. S. V. Dravid

BOS Chairman: Dr. D.N. Kamble

Computer Aided Machine Drawing (MEUA21206)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits:3 Lecture (L): 2 hrs./week Practical (P): 2hrs./week Tutorial (T): --	-	-	-	-	50	-	50

Prerequisite: Engineering Graphics and Mechanical Workshop.

Course Objectives:

- To understand engineering drawings.
- To understand parametric modeling concept, create sketches, solid models, assembly models of simple machines.
- To develop the ability to apply limits, fits and geometric tolerances to components and assemblies and generate manufacturing/production drawings.

Course Outcomes:

Upon completion of the course, students will be able to

1. Interpret engineering drawings as per I.S. conventions.
2. Generate the solid and surface models from drawings.
3. Create the assemblies of machine components.
4. Interpret tolerances using production drawings of machine components.

Unit I– Introduction to Machine Drawing

Introduction – Machine Drawing Standards, I.S. Code and Conventions, Thread Terminology, Thread Engagement, I.S. Conventions for Threads, Nut Bolt Description, Types of Bolts, I.S. Conventions for Bolts, Types of Nuts, I.S. Conventions for Nuts, I.S. Conventions for Screws, Representation of machine elements and parts such as keys, gears, couplings, welds, etc.

Unit II –Part Modeling

Introduction to Graphical User Interface (GUI) of commercially used drafting and solid modeling software, Fundamentals of modeling, Solid modeling, application & modification of constraints and dimensions, Geometrical and Dimensional Constraints, transform the 2-dimensional sketch into 3 dimensional solid, CAD Modules – Sketcher, Solid Modeling, Feature operations, List of Toolbars, Generating Basic Surfaces, Performing Operations.

Unit III: Assembly Modeling

Assembly modeling – defining relationship between various parts of machine, Top down and Bottom Up Assembly approaches, List of Toolbars, applications of tools, Creation of constraints, Generation of exploded view, Demonstrations using applications, Examples of Shaft joints, Shaft couplings, Machines assemblies.

Unit IV: Production Drawing

Dimensioning Techniques, Limit, fits and tolerances, Need of Geometrical Tolerance, Geometrical Characteristics of Symbols, Geometric dimensioning and tolerancing (GD & T), Indication of Maximum Material Condition, Least Material Condition, Tolerance stack up analysis.
Generation of 2-dimensional production drawings from 3-Dimensional parts and assembly using CAD software, Drafting concepts, Appropriate dimensioning and tolerance.

Laboratory Work:

List of assignments:

1. Introduction to mechanical CAD Packages and demonstration of part modeling, assembly and detailing with simple examples.
2. Machine drawing conventions using 2 D modeling tool.
3. Two dimensional drawings of machine components using sketcher workbench.
4. Part modeling of machine components using commands of the CAD Software e.g. shafts, springs, forks, connectors, pins, pulleys etc.
5. Parametric Solid Modeling of shaft couplings using CAD software.
6. Solid Modeling of the machine components using CAD software.
7. Assembly modeling applications using CAD software.
8. Surfacing modeling applications using CAD software.
9. Tolerances stack up analysis.
10. Manufacturing/Production Drawings of the parts and assemblies with appropriate tolerance.

Text Books:

1. N. D. Bhatt and V.M. Panchal, "Machine Drawing", Charoter Publications ISBN-13:9789380358888
2. Ajeet Singh, "Machine Drawing", McGraw Hill Publications, New Delhi 2012.

Reference Books:

1. Ibrahim Zeid, Mastering CAD/CAM, McGraw-Hill ISBN-10: 0072868457 ISBN-13: 978-0072868456
2. Help Manuals and Tutorials of Referred CAD Softwares.

Course Coordinator: Mr. N. B. Kate

BoS Member: Dr. A.P. Kulkarni

BoS Chairman: Dr .D. N. Kamble

Vishwakarma Institute of Information Technology, Pune-48

(An Autonomous Institute affiliated to Savitribai Phule Pune University)

Department of Mechanical Engineering**Data Structure and Algorithm (MEUA21207)**

Teaching Scheme	Examination Scheme						
Credits:2	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 1 hrs./week							
Practical (P): 2 hrs./week	--	--	--	--	50	-	50
Tutorial (T): 0 hr.							

Prerequisite: Fundamental knowledge of programming language and basics of algorithms Companion Course Engineering**Course objectives:**

- To study data structures and their implementations and applications.
- To learn different searching and sorting techniques.
- To study some advanced data structures such as trees, graphs and tables.
- To learn algorithm development and analysis of algorithms

Course Outcomes:

Upon completion of the course, students will be able to

1. Perform basic analysis of algorithms with respect to time and space complexity.
2. Select appropriate searching and/or sorting techniques and Implement data structures for given application.

Unit I–Introduction

- A) **Introduction to Data Structures:** Concept of data, Data object, Data structure, Concept of Primitive and non-primitive, linear and Nonlinear, static and dynamic, persistent and ephemeral data structures, Definition of ADT Analysis of algorithm: Frequency count and its importance in analysis of an algorithm, Time complexity & Space complexity of an algorithm, Sequential Organization: Single and multidimensional array, Linked Organization: Concept of linked organization, Singly Linked List, Doubly Linked List, Circular Linked List (Operations: Create, Display, Search, Insert, Delete).
- B) **Searching and Sorting:** Need of searching and sorting, Concept of internal and external sorting, sort stability, Searching methods: Linear and binary search algorithms, Sorting methods: Bubble, insertion, Quick, Merge and comparison of all sorting methods w.r.to its worst case time complexity.

Unit II –Stack, Que and Trees

- A) **Stack:**-Concept of stack, Concept of implicit and explicit stack, stack as an ADT using sequential and linked organization, Applications of stack: recursion,
- B) **Queue:** Concept of queues as ADT, Implementation of queue using array and linked organization, Concept of circular queue, priority queue, Applications of queue:
- C) **Trees :** Trees and binary trees-concept and terminology, Expression tree, Binary search tree, Recursive algorithms for binary searchtree traversals Applications of trees.
- D) **Graph** -Concept and terminologies

List of Assignments (1 Assignment 2 turns each)

1. Represent matrix using two dimensional arrays and perform following operations

i. Addition

ii .multiplication

iii. Transpose

iv. Saddle point

v. Lower and Upper triangular Matrix

2. Write a menu driven Program in C++ for the following operations on Singly Linked List (SLL) of Student Data with the fields: PRN, Name, Branch, Semester, Cell Number

a. Create a SLL of N Students

b. Display the SLL and count the number of nodes in it

c. Perform Insertion

d. Perform Deletion

3. Perform implementation of STACK using Array

a. Push an Element on to Stack

b. Pop an Element from Stack

c. Demonstrate Overflow and Underflow situations on Stack

d. Display Stack

Support the program with appropriate functions for each of the above operations

4. Implement FCFS (Queue) algorithm of job scheduling in operating system with the help of suitable data structure.

5. Write C++ program to maintain club members, sort on roll numbers in ascending order. Write function for Binary Search and Linear Search to search whether particular student is member of club or not.

6. Department maintains student's database. The file contains roll number, name, division and address.

Write a program to create a sequential file to store and maintain student data. It should allow the user to add, delete information of student. Display information of particular student. If record of student does not exist an appropriate message is displayed. If student record is found it should display the student details.

7. Represent graph as adjacency matrix or list and perform Depth first Traversal and Breadth First Traversal

OR

7. Create BST and perform Depth first Traversal and Breadth First Traversal

1) Simple applications involve temperature analysis in a continuously varying process (like *power plant, furnaces in metal plants*)

2) Velocity gradient, acceleration gradient, displacement gradient, etc in the *automotive industries*.

3) Motions constrains and force propagation analyses of various assemblies- *Machineries, automobile industries* etc

4) Stress- Strain Curve - Young's modulus determination - *Material Sciences/ Metallurgy*

5) Projectile/ Trajectory monitoring

6) Force distribution in structures, trusses, etc

7) Localisation process, etc

Take any system/ process- you can apply graph theory making its working and reactions in the process parameters easy to understand.

Text Books:

1. E. Horowitz, S. Sahni, D. Mehta, "Fundamentals of Data Structures in C++", Galgotia Book Source, New Delhi, 1995, ISBN 16782928

2. Y. Langsam, M. Augenstin, A. Tannenbaum, "Data Structures using C and C++", 2nd Edition, Prentice Hall of India, 2002, ISBN-81-203-1177-9.

Reference Books:

1. G. A.V, PAI , "Data Structures and Algorithms ", McGraw Hill, ISBN -13: 978-0-07-066726-6
2. A. Tharp , "File Organization and Processing", 2008 ,Willey India edition, 9788126518685
3. M. Folk, B. Zoellick, G. Riccardi, "File Structure An Object Oriented Approach with C++", Pearson Education, 2002, ISBN 81 - 7808 - 131 - 8.
4. M. Welss, "Data Structures and Algorithm Analysis in C++", 2nd edition, Pearson Education, 2002, ISBN81-7808-670-0

Course Coordinator: Computer Faculty

BoS Member: Dr. S. S. Chinchankar

BoS Chairman: Dr .D N. Kamble



Semester - IV



Instrumentation and Control (MEUA22201)

Teaching Scheme	Examination Scheme						
Credits:4 Lecture (L): 3hrs./week Tutorial (T): -- hr. Practical (P): -- 2 hrs./week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	-	25	100
Prerequisite: Electronics, Electrical Engineering, Smart Sensor							
Course Objectives:							
<ul style="list-style-type: none"> To understand the interdisciplinary applications of Electronics, Electrical, Mechanical and Computer Systems for the Control of Mechanical and Electronic Systems 							
Course Outcomes:							
Upon completion of the course, students will be able to							
<ol style="list-style-type: none"> Discuss the key elements of mechatronics system and types of sensors and actuators. Explain Electrical Motor and actuators by considering the Mechanical aspects. To Know the Interfacing of Sensors, Actuators using appropriate DAQ and different block diagram technique Analyze the time and Frequency domain analysis of system model for control application and PID control system. Apply Program Logic Controller for implementation on real time systems. Identify the Stability mechatronics system via identification of poles and zeros. 							
Unit I : Sensors and Transducers							
Definition, Multidisciplinary Scenario, Introduction to Measurement system, characteristics: - Static and Dynamic Sensors: Position Sensors: - Potentiometer, Linear variable differential transformer (LVDT), Digital Transducers (optical encoder), Nozzle Flapper, Tachometers, theory of accelerometer and vibrometers, Flow sensors, strain gauge, hall effect sensor, anemometer, digital manometer, calibration of thermocouple.							
Unit II: Electrical Actuating System							
Basic Principle of Electromechanical Switching, Solenoids, Electrical Relays, Electrical Motor, Lenz Law, Fleming's right hand rule, Construction working and Principle: AC Motor, DC Motor, Stepper Motor & Servo Motor, mechanical aspects of motor selection.							
Unit III: Block Diagram Representation & Data Acquisition System							
Open and Closed loop Control System; Concept of Transfer Function; Block Diagram & Reduction principles, Introduction to Signal Communication & Types-Synchronous, Asynchronous, Serial, Parallel, Data Acquisition system, Bit width, Sampling theorem, Aliasing, Sample and hold circuit, Sampling frequency; Interfacing of Sensors / Actuators to Data Acquisition system.							
Unit IV: Programmable Logic Controller							
Introduction to PLC, PLC Architecture, Latching, Timers, Counter, Different scans in PLC, Ladder diagram programming for different types of logic gates, Practical Examples of Ladder Programming, Data Handling.							
Unit V: Control System							
Proportional (P), Integral (I) and Derivative (D) control actions; PI, PD and PID control systems, Unit step Response analysis via Transient response specifications: Percentage overshoot, Rise time,							

Delay time, Steady state error; Manual tuning of PID control.

Unit VI: Modelling and Analysis of Mechatronics System

Transfer Function based modeling of Mechanical system, Stability Analysis via Poles & Zeros; Stability Analysis using Routh Hurwitz Criterion, Frequency Domain Parameters-Natural Frequency, Damping Frequency and Damping Factor, Introduction to Pneumatic and hydraulic actuation systems, Different components of Hydraulic systems, Servo valves, Stages in designing Mechatronics Systems

List of Practical:

Any 8

1. Measurement of displacement using LVDT.
2. Study of different types of sensor using sensor board
3. Interfacing of any one sensor to Data Acquisition System
4. PLC control system: - ladder logic implementation on real time system.
5. Speed control of DC motor.
6. Demonstration of water level control/Indicator system using PLC.
7. Demonstration of bottle filling plant using PLC.
8. Real Time Temperature / Flow Control using PID Control system.
9. PID control Design, Tuning using suitable Simulation Software
10. Study of Modeling and Analysis of a typical Mechanical System

Text Books:

1. K.P. Ramchandran, G.K. Vijayaraghavan, M.S. Balasundaram, Mechatronics: Integrated
2. Mechanical Electronic Systems, Willey Publication. ISBN: 9788126518371.
3. Bolton, Mechatronics - A Multidisciplinary approach, 4th Edition, Prentice Hall. ISBN 13: 9780132407632.
4. Smaili.A and Mrad.F, "Mechatronics integrated technologies for intelligent machines", Oxford university press, 2008.
5. Nitaigour Premchand Mahalik, Mechatronics-Principles, Concepts and Applications, Tata
6. McGraw Hill, 1stEdition, 2003 ISBN.No. 0071239243, 9780071239240.

Reference Books :

1. Bishop (Editor), Mechatronics – An Introduction, CRC Press, 2006. ISBN 13: 9780849363580.
2. Mahalik, Mechatronics – Principles, concepts and applications, Tata Mc-Graw Hill publication, New Delhi.ISBN 13: 9780070483743.
3. C. D. Johnson, Process Control Instrumentation Technology, Prentice Hall, New Delhi. ISBN-13:978-0134413051.
4. Rajput. R.K, A textbook of mechatronics, S. Chand & Co, 2007.

Course Coordinator: Mr. P P Rathod

BoS Member: Dr. S. S. Chinchankar

BoS Chairman: Dr .D N. Kamble

Applied Thermodynamics (MEUA22202)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits:4							
Lecture (L): 3hrs./week							
Tutorial (T): -- hr.							
Practical (P): 2 hrs./week	20	30	20	30	25	-	125

Prerequisite: Thermodynamics, Engineering Mathematics

Course Objectives:

- To apply concepts of thermodynamics to power producing and power absorbing devices in order to understand their functioning and improve their performance.

Course Outcomes:

Upon completion of the course, students will be able to

- Recognize classification and working of different I C Engines.
- Determine stoichiometric air required for fuel combustion.
- Use of Psychrometric charts and estimate various properties related to Psychrometry and processes.
- Analyze flow through nozzles and turbine.
- Illustrate construction and working of reciprocating air compressor and analyze its performance.
- Analyze centrifugal air compressor performance.

Unit I : Introduction to I C Engines

Classification of I C Engines, Components of Engines, Two stroke and four stroke engines, Petrol engine, Diesel engine, Alternative fuel, Hybrid engines and comparison. Introduction to soft tools for I C Engines.

Unit II: Combustion Thermodynamics

Introduction to solid, liquid and gaseous fuels– Stoichiometry, exhaust gas analysis- Conversion of Volumetric Analysis to Gravimetric Analysis, Conversion of Gravimetric Analysis to Volumetric Analysis, Combustion, Composition of Dry Air, Amount of Air Required for Combustion, Air-Fuel Ratio.

Unit III: Psychrometry Basics

Properties of dry and wet air, use of psychrometric chart, processes involving heating/cooling and humidification/dehumidification, concept of dew point.

Unit IV: Flow through Nozzle and Steam turbines

Flow of steam nozzle, super saturation- compressible flow in diffusers, efficiency of nozzle and diffuser, Analysis of steam turbines, velocity and pressure compounding of steam turbines.

Unit V: Reciprocating Compressor

Reciprocating compressors, staging of reciprocating compressors, optimal stage pressure ratio, effect of intercooling, minimum work for multistage reciprocating compressors.

Unit VI: Centrifugal Compressors

Classification of compressors, Construction, velocity diagram, flow process on T-S Diagram, Euler's

work, slip and slip factor, actual work input, performance characteristics, various losses in centrifugal compressor, Surging & Chocking.

List of Practical: Any 8 experiment

1. Demonstration of two stroke and four stroke I C Engines
2. Determination of calorific value using Bomb calorimeter.
3. Determination of calorific value using Junker gas calorimeter.
4. Measurement of fuel properties such as Flash point, Pour point, Cloud Point.
5. Demonstration of Psychrometric processes.
6. Determination of performance of air Nozzles.
7. Performance test on reciprocating air compressor.
8. Study and trial on centrifugal air compressor and plotting its characteristics
9. Performance estimation of any thermal system using any suitable software.
10. Visit to any processing industry having steam turbine.

Text Books:

1. Y. Cengel & Boles: Thermodynamics – An Engineering Approach, Tata McGraw Hill Publications
2. R. K. Rajput, Engineering Thermodynamics, EVSS Thermo Laxmi Publications
3. P. L Ballany: Thermal Engineering, Khanna Publishers
C.P. Arora: Engineering Thermodynamics, Tata McGraw Hill Publications

Reference Books :

1. Domkundwar, Thermal engineering, Dhanpat Rai & Co.
2. P. K. Nag, Engineering Thermodynamics, Tata McGraw Hill Publications
3. V. Ganeshan, Internal Combustion engines, Tata McGraw Hill Publications
0071336648, 9780071336642

Prepared By: Mrs. H Y Kolekar

BOS Member: Dr. A D Kale

BOS Chairman: Dr. D.N. Kamble

Fluid Mechanics and Machines (MEUA22203)

Teaching Scheme	Examination Scheme						
Credits:4	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 3 hrs./week Practical (P): 2 hrs./week Tutorial (T): -- hr.	20	30	20	30	25	-	125

Prerequisite: Engineering Mechanics, Engineering Mathematics - I, II & III, Engineering Physics.

Course objectives:

- To understand various fluid properties and learn fluid statics and dynamics.
- To understand the importance of dimensional analysis and energy losses in pipes.
- To obtain the velocity and pressure variations in various types of simple flows
- To analyze the flow in water pumps and turbines.

Course Outcomes:

Upon completion of the course, students will be able to

1. Explain the significance of fluid properties and apply fluid static systems.
2. Apply Continuity and Bernoulli's equations in solving the problems in fluids.
3. Calculate energy losses through various pipes and apply dimensionless numbers in fluid system.
4. Analyze the internal flow through pipe and external flows over the bodies.
5. Evaluate the performance of hydraulic turbines.
6. Evaluate the performance of centrifugal pump.

Unit I-Fluid Properties and Statics

Fluid Properties - Definition of fluid, Newton's law of viscosity, Units and dimensions-Properties of fluids, mass density, specific volume, specific gravity, viscosity, compressibility and surface tension.
Fluid Statics – Introduction, Hydrostatics law, Pascal's law, Total pressure, Center of pressure, Buoyancy and floatation. .

Unit II –Fluid Kinematics and Dynamics

Fluid Kinematics – Introduction, flow visualization, flow classifications, Continuity equation, velocity and acceleration, stream function and velocity potential function.
Fluid Dynamics – Introduction, Euler's equation of motion, Bernoulli's equation and its Applications.

Unit III –Flow through pipes and Dimensional Analysis

Flow Through Pipes - Energy losses in pipes, Darcy Weisbach's equation, pipes in series and parallel, siphon, Moody's diagram.

Dimensional analysis – Need, methods, Buckingham's Pi theorem, Dimensionless numbers.

Unit IV- Internal and External Flows

Internal flow – Laminar flow through circular pipe, laminar flow between parallel plates.
External flow – Concept of boundary layer, flow over a flat plate, measure of boundary layer thickness, separation of boundary layer and methods of controlling it, Introduction CFD.

Unit V- Hydraulic Turbines

Pelton wheel – Introduction to impulse momentum principle and turbines, classification of water turbines, working principle heads and efficiencies, velocity triangle and analysis, specific speed and unit quantities.
Francis and Kaplan Turbine – Introduction, working principle, velocity triangles and analysis, comparison.

Draft tube – need and types, cavitations, governing mechanism, selection and performance characteristics.

Unit VI – Centrifugal Pump

Introduction, classification, working principle, heads and efficiencies, velocity triangle and analysis, Pumps in series and parallel, specific speed, minimum starting speed, selection, priming and cavitation, maximum suction lift and NPSH, performance curves.

List of Practical:

Practical consist of **any eight** experiments of the following –

1. Study and Demonstration of pressure measuring devices
2. Determination of viscosity of liquids by using Redwood's viscometer.
3. Verification of modified Bernoulli equation.
4. Determination of stability of floating body.
5. Determination of coefficient of discharge of V notch / Venturimeter.
6. Determination of major/minor losses in various pipes fittings.
7. Laminar and Turbulent flows by Reynolds' apparatus.
8. Verification of impulse momentum principle by using curve vane.
9. Determination of the performance characteristics of Pelton wheel/Francis Turbine.
10. Determination of the performance characteristics of Centrifugal pump.
11. Fly Wheel air flow measurement and analysis with computational tools.
12. Industrial visit to any hydropower plant / pumping station and report based on it.

Text Books:

1. Dr. R. K. Bansal , “ Fluid mechanics & Hydraulic machines” , Laxmi Publication Pvt. Ltd. , New Delhi, ISBN : 13: 978-8131808153.
2. Dr. P. M. Modi& Dr. S. M. Seth, “Hydraulics & Fluid Mechanics”, Standard Book House, ISBN: 978-81-89401-26-9.
3. Cengel&Cimbla, “Fluid Mechanics” Tata McGraw - Hill.
4. B. U. Pai, “Turbomachnies”, Wiley India, ISBN 13: 9788126539550.

Reference Books:

1. V.P. Vasandani, Theory of Hydraulic Machinery Khanna Publishers, Delhi, ISBN 10: 0-07-0643419-X.
2. Dr. J. Lal, Hydraulic Machines, Metropolitan Book Co. Pvt. Ltd., Delhi, ISBN 10: 0-07-0643419-X.
3. Kundu, Cohen, Dowling, “Fluid Mechanics” Elsevier, India.
4. White, “Fluid Mechanics” Tata McGraw - Hill.

Course Coordinator:Mr. D. B. Nalawade

BoS Member: Dr. S. S.Kore

BoS Chairman: Dr .D N. Kamble

Strength of Materials (MEUA22204)

Teaching Scheme	Examination Scheme						
Credits:4 Lecture (L): 3hrs./week Tutorial (T): -- hr. Practical (P): -- 2 hrs./week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	25	-	125

Prerequisite: Engineering Mathematics, Engineering Mechanics.

Course Objectives:

- 1 To provide fundamental knowledge for determination of stress and strain for deformable body.
- 2 To apply the concept of principal stresses and theories of failure.
- 3 To draw shear force and bending moment diagram for different beams.
- 4 To determine bending and shear stress for different beam cross-sections.
- 5 To determine slope, deflection on beam and energy stored in members.
- 6 To provide fundamental knowledge to design shaft and column.

Course Outcomes:

Upon completion of the course, students will be able to

1. Analyze the structural members subjected to different stresses using the fundamental concepts.
2. Explain shear force and bending moment distribution across the beam.
3. Investigate the effect beam cross section on bending and shear stresses.
4. Evaluate the strains and deformation due to the elastic stresses developed within the materials.
5. Solve problems relating to torsional deformation of bars and other simple structures.
6. Ability to design and conduct experiments, as well as to analyze and interpret data.

Unit I: Simple Stress and strain

Deformation in solids, stress and strain- tension, compression and shear stress, Hook's law, elastic constants and their relations, volumetric, linear and shear strain, stresses and strains in determinate and indeterminate, homogeneous and composite bars under concentrated loads and self weight, thermal stress and strain.

Unit II: Principal Stresses and Theories of Failure

Normal and shear stresses on any oblique plane. Concept of principal planes, Mohr's circle, Maximum Principal stress theory, Maximum shear stress theory, Maximum Principal strain theory, Maximum strain energy theory.

Unit III: Shear Force and Bending Moment Diagram

Types of beams, shear forces and bending moment diagrams (Cantilever, Simply supported and Overhang beams) subjected to concentrated loads, uniformly distributed loads, uniformly varying loads and couples, Relationship between rate of loading, shear force and bending moment. Maximum bending moment and positions of points of contra-flexure.

Unit IV: Bending and Shear Stress

Bending stresses: Theory of simple bending, assumptions, flexural formula, moment of resistance, section modulus, bending stresses in symmetrical sections. Bending stress distribution diagram (rectangular, I,T).

Shear stresses: Concept, derivation of shear stress distribution formula, shear stress distribution diagram for common symmetrical sections, maximum and average shear stress.

Unit V: Slope and Deflection

Boundary condition, Computation of slopes and deflection in beams for standard cases, deflection of a beam using Macaulay's Method.

Strain Energy: Concept, strain energy stored in the member and stresses due to the gradually applied load, suddenly applied load, impact load.

Unit VI: Torsion and Buckling

Torsion: Theory of torsion and assumptions, stresses in a solid and hollow circular shaft, strength and rigidity criterion for the design of the shaft, power transmitted by a solid and hollow circular shaft, shafts in series and parallel.

Buckling of columns: Concept of buckling of columns, Euler's formula for buckling load for a different column, equivalent length, limitations of Euler's formula, Rankine's formula.

List of Practical: Lab Practice shall consist of the following *any 8* experiments

1. Determination of elongation, stress and strain of a bar using suitable software (Open-source/CAE software)
2. Shear test of ductile material on Universal Testing Machine
3. Principal stresses through the graphical and analytical method.
4. Experimental verification of flexural formula in bending for cantilever beam
5. Experimental verification of flexural formula in bending for simply supported beam
6. Experimental verification of torsion formula for a circular bar
7. Study of Shear force and bending moment diagrams with different end conditions using suitable software (programming language, open-source software etc)
8. Develop a program to determine slope and deflection in standard beams (using MATLAB/Python)
9. Experimental study of buckling of columns with different load conditions

Text Books:

1. S. Ramamurtham and R. Narayanan, "Strength of Materials", 18th Edition, Dhanpat Rai Publication, ISBN: 81-87433-54-X.
2. S.S. Rattan, "Strength of Material", 2nd Edition, Tata McGraw Hill Publication Co. Ltd., ISBN: 978-0-07-107256-4
3. R. K Bansal, "Strength of Materials", 6th Edition, Laxmi Publication, ISBN: 978-81-318-0814-6.
4. S.S. Bhavikatti, "Strength of Materials", Vikas Publishing, 4th Edition ISBN: 9789325971578.
5. Rajput R. K., "Strength of Materials", S. Chand Publication. ISBN-10 : 8188458104

Reference Books :

1. Ferdinand Beer, Jr., E. Russell Johnston, John DeWolf, David Mazurek, 6th Edition, "Mechanics of Materials", Tata McGraw Hill Publication Co. Ltd., ISBN-13: 978-0073380285
2. Timoshenko S. P. and Young D. N., "Strength of Materials", Affiliated East-West Press PVT. LTD. New Delhi, 2006, ISBN: 8176710199.
3. Singer and Pytel, "Strength of Materials", Addison Wesley Publishing Corporation, 1999, ISBN 0 321 04541 6.

Course Coordinator: Mr. N H Ambhore

BoS Member: Dr. S. S. Chinchankar

BoS Chairman: Dr .D N. Kamble



Manufacturing Technology (MEUA22205)

Teaching Scheme	Examination Scheme						
Credits:3 Lecture (L): 3 hrs./week Practical (P): -- Tutorial (T): -- hr.	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	-	-	100

Prerequisite: Engineering Physics, Engineering Chemistry, Engineering Mathematics, Manufacturing Processes and Workshop Practice.

Course objectives: Manufacturing Technology covers the behavior of materials and the processes used to convert raw materials into finished products.

The course emphasizes process selection and sequencing, economics, quality and design for manufacture.

- Evaluate economics of machining processes understanding machining mechanics at different cutting conditions.
- To correlate the material type with the possible fabrication processes
- To describe the operations and tools for major manufacturing processes
- To interpret the knowledge about manufacturing processes, parameters and their effects on performance.

Course Outcomes:

Upon completion of the course, students will be able to-

1. Apply cutting mechanics to metal machining based on cutting force and power consumption.
2. Evaluate economics of machining processes understanding machining mechanics at different cutting conditions.
3. Derive various processes for thread and gear manufacturing.
4. Differentiate grinding and super-finishing processes.
5. Characterize (process parameters and response) of non-conventional machining processes for various applications.
6. Design Jigs and fixtures considering the Principles of locating and clamping devices.

Unit I: Theory of Metal cutting

Mechanics of chip formation, Types of chips, Merchant's circle of forces- Estimation of shear force, Normal shear force, Friction force, Normal friction force, Material Removal Rate (MRR), Cutting power estimation, Calculation of Total power and Specific energy. Mechanics of shearing (orthogonal and oblique), Shear plane angle, Shear stress, strain and Shear strain rate. Single point cutting tool nomenclature, cutting tool materials.

Machinability - Factors affecting machinability, Tool life, Types of tool wear and remedial actions, Cutting fluid and their types, Effect of process parameters on tool life, Taylor's tool life relation.

Unit II: Economics of Metal Cutting

Material removal rate and machining time: Turning, Drilling and Milling operations. Surface finish in machining, Economics of machining operations, Optimizing cutting parameters for minimum cost, Optimizing machining cost for maximum production and optimum cutting speed for maximum efficiency.

Unit III: Thread and Gear Manufacturing

Types of threads, elements and forms of screw threads. Thread cutting processes: by form tool, tapping, die heads, thread milling, thread rolling, thread grinding. Gear teeth forms and tooth terminology.

Gear Manufacturing: Casting, forming by form cutter, broaching, Gear generating Methods-Rack cutter, Pinion cutter, Gear shaping and hobbing processes.

Gear finishing: Gear shaving, Gear burnishing, Gear grinding, gear honing and gear lapping processes.

Unit IV: Grinding and Finishing Process

Introduction to abrasive machining and finishing operations, types of grinding machines, grinding wheel

shapes and sizes ,standard marking system, selection of grinding wheel, glazing, dressing, balancing and mounting of grinding wheel, Surface finish in grinding.

Finishing operations: Lapping, Honing and super finishing processes, Polishing, buffing and burnishing processes.

Unit V: Non-Conventional Machining Processes

Introduction, classification of non-conventional machining processes, selection of process parameters and summary of process characteristics. Advantages, limitations and applications of abrasive jet machining (AJM), ultrasonic machining (USM), Electrochemical machining (ECM), electric discharge machining (EDM), electron beam machining (EBM), laser beam machining (LBM) and plasma arc machining (PAM). Comparison of advanced machining processes with conventional machining.

Unit VI: Jigs and fixtures

Definition and concept of Jig and Fixture, General guidelines to design Jigs and fixtures, advantages of jig and fixtures, concept of degrees of freedom, 3-2-1 principle of location , Principles of clamping, locating devices. Types of clamps. Materials used for clamping and locating devices.

Types of Jigs: Channel jig, Template jig, Plate jig, Angle plate jig, Turn over jig, Box jig, and Latch jig.

Types of Fixtures: Turning fixture, Welding fixture, Milling fixture, Indexing fixtures. Concept of modular fixture. Pokayoke concept in jigs and fixtures.

Text Books:

1. Hajara Choudhari, Bose S.K. – Elements of workshop Technology Vol. II , Asian Publishing House, ISBN 0713136227
2. M.P Grover – Fundamentals of modern manufacturing: Materials and systems, John Wiley & Sons, Inc, New Jersey, 2010, ISBN 978-0470-467008.
3. R. K. Jain, Production Technology, Khanna Publishers, 16th Edition, 2003.
4. P. C. Sharma, Production Engineering, S. Chand Publication

Reference Books :

1. P. K Mishra, Non- conventional machining, Narosa Publishing House 10.
2. V. K Jain, Advanced machining processes , Allied Publisher, New Delhi 11.
3. Gary F. Benedict, Non – traditional manufacturing processes, Marcel Dekker Inc. 12.
4. M. H. A Kempster, An Introduction to Jig and Tool Design, ELBS 13.
5. P. H. Joshi, Jigs and fixtures , Tata McGraw Hill 14.
6. Black, and Kohser, Materials and Processes in Manufacturing, DeGarmo, John Wiley & Sons, Inc, New York, 2011.
7. Kalpakjian and Schmid - Manufacturing Engineering and Technology, Prentice Hall, New Jersey, 2013
8. Production technology –HMT, Tata McGraw Hill publication

Course Coordinator: Dr. B. S. Rathod

BoS Member: Dr.S .S. Chinchankar

BoS Chairman: Dr .D N. Kamble

Metrology and Quality Control (MEUA22206)

Teaching Scheme	Examination						
	CIE	ISE	SCE	ESE	TW	PR/OR	Total
Credits: 2 Lectures (L): 1hrs./week Tutorials (T):--- Practical (P): 2hrs./week							
	--	--	--	--	--	50	50

Course Objectives:

- Select suitable instrument / gauge / method of inspection for determining geometrical and dimensional Measurements.
- Calibrate measuring instruments and design inspection gauges.
- Understand the advances in Metrology such as use of CMM, Laser for Metrology etc.
- Select and apply appropriate Quality Control Technique for given application

Course Outcomes:

After successful completion of the course, student will be able to

1. Design Limit gauges considering Allowance and Gauge makers tolerance.
2. Evaluate Dimensional and Geometric Errors using Comparators, Gear and hread.
3. Differentiate Cost of quality and value of quality with a view to Improve Product design using various quality tools.
4. Produce an Inference about Process capability by plotting Process control charts using suitable sampling Plans

Unit I: Standards and Gauges

Principles of Engineering metrology, Measurement standards, Types and sources of errors, Accuracy and Precision.

Tolerances, Limits and Fits [IS 919-1993], Taylor's principle, Types of gauges, Wear allowance on gauges, Gauge design numerical.

UnitII: Measurement of Mechanical elements.

Comparators, Measurement of geometric form, Thread form (Major, Minor and Effective diameter, Thread angle and Pitch), Gear Metrology:(Gear form and tooth thickness),Numerical, Introduction to Advanced metrology :Coordinate Measuring Machine&Multi Gauging System.

Unit III: Introduction to Quality Tools

Concept of Quality: Various Definitions and Quality Statements, Cost of quality and value of quality, Deming's cycles & 14 Points, Juran Trilogy approach, Old New Seven Tools, Quality Circles.

Importance of Quality deployment at Design and Manufacturing Engineering: Opportunities for improvement product design, Importance of initial planning for quality

Unit IV: Introduction to Statistical Quality Control

Statistical quality control: Statistical concept, Frequency diagram, Concept of variance analysis, Control Chart for Variable (X & R Chart) & Attribute (P & C Chart), Process capability, Statistical Process Control (Numerical). Production Part Approval Method (PPAP). Acceptance Sampling: Sampling Inspection, OC Curve and its characteristics, sampling methods, Sampling Plan: Single, Double (Numerical), Multiple, Comparison of Plan, calculation of sample size, AOQ, Probability of Acceptance (Numerical).

List of Practical's: - (any Eight)

1. Demonstration of linear and angular measuring instruments, slip gauges and their applications.
2. Error determination of linear / angular measuring instruments and determination of linear and angular dimensions of given part, (MSA: Gauge R & R).
3. Calibration of measuring instrument. Example – Dial gauge, Micrometer, Vernier (any one)
4. Verification of dimensions and geometry of given components using Mechanical /Pneumatic comparator. [An assignment with this experiment write-up as, Introduction to use of Standard CODE viz. ASME-Y14.5, ISO-1101].
5. Machine tool alignment testing on machine tool – Lathe / Drilling / Milling.
6. Demonstration of surfaces inspection using optical flat/interferometers. / Demonstration of surface roughness measurement using surface roughness tester.
7. Determination of geometry and dimensions of given composite object / single point tool, using profile projector and tool maker's microscope.
8. Measurement of spur gear parameters using Gear Tooth Vernier / Span Micrometer / Gear Rolling Tester.
9. Demonstration on Advance Measuring Instrument (CMM, Multi GuagingSystem)
10. Assignment on process capability and Control charts.

Textbooks:

1. Jain R.K., Engineering Metrology, Khanna Publication.
2. I. C. Gupta, Engineering Metrology, Dhanpath Rai.
3. Bewoor A. K. and Kulkarni V. A., Metrology and Measurements, Tata McGraw hill Publication.
4. Grant S.P., Statistical Quality Control, Tata McGraw hill Publication.
5. Mahajan M. Textbook of Metrology Dhanpath Rai. Publications.
6. Ragvendra N V, Engineering Metrology and Measurement, Oxford University Press

Reference Books:

1. Narayana K.L., Engineering Metrology.
2. Galyer J.F & Shotbolt C.R., Metrology for engineers
3. Gupta I.C., Engineering Metrology, Dhanpatrai Publications

4. Judge A.W., Engineering Precision Measurements, Chapman and Hall

Course Coordinator: Mr. A. A. Somatkar

BoS Member: Dr. S. C. Chinchankar

BoS Chairman: Dr. D. N. Kamble



Data Analytics (MEUA22207)

Teaching Scheme	Examination Scheme						
Credits: 2 Lectures (L): 1 hr./week Tutorials (T): --hrs. Practical (P): 2 hrs/week	CIE	ISE	SCE	ESE	TW	PR/OR	Total
	-	-	-	-	--	50	50

Prerequisites: Engineering Mathematics, Python programming

Course Objectives:

To introduce conceptual understanding using simple and practical examples and make you comfortable using analytics in your career. This course will make you know how to work with real data and choose the right methodology to correctly interpret the result.

Course Outcomes:

Upon completion of the course, students will be able to

1. Apply statistical concepts and probability theory to analyze data that can assist present and future business managers in making better decisions.
2. Develop both one-and two-tailed null and alternative hypotheses and that can be tested in a business setting by examining the rejection and non-rejection regions in light of Type I and Type II errors.
3. Calculate the coefficient of determination and confidence intervals to measure the fit for regression models.

Unit I: Introduction to Data Analytics and Probability Theory

Classification of data analytics, importance of data analytics, levels of data, types of variables, central tendency: mean, mode, percentile, and dispersion: skewness, kurtosis, range, variance, coefficient of variation, probability distributions: Binomial, Poisson, Hypergeometric, Exponential, Normal, and central limit theorem.

Unit II: Sampling Distributions and Hypothesis Testing

Sampling distributions: sample mean, sample proportion and sample variance, Hypothesis testing: p-value, critical value and confidence interval value, type-I and II errors, test for population mean, proportion and variance

Unit III: Regression Analysis

Simple and multiple linear regression: model assumptions, parameter estimation (least square method), test for significance (t and F test).

Practical:

1. Assignment of central tendency and dispersion.
2. Assignment on probability distributions.
3. Assignment on sampling distribution -I.
4. Assignment on sampling distribution - II
5. Assignment on testing of hypothesis for population mean
6. Assignment on testing of hypothesis for population proportion
7. Assignment on testing of hypothesis for population variance
8. Assignment on simple linear regression
9. Assignment on multiple linear regression

Textbooks:

1. Jay L. Devore, Probability and Statistics for Engineering and the Sciences, 8th Edition, Cengage Learning, 2010.
2. P.V. Sukhatme, Sampling Theory of Surveys with Applications, Indian Society for Agricultural Statistics, New Delhi.
3. Douglas C. Montgomery, George C. Runger, Applied Statistics and Probability for Engineers, Wiley, Year: 2018, ISBN: 1119409535
4. Ken Black, Business Statistics for Contemporary Decision Making, 6th Edition, Wiley

Reference Books:

1. Douglas C. Montgomery, Design and Analysis of Experiments, John Wiley, Year: 2001
2. Douglas C. Montgomery, Elizabeth A. Peck, G. Geoffrey Vining, Introduction to Linear Regression Analysis, Wiley, 2012

Course Coordinator: Dr. S. C.Chinchanikar

BoS Member: Dr. S. C. Chinchanikar

BoS Chairman: Dr .D N. Kamble



BansilalRamnathAgarwal Charitable Trust's
Vishwakarma Institute of Information Technology, Pune-48
(An Autonomous Institute affiliated to Savitribai Phule Pune University)



**Curriculum for
T. Y. B. Tech
(Mechanical Engineering)
2018 Pattern**

**Department of
Mechanical Engineering**

VISION

Excellence in Mechanical Engineering for Global Acceptance

MISSION

- Make spirited mechanical engineers with morals, values and principles for sustainable development of society.
- Strive continuously to impart knowledge and skills of the highest standards.
- Our engineers will respond to the current and future needs of the industry, higher studies as well as research.

Program Educational Objectives-

1. Graduates of the program will become competent engineers suitable for the mechanical engineering based industry and higher education.
2. Graduates of the program will acquire the necessary foundation in fundamental mechanical engineering subjects for development of mathematical and analytical abilities.
3. Graduates of the program will acquire the knowledge and skills in mechanical engineering to provide technological solutions.
4. Graduates of the program will learn managerial, financial and ethical practices such as, project and financial management skills, multidisciplinary approach and soft skills.
5. Graduates of the program will respond to growing demands of society through lifelong learning.

Program Outcomes-

At the end of the program, a student will be able to

1. **Engineering knowledge-** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis-** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
3. **Design/development of solutions-** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
4. **Conduct investigations of complex problems-** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage-** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society-** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability-** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics-** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work-** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication-** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance-** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning-** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Program Specific Outcomes-

At the end of the mechanical engineering program, a student will be able to-

1. Identify, automate and apply manufacturing processes for production of mechanical components considering effective use of man, machines, and material resources.
2. Design, formulate, develop and analyze mechanical components and systems using design engineering principles and modern CAD/CAE tools
3. Specify, analyze, evaluate, audit, design and build thermal and fluid systems using modern engineering tools

T.Y. B. TECH (MECHANICAL ENGINEERING), SEMESTER V (PATTERN 2018)

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/OR/TW		
ES31181ME	Numerical Methods*	TH	3	-	2	20	30	20	30	25	125	4
MEUA31182	Heat Transfer*	TH	3	-	2	20	30	20	30	25	125	4
MEUA31183	Professional Elective-I	TH	3	-	-	20	30	20	30	-	100	3
MEUA31184	Design of Machine Elements-II	TH	3	-	-	20	30	20	30	-	100	3
MEUA31185	Kinematics and Theory of Machines	TH	3	-	2	20	30	20	30	25	125	4
MEUA31186	Automation in Manufacturing	CE	2	-	2	-	-	50	-	25	75	3
M3	Mandatory course	AU	-	-	-	-	-	-	-	-	-	-
	Total	-	17	-	8	100	150	150	150	100	650	21

*Courses having Practical/Oral

CIE: Continuous Internal Evaluation SCE: Skill and Competency Examination

ISE: In-Semester Examination ESE: End Semester Examination

Professional Elective-I-

MEUA31183A	Energy Conservation and Management
MEUA31183B	Composite Materials
MEUA31183C	Advanced Manufacturing Processes
MEUA31183D	Advanced Metallurgy

List of Mandatory Courses-

Environmental Sciences, Induction training, Indian Constitution, Essence of Indian Traditional Knowledge

BoS Chairman

Dean Academics

Director

T.Y. B. TECH (MECHANICAL ENGINEERING), SEMESTER VI (PATTERN 2018)

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/OR/TW		
MEUA32181	Professional Elective-II	TH	3	-	2	20	30	20	30	25	125	4
MEUA32182	Professional Elective – III	TH	3	-	2	20	30	20	30	25	125	4
MEUA32183	Mechanical Vibration *	TH	3	-	2	20	30	20	30	25	125	4
ES32184ME	Operation Research	TH	3	-	-	20	30	20	30	-	100	3
IOEUA32185	Open Elective-I	TH	3	-	-	20	30	20	30	-	100	3
MEUA32186	Computer Aided Engineering	CE	2	-	2	-	-	50	-	25	75	3
M3	Mandatory Course	AU	-	-	-	-	-	-	-	-	-	-
	Total	-	17	-	8	100	150	150	150	100	650	21

*Courses having Practical/Oral

Professional Elective-II		Professional Elective-III		Open Elective-I	
MEUA32181A	Refrigeration and Air Conditioning	MEUA32182A	I. C. Engines	IOEUA32185A	Information and Cyber Security
MEUA32181B	Tribology	MEUA32182B	Solid Mechanics	IOEUA32185B	Automotive Electronics
MEUA32181C	Design for Manufacturing and Assembly	MEUA32182C	Hybrid and Electric Vehicles	IOEUA32185C	Industrial Engineering
MEUA32181D	Data Analytics	MEUA32182D	Robotics	IOEUA32185D	Artificial Neural Network in Engineering
				IOEUA32185E	Social Media Analytics

List of Mandatory Courses-

Environmental Sciences, Induction training, Indian Constitution, Essence of Indian Traditional Knowledge

BoS Chairman

Dean Academics

Director

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Semester – I

Numerical Methods (MEUA31181)

Teaching Scheme	Examination Scheme						
Credits: 4	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 3 hrs./week							
Tutorial (T): -- hr							
Practical (P): 2 hrs./week.	20	30	20	30	25	-	125

Prerequisite: Engineering Mathematics I, II and III

Course objectives:

- To recognize the difference between analytical and numerical methods and to provide the necessary concepts of a few numerical methods for solving complex Mechanical engineering Problems
- To offer hands-on experience for developing programming skills to provide solutions to mechanical problems using numerical methods.

Course Outcomes:

By the end of the course, students will be able to

1. Determine the root to given equations using appropriate numerical method.
2. Implement appropriate numerical method to solve linear systems of equations.
3. Demonstrate the use of regression/interpolation methods to find values based on the graphical and/or tabulated data.
4. Apply numerical methods to obtain approximate integration for given problem.
5. Evaluate an approximate solution of ordinary differential equation.
6. Solve a partial differential equation using finite difference approach.

Unit I–Errors, Approximations and Roots of Equation

Errors & Approximations- Significant figures, Accuracy & Precision, Errors Round-Off Error, Truncation Error, Error Propagation
 Roots of Equations- Bisection Method, Newton Raphson method, Successive approximation method, Convergence and Divergence

Unit II - Simultaneous Equations

Gauss Elimination Method, Partial Pivoting, Gauss-Seidal method and Thomas algorithm for Tri-Diagonal Matrix.

Unit III -Curve Fitting and Interpolation

Curve Fitting- Least Square Technique- Straight Line, Power Equation, Exponential Equation and Quadratic Equation.
 Interpolation- Lagrange's Interpolation, Newton's Forward Difference interpolation, Inverse Interpolation

Unit IV- Numerical Integration

Trapezoidal rule, Simpson's 1/3rd Rule, Simpson's 3/8th Rule, Gauss Quadrature Method. Double Integration

Unit V- Ordinary Differential Equations

Taylor series method, Euler Method, Modified Euler Method, Runge-Kutta Second Order Method, Runge-Kutta fourth order Method, Simultaneous equations using Runge Kutta 2nd order method.

Unit VI - Partial Differential Equations

Finite-Difference Approximations to Partial Derivatives, Solution of Elliptical and Parabolic Equations, Solution of One-Dimensional Heat Equation, Solution of Wave Equation

Lab practice/Term Work-

Term work shall consist of following assignments.

1. Program on Roots of Equation
 - a) Bisection Method or False position Method,
 - b) Newton Raphson method or Successive approximation method
2. Program on Simultaneous Equations
 - a) Gauss Elimination Method,
 - b) Gauss-Seidal method.
3. Program on Numerical Integration
 - a) Trapezoidal rule,
 - b) Simpson's Rules ($1/3^{\text{rd}}$ & $3/8^{\text{th}}$) [In one program only]
 - c) Double integration
4. Program on Curve Fitting
 - a) Straight line,
 - b) Power equation Or Exponential equation
 - c) Quadratic equation
5. Program on Interpolation
 - a) Lagrange's Interpolation,
 - b) Newton's Forward interpolation,
6. Program on Ordinary Differential Equations
 - a) Euler Method
 - b) Runge-Kutta Methods- Second order,
8. Program on Partial Differential Equations

Text Books:

1. B. S. Garewal, Numerical Methods in Engineering and Science- With Programs in C, C++ and MATLAB, New Delhi, Khanna Publishers
2. Jain M K, Iyengar S R K, Jain R K, Numerical Methods for Scientific and Engineering Computation, New Age International (P) Ltd. Publisher
3. Rao V. Dukkipati, Applied Numerical Methods using Matlab, New Age International Publishers

Reference Books:

1. Mathews John H, Fink Kurtis , Numerical Methods Using MATLAB, Dorling Kindersley (India) Pvt. Ltd
2. Stanton Ralph G , Numerical Methods for Science and Engineering, Prentice Hall of India
3. Chapra Steven C; Canale Raymond P , Numerical Methods for Engineers- with Software and Programming Applications, Tata McGraw Hill
4. Balagurusamy, Numerical Methods, Tata McGraw Hill
5. Thangaraj, Computer Oriented Numerical Methods, Prentice Hall of India
6. Sastry, Introductory Methods of Numerical Analysis, Prentice Hall of India

Heat Transfer (MEUA31182)

Teaching Scheme	Examination Scheme						
Credits: 4	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 3 hrs./week							
Tutorial (T): -- hr							
Practical (P): 2 hrs./week.	20	30	20	30	25	-	125

Prerequisite: Thermodynamics, Fluid Mechanics, Engineering Mathematics

Course objectives:

- The aim of the course is to build a solid foundation in heat transfer exposing students to the three basic modes namely conduction, convection and radiation.
- Rigorous treatment of governing equations and solution procedures for the three modes will be provided, along with solution of practical problems using empirical correlations.
- The course will also briefly cover boiling and condensation heat transfer, and the analysis and design of heat exchangers.

Course Outcomes:

Upon the completion of the course, students will be able to

1. Understand the various modes of heat transfer and implement the basic heat conduction equations for Steady, one dimensional thermal system with and without internal heat generation.
2. Apply heat conduction in extended surfaces.
3. Formulate and analyze a transient heat transfer problem.
4. Determine the heat transfer rate in natural and forced convection.
5. Interpret heat transfer by radiation between objects with simple geometries.
6. Analyze the heat exchangers and investigate their performance.

Unit I - Steady State Conduction

Introduction-Applications of heat transfer, Modes of heat transfer, Thermal conductivity, Thermal diffusivity

Unidirectional steady state conduction without internal heat generation-Fourier's law, Application of Fourier's law to infinite slab, infinite long hollow cylinder and hollow sphere, Electrical Analogy of conduction, concept of conduction and film resistances, critical insulation thickness, (Numerical) Three dimensional general differential equation of conduction in Cartesian, cylindrical and spherical geometry (no derivation for Cylindrical and spherical geometry), Laplace, Fourier's and Poisson's equation.

Unidirectional steady state conduction with internal heat generation-Boundary conditions, Application of Poisson's equation (No Numerical)

Unit II - Heat conduction through Extended Surfaces – Fins

Types of fins and its applications, Fin effectiveness and fin efficiency, concept of pin fin, Differential equation of pin fin, boundary condition based classification of pin fins, Analysis of pin fin

Unit III - Unsteady state conduction

Validity and criteria of lumped system analysis, Biot and Fourier number, Time constant and response of thermocouple, (Numerical) Transient heat analysis using Heisler and Grober charts.

Unit IV- Convection

Fundamentals of Convection-Heat convection, velocity and thermal boundary layers (No Numerical)

Forced Convection-Governing equation of forced convection, physical significance of dimensionless numbers, Correlations for flow through Duct/Internal flow and flow over flat plate/ External flow (Numerical)

Natural Convection-Mechanism of natural convection, Governing equation of natural convection,

physical significance of dimensionless numbers, correlations for simple geometry cases (Numerical)
Condensation and boiling-Film wise and drop wise condensation, Typical pool boiling curve (No Numerical)

Unit V-Radiation

Fundamental concepts, Laws of radiation, solid angle, intensity of radiation, (No Numerical); Radiation between two black surfaces, shape factor, concept of electrical analogy, Radiation between two finite grey surfaces, Radiation shields (Numerical)

Unit VI- Heat Exchanger

Types of heat exchangers, Overall heat transfer coefficient with scaling effect, Analysis and design of heat exchangers using both LMTD and NTU – ϵ method, Introduction mass transfer, Similarity and difference between heat and mass transfer.

Lab practice consists of the following -

1. Determination of Thermal Conductivity of metal rod.
2. Determination of Thermal Conductivity of insulating powder.
3. Determination of Thermal Conductivity of Composite wall.
4. Determination of heat transfer coefficient in Natural Convection.
5. Determination of heat transfer coefficient in Forced Convection.
6. Determination of temperature distribution, fin efficiency in Natural Convection.
8. Determination of Emissivity of a Test surface.
8. Determination of Stefan Boltzmann Constant.
9. Determination of critical heat flux.
10. Determination of NTU/effectiveness of a heat exchanger (Evaporator/Condenser).

Text Books:

1. F.P. Incropera, D.P. Dewitt, Fundamentals of Heat and Mass Transfer, JohnWiley.
2. Mahesh M. Rathod, Engineering Heat and Mass Transfer, Third Edition, UniversityScience Press,2016
3. Y. A. Cengel and A.J. Ghajar, Heat and Mass Transfer – Fundamentals and Applications, Tata McGraw Hill Education Private Limited.
4. S.P. Sukhatme, A Textbook on Heat Transfer, Universities Press.
5. R.C. Sachdeva, Fundamentals of Engineering Heat and Mass Transfer, New Age Science.
6. P.K. Nag, Heat & Mass Transfer, McGraw Hill Education Private Limited.
7. V. M. Domkundwar, Heat Transfer
8. Holman, Fundamentals of Heat and Mass Transfer, McGraw – Hill publication



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Department of Mechanical Engineering

Energy Conservation and Management (MEUA31183A)

Teaching Scheme	Examination Scheme						
Credits: 3 Lecture (L): 3hrs./week Tutorial (T): -- hr Practical (P): -- hrs.	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	-	-	100

Prerequisite: Environment Studies, Thermodynamics, Applied Thermodynamics

Course objectives:

- The course is prepared to provide detailed understanding of energy conservation and management, 3Es (Energy, Economics and Environment) and their interaction, energy audit and financial management.

Course Outcomes:

After successful completion of the course, student will be able to

1. To understand the basic knowledge of different terms & principles of energy conservation norms.
2. To evaluate the energy saving different mechanical utilities.
3. To aware energy conservation in mechanical utilities.
4. To understand simple payback period, energy rates.
5. To understand efficient heat & electricity utilization, saving and recovery in different thermal and electrical system.
6. To prepare energy audit report for different energy conservation instances

Unit I- Energy scenario and Energy conservation Act

Energy Scenario- Classification of Energy, Indian energy scenario, energy pricing, energy security, energy conservation and its importance, energy strategy for the future.

Energy Conservation Act 2001 and related policies- Energy conservation Act 2001 and its features, notifications under the Act, Schemes of Bureau of Energy Efficiency (BEE) including Designated consumers, State Designated Agencies, Electricity Act 2003, Integrated energy policy, National action plan on climate change, ECBC code for Building Construction.

Unit II-Financial Management and Energy Monitoring and Targeting

Financial Management and Energy Monitoring and Targeting- Investment-need, appraisal and criteria, financial analysis techniques simple payback period, return on investment, net present value, internal rate of return, cash flows, risk and sensitivity analysis; financing options.

Energy Monitoring and Targeting- Defining monitoring & targeting, elements of monitoring & targeting, data and information-analysis, techniques – energy consumption, production, cumulative sum of differences (CUSUM). Energy Management Information Systems (EMIS)

Unit III-Energy Management & Audit

Definition, energy audit, need, types of energy audit. Energy management (audit) approach- understanding energy costs, Bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution, energy audit instruments and metering

Unit IV-Energy Efficiency in Thermal Utilities and systems

Energy conservation in power producing devices- Boilers, Steam Systems, Furnaces, Heat Exchangers
Energy conservation in power absorbing devices- Heating ventilation air conditioning (HVAC) and Refrigeration System, turbines, compressors and pumps. Thermal insulations and its calculations.



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Unit V-Electrical utility systems

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 VI-Energy conservation case studies

Energy conservation in vehicles, energy conservation in buildings, Power quality issues related to Energy Efficient Technologies, Energy Conservation Practice – Case Studies of Hospitals, Industry, Residential buildings etc.

Text Books:

1. C.B.Smith, Energy Management Principles, Pergamon Press, New York, 1981.
2. W.C. Turner, Energy Management, Hand Book.
3. W.F.Kenny, Energy Conservation in Process Industry.
4. Trivedi, P.R, Jolka K.R., Energy Management, Commonwealth Publication, New Delhi, 1998

Reference Books :

1. Energy Conservation Guidebook, Dale R Patrick, Stephen W Fardo, 2nd Edition, CRC Press
2. Handbook of Energy Audits, Albert Thumann, 6th Edition, The Fairmont Press
3. Bureau of Energy Efficiency Reference book- No.1, 2, 3 4
4. Energy Management Handbook, W.C. Turner, John Wiley and Sons, A Wiley Interscience publication
5. Carbon Capture and Sequestration- Integrating Technology, Monitoring, and Regulation edited by E J Wilson and D Gerard, Blackwell Publishing
6. Heating and Cooling of Buildings - Design for Efficiency, J. Krieder and A. Rabl, McGraw Hill Publication, 1994



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Composite Materials (MEUA31183C)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits: 3 Lecture (L): 3hrs./week Tutorial (T): -- hr Practical (P): -- hrs.	20	30	20	30	-	-	100

Prerequisite:

1. Strength of Material
2. Design of Machine Elements
3. Material Science

Course Objectives :

- To understand importance of composite materials in various applications such as aerospace, automotive
- To understand various fabrication methods of composite material
- To know various composite testing methods and standards of testing
- To develop an understanding of the micro and macro mechanical analysis of composite materials

Course Outcomes :

By the end of the course, students will able to

1. Identify different types of composite materials and its constituents and list its applications in various fields
2. Understand the various manufacturing methods of composite materials
3. Apply various ASTM testing standards for characterizing composite materials
4. Apply strength of material approach to analyze lamina at micromechanical level
5. Analyze composite lamina at macromechanical level
6. Apply Classical Lamination Theory for the analysis of composite laminates

Unit I - Introduction to Composite Material

Introduction to Composite Materials, classification of composite materials, Matrices and Reinforcement, Types of Fiber Reinforcement, Types of matrix materials- Thermoset and Thermoplastic, , Advantages and Disadvantages, Applications of composite materials, Mechanics Terminology

Unit II -Manufacturing of Composite Material

Composite Manufacturing Processes, Hand Lay-up process, Compression molding process, Vacuum Impregnation Methods, Resin Transfer molding, Filament winding , Pultrusion, Prepregs, Stacking of reinforcements

Unit III -Composite Material Characterization

Composite testing, Need for testing ,Major types of testing, Physical testing, Mechanical testing as per ASTM standards- Tensile, compression, shear, flexural, impact, fatigue and creep test, Chemical testing , Thermal testing



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Volume and Mass Fractions, Density, and Void Content

Unit IV-Micromechanical Analysis of a Lamina

Evaluation of the Elastic Moduli- Strength of material approach- Representative Volume Element (RVE), Rule of Mixtures, Inverse Rule of Mixtures. Ultimate Strengths of a Unidirectional Lamina, Coefficient of thermal expansion, Coefficient of moisture expansion

Unit V-Macromechanical Analysis of Lamina

Hooke's Law for Different Types of Materials- Anisotropic Material, Orthotropic/Specially Orthotropic, Hooke's Law for a Two-Dimensional Unidirectional Lamina, Plane Stress Assumption, Relationship of Compliance and Stiffness Matrix to Engineering Elastic Constants of a Lamina, Two-Dimensional Angle Lamina, Strength Failure Theories of an Angle Lamina- Tsai-Wu Failure Theory

Unit VI-Macromechanical Analysis of Laminates

Laminate Code, Classical Lamination Theory- Stress-Strain and Strain-Displacement Equations, Strain and Stress in a Laminate, Force and Moment resultants related to Midplane Strains and Curvatures, extensional, coupling, and bending stiffness matrices, analyzing a laminated composite. Special Cases of Laminates- Symmetric Laminates, Cross-Ply Laminates, Angle Ply Laminates, Antisymmetric Laminates, Balanced Laminate, Quasi-Isotropic Laminates

Text Books :

1. Autar K. Kaw, Mechanics of Composite Materials, , CRC, Taylor and Francis 2006, ISBN-10-0-8493-1343-0.
2. Robert M. Jones, Mechanics of Composite Materials, Taylor and Francis 2010, ISBN-10-1-56032-812-X.
3. Madhujit Mukhopodhyay , Mechanics of Composite Materials and Structures , University Press (India) PVT Ltd, 2009, ISBN- 9888183814881
4. Mallick PK, Fiber-reinforced composites- materials, manufacturing, and design. CRC press, Taylor and Francis Group 2008; ISBN- 13- 988-0-8493-4205-9.

Reference Books :

1. Isaac M. Daniels, Oriilshai, "Engineering Mechanics of Composite Materials", Oxford University Press, 1994.
2. Bhagwan D. Agarwal, Lawrence J. Broutman, "Analysis and Performance of fiber composites", John Wiley and Sons, Inc. 1990.
3. Mathews, F. L. and Rawlings, R. D., "Composite Materials- Engineering and Science", CRC Press, Boca Raton, 03.
4. Mazumdar S. K., "Composite Manufacturing – Materials, Product and Processing Engineering", CRC Press, Boca Raton, 02.



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Advanced Manufacturing Processes (MEUA31183D)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits: 3 Lecture (L): 3hrs./week Tutorial (T): -- hr Practical (P): -- hrs.	20	30	20	30	-	-	100

Prerequisite: Engineering Mathematics, Manufacturing Processes and Material Science

Course Objectives :

- To demonstrate working principles, process parameters and applications of advanced manufacturing processes such as special forming processes, advanced joining processes, hybrid non-conventional machining techniques, micro and nano fabrication techniques and additive manufacturing processes
- To demonstrate working principles and applications of material characterization techniques for knowing composition and structure of a material

Course Outcomes:

Upon completion of the course, students will be able to

1. Compare special forming processes in terms of working principle, applications, process parameters and characteristics
2. Differentiate advanced joining processes in terms of working principle, applications, process parameters and characteristics
3. Distinguish hybrid non-conventional machining techniques in terms of working principle, applications, process parameters and characteristics
4. Explain working principle, applications, process parameters and characteristics of micro and nano fabrication techniques.
5. Elaborate additive manufacturing processes in terms of their working principle, process parameters, characteristics and applications.
6. Explain material characterization techniques to identify composition and structure including defects at surface and bulk of a material.

Unit I- Special Forming Processes

Principle, Process variables, characteristics, advantages, limitations and applications of High Energy Rate Forming process, High Velocity Forming, Explosive forming, Magnetic pulse forming, Electro hydraulic forming, Metal spinning, Flow forming, Stretch forming, Incremental sheet metal forming, Petro-forge forming, Micro forming, Micro coining, Micro extrusion, Micro bending/laser bending, fine blanking.

Unit II- Advanced Joining Processes

Friction stir welding, Electron Beam welding, Laser beam welding, Ultrasonic welding, Under water welding, Cryogenic welding, Thermal spray coatings, Welding of plastics and composites, Explosive joining, Adhesive bonding

Unit III- Hybrid Non-conventional Machining Techniques



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Introduction to hybrid processes, Abrasive flow finishing, Magnetic abrasive finishing, Abrasive water-jet machining, Wire electric discharge machining, Electrochemical grinding, Electrochemical Deburring, Shaped tube electrolytic machining, Electro-jet Machining, Electrolytic In-process dressing, Ultrasonic assisted EDM, Rotary EDM, Electrochemical discharge Machining, Laser surface treatments.

Unit IV- Micro Machining and Nano Fabrication Techniques

Introduction, need of micro and nano machining, Machine/setup, Process parameters, Mechanism of material removal, Applications, Advances of the Diamond Turn machining, Ultrasonic micromachining, Focused Ion Beam Machining, Lithography, photochemical machining, Challenges in micro and nano fabrication techniques.

Unit V- Additive Manufacturing Processes

Introduction and principle of the additive manufacturing process; Generalized additive manufacturing process chain; Classification of additive manufacturing processes and its principle, process steps and materials; Post-processing of parts manufactured by Additive Manufacturing (AM) processes, Software issues in AM, Design For Additive Manufacturing (DFAM), Applications of Additive Manufacturing in Medical and Aerospace technologies

Unit VI- Material Characterization Techniques

Introduction- Material Characterization Microscopy- Electron Microscopes, Scanning Electron Microscope, Transmission Electron Microscope, Scanning Tunneling Microscope, Atomic Force Microscope, Field Ion Microscope; Spectroscopy- Energy-dispersive X-ray spectroscopy, X-Ray Diffraction, X-Ray Photoelectron Spectroscopy (XPS), Nuclear Magnetic Resonance Spectroscopy (NMR), Electron Backscatter Diffraction (EBSD)

Text Books:

1. V. K. Jain, "Advanced Machining Processes", Allied Publishers Pvt. Ltd.
2. M. P Groover., Fundamentals of Modern Manufacturing- Materials, Processes, and Systems, 6 th Edition, Wiley 2015 3.
3. A. Ghosh, A. K. Mallik, Manufacturing Science, Affiliated East-West Press Pvt. Ltd., New Delhi

Reference Books :

1. ASM- Metal Handbook, Volume 6, "Welding, Brazing and Soldering", Metal Park, Ohio.
2. ASM- Metal Handbook, Volume 14, "Forming", Metal Park, Ohio.
3. V. K. Jain, Micro manufacturing Processes, CRC Press ISBN-13- 988-1138086426 ISBN-



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Advanced Metallurgy (MEUA31183B)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits: 3 Lecture (L): 3 hrs./week Tutorial (T): -- hr Practical (P): -- hrs.	20	30	20	30	-	-	100

Prerequisite: Material Science and Ferrous Metallurgy

Course objectives:

- 1 Apply the fundamentals of metals to decide properties of polymers and composites.
- 2 To understand fundamentals of different surface hardening and surface improvement process
- 3 To understand the use of powder metallurgy in industries.

Course Outcomes:

- 1 Describe the importance polymers and composites with its mechanical properties for industrial applications.
2. To apply the knowledge of stainless-steel in the selection process and to know different surface coating processes.
3. To understand different surface hardening treatments to improve hardness of surface hardness.
4. To know different nonferrous materials and their uses.
5. Describe the importance, processing and applications of powder metallurgy.
6. To know different technology and materials.

Unit I-Materials

Classification of Engg. Materials, Polymers and its types. Ceramics classification its types and uses, calculation about isostain and isostress conditions Ceramic and Polymeric used in industry.

Unit II- Stainless steels and Surface coating processes

Classification & Effect of alloying elements added in stainless steel, examples of stainless steels types and uses, sensitization & weld decay of stainless steel, Basic concept of corrosion, surface coating processes and its advantages, introduction of PVD, CVD, Ion implantation.

Unit III-Surface Treatments

Hardenability & hardenability testing, classification of Modified heat treatments, surface hardening treatments, carburizing, nitriding, flame hardening, and induction hardening.

Unit IV-Non Ferrous Metals & Alloys

Classification, Composition, Properties & applications of- Copper and Its alloys, Nickel and Its alloys, Aluminum and Its alloys, Titanium and Its alloys. Specific alloys- soldering & brazing alloy, Precipitation hardening alloys. Bearing materials and their applications.

Unit V-Powder Metallurgy

Basic steps of powder metallurgy process, powder manufacturing, Conditioning of metal powders, Compacting (cold compaction, hot compaction), Pre-sintering & sintering secondary operations Advantages, limitations and applications of powder metallurgy. Production of typical P/M components



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(with flow charts), self lubricated bearing, cemented carbides.

Unit VI-Introduction to Advanced Materials

Classification of biomaterials - Comparison & properties of some common biomaterials, Introduction to bio sensors. Basic concepts of Nano science, Properties and technological advantages of Nano materials, Carbon Nanotubes and applications. Introduction to Smart materials and super alloys.

Text Books:

- 1) Dr. V.D. Kodgire & S. V. Kodgire, "Material Science & Metallurgy For Engineers", Everest Publication 2008, ISBN 81-86314-00-8.
- 2) Callister W. D., Materials Science and Engineering, John Wiley, ISBN 9880480419988

Reference Books :

- 1) Smith W.F., "Principles of Material Science and Engineering", McGraw Hill Book Co., 2002. ISBN- 0080591695
- 2) Donald R. Asklund, Phule P. P., "Science and engineering of materials", Thomson Learning, 2003. ISBN- 0534553966
- 3) Higgins R. A., "Engineering Metallurgy", Viva books Pvt. Ltd., 2000, ISBN 0340568305
- 4) Raghvan V., "Material Science & Engg." Prentice Hall of India, New Delhi. 2003
- 5) Avner, S.H., Introduction to Physical Metallurgy, Tata McGraw-Hill, 1998. ISBN 10- 0084630068
- 6) T.E. Reed-Hill and R. Abbaschian, Physical Metallurgy Principles, Thomson, 3rd edition, 2003, ISBN-13- 988-0-495-08254-5
- 7) A.K. Sinha, "Powder Metallurgy", Dhanpat Rai Publishing, ISBN 13- 988938318214



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Design of Machine Elements-II(MEUA31184)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits: 3							
Lecture (L): 3 hrs./week							
Tutorial (T): -- hr							
Practical (P): -- hrs.	20	30	20	30	-	-	100

Prerequisite: Basic Mechanical Engg., Engg. Graphics, Strength of Materials, Theory of Machines, CAMD, Machine Design I

Course objectives:

1. Enable students to attain the basic knowledge required to understand, analyze, design and select machine elements.
2. Broaden skills in team work, critical thinking, communication, planning and scheduling through design projects.
3. Enable students to apply engineering tools/techniques to product design.
4. Give practice in longer open-ended problems using design methodology.

Course Outcomes:

- 1) To understand and develop machine elements subjected to fluctuating loads.
- 2) To understand and apply principles of gear design to spur and Helical gears for required applications.
- 3) To design the Bevel Gears for required applications.
- 4) To study and select different types of bearings from manufacturer's Catalogue.
- 5) To achieve an expertise in design of Sliding contact bearing in industrial applications.
- 6) To design fasteners and welded joints subjected to different loading conditions.

Unit I-Design of Fluctuating load

Stress concentration - causes & remedies, Fluctuating stresses, fatigue failures, S-N curve, endurance strength and modifying factors, design for finite and infinite life, cumulative damage in fatigue failure, Soderberg, Gerber, Goodman, Modified Goodman diagrams, Fatigue design of components under combined stresses.

Unit II-Design of Spur and Helical Gear

Gears basics-Selection of materials for gears, Standard systems of gear tooth, and Basic modes of gear tooth failures.

Spur Gears-Number of teeth and face width, Beam strength (Lewis) equation, Effective load on gear, Wear strength (Buckingham's) equation, Estimation of module based on beam and wear strength, Estimation of dynamic tooth load by velocity factor and Buckingham's equation, Design of spur gear, Force analysis (Numerical Treatment).

Helical Gears-Beam and wear strengths, Effective load on gear tooth, Estimation of dynamic load by velocity factor and Buckingham's equation, Design of helical gears, Force analysis (Numerical Treatment).

(Self-Learning)-Velocity factor, Service factor, Load concentration factor

Unit III-Design of Bevel gears

Bevel Gear-Beam strength of bevel gears, Wear strength of bevel gears, and effective load on gear tooth, gear design for maximum power transmission Force analysis (Numerical Treatment).

(Self-Learning)-Spiral Bevel Gears. Gear Terminology, Virtual number of teeth

Unit IV- Rolling contact bearing

Types, Static and dynamic load carrying capacities, Load-life relationship, Selection of rolling contact



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bearings from manufacturer's catalogue, Design for cyclic loads and speed, bearing with probability of survival other than 90%, Mounting of bearings.

(Self-Learning)-Materials, maintenance of bearings, condition monitoring, major failures in bearing. etc.

Unit V- Sliding Contact Bearing

Hydrostatic step bearing, Petroff's equation, Reynolds's equation, Somerfield number, Raimondi and Boyd method, Temperature Rise, minimum oil film thickness, selection of bearing parameters

(Self-Learning)- Types of Lubrication, Modes of lubrication, advantages and disadvantages, Tribology of bearing design.

Unit VI-Welded Joints and Threaded Joints

Strength of Welds Stress in Welds, Axially loaded unsymmetrical welded joints, eccentric load in plane of welds, welded joints subjected to bending. Basic types of screw fasteners, bolts of uniform strength, I.S.O. Metric screw threads, bolts under tension, eccentrically loaded bolted joint in shear, eccentric load perpendicular and parallel to axis of bolt, eccentric load on circular base(Threaded joints Theoretical treatment only)

Text Books:

1. Bhandari V.B. – “Design of Machine Elements” – Tata McGraw Hill Publ. Co. Ltd., ISBN-0080681891
2. Shigley J.E. and Mischke C.R. – “Mechanical Engineering Design” McGraw Hill Publ. Co. Ltd., ISBN- 0081088839

Reference Books :

1. Spotts M.F. and Shoup T.E. – “Design of Machine Elements” – Prentice Hall International. ISBN-8188584219.
2. Design Data Book– P.S.G. College of Technology, Coimbatore.
3. Juvinal R.C. – “Fundamentals of Machine Components Design” – John Wiley and Sons. ISBN-1118214110
4. Allen Strickland Hall, A. Holowenko, Herman G. Laughlin – “Schaum's Outline of Machine Design”. ISBN-0080255954
5. R. L. Norton-“Machine Design- An Integrated Approach”; Pearson Education India. ISBN-8131805331



Kinematics and Theory of Machines (MEUA31185)

Teaching Scheme	Examination Scheme						
Credits: 3	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 3 hrs./week							
Tutorial (T): -- hr							
Practical (P): 2 hrs./week	20	30	20	30	-	25	125
Prerequisite: Engineering Mathematics –I & II, Engineering Physics, Engineering Graphics & Design							
Course objective:							
<ul style="list-style-type: none"> Make the student conversant with commonly used mechanisms for industrial applications and develop competency in solving kinematic problems related to it. 							
Course Outcomes:							
Upon completion of the course, students will be able to <ol style="list-style-type: none"> Identify different mechanisms used in simple mechanical systems. (<i>Practical 2</i>) Apply graphical or analytical method for kinematic analysis of simple mechanisms. Analyze motion conversion of mechanism using relative polygon method. Explain fundamental concepts required for gear design. Compute speed and torque in different gear trains Calculate various parameters involved in clutch and brake system. 							
Unit I - Fundamentals of Kinematics and Mechanisms							
Kinematic link, Kinematic Pair, Mechanism, Machine, Degree of freedom, Kutzbach Criterion, Grubler's criterion, four bar chain and its inversions, Grashoff's law, Slider crank chain and its inversion, Double slider crank chains and its inversion, Universal Joint. Pantograph and Geneva mechanism.							
Unit II - Kinematic Analysis of Mechanisms - I							
Instantaneous center of rotation (ICR) method- Definition & Types of ICR, Kennedy's Theorem, Methods of locating ICRs Analytical method for displacement, velocity and acceleration analysis of slider crank Mechanism, Loop closure equation, Velocity and acceleration analysis of slider crank mechanisms using complex algebra method							
Unit III - Kinematic Analysis of Mechanisms - II							
Relative polygon method- Velocity & acceleration polygons for simple mechanisms. Velocity and acceleration diagrams for the mechanisms involving Coriolis component of acceleration. Klein's construction.							
Unit IV - Gears							
Classification, spur gear- definition, terminology, fundamental law of toothed gearing, involute and cycloidal profile, path of contact, arc of contact, conjugate action, contact ratio, minimum number of teeth, interference and under cutting, force analysis, +							
Unit V - Gear Trains							
Types of Gear Trains, Analysis of epicyclic gear trains, Holding torque, Simple, compound and epicyclic gear trains, torque on sun and planetary gear train, compound epicyclic gear train, Bevel							



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epicyclic Gear train.

Unit VI - Friction Clutches and Brakes

Torque transmitting capacity of Pivot and collar friction, Plate clutches, Cone clutches, Centrifugal clutch, Braking torques of different types of brakes, introduction to dynamometer.

Lab practice shall be consisting of any ten from the following assignments-

1. Draw (any 4) configurations of mechanisms and determine types of pairs, links, degree of freedom.
2. Build a working model or CAD model of any one quick return motion mechanism or straight-line motion mechanism or inversion of slider crank mechanism.
3. Build and execute a computer program to solve problem on velocity and acceleration analysis using analytical methods and compare results.
4. Perform velocity analysis using Instantaneous center of rotation (ICR) method.
5. Perform velocity and acceleration analysis using relative polygon method.
6. Perform velocity and acceleration analysis for mechanism involving Coriolis component.
7. Measure torque transmitting capacity of friction clutch or power transmitted by the dynamometer or power absorbed by the brake
8. Draw conjugate profile for any general type of gear tooth.
9. Generate involute gear tooth profile using rack shift model
10. Perform analysis of the epicyclic gear train
11. Velocity ratios of simple, compound and differential gear trains

Drawings of design project should be on any Cad Software.

Text Books:

4. Rattan S.S., "Theory of Machines", 2nd., TataMcGraw-hill publishing, 2005, ISBN 008-059120-2
5. Thomas Bevan, "Theory of machines", CBS publishers and Distributors, 1984. ISBN-8131829656

Reference Books:

1. Ghosh Amitabh and Malik Ashok Kumar, "Theory of mechanisms and Machines", 3ed, Affiliated East West press, 2000, ISBN 81-85938-93-8
2. Allen Strickland, Jr. Hall, "Kinematics and Linkage Design", Waveland PrInc (1986) ISBN 10- 0881332820
3. Wilson C.E., Sandler J. P. "Kinematics and Dynamics of Machinery", Person Education. ISBN 020135099-8
6. Erdman A.G. and Sandor G.N., "Mechanism Design, Analysis and Synthesis" Volume-I, Prentice -Hall of India.
7. Shigley Joseph Edward and Vicker John Joseph. "Theory of Machines and Mechanisms", 3ed., 1995, Oxford University Press. ISBN 0-19-515598-x.
8. Ballaney P. L., "Theory of Machines and Mechanisms", Khanna Publisher Delhi, 1999. ISBN-818409122X.



Automation in Manufacturing(MEUA31186)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits: 3 Lecture (L): 2 hrs/week Tutorial (T): -- hr Practical (P): 2 hrs/week	-	-	50	-	-	25	75

Prerequisite: Engineering Graphics, Computer aided Machine drawing

Course objectives:

- To understand the importance of automation in the field machine tool based manufacturing
- To get the knowledge of various elements of manufacturing automation CAD/CAM
- To understand the basic of product design and the role of manufacturing automation

Course Outcomes:

After successful completion of the course, student will be able to

1. Generate CNC program for Turning / Milling and generate tool path using CAM software
2. Comprehensive picture of computer based automation of manufacturing operation
3. Recognize the need of automation and RP in industry.
4. Comprehend the basic components and total functionality of an industrial robot

Unit I- Computer Aided Manufacturing (CAM)

Numerical Control Machines, Computer Numerical Control , Types of CNC, Coordinate Systems, Direct & Distributed Numerical Control Machines, CNC part program, Computer aided part programming, Tooling, Controllers used, Computer Integrated Manufacturing, Computer Aided Process Planning, Computer Aided Quality Control

Unit II- Automation

Automation- Introduction, Automation strategies, Types of Automation - Hard and Soft Automation, Flexible Manufacturing System Types, Advantages, Limitations, AGVs and AS/RS, Group Technology

Unit III- Rapid prototyping

Rapid Prototyping - Introduction, classification of RP Processes (SLA, LOM, SLS, FDM, 3D printing), Working principle.

Unit IV- Robotics

Robotics- RIA, definition of Robot, Laws of robotics, Classification of robots, robot anatomy, Joints, End Effectors



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List of Practical-

1. Tool path generation and simulation for Turning, and drilling with help of suitable software.
2. Tool path generation and simulation for Grooving and Threading with help of suitable software
3. Tool path generation and simulation for Milling Facing, Pocketing. with help of suitable software.
4. Tool path generation and simulation for Milling , Pocketing, Contouring and drilling, etc. with help of suitable software
5. Manufacturing of product using additive manufacturing.
6. Case Study/ Industrial Visit based on Rapid prototyping
7. Case Study/ Industrial Visit based on Automation
8. Computer Simulation of Robot
9. Build a model based on any configuration of robot

Manufacturing of component using CNC Machine

Text Books:

1. Ibrahim Zeid and R. Sivasubramanian - CAD/CAM - Theory and Practice Tata McGraw Hill
2. S.K. Sinha, CNC Programming using Fanuc Custom Macro B, McGraw-Hill Professional
3. S. R. Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill.
4. Radhakrishnan P; Subramanyan S , CAD/CAM/CIM , New Age International

Reference Books :

1. IbraimZeid, Mastering CAD/CAM,Tata McGraw Hill Publishing
2. Groover M. P, Automation Production Systems and Computer Integrated Manufacturing, PHI
3. Rao P. N., Introduction to CAD/CAM Tata McGraw Hill
4. M.P Groover , Automation , Prodcuyion System and Computer integrated manufacturing , Prentic Hall



SEMESTER- II



Refrigeration and Air-conditioning (MEUA32181A)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits: 4 Lecture (L): 3 hrs./week Tutorial (T): -- hr Practical (P): 2 hrs./week	20	30	20	30	-	25	125

Prerequisite: Basics of thermodynamics, Fluid Mechanics and Heat Transfer

Course objectives:

1. Learning the fundamental principles and different methods of refrigeration and air conditioning.
2. Understand various refrigeration cycles and evaluate performance using Mollier charts and/ or refrigerant property tables.
3. Comparative study of different refrigerants with respect to properties, applications and environmental issues.
4. Study the basic air conditioning processes on psychrometric charts, calculate cooling load for its applications in comfort and industrial air conditioning.
5. Study of the various equipment-operating principles, operating and safety controls employed in refrigeration air conditioning systems.

Course Outcomes:

By the end of the course, students will

- 1) Illustrate the fundamental principles and applications of refrigeration and air conditioning system.
- 2) Obtain cooling capacity and coefficient of performance by conducting test on vapor compression refrigeration systems.
- 3) Present the properties, applications and environmental issues of different refrigerants.
- 4) Calculate cooling load for air conditioning systems used for various applications.
- 5) Operate and analyze the refrigeration and air conditioning systems.

Unit I - Fundamentals & Applications of Refrigeration and Air Conditioning

Reverse Carnot cycle, block diagram of refrigerator & heat pump, modified reverse Carnot cycle (Bell Coleman cycle), Applications of Refrigeration and Air Conditioning, Refrigerants, environmental issues and selection of Compressor

Unit II - Vapour Compression Cycle and systems

Working of simple vapour compression system, representation of vapour compression cycle (VCC) on T-s and P-h diagram, COP, EER, SEER, IPLV, NPLV, effect of operating parameters on performance of VCC(Numerical), actual VCC, methods of improving COP using flash chamber, sub-cooling and liquid vapour heat exchanger, comparison of VCC with Reverse carnot cycle.

Unit III - Vapour Absorption System

Introduction, Working of simple vapour absorption system (VAS), desirable properties of binary mixture (aqua-ammonia), performance evaluation of simple VAS (simple numerical treatment), actual VAS, Li-Br absorption system, three fluid system (Electrolux refrigeration), applications of VAS, comparison between VCC and VAC.

Unit IV - Psychrometry and Air conditioning Processes

Introduction to air conditioning, psychrometry, psychrometric properties and terms, psychrometric



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relations, Psychrometric processes and its representation on psychrometric chart, BPF of coil, ADP, adiabatic mixing of two air streams. (Numerical)

Unit V - Air conditioning system- Cooling Load Calculations

Psychrometric chart with numerical on SHF, RSFH, GSFH, ESFH. factors contributing to cooling load. Cooling Load Calculations (Numerical), Concept of infiltration and ventilation
Thermodynamics of human body, comfort and comfort chart, factors affecting human comfort, Indoor air quality requirements,

Unit VI - Air Conditioning systems and Ducts

Air handling unit, Classification of ducts, duct material, pressure in ducts, pressure losses in duct (friction losses, dynamic losses), Working of summer, winter and all year round AC systems and their materials, all air system, all water system, air water system, unitary and central air conditioning.

Term-Work

The Term-Work shall consist of any eight experiments

- 1) Test on Domestic Refrigerator for evaluation of EER
- 2) Test on vapour compression test rig
- 3) Test on air conditioning test rig
- 4) Test on ice plant test rig
- 5) Test on vapour absorption test rig
- 6) Visit to Vapour absorption refrigeration plant
- 7) Estimation of cooling load of simple air conditioning system (case study)
- 8) Case study on cold storage
- 9) Visit to any refrigeration or air conditioning plant
- 10) Thermal analysis of refrigeration cycle using suitable software

Text Books:

1. Arora C. P., Refrigeration and Air Conditioning, Tata McGraw-Hill
2. Arora and Domkundwar, Refrigeration & Air Conditioning, Dhanpatrai & Company, New Delhi
3. Khurmi R.S. and Gupta J.K., Refrigeration and Air conditioning, Eurasia Publishing House Pvt. Ltd, New Delhi, 1994.
4. Sapali S.N., Refrigeration and Air Conditioning, PHI learning Pvt. Ltd, New Delhi.

Reference Books :

1. Dossat Ray J, Principles of refrigeration, S.I. version, Willey Eastern Ltd, 2000
2. Stockers W.F and Jones J.W., Refrigeration and Air conditioning, McGraw Hill International editions 1982.
3. Threlkeld J.L, Thermal Environmental Engineering, Prentice Hall Inc., New Delhi
4. Aanatnarayan, Basics of refrigeration and Air Conditioning, Tata McGraw Hill Publications
5. Roger Legg, Air Conditioning System Design, Commissioning and Maintenance
6. ASHRAE & ISHRAE handbook



Tribology(MEUA32182B)

Teaching Scheme	Examination Scheme						
Credits: 4	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 3 hrs./week							
Tutorial (T): -- hr							
Practical (P): 2 hrs./week	20	30	20	30	-	25	125

Prerequisite: Fluid Mechanics, Engg. Mathematics, SOM, Material Science and Metallurgy

Course Outcomes:

At the end of the course-

1. For these simplified course contents, student develops confidence in him/her to fulfill course objectives. –
2. Term work includes simple case study/assignment/seminar/visit and in-semester theory examination as a part of learning process encourages students. –
3. He/she proves himself/herself to be excellent practical engineer in any tribological industry.

Course objectives:

After successful completion of this course, students will be able-

1. To know about properties of lubricants, modes of lubrication, additives etc. –
2. To Select suitable/proper grade lubricant for specific application. –
3. To select suitable material combination for tribological contact. –
4. To Apply the basic theories of friction, wear and lubrications about frictional behavior commonly encountered sliding surfaces. –
5. To suggest an explanation to the cause of tribological failures. –
6. To design bearing, friction, wear test rig for laboratory purposes

Unit I- Introduction To Tribology

1. Tribology definition. 2. Tribology in design- bearing material its properties and construction Tribological design of oil seals and gasket. 3. Tribology in industry (Maintenance). 4. Lubrication- Definition, basic modes of lubrication, properties of lubricants, additives, EP lubricants, Recycling of used oil, oil conservation, oil emulsion. 5. Bearing Terminology-Types of Sliding contact, rolling contact bearings. 6. Comparison between sliding and rolling contact bearing. (Theoretical treatment only)

Unit II- Introduction to Friction

1. Friction- Introduction, laws of friction, Friction classification, causes of friction. 2. Theories of dry friction. 3. Friction measurement. 4. Stick-slip motion and friction instabilities.

Unit III-Hydrodynamic lubrication

1. Theory of hydrodynamic lubrication, mechanism of pressure development in oil film. 2. Two dimensional Reynolds equation and its limitations, Petroff's equation. 3. Infinitely long journal bearing, infinitely short journal bearing and finite bearing, designing journal bearing using Raimondi and Boyd approach.

Unit IV-Hydrostatic lubrication

1. Hydrostatic lubrication-Basic concept, advantages, limitations, viscous flow through rectangular slot, load carrying capacity, flow requirement of hydrostatic step bearing, energy losses, optimum design of stepped bearing, compensators and their actions. 2. Squeeze film lubrication- Basic concept, circular and rectangular plate approaching a plane

Unit V Elasto-hydrodynamic lubrication

1. Elasto-hydrodynamic lubrication-Principle and applications, pressure viscosity term in Reynold's equation, Hertz theory, Ertel-Grubin equation, lubrication of spheres.



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Unit VI – Wear

Types of wear - Simple theory of sliding wear mechanism -Abrasive wear - Materials for adhesive and abrasive wear - Corrosive wear - Surface fatigue wear - Wear of ceramics and polymers - Wear measurements

Lab Work- The Lab Work shall consist of,

A] Any two case study of the following-

1. Lubrication and lubrication type.
2. Surface friction
4. Surface engineering and materials for bearing

B] Assignment based on the Tribological design of the system like I C Engine, Machine Tool, Rolling Mill.

OR

Industrial visit- students should visit the industry to study the lubrication systems or to study the techniques of surface coating.

OR

Seminar on recent trends in Tribology or related areas- A seminar on recent trends in Tribology or related areas shall be given by the student. A seminar report shall be submitted as a part of term work.

Instrument/Equipment- Required for Measurement of Material wear. (**Pin on disk wear test**).

Text Books:

1. Hutchings.I.M, “Tribology, Friction and Wear of Engineering Material”, Edward Arnold, London, 1992
2. Williams.J.A, “Engineering Tribology”, Oxford University Press, 2005.
3. GwidonStachowiak, Andrew W Batchelor., “Engineering tribology”, Elsevier Butterworth – Heinemann, USA, 2005.

Reference Books :

1. Stolarski.T.A, “Tribology in Machine Design”, Industrial Press Inc., 1991.
2. Bowden.F.P, and Tabor.D, “Friction and Lubrication”, Heinemann Educational Books Ltd., 2001.
3. Cameron.A, “Basic Lubrication theory”, Longman, U.K., 1981.
4. Neale.M.J, (Editor), “Tribology Handbook”, Newnes Butter worth, Heinemann, U.K., 1999.

**Design for Manufacturing and Assembly(MEUA32181C)**

Teaching Scheme	Examination Scheme						
Credits: 4 Lecture (L): 3 hrs./week Tutorial (T): -- hr Practical (P): 2 hrs./week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	-	25	125

Prerequisite: Engineering Graphics, Manufacturing Processes-I &II, Machine Design I&II, Manufacturing Basics, CAD /CAM Software modeling knowledge.

Course objectives:

To develop the ability, to know the concepts of Engineering Mathematics and to apply these to solve engineering problems in various fields. The Tutorial sessions and assignments will help the students to practice more problems on all the topics mentioned in the course contents.

Course Outcomes:

1. Understand various the concept of DFMA and its importance in designating.
2. Recognize the various casting design recommendation
3. Apply various design recommendations for various machining processes
4. Categorize various design recommendation for sheet metal and additive manufacturing
5. Describe various design recommendation for basic joining and cleaning processes
6. Develop different part assemblies considering its design recommendations using CAD tools

Unit I- Introduction to DFMA

Introduction, History of DFMA, steps for applying DFMA during product design, Advantages of applying DFMA during product design, Introduction to Manufacturing Process- Classification of manufacturing process, Basic manufacturing processes.

General design principles for manufacturability- Responsibilities of Design Engineers, Responsibilities of Manufacturing Engineers, Basic Principles of Designing for Economical Production. General Design Rules.

Unit II- Design for Casting and Injection Molding

Introduction to casting, Design consideration for casting, investment casting- Introduction, Steps, Typical characteristics and applications, Die casting- Introduction, Advantages, Disadvantages, Applications, Suitable material consideration, General design consideration, Specific design recommendation,

Injection molding- Introduction, Design recommendations, Design for powder metal processing- Introduction to powder metal processing, Typical characteristics and applications, Limitations, Design recommendations.

Unit III- Design for machining



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Introduction to machining, Recommended materials for machinability, Design recommendations, Design for tuning, milling, planning, shaping and slotting operations- Process description, Typical characteristics and applications, Suitable materials, Design recommendations, Design for machining round holes- Introduction, Suitable materials, Design recommendations, Recommended tolerances, Design for broached parts- Process description, Typical characteristics of broached parts, Suitable materials for broaching, Design recommendations

Unit IV- Designing For Sheet Metal and additive manufacturing

Introduction to Sheet Metal Process, Typical Sheet Metal Parts, Recommended Materials for Sheet metal. Typical defects in sheet metal components, Design recommendations for different Sheet Metal Process like punching, bending, forming, Laser cutting, plasma cutting
Introduction to Additive manufacturing, Typical additive manufacturing parts, Design Recommended Materials for additive manufacturing.

Unit V- Design for cleaning and joining processes

Introduction to cleaning and polishing processes- Design recommendations, Design for plated surface- Electroplating process, Typical characteristics, Design recommendations for plating, Design for welding, soldering and brazing- Design recommendations, Typical characteristics, Suitable materials, Design for adhesively bonded assemblies- Introduction, characteristics, Suitable materials, Design recommendations for adhesive joint.

Unit VI- Designing For Assembly using CAD

The assembly process, Characteristics and applications, Economic significance of assembly, Design for Assembly- Introduction, Design consideration, Design for Fasteners- Introduction, Design recommendation for fasteners. Introduction to CAD- Geometric Representation in CAD, Extraction of part feature information from CAD Model- Introduction, Feature recognition techniques, Free Form Features, Hybrid Techniques, Extraction of assembly feature information from CAD Model- Introduction, Assembly features, Top down and bottom-up design approach. Typical Industrial challenges in Design for assembly process Definition of assembly feature attributes,

List of Practical-

1. Introduction to Various DFM tools
2. Demonstration of DFM Pro
3. Manufacturability Analysis for Casting
4. Manufacturability Analysis for Injection Molding
5. Manufacturability Analysis for Turning
6. Manufacturability Analysis for Milling
7. Manufacturability Analysis for Sheet metal component
8. Manufacturability Analysis for component produced using Additive manufacturing

Manufacturability Analysis for Sub Assembly

Text Books:

1. Geoffrey Boothroyd, Peter Dewhurst and Winston Knight (2002) Product Design for Manufacture and Assembly, Third Edition, CRC press, Taylor & Francis, Florida, USA



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2. O. Molloy, S. Tilley and E.A. Warman (1998) Design for Manufacturing and assembly, First Edition, Chapman & Hall, London, UK.
3. A.K. Chitale and R.C. Gupta, (1999) Product design and Manufacturing, Prentice Hall of India, New Delhi.

Reference Books :

1. J. Lesko, (1999) Industrial Design, Materials and Manufacture Guide, John Willy and Sons, Inc
2. George E. Dieter and Linda C. Schmidt (2009), Engineering Design, Fourth edition, McGraw-Hill companies, New York, USA
3. D. E. Whitney, (2004) Mechanical Assemblies- Their Design, Manufacture, and Role in Product Development, Oxford University Press, New York
4. James G. Bralla (1998) Design for Manufacturability Handbook, Second Edition, McGraw-Hill companies, New York, USA
<https://dfmpro.com/cad-systems/dfx/>



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Data Analytics (MEUA32182D)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits: 4 Lecture (L): 3 hrs./week Tutorial (T): -- hr Practical (P): 2 hrs./week	20	30	20	30	-	25	125

Prerequisite- Engineering Mathematics

Course objectives:

To introduce conceptual understanding using simple and practical examples and make you comfortable using analytics in your career. This course will make you know how to work with real data and choose the right methodology; especially fundamental understanding of why to use particular technique, how to use it correctly and how to correctly interpret the result.

Course Outcomes:

Upon completion of the course, students will be able to

1. Learn the concepts of descriptive and inferential statistics, and levels of data measurement and basic statistics that will be used to summarize data.
2. Apply statistical concepts and probability theory to analyze data that can assist present and future business managers in making better decisions.
3. Estimate the population mean with a known and an unknown population standard deviation with the z statistic, and t statistic respectively and population variance using the chi-square distribution.
4. Develop both one- and two-tailed null and alternative hypotheses that can be tested in a business setting by examining the rejection and non-rejection regions in light of Type I and Type II errors and test hypotheses about the difference in two population variances using the F distribution.
5. Test a completely randomized design using a one-way and two-way analysis of variance and calculate the coefficient of determination and confidence intervals to measure the fit for regression models and to estimate the conditional mean of the dependent variable respectively.
6. Calculate the residual, standard error of the estimate, coefficient of multiple determination, and adjusted coefficient of multiple determination of a regression model.

Unit I- Introduction to Data Analytics

Classification of data analytics, importance of data analytics, levels of data, types of variables, central tendency- mean, mode, percentile and dispersion- skewness, kurtosis, range, variance, coefficient of variation

Unit II- Probability Theory

Probability and its terminology, conditional probability, independent events, Bayes'rule, pdf, cdf, mean and variance of random variable and their properties, covariance, correlation coefficient, probability distributions- Binomial, Poisson, Hypergeometric, Exponential, Normal, and central limit theorem.

Unit III- Sampling Theory

Population, sample, sampling techniques, errors, types of sampling distributions- sample mean, sample proportion and sample variance, point and interval estimates, confidence intervals, student's t distribution, chi-square distribution



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Unit IV- Hypothesis Testing

Hypothesis testing- null and alternative hypothesis, type I and II errors, power of a test, approaches for hypothesis testing- p-value, critical value and confidence interval value, test for population mean, proportion and variance- one sample and two sample test, F-distribution.

Unit V- ANOVA and Regression Analysis - I

Conceptual overview, one-way (CRD) and two-way ANOVA (RBD), factorial experiment, simple linear regression- model assumptions, parameter estimation (least square method), test for significance (t and F test), confidence interval for parameters, coefficient of determination.

Unit VI- Regression Analysis - II

Multiple linear regression- model assumptions, parameter estimation (least square method), test for significance (t and F test), confidence interval for parameters, coefficient of determination, Residual analysis, dummy variable, logistic regression, confusion matrix and ROC analysis, curvilinear relationship.

Tutorial-

1. Assignment of central tendency and dispersion.
2. Assignment on Baye's rule and probability distributions.
3. Assignment on sampling distribution.
4. Assignment on testing of hypothesis
5. Assignment on one-way and two-way ANOVA
6. Assignment on factorial experiment
8. Assignment on simple linear and multiple linear regression
8. Assignment on logistic regression and confusion matrix

Text Books:

1. Jay L. Devore, Probability and Statistics for Engineering and the Sciences, 8th Edition, Cengage Learning, 2010.
2. P.V. Sukhatme, Sampling Theory of Surveys with Applications, Indian Society for Agricultural Statistics, New Delhi.
3. Douglas C. Montgomery, George C. Runger, Applied Statistics and Probability for Engineers, Wiley, Year- 2018, ISBN- 1119409535
4. Ken Black, Business Statistics for Contemporary Decision Making, 6th Edition, Wiley

Reference Books :

1. Douglas C. Montgomery, Design and Analysis of Experiments, John Wiley, Year- 2001
2. Douglas C. Montgomery, Elizabeth A. Peck, G. Geoffrey Vining, Introduction to Linear Regression Analysis, Wiley, 2012



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Internal Combustion Engines (MEUA32182A)

Teaching Scheme	Examination Scheme						
Credits: 4 Lecture (L): 3 hrs./week Tutorial (T): -- hr Practical (P): 2 hrs./week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	-	25	125

Prerequisite: Engineering Chemistry, Basic Mechanical Engineering, Thermodynamics.

Course objectives:

- To get familiar with the fundamentals of IC engines, construction and working principle of an engine, and testing of an engine for analyzing its performance.
- To study the combustion and its controlling factors.
- To study emissions from IC engines and its controlling methods and emission norms.

Course Outcomes:

By the end of the course, students will able to

1. Classify various types of Engines, Compare Air standard, Fuel Air and Actual cycles and make out various losses in real cycles.
2. Understand S. I. & C. I. Engine systems.
3. Describe the stages of combustion in S. I. Engines.
4. Describe the stages of combustion in CI Engines
5. Carry out Testing of I. C. Engines and analyze its performance.
6. Suggest methods to minimize environmental hazards caused by IC engines.

Unit I-Basics of IC Engines

- a) Heat Engine, IC and EC engines, IC Engine construction - components and materials, Engine nomenclature, Valve timing diagram, Intake and exhaust system, Engine classification, Applications.
- b) Gas Power Cycles- Otto Cycle, Diesel Cycle, Dual Cycle and its Comparison.
- c) Fuel air cycle, Assumptions, Comparison with air standard cycle, Effect of variables on performance, Actual cycle and various losses.

Unit II- Engine Systems

- a) Fuel Injection System for S. I. Engines- Principle of carburetion, Simple or elementary carburetor, Complete carburetor, Types of carburetors, MPFI System.
Fuel Injection System for C. I. Engines- Direct & Indirect Fuel Injection System, Types of fuel pump and Injector.
- b) Cooling System, Lubrication System, Ignition System, Starting System, Supercharging and turbo-charging methods and their limitations, Timing System.

Unit III- Combustion in SI Engines

- a) Stages of combustion, Flame propagation, Rate of pressure rise, abnormal combustion, Phenomenon of Detonation in SI engines, Effect of engine variables on Detonation.
- b) Combustion chamber designs.



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Unit IV- Combustion in CI Engines

- a) Stages of combustion, Factors affecting combustion, Phenomenon of knocking in CI engine. Effects of knocking, Methods to control knock, Comparison of knocking in SI & CI engines.
- b) Combustion chamber design

Unit V-Testing of IC Engines

- a) Objective of testing, Various performance parameters for IC Engine - Indicated power, brake power, friction power, SFC, AF ratio etc. Methods to determine various performance parameters, characteristic curves, Heat balance sheet.

Unit VI-IC Engine Systems, Emissions & its control

- a) Air pollution due to IC engine and its effect, Sources of emissions, Euro norms, Bharat stage norms, Emission control methods for SI and CI engines.
- b) Developments in IC engines (CNG / LPG / Solar / Hybrid).

Any eight experiments of the following-

1. Overhauling of petrol / diesel engine.
2. Demonstration & study of commercial exhaust gas analyzers.
3. Test on Multi cylinder Petrol / Gas engine for determination of Friction power (Mores Test).
4. Test on diesel engine to determine various efficiencies, SFC and Heat balance sheet.
5. Test on variable speed diesel / petrol engine.
6. Visit to Automobile service station / engine manufacturing plant.
7. Assignment using engine simulation software.
8. Assignment on any one advanced technology related to I.C. Engine such as VVT, VGT, HCCI, CRDI.

OR

Assignment on alternative fuels used in I.C. Engines.

Text Books:

1. V. Ganesan - Internal Combustion Engines, Tata McGraw-Hill
2. M.L. Mathur and R.P. Sharma - A course in Internal combustion engines, Dhanpat Rai
3. H.N. Gupta - Fundamentals of Internal Combustion Engines, PHI Learning Pvt. Ltd.

Reference Books :

1. Heywood - Internal Combustion Engine Fundamentals, Tata McGraw-Hill
2. Domkundwar&Domkundwar - Internal Combustion Engine, Dhanpat Rai
3. R. Yadav - Internal Combustion Engine, Central Book Depot, Allahabad



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Solid Mechanics (MEUA32182B)

Teaching Scheme	Examination Scheme						
Credits: 4 Lecture (L): 3 hrs./week Tutorial (T): -- hr Practical (P): 2 hrs./week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	-	25	125

Prerequisite: Physics, Engineering Mathematics.

Course objectives:

- To develop ability to understand the effect of force and motion in design engineering..

Course Outcomes:

By the end of the course, students will be able to

- Understand the theory of elasticity including strain/displacement
- Apply Hooke's law relationships in context with stability of mechanical components.
- Characterize the magnitude of combined stresses in individual members and complete structures.
- Develop an understanding of material behavior under torsion of thin walled sections.
- Evaluate buckling of beams under loading.
- Analyze and design thin and thick shell for applied pressure

Unit I –Introduction to Solid Mechanics

Generalized Hooke's law, Linear elasticity, Plane stress and plane strain problems, Mohr's circle

Unit II –Theory of Elasticity

Introduction to governing equations in Cartesian coordinates, Equations of equilibrium in cylindrical coordinate system, Stress and strain matrices

Unit III Bending of Beams

Asymmetrical bending, Shear centre, Bending of curved beams, Stress distribution in beam with rectangular, circular and trapezoidal cross section, stresses in crane hooks, ring and chain links

Unit IV- Torsion

Torsion of general prismatic bars of solid section, Torsion of Thin walled tubes, Torsion of Thin walled Multiple-Cell closed sections

Unit V- Buckling of columns

Concept of buckling of columns, Expression for crippling load for various end conditions of column, Limitations of Euler's formula, Rankine's formula, safe load on columns

Unit VI –Thick and thin Cylinders

Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure.

Lab practice shall be consisting of any ten from the following assignments-

- Assignment 1- Stress analysis using Mohr's Circle
- Assignment 2- Evaluating Airy's stress function for Cartesian coordinate system.
- Assignment 3- Evaluating Airy's stress function for Polar coordinatesystem.



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4. Assignment 4- Evaluating shear center of thin walled section (04 Problems)
5. Assignment 5- Torsional analysis of open section (04 Problems)
6. Assignment 6- Torsional analysis of closed section (04 Problems)
7. Assignment 8- Demonstration of buckling of beam.

Assignment 8- Thin and thick cylinder (02 Problems each)

Text Books:

9. Kazmi, S. M. A., "Solid Mechanics" TMH, Delhi, India.
10. Strength of Materials by R. Subramanian, Oxford University Press, New Delhi.
11. Laboratory Manual of Testing Materials - William Kendrick Hall

Reference Books:

7. Timoshenko, S. and Young, D. H., "Elements of Strength of Materials" ,DVNC,New York, USA.
8. Hibbeler, R. C. Mechanics of Materials. 6th ed. East Rutherford, NJ- Pearson Prentice Hall, 2004
9. Crandall, S. H., N. C. Dahl, and T. J. Lardner. An Introduction to the Mechanics of Solids. 2nd ed. New York, NY- McGraw Hill, 1989
10. Mechanics of Materials - Ferdinand P. Beer, E. Russel Jhonston Jr., John T. DEwolf TMH 2002.



Hybrid and Electric Vehicles (MEUA32182C)

Teaching Scheme	Examination Scheme						
Credits: 4 Lecture (L): 3 hrs./week Tutorial (T): -- hr Practical (P): 2 hrs./week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	-	25	125

Prerequisite: DME, SOM, I&C, Electronics and Electrical Engineering.

Course Objective:

To understand the comprehensive overview of Electric and Hybrid Electric Vehicles.

Course Outcomes:

After successful completion of this course, students will able to

1. Understand the importance of hybrid electrical vehicle and its performance.
2. Describe the different electrical propulsion unit and battery storage unit.
3. Design electric drive train and its components.
4. To know the various concepts of hybrid electric drive train and power flow control.
5. Apply vehicle dynamics fundamental to model the HEV
6. Identify the energy management system and power electronics in HEV

Unit I- Introduction to Hybrid Electric Vehicles

History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Conventional Vehicles- Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance.

Unit II-Electric Propulsion and Battery Storage Unit

Introduction to electric components used in hybrid and electric vehicles, Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Basics – Battery Types, Batterybased energy storage, Fuel Cell based energy storage, Hybridization of different energy storage devices..

Unit III-Electric Vehicle Drive Train

Electric Drive-trains-Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Transmission configuration, Components – gears, differential, clutch, brakes regenerative braking, motor sizing.

Unit IV- Hybrid Electric Drive-trains

Basic concept of hybrid traction, introduction to various hybrid drive-train topologies- series, parallel and series, parallel configuration – Design – Drive train, sizing of components, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Unit V–Vehicle Dynamics Fundamentals for HEV Modeling and Computer Simulation

Various strategies for improving vehicle energy/fuel efficiency, Vehicle chassis mathematical model in various operation conditions (steady motion, acceleration, regenerating braking, coasting, moving up and down a hill). Series HE powertrain mathematical model.

Unit VI -Power Electronics in Hybrid Electric Vehicles

Rectifiers, Buck convertor, Voltage source inverter, Current source inverter, DC-DC convertor, Plug-in Hybrid Electric Vehicles- Introduction to energy management strategies, PEV configurations, Power management problems, Component sizing, comparison of different energy management strategies

Practical -

1. Study practically layout of electric vehicle.



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2. Study Battery management system
3. Demonstrate components of electrical vehicle.
4. Demonstration of electrical drive train of electric BAJA
5. Demonstration of HEV drive train.
6. study and analyze two strategies for ICE/Battery power split
7. HEV modelling using any simulation software.
8. Performance characteristic of HEV using software
9. Four wheel alignment test

Industrial Visit

Text Books :

1. Iqbal Hussein, Electric and Hybrid Vehicles- Design Fundamentals, CRC Press, 2003.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

Reference Books :

1. MehrdadEhsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles- Fundamentals, Theory and Design, CRC Press, 2004.
2. Sandeep Dhameja, "Electric Vehicle Battery Systems", Newnes, 2000.



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Robotics (MEUA32182D)

Teaching Scheme	Examination Scheme						
Credits: 4 Lecture (L): 3 hrs./week Tutorial (T): -- hr Practical (P): 2 hrs./week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	-	25	125

Prerequisite: Engineering graphics, Engineering mathematics, CAMD, Strength of materials, Manufacturing Process, Instrumentation and Control

Course objectives:

- Understand the basic components of an industrial robot.
- Mechanism involved in robotic system
- Different Robot programming methods
- Important role of automation and robots in manufacturing Environments

Course Outcomes:

After successful completion of this course, students will able to

1. Describe basic concepts in robotics, grippers, actuators, drivers, control systems, kinematics and dynamics
2. Understanding of Design and modeling of grippers.
3. Suggest robots for simple and industrial applications.
4. Perform programming of robot for different applications.
5. Describe industrial relevance of robotics and automation
6. Analyzing of automated manufacturing system

Unit I – Introduction to Robotics

Basic concepts, Three laws of robotics, Robot anatomy, Classification, structure of robots, Point to point and continuous path robotic systems, Robot performance- resolution, accuracy, repeatability, dexterity, compliance, RCC device, Fixed and Euler angle representation..

Unit II – Robot Grippers, Sensors and Drives

Types of grippers , Design aspect for gripper, Force analysis for various basic gripper systems, Gripper applications, Characteristics of sensing devices, Classification, Selection and applications of sensors, Types of Sensors, Types of Drives, Actuators and its selection while designing a robot system.

Unit III - Robot Direct and Inverse Kinematics

Transformation matrices and their arithmetic, Link and joint description, Denavit – Hartenberg parameters, Frame assignment to links, Direct kinematics, Kinematics redundancy, Inverse kinematics, Velocities and static forces in manipulators, Jacobians, singularities, Static forces, Jacobian in force domain, Trajectory generations, Manipulator mechanism design

Unit IV- Motion Planning and Robot Programming

Joint and Cartesian space trajectory planning and generation, Methods of robot programming, Lead through programming, Motion interpolation, Branching capabilities, WAIT, SIGNAL and DELAY commands, subroutines, Programming Languages - Introduction to various types such as RAIL and VAL II, Features of each type and development of languages for recent robot systems.

Unit V- Automation in Robotics

Automation in production system, Principles and strategies of automation, Basic elements of an automated system, Levels of automations. Flow lines & transfer mechanisms, Fundamentals of transfer



lines, Robotic vision system, image acquisition, spatial and amplitude digitization, image processing and analysis.

Unit V- Automated manufacturing system

Components, Classification and overview of manufacturing systems, Manufacturing cells, GT and Cellular manufacturing, FMS, FMS and its application. Automated storage system, Robot applications in material handling, machine loading/unloading, assembly, inspection and processing.

List of Practical's (Any 8)

1. Study of degrees of freedom, no of links & other robot parameters and different types of robots using a Robot Simulating software
2. Design, Modelling and analysis of any two types of gripper.
3. Study of end effect of an industrial robot using suitable software.
4. Motion study and simulation of a robotic manipulator using suitable software
5. Trajectory planner for a robotic manipulator using Matlab.
6. Determination of manipulator Jacobian by Matlab code.
7. Study of Eyantra ATMEGA robot motion.
8. Design of feedback control system.
9. Design of feed forward control system.
10. Study of automated manufacturing system practically.

Text Books:

1. S. K. Saha, Introduction to Robotics, TataMcgraw Hill Education Private Limited, ISBN-13-978-0-07-066900-0
2. M. P. Groover, Automation, Production Systems and Computer Integrated Manufacturing, Pearson Education, 5th edition, ISBN-13- 978-0132393218

Reference Books:

11. John J. Craig, Introduction to Robotics (Mechanics and Control), Addison-Wesley, 2nd Edition, 2004, ISBN-13-978-81-317-1836-0
12. Mittal R. K. and Nagrath J. J., Robotics and control, Tata McGraw Hill, New Delhi, ISBN- 13-0-07-048293-7
13. Groover M. P., Wiess M., Nagel R. N. and Odery N. G. Industrial Robotics- Technology, Programming and Applications, McGraw Hill Inc. Singapore 2000, ISBN-13-978-0-07-026509-7
14. Viswanandham, Performance Modeling of Automated Manufacturing Systems, PHI, 1st edition, 2009, ISBN-0-13-658824-7

**Mechanical Vibration (MEUA32183)**

Teaching Scheme	Examination Scheme						
Credits: 4 Lecture (L): 3 hrs./week Tutorial (T): -- hr Practical (P): 2 hrs./week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	25	-	125

Prerequisite: Engineering Mathematics, Strength of Materials, Theory of Machines.

Course objectives:

- To understand the fundamentals of free and forced vibrations.
- To develop analytical competency in solving vibration problems.
- To study vibration characteristics of the multi degrees of freedom system.
- To familiar with various vibrations measurement instruments and vibration control techniques.

Course Outcomes:

After successful completion of the course, student will be able to

1. Understand the need and importance of vibration analysis in mechanical design of machine parts that operate in vibratory conditions.
2. Analyze the mathematical model of a linear vibratory system to determine its response
3. Estimate natural frequency for single DOF undamped and damped free vibratory systems.
4. Determine response to forced vibrations due to harmonic excitation, base excitation and excitation due to unbalance forces.
5. Estimate natural frequencies, mode shapes for 2 DOF undamped free longitudinal and torsional vibratory systems.
6. Describe vibration measuring instruments for industrial/real life applications along with suitable method for vibration control.

Unit I- Fundamentals of Vibration

Brief history of mechanical vibration, importance of the study of vibration, Terminology of vibratory system, Elements of vibratory system, modeling of system. degree of freedom, discrete and continuous system, Equivalent systems- Springs in series and parallel, types of vibration.

Unit II- Undamped Free Vibration of Single Degree Freedom System

Evaluation of natural frequency, Equilibrium method, Energy method and Rayleigh's methods, Natural frequency for longitudinal, transverse, and torsional vibratory systems.

Unit III- Damped Free Vibration of Single Degree Freedom System

Different types of damping, Damped free vibrations with viscous damping, study of vibration response of over damped, critically damped and under damped systems, logarithmic decrement, introduction to damped free torsional vibrations.

Unit IV- Forced Vibrations- Single Degree Freedom System

Types of source of excitation, resonance phenomenon, forced damped vibrations of longitudinal systems with constant harmonic excitation, magnification factor, frequency response to harmonic excitation phase difference, excitation due to reciprocating and rotating unbalance, forced vibration due to base excitation. Force and Motion transmissibility. Quality factor and bandwidth.



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Unit V- Undamped Vibration of Two Degree Freedom Systems

Introduction of two degree of freedom system, Free undamped longitudinal vibrations of two degrees of freedom system, natural frequency and mode shapes, Evaluation of Eigen value and Eigen vector by Matrix method. Free torsional vibrations of two rotor system.

Unit VI- Measurement and Control of Vibration

Vibration measurements- vibration measuring devices, accelerometers, impact hammer, vibration shaker-construction, principles of operation and uses, vibration analyzer, analysis of vibration spectrum, standards related to measurement of vibration and accepted levels of vibration.

Vibration control- vibration control methods, passive and active vibration control, control of natural frequency, vibration isolators and undamped dynamic vibration absorbers. Types of failures on account of uncontrolled vibrations.

Tutorials-

List of tutorials-

1. To determine natural frequency and stiffness of spring-mass system.
2. To determine the natural frequency of damped vibration of single degree freedom system and to find its damping coefficient.
3. To determine natural frequency of transverse vibration of beam using vibration analyzer.
4. To determine the frequency response curve under different damping conditions for single degree freedom system of vibration.
5. To verify natural frequency of torsional vibration of two rotor system and position of node.
6. Analysis of machine vibration signature using any analysis software package.
7. Noise measurement and analysis using vibration Analyzer
8. Experimental verification of principle of Dynamic Vibration Absorber.
9. Determine the free response of an SDOF damped system with different damping using suitable software.
10. Determine total response of SDOF damped system to harmonic excitation using suitable software.

Text Books:

1. S. S. Rao, "Mechanical Vibrations", 4th Edition, Pearson Education Inc. New Delhi, ISBN-9888188588843
2. G. K. Grover, "Mechanical Vibrations", 8th Edition, New Chand and Bros, Roorkee, ISBN-988-81-85240-56-5
3. V. P. Singh, "Mechanical Vibrations", Dhanpat Rai and Sons, New Delhi, ISBN- 1234568150209
4. S. G. Kelly, "Mechanical Vibrations", Schaum's outlines, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 0080340412
5. V. Ramamurti, "Mechanical Vibration Practice and Noise Control", Narosa Publishing House, ISBN-988-81-8488-199-9

Reference Books :

1. W.T. Thomson, Marie Dillon Dahleh, "Theory of vibrations with applications", 5th Edition, Pearson Education Pvt. Ltd., ISBN- 9888131804820
2. W. Weaver, Jr., S. P. Timoshenko, D. H. Young, "Vibration Problems in Engineering", 5th Edition ISBN- 988-0-481-63228-3.
3. Leonard Meirovitch, "Fundamentals of vibrations", Waveland Pr Inc; Reissue edition, ISBN-10-1588666918
4. J. P. Den Hartog, "Mechanical Vibrations", Dover Publications INC, New York, ISBN- 0-486-64885-4



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Operations Research (ES32184ME)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits: 3 Lecture (L): 3hrs./week Tutorial (T): -- hr Practical (P): -- hrs.	20	30	20	30	-	-	100

Prerequisite: Engineering Mathematics

Course objectives:

- To familiarize the students with various tools of optimization, probability and statistics as applicable scenarios in industry for better management of various resources

Course Outcomes:

By the end of the course, students will be able to

- Solve linear programming problems using appropriate techniques
- Propose the best strategy using decision making methods under uncertainty and game theory
- Apply the concept of transportation/assignment models to optimize available resources
- Develop mathematical skill to solve inventory and replacement problems
- Perform minimization of process time
- Use CPM and PERT techniques, to plan, schedule, and control project activities.

Unit I - Introduction to Operations Research

Introduction to Operations Research- Basics definition, scope, objectives, phases, models and limitations of Operations Research.

Linear Programming Problem- Formulation of LPP, Graphical solution of LPP. Simplex Method, Artificial variables, Two-phase method, Duality

Unit II – Decision Theory and Theory of Games

Decision Theory- Meaning and Steps in Decision Making, Types of Management Decisions, Decision under Certainty, Decision under Risk, Decision under Uncertainty, Decision Trees

Theory of Games- Introduction, Minimax and Maximin Principle, Solution of Game with Saddle Point, Solution by Dominance, Solution by Graphical Method, $m \times n$ size Game Problem

Unit III – Transportation and Assignment Model

Transportation Model- Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test- the stepping stone method and MODI method.

Assignment model- Formulation. Hungarian method for optimal solution. Solving unbalanced problem

Unit IV – Inventory Control and Replacement Analysis

Inventory Control-Basic Concepts, fixed order quantity inventory model, economic order quantity inventory models, probabilistic inventory model



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Replacement Analysis- Replacement of Items that Deteriorate, Replacement of Items that Fail Suddenly- Individual replacement policy, Group replacement policy.

Unit V – Queuing Theory and Sequencing Model

Queuing Theory- Introduction, Basis Structure, Terminology (Kendal's Notations), Queuing Model M/M/1- /FIFO, M/M/c.

Sequencing models- Solution of sequencing Problem - Processing of n jobs through two machines, Processing of n jobs through three machines, Processing of two jobs through m Machines, Processing of n jobs through m Machines.

Unit VI – Project Management

Fundamentals of CPM and PERT networks, CPM- Construction of networks, Fulkerson's rule ,Critical paths, Forward and backward pass, Activity Float analysis, Crashing Analysis, PERT- Time estimates, Construction of networks, Probability of completing projects by given date.

Text Books:

1. Sharma S.D., "Operations Research", Kedarnath Ramnath and company publications. ISBN-13-1234568142552
2. Gupta P.K., Hira D.S., "Operations Research", S Chand and Co. Ltd., New Delhi. ISBN 13-9888121902816
3. Taha H.A., "Operations Research - An introduction", Prentice Hall Pvt. Ltd. ISBN-13- 988-0132555938

Reference Books:

1. Hillier F.S., Lieberman G.J., "Introduction to Operations Research", Tata McGraw-Hill. ISBN 988-0-08-338629-5
2. Wagner H.M., "Principles of Operations Research", Prentice-Hall India ISBN 988-0-9843388-2-8
3. Ravindran A., "Operations Research", Tata McGraw-Hill. New Delhi ISBN-13- 988-0481086086
4. Basu S.K., Pal D.K., and Bagchi H., "Operations Research for Engineers", Oxford and IBH Publishing ISBN 81-204-1251-6
5. Panneerselvam R., "Operations Research", Prentice Hall of India Ltd., New Delhi ISBN 81-203-1923-0

**Open Elective- I Information and Cyber Security(IOEUA32185A)**

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits: 3 Lecture (L): 3hrs./week Tutorial (T): -- hr Practical (P): -- hrs.	20	30	20	30	-	-	100

Prerequisites : Fundamentals of Computer Networks**Course Objectives :**

- To know the need and basic of security
- To learn various types of Cryptographic algorithm
- To learn various authentication techniques
- To acquire knowledge of protocols employed to provide Confidentiality and integrity
- To understand various threats
- To acquaint with current security scenario

Course Outcomes :

After completion of the course, student will be able to

1. Identify the need and basic of security (Knowledge)
2. Summarize various Cryptographic algorithm (Understand)
3. Infer various authentication techniques(Understand)
4. Summarize protocols for confidentiality and integrity (Understand)
5. Identify various threats(Knowledge)
6. Relate with current industry trends (Understand)

Unit I -Security Basics and Introduction to cryptography

Introduction, Elements of Information Security, Understanding concepts: threat, exploit, privacy, vulnerability and policy, Types of Attacks, Operational Model of Network Security, Cryptography, Substitution Ciphers, Transposition Ciphers, Stenography applications and limitations

Unit II- Symmetric Key Cryptography

Introduction, Encryption Methods: Symmetric, Asymmetric, Block Ciphers and methods of Operations, Data Encryption Standard (DES), Advance Encryption Standard (AES).

Unit III -Asymmetric Key Cryptography

Public Key Cryptography, RSA Algorithm: Working, Key length, Security, Key Distribution, Deffie-Hellman Key Exchange, Authentication methods, Message Digest, Kerberos, X.509



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Authentication service.
Digital Signatures: Implementation, Algorithms, Standards (DSS), Authentication Protocol

Unit IV -Network Layer Security

IP Security: IPSec protocols, and Operations, AH Protocol,ESP Protocol, ISAKMP Protocol, Oakkey determination Protocol, VPN.

WEB Security:

Introduction, Secure Socket Layer (SSL), SSL Session and Connection, SSL Record Protocol,Change Cipher Spec Protocol, Alert Protocol, Handshake Protocol.

Electronic Mail Security: Introduction, Pretty Good Privacy, MIME, S/MIME, Comparison. Secure Electronic Transaction(SET)

Unit V -Firewall And Intrusion

Introduction, Computer Intrusions. Firewall Introduction, Characteristics and types, Benefits and limitations. Firewall architecture, Trusted Systems, Access Control.

Intrusion detection, IDS:

Need, Methods, Types of IDS, Password Management, Limitations and Challenges.

Unit VI -Introduction to OWASP

Introduction, Top 10 Vulnerabilities, understanding Top 10 Vulnerabilities.

Text Books :

- 1 AtulKahate, "Cryptography and Network Security", McGraw Hill Publication, 2nd Edition, 2008,ISBN : 978-0-07-064823-4
- 2 Dr.V.K.Pachgare, "Cryptography and Network Security", PHI, 2nd Edition, 2015

Reference Books :

- 1 William Stallings, "Cryptography and network security principles and practices", Pearson, 6th Edition, ISBN : 978-93-325-1877-3
- 2 Forouzan, "Cryptography and Network Security (SIE)", McGraw Hill, ISBN, 007070208X, 9780070702080

Web Resource:

- | | |
|---|---------------|
| 1 | www.owasp.org |
|---|---------------|



Open Elective I
Automotive Electronics (IOEUA32185B)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits: 3 Lecture (L): 3 hrs./week Tutorial (T): -- hr Practical (P): -- hrs.	20	30	20	30	-	-	100

Prerequisite: Readers/students are expected to know the following concepts-
Basics of sensors and actuators, general automotive system, basics of OS

Course objectives:

1. To make familiar about automotive system operations.
2. To illustrate need for automation in automotive operations and appropriate electronics for the same.
3. To discuss suitability of electronics hardware and software platform for control, compute and communication systems in automotive.
4. To discuss control algorithms used in automotive.
5. To introduce various communication standards used for intra and inter-cluster communication in automotive electronic system.
6. To make awareness of fault diagnosis system in automotive.

Course Outcomes:

After successfully completing the course students will be able to

1. understand powertrain and transmission mechanism of SI and DI engine.
2. identify need of automation in automotive operations and appropriate electronics for the same.
3. select suitable electronics hardware and software platform for design and development of various control, compute and communicate oriented automotive systems.
4. understand control theory for automotive systems
5. understand communication and fault diagnostic protocols used in automotive
6. able to use the techniques, skills, and modern engineering tools necessary for automotive engineering practice

Unit I- Power Train Engineering and fundamentals of Automotive.

Fundamentals of Petrol, diesel and gas engines and electric motors. Basic Automotive System. Alternators and charging, battery technology, Ignition systems. Basic of Hybrid designs (solar power, electric/gasoline, LPG, fuel cells). Basic Transmission systems.

Unit II- Sensors and actuators in Automotive

In-vehicle sensors- Working principles, Characteristics, limitations and use within the automotive context of the following- Temperature sensing e.g. coolant. Position sensing e.g. crankshaft, throttle plate. Pressure sensing e.g. exhaust differential, tyre pressure measurement system. Distance sensing e.g. anti-collision, Velocity sensing e.g. speedometer, anti-skid, Torque sensing e.g. automatic transmission, Vibration sensing e.g. Airbags, Flow sensing and measurement e.g. Fuel injection.

Use of Actuators- Types, working principle, Characteristics, limitations and use within the automotive context of each type.

Unit –III- Electronics processing System in automotive

Interfacing electronics- Operational amplifier circuits, Instrumentation amplifiers, Comparators. Level shifting, Wave-shaping, Filters. Noise mechanisms and reduction.
Electronics control unit- Automotive processors and OS, typical design consideration of ECU.



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Unit IV- Automotive Control Systems

Control system approach in Automotive- Analog and Digital control methods. Cruise control, traction control, actuator limiting, wind-up, gain scheduling, adaptive control.

Special Control Schemes- Vehicle braking fundamentals, Antilock systems, Variable assist steering and steering control, Controls for Lighting, Wipers, Air-conditions/Heating, Remote keyless Entry and Anti-theft System. Spark Ignition and Compression Ignition Engines and their electronic controls.

Engine management testing- Engine management system strategies and implementation, Simulation and implementation methods.

Unit V- Automotive Communication Systems

Communication interface with ECUs- Interfacing techniques and interfacing with infotainment gadgets. Automotive Buses- Use of various buses such as CAN, LIN, Flexural, Recent trends in automotive buses (Such as OBDII, MOST, IE, IELLI, D2B, and DSI- Only Comparative study).

Application of Telematics in Automotive- Global Positioning Systems (GPS) and General Packet Radio Service (GPRS), for use in an automotive environment.

Unit VI- Diagnostics and Safety in Automotive.

Fundamentals of Diagnostics- Basic wiring system and Multiplex wiring system. Preliminary checks and adjustments. Self-Diagnostic system. Fault finding and corrective measures. Electronic transmission checks and Diagnosis. Diagnostic procedures and sequence. On board and off board diagnostics in Automotive.

Safety in Automotive-Safety norms and standards. Passenger comfort and security systems. Electromagnetic environment and Automotive EMC Standards. SAE and IEEE Standards.

Text Books:

1. Williams. B. Ribbens, "Understanding Automotive Electronics", 6th Edition, 2003, Elsevier Science, Newness Publication.
2. Robert Bosch, "Automotive Electronics Handbook", John Wiley and Sons, 2004.
3. K.P. Ramchandran, G.K. Vijayraghavan, M.S. Balsundaram, "Mechatronics- Integrated Mechanical and Electronic System", Wiley India, 2010.

Reference Books :

1. Ronald K Jurgen, "Automotive Electronics Handbook", 2nd Edition, **McGraw-Hill**, 1999.
2. James D Halderman, "Automotive Electricity and Electronics", PHI Publication 2005.



Open Elective-I

INDUSTRIAL ENGINEERING (IOEUA32185C)

Teaching Scheme	Examination Scheme						
Credits: 3 Lecture (L): 3 hrs./week Tutorial (T): -- hr Practical (P): -- hrs.	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	-	-	100

Course objectives:

- To introduce the concepts, principles and framework of contents of Industrial Engineering.
- To acquaint the students with various productivity enhancement techniques.
- To acquaint the students with different aspects of Production Planning and Control and Facility Design.
- To introduce the concepts of various cost accounting practices as applied in industries
- To acquaint students with different aspect of simulation modeling for various industrial engineering applications.

Course Outcomes:

After successful completion of the course, student will be able to

1. Compute the partial productivity and total productivity indexes considering different influencing factors
2. Analyse each operation with a view to eliminate unnecessary operations, avoidable delays and other forms of waste.
3. Compute the standard time for a qualified worker to carry out a specified job at a defined level of performance.
4. Design a physical arrangement of facilities most economically at optimum plant location.
5. Design the production system considering an estimate of future event through past data.
6. Calculate optimum inventory level by establishing the relationship among the factors affecting profit.

Unit I-Introduction to Industrial Engineering and Productivity

Definition and Role of Industrial Engineering, Types of production systems and organization structure, Functions of management. Measurement of productivity- Factors affecting the productivity, Productivity Models and Index (Numerical), Productivity improvement techniques.

Unit II- Methods Study

Work Study- Definition, objective and scope of work-study, Human factors in work-study.

Method Study- Definition, objective and scope of method study, work content, activity recording and exam aids.

Charts to record movements- Operation process charts, flow process charts, travel chart, two-handed chart and multiple activity charts.

Principles of Motion Economy- Classification of movements, SIMO chart, and micro motion study. Definition and installation of the improved method, brief concept about synthetic motion studies. Introduction to Value Engineering and Value Analysis.



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Unit III- Work System Design

Work Measurements- Definition, objectives and uses, Work measurement techniques.

Work Sampling- Need, confidence levels, sample size determinations, random observation, conducting study with the simple problems.

Time Study- Definition, time study equipment, selection of job, steps in time study. Breaking jobs into elements, recording information, Rating and standard rating, standard performance, scales of rating, factors affecting rate of working, allowances and standard time determination.

Introduction to PMTS, MTM and MOST.

Unit IV- Production Planning and Control

Introduction- Types of production systems, Need and functions of PPC, Aggregate production planning. Capacity Planning, ERP- Modules, Master Production Schedule, MRP and MRP-II.

Forecasting Techniques- Causal and time series models, moving average, exponential smoothing, trend and seasonality (Numerical), Demand Control strategies (MTO, MTA, MTS).

Introduction to Supply Chain Management- Basic terminologies.

Unit V-Facility Design

Plant Location- Need and factors influencing plant location, Plant Layout- Objectives, principles, types of plant layouts.

Introduction to Assembly Line Balancing and Layout parameters to evaluate.

Material Handling systems- Objectives, relation with plant layout, principles. Types and purpose of different material handling equipment, Selection of material handling equipment.

Inventory control and Management- Types of inventories, Need of inventories, terminology, costs, Inventory Models- Basic production models, (with and without shortage and discount), ABC, VED Analysis.

Unit VI- Engineering Economy, Human Resource and Industrial Safety

Introduction to Costing- Elements of Cost, Break-Even Analysis (Numerical). Introduction to Debit and Credit Note, Financial Statements (Profit and loss account and Balance Sheet), Techniques for Evaluation of capital investments.

Human Resource Development- Functions- Manpower Planning, Recruitment, Selection, Training. Concept of KRA (Key Result Areas), Performance Appraisal (Self, Superior, Peer, 360°). Industrial Safety- Safety Organization, Safety Program

Text Books:

1. M Mahajan, Industrial Engineering and Production Management, Dhanpat Rai and Co.
2. O. P. Khanna, Industrial engineering and management, Dhanpat Rai publication
3. MartendTelsang, Industrial Engineering, S. Chand Publication.
4. Banga and Sharma, Industrial Organization & Engineering Economics, Khanna publication

Reference Books :

1. Introduction to Work Study by ILO, ISBN 978-81-204-1718-2, Oxford & IBHPublishing Company, New Delhi, Second Indian Adaptation, 2008.
2. H. B. Maynard, K Jell, Maynard 's Industrial Engineering Hand Book, McGraw Hill Education.
3. Askin, Design and Analysis of Lean Production System, Wiley, India



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4. Zandin K.B., Most Work Measurement Systems, ISBN 0824709535, CRCPress,2002
5. Martin Murry, SAP ERP- Functionality and Technical Configuration, SAP Press; 3rdNew edition (2010).
6. Barnes, Motion and time Study design and Measurement of Work, Wiley India
7. Raid Al-Aomar, Adwerd J Williams, Onur M. Uigen 'Process Simulation using WITNESS', Wiley



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Open Elective – I
Artificial Neural Network in Engineering (IOEUA32185D)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits: 3							
Lecture (L): 3 hrs./week							
Tutorial (T): -- hr							
Practical (P): -- hrs.	20	30	20	30	-	-	100

Course objectives:

1. To make students aware of various soft computing techniques in general and Artificial Neural Networks in particular, giving details about its working and analogy with Biological Neural networks.
2. To give students ideas about designing and training an Artificial Neural network using different algorithms to solve univariate and multivariate time series problems.

Course Outcomes: At the end of the course the students will have an ability to-

1. Understand ANN as AI, soft computing and data driven model and describe its types
2. Compute the Net information given components of neuron
3. Describe various network training algorithms
4. Determine various design related aspects of ANN namely architecture, stopping criteria, performance function, overfitting
5. Describe working of Recurrent networks, Radial basis function networks, Generalized regression neural networks, Self-organizing maps using case studies
6. Design, train, and test 2 or 3 layered Feed forward back propagation neural network for time series and cause effect models

Unit I – Introduction to Artificial Neural Networks

Biological Neural Network, Introduction to Artificial Intelligence, soft computing techniques, Data driven modeling, ANN as AI, Soft computing and data driven technique, Artificial Neuron, ANN- history and general properties, ANN types according to architecture and Neuro-Dynamics, ANN Vs empirical, statistical, physical, physics based models

Unit II–Artificial Neuron

Components of artificial neuron, methods of computing net information, Activation functions (linear, sigmoidal, hyperbolic tangent, hard limiter, soft-lin), perceptron, Multi-layered perceptron (MLP)

Unit III – Network training

Pre-training procedures- data normalization, network initialization, Types of training-Supervised and unsupervised, Network training using supervised training algorithms – Standard back propagation algorithm or gradient descent algorithm (mathematical treatment), introduction to Network training using conjugate gradient, resilient back propagation, Broydan-Fletcher-Goldfarb-Shanno algorithm, One step secant algorithm, Levenberg-Marquardt algorithm

Unit IV– Important Aspects of ANN design

Network architecture- inputs, outputs, number of hidden layers, number of hidden neurons, stopping criteria, overfitting, validation, testing, De-normalization, Evaluating model performance, data division, performance function

Unit V– Types of ANN

Recurrent networks, Radial basis function networks, Generalized regression neural networks, Self-



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organizing maps (discuss using case studies of each referring to published papers and literature).

Unit VI – Applications of Feed Forward Back Propagation Neural Networks

Time series (univariate and multivariate) models, cause-effect models, Applications in Civil engineering, Electronics and Telecommunications, Mechanical Engineering, Computer Engineering, design, train and test simple 2 or 3 layered feed forward back propagation ANN for time series and cause effect models.

Image Classifications using ANN

Continuous Evaluation

1. Calculation of network output for any given ANN with sigmoidal, hyperbolic tangent and linear activation functions
2. Implementing standard backpropagation algorithm manually, Using WEKA or any other software
3. Designing, training, and testing 2-3 layered FFBP ANN using standard backpropagation algorithm for any time series problem (univariate)
4. Evaluating the performance of ANN developed in Experiment 3 by varying number of hidden neurons, activation functions, normalization ranges
5. Designing, training, and testing 2-3 layered FFBP ANN using standard backpropagation algorithm for any time series problem (multi-variate)
6. Evaluating the performance of ANN developed in Experiment 5 by varying number of hidden neurons, activation functions, normalization ranges
7. Designing, training, and testing 2-3 layered FFBP ANN using standard backpropagation algorithm for any cause effect problem
8. Evaluating the performance of ANN developed in Experiment 7 by varying number of hidden neurons, activation functions, normalization ranges
9. Demonstration of MNIST digit classification using ANN.

Textbooks:

1. Wasserman, P.D., (1993), " Advanced methods in neural computing", Van Nostrand Reinhold, New York
2. Kosko, B., (1992), "Neural Networks and Fuzzy systems", Prentice Hall, Englewood Cliffs, NJ
3. Bose, N. K., Liang, P. (1998), "Neural Network Fundamentals with Graphs, Algorithms and Applications", Tata McGraw-Hill Publication.



Open Elective I

Social Media Analytics (IOEUA32185E)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits: 3 Lecture (L): 3 hrs./week Tutorial (T): -- hr Practical (P): -- hrs.	20	30	20	30	-	-	100

Prerequisites-

1. Basic knowledge of Graphs.
2. Data mining.
3. Data Analysis.

Course objectives:

1. To understand foundations of Social Media Analytics.
2. To Visualize and understand the data mining aspects in social networks.
3. To solve mining problems by different algorithms.
4. To understand network measures for social data.
5. To understand behavioral part of web applications for Analysis.
6. To analyze the data available on any social media applications.

Course Outcomes:

By the end of the course, students should be able to

1. Understand the basics of Social Media Analytics.
2. Understand the visualization of social networks and the significance of Data mining in Social media.
3. Demonstrate the algorithms used for text mining.
4. Compare and Apply network measures for social media data.
5. Explain Behavior Analytics techniques used for social media data.
6. Apply social media analytics for Facebook, LinkedIn and Twitter kind of applications.

Unit I – Introduction to social media analytics (sma) and types of analytics tools

Social media landscape, Need for SMA; SMA in Small organizations; SMA in large organizations; Application of SMA in different areas,

The foundation for analytics, Social media data sources, Defining social media data, data sources in social media channels, Estimated Data sources and Factual Data Sources, Public and Private data, data gathering in social media analytics

UNIT II -The social networks perspective and its visualization

Unit III – Text Mining in Social Networks

Introduction, Keyword search, Classification Algorithms, Clustering Algorithms-Greedy Clustering, Hierarchical clustering, k-means clustering, Transfer Learning in heterogeneous Networks, Sampling of online social networks, Comparison of different algorithms used for mining, tools for text mining.

Unit IV - Network Measures



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Centrality- Degree Centrality , Eigenvector Centrality, Katz Centrality , PageRank, Betweenness Centrality, Closeness Centrality ,Group Centrality ,Transitivity and Reciprocity, Balance and Status, Similarity- Structural Equivalence, Regular Equivalence

Unit V – Behavior Analytics

Individual Behavior- Individual Behavior Analysis, Individual Behavior Modeling, Individual Behavior Prediction Collective Behavior- Collective Behavior Analysis, Collective Behavior Modeling, Collective Behavior Prediction

Unit VI - Case Study

Mining Twitter- Overview, Exploring Twitter's API, Analyzing 140 Characters
Mining Facebook- Overview, Exploring Facebook's Social Graph API's, Analyzing Social Graph Connections.
Mining Linked In- Overview, Exploring Linked In API

Text Books:

1. Reza Zafarani Mohammad Ali Abbasi Huan Liu, Social Media Mining, Cambridge University Press, ISBN- 10- 1107018854.
2. Charu C. Aggarwal, Social Network Data Analytics, Springer, ISBN- 978-1-4419-8461-6.
3. Matthew Ganis, AvinashKohirkar Social Media Analytics- Techniques and Insights for Extracting Business Value Out of Social Media, Pearson publications, 2016

Reference Books :

1. Marshall Sponder, Social Media Analytics- Effective Tools for Building, Interpreting, and Using Metrics, McGraw Hill Education, 978-0-07-176829-0. 2.
2. Matthew A. Russell, Mining the Social Web, O'Reilly, 2nd Edition, ISBN-10-1449367615.
3. Jiawei Han University of Illinois at Urbana-Champaign Micheline Kamber, Data Mining- Concepts and Techniques, Morgan Kaufmann, 2nd Edition, ISBN- 13- 978-1-55860-901-3 ISBN- 10- 1-55860-901-6.
4. Bing Liu, Web Data Mining - Exploring Hyperlinks, Contents and Usage Data, Springer, 2nd Edition, ISBN- 978-3-642-19459-7



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Computer Aided Engineering (MEUA32186)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits:2 Lecture (L): 2hrs./week Tutorial (T): -- hr Practical (P): 2 hrs/week	-	-	50	-	-	25	75

Prerequisite: Readers/students are expected to know the following concepts:

- Engineering Graphics, Engineering Mathematics, Computer Aided Machine Drawing, Strength of Materials.

Course Objectives:

- To apply homogeneous transformation matrix for geometrical transformations of 2D/3D CAD entities.
- To predict performance of simple mechanical components viz. beam, shafts, plates, trusses using FEA (Mathematical and Software treatment)

Course Outcomes:

After successful completion of the course, student will be able to

1. Produce a good quality meshing of mechanical components using commercial software
2. Compute stresses, strains, and deflection in the given problem under static loading
3. Apply homogeneous transformation matrix for geometrical transformations of 2D & 3D CAD entities for basic geometric transformations.
4. Model the curves, surfaces and solid geometry

Unit I: Introduction to Finite Element Analysis

Introduction: Brief History of FEM, Finite Element Terminology (nodes, elements, domain, continuum, Degrees of freedom, loads and constraints), General FEM procedure, Applications of FEM in various fields, Advantages, and disadvantages of FEM.

Introduction to meshing. Types of element, meshing Techniques. 1D, 2D and 3D Meshing, Mesh Quality Check. Effect of Mesh Density in the critical Region, Effect of biasing in the critical region, Quality check

Unit II: One Dimensional Finite Element Analysis

One Dimensional Problem: Finite element modeling, coordinate, and linear shape function, Assembly of Global Stiffness Matrix and Load Vector, Properties of Stiffness Matrix, Finite Element Equations, Temperature Effects, Penalty approach,

Unit III: Computer Graphics

Computer Graphics Module, Transformations-Introduction, Formulation, Translation, Rotation, Scaling and Reflection. Homogenous Representation, Concatenated Transformation, Mapping of Geometric Models, Inverse Transformations. Projections: Orthographic and Isometric.

Unit IV: Geometric Modeling



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Curves-Introduction, Analytic Curves & Synthetic Curves -
Surfaces-Introduction, Surface Representation, Analytic Surfaces
Solids: Introduction, Geometry and Topology, Solid Representation, Boundary
Representation, Constructive Solid Geometry, Boolean operation for CSG, Hybrid Modeling, Feature
Based
Modeling, Parametric Modeling, Constraint Based Modeling

Practicals:

1. 1D meshing and quality check
2. 2D meshing and quality check
3. 3D meshing and quality check
4. Static structural analysis of Beams
5. Static structural analysis of Trusses
6. Static structural analysis of any mechanical element/part/component
7. Static structural analysis of any mechanical assembly
8. Modal analysis of any mechanical element/part/component
9. Build and execute a computer program on concatenated Transformation
10. Demonstration of Application Programming Interface (API).

Text Books:

1. . Nitin Gokhale, "Practical Finite Element Analysis", Finite to Infinite
2. J. N. Reddy, "An Introduction to the Finite Element Method", Tata McGraw Hill
3. Ibrahim Zeid and R. Sivasubramanian - CAD/CAM - Theory and Practice Tata McGraw Hill
4. C.S. Krishnamurthy, "Finite Element Analysis: Theory & Programming", Tata McGraw Hill.

Reference Books :

7. Chandrupatla T. R. and Belegunda A. D. -Introduction to Finite Elements in Engineering - Prentice Hall India.
8. Seshu P. Text book of Finite Element Analysis, PHI Learning Private Ltd. New Delhi, 2010
9. Ibrahim Zeid, Mastering CAD/CAM Tata McGraw Hill Publishing

Prepared by-Mr. Naren Kate

BOS Member-Dr. Atul P. Kulkarni

BOS Chairman- Dr. D. N. Kamble

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**Curriculum for
Final Year B. Tech
(Mechanical Engineering)
2018 Pattern**

**Department of
Mechanical Engineering**



VISION

Excellence in Mechanical Engineering for Global Acceptance

MISSION

- Make spirited mechanical engineers with morals, values and principles for sustainable development of society.
- Strive continuously to impart knowledge and skills of the highest standards.
- Our engineers will respond to the current and future needs of the industry, higher studies as well as research.

Program Educational Objectives-

1. Graduates of the program will become competent engineers suitable for the mechanical engineering based industry and higher education.
2. Graduates of the program will acquire the necessary foundation in fundamental mechanical engineering subjects for development of mathematical and analytical abilities.
3. Graduates of the program will acquire the knowledge and skills in mechanical engineering to provide technological solutions.
4. Graduates of the program will learn managerial, financial and ethical practices such as, project and financial management skills, multidisciplinary approach and soft skills.
5. Graduates of the program will respond to growing demands of society through lifelong learning.

Program Outcomes-

At the end of the program, a student will be able to

1. **Engineering knowledge-** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis-** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
3. **Design/development of solutions-** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
4. **Conduct investigations of complex problems-** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage-** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.



6. **The engineer and society-** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability-** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics-** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work-** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication-** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance-** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning-** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Program Specific Outcomes-

At the end of the mechanical engineering program, a student will be able to-

1. Identify, automate and apply manufacturing processes for production of mechanical components considering effective use of man, machines, and material resources.
2. Design, formulate, develop and analyze mechanical components and systems using design engineering principles and modern CAD/CAE tools
3. Specify, analyze, evaluate, audit, design and build thermal and fluid systems using modern engineering tools



**FINAL YEAR B. TECH (MECHANICAL ENGINEERING), SEMESTER VII
(PATTERN 2018) MODULE I**

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CI E	ISE	SCE	ESE	PR/OR/TW		
MEUA40181	Professional Elective-IV	TH	3	-	2	20	30	20	30	25	125	4
MEUA40182	Professional Elective-V	TH	3	-	2	20	30	20	30	25	125	4
IOEUA40183	Open Elective-II	TH	3	1	-	20	30	20	30	25	125	4
IOEUA40184	Open Elective-III	TH	3	-	2	20	30	20	30	25	125	4
MEUA40185	Intellectual Property Rights	CE	2	-	-	-	-	50	-	-	50	2
MEUA40186	Project Work	CE-PR/OR	-	-	10	100	-	-	-	50	150	5
M4	Mandatory Course	AU	-	-	-	-	-	-	-	-	-	-
	Total	-	14	1	16	180	120	130	120	150	700	23

CIE: Continuous Internal Evaluation
ISE: In-Semester Examination

SCE: Skill and Competency Examination
ESE: End Semester Examination

Professional Elective-IV		Professional Elective-V	
Course Code	Course Title	Course Code	Course Title
MEUA40181A	Finite Element Analysis	MEUA40182A	Industrial Fluid Power
MEUA40181B	Computational Fluid Dynamics	MEUA40182B	Mechanical System Design
MEUA40181C	Reliability Engineering	MEUA40182C	Total Quality Management
MEUA40181D	Design of Thermal System	MEUA40182D	Automobile Engineering

Open Elective -II		Open Elective -III	
Course Code	Course Title	Course Code	Course Title
IOEUA40183A	Project Planning and Management	IOEUA40184A	Robotics
IOEUA40183B	Software Testing	IOEUA40184B	Quantum Computing
IOEUA40183C	5G Mobile Networks	IOEUA40184C	Business Intelligence
IOEUA40183D	Cloud Computing	IOEUA40184F	Business Analytics
IOEUA40183E	Solar And Wind Energy		



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**FINAL YEAR B. TECH (MECHANICAL ENGINEERING), SEMESTER VII
 (PATTERN 2018) MODULE II**

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/OR/TW		
MEUA40187	Semester Internship	CE-PR/OR	-	-	24	100	-	-	-	50	150	12
M4	Mandatory Course	AU	-	-	-	-	-	-	-	--	-	-
	Total		-	-	24	100	-	-	-	50	150	12

**FINAL YEAR B. TECH (MECHANICAL ENGINEERING), SEMESTER VIII
 (PATTERN 2018) MODULE III**

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/OR/TW		
MEUA42181	Professional Elective/Professional core	TH	3	-	2	20	30	20	30	25	125	4
IOEUA42182	Open Elective-IV	TH	2	-	2	20	30	20	30	25	125	3
IOEUA42183	Open Elective-V (Humanities and Social Science)	TH	2	-	2	20	30	20	30	25	125	3
MEUA42184	Introduction to Research	CE PR/ OR	1	-	2	-	-	-	-	25	25	2
M4	Mandatory Course	AU	-	-	-	-	-	-	-	-	-	-
	Total	-	8	-	8	60	90	60	90	100	400	12

Professional Elective-VI		Open Elective-IV		Open Elective-V	
Course Code	Course Title	Course Code	Course Title	Course Code	Course Title
MEUA42181A	Power Plant Engineering	IOEUA42182A	Engineering Economics	IOEUA42183A	Inferential Statistics for Data Science
MEUA42181B	Noise Measurement and Control	IOEUA42182B	Computational Biology	IOEUA42183B	E- Commerce
		IOEUA42182C	Software Quality Assurance System	IOEUA42183C	Rural Technology
		IOEUA42182D	Technology and Financial Management	IOEUA42183D	Product Design Engineering
		IOEUA42182E	Non-Destructive Techniques and Engineering Diagnosis	IOEUA42183E	Numerical Methods

BoS Chairman

Dean Academics

Director



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**FINAL YEAR B. TECH (MECHANICAL ENGINEERING), SEMESTER VIII
 (PATTERN 2018) MODULE IV**

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/OR/TW		
MEUA40187	Semester Internship	CE-PR/OR	-	-	24	100	-	-	-	50	150	12
M4	Mandatory Course	AU	-	-	-	-	-	-	-	--	-	-
	Total		-	-	24	100	-	-	-	50	150	12

**FINAL YEAR B. TECH (MECHANICAL ENGINEERING), SEMESTER VIII
 (PATTERN 2018) MODULE V**

Course Code	Course Title	Course Type	Teaching Scheme			Examination Scheme					Total	Credits
			L	T	P	CIE	ISE	SCE	ESE	PR/OR/TW		
MEUA40181	Professional Elective-IV	TH	3	-	2	20	30	20	30	25	125	4
MEUA40182	Professional Elective-V	TH	3	-	2	20	30	20	30	25	125	4
IOEUA40183	Open Elective-II	TH	3	1	-	20	30	20	30	25	125	4
IOEUA40184	Open Elective-III	TH	3	-	2	20	30	20	30	25	125	4
MEUA40185	Intellectual Property Rights	CE	2	-	-	-	-	50	-	-	50	2
MEUA40186	Project Work	CE-PR/OR	-	-	10	100	-	-	-	50	150	5
M4	Mandatory Course	AU	-	-	-	-	-	-	-	-	-	-
	Total	-	14	1	16	180	120	130	120	150	700	23

CIE: Continuous Internal Evaluation
ISE: In-Semester Examination

SCE: Skill and Competency Examination
ESE: End Semester Examination

BoS Chairman

Dean Academics

Director



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Professional Elective-IV		Professional Elective-V	
Course Code	Course Title	Course Code	Course Title
MEUA40181A	Finite Element Analysis	MEUA40182A	Industrial Fluid Power
MEUA40181B	Computational Fluid Dynamics	MEUA40182B	Mechanical System Design
MEUA40181C	Reliability Engineering	MEUA40182C	Total Quality Management
MEUA40181D	Design of Thermal System	MEUA40182D	Automobile Engineering

Open Elective -II		Open Elective -III	
Course Code	Course Title	Course Code	Course Title
IOEUA40183A	Project Planning and Management	IOEUA40184A	Robotics
IOEUA40183B	Software Testing	IOEUA40184B	Quantum Computing
IOEUA40183C	5G Mobile Networks	IOEUA40184C	Business Intelligence
IOEUA40183D	Cloud Computing	IOEUA40184F	Business Analytics
IOEUA40183E	Solar And Wind Energy		

NOTE:

- Students who will register for Module-I in Semester VII have to register either of Module-III or Module IV in Semester VIII
- Students who will register for Module-II in Semester VII have to register for Module-V in Semester VIII

List of Mandatory Courses:

Environmental Sciences, Induction training, Indian Constitution, Essence of Indian Traditional Knowledge

BoS Chairman

Dean Academics

Director



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2	MEUA40182	Professional Elective-V	19-27
3	IOEUA40183	Open Elective-II	28-38
4	IOEUA40184	Open Elective-III	39-49
5	MEUA40185	Intellectual Property Rights	50-51
6	MEUA40186	Project Work	52
FINAL YEAR B. TECH , SEMESTER VII/VIII MODULE II/IV			
7	MEUA40187	Semester Internship	
FINAL YEAR B. TECH , SEMESTER VIII MODULE III			
10	MEUA42181	Professional Elective/Professional core	53-57
11	IOEUA42182	Open Elective-IV	58- 66
12	IOEUA42183	Open Elective-V	67-77



BansilalRamnathAgarwal Charitable Trust's

Vishwakarma Institute of Information Technology, Pune-48
(An Autonomous Institute Affiliated to Savitribai Phule Pune University)
Department of Mechanical Engineering

MODULE-I/V

SEMESTER-VII/VIII



BansilalRamnathAgarwal Charitable Trust's
Vishwakarma Institute of Information Technology, Pune-48
(An Autonomous Institute Affiliated to Savitribai Phule Pune University)
Department of Mechanical Engineering

Professional Elective-IV
Finite Element Analysis (MEUA40181A)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits : 4 Lecture (L) : 3hrs./week Tutorial (T): -- hr. Practical (P): 2 hrs./week	20	30	20	30	25	-	125

Prerequisite:

Engineering Mechanics, Strength of Materials, Design of Machine elements, Engineering Mathematics, Heat Transfer, Dynamics of Machinery, Fundamentals of Programming Language

Course objectives:

- To understand the general procedure and philosophy of Finite Element Method as applied to solid mechanics and thermal analysis problems.
- To familiarize students with the displacement-based finite element method for displacement and stress analysis and to introduce related analytical and computer tools. It provides a bridge between hand calculations based on mechanics of materials and machine design and numerical solutions for more complex geometries and loading states.
- To study approximate nature of the finite element method and convergence of results are examined

Course Outcomes:

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

1. Understand the concept of finite element method and formulate element stiffness matrix for 1D bar element.
2. Analyze truss, beam and frame element to solve for displacements and stresses.
3. Obtain finite element formulation for two-dimensional plane stress and plane strain problems using constant strain triangle (CST) elements.
4. Use concepts of isoparametric quadrilateral and higher order elements in finite element formulation for 2D problems and solve numerical integration using Gaussian quadrature.
5. Develop and solve finite element equations for 1D steady state heat conduction and convection problems in heat transfer using Galerkin weighted residual method
6. Formulate and solve dynamics problem using finite element method
7. Use commercial finite element analysis software to solve complex problems in solid mechanics and heat transfer

Unit 1: Fundamentals Concepts of FEA

Introduction to FEA, General Procedure for Finite Element Analysis, Brief history of Finite Element Method, Advantages and disadvantages of FEA, Applications of FEA in various fields, The Rayleigh-Ritz method

1D Bar Element: Finite element formulation of 1D linear bar element using Potential Energy approach (with general steps involved in FEA) - shape functions, element stiffness matrix, force terms, assembly of global stiffness matrix and load vector, treatment of boundary conditions- elimination approach, calculation of nodal displacement, strain and element stresses, reaction forces, properties of stiffness matrix, Quadratic shape functions, temperature effect- temperature load vector.

Numerical Examples: 1D linear bar element (with temp effect)

Unit 2: Plane Truss, Beam and Frame Elements

Analysis of Truss Element: Formulation of Element Matrices, Direction cosine, assembly of global stiffness matrix, element strains and stresses, Numerical Examples:



Analysis of Beam Element: Hermite Shape function (Derivation), element stiffness matrix, element load vector, Numerical Examples

Plane Frame Element: Introduction to element stiffness matrix

Unit 3: 2D Elements

Two-Dimensional Stress Analysis: Plane Stress/Strain problems in 2D elasticity, constitutive relations Constant Strain Triangle (CST), Linear Strain Rectangle (LSR), Displacement function, Pascal's triangle, compatibility and completeness requirement, geometric isotropy, Convergence requirements, strain field, stress field, Formulation of element stiffness matrix and load vector for Plane Stress/Strain problems. Assembly of global stiffness matrix and load vector, Boundary conditions, solving for primary variables (displacement), stress calculations

Unit 4: Isoparametric Elements & Numerical Integration

Concept of isoparametric elements, Terms Isoparametric, super parametric and subparametric, Isoparametric formulation of bar element.

Coordinate mapping - Natural coordinates, Area coordinates (for triangular elements), higher order triangular and quadrilateral elements (Lagrangean and serendipity elements), geometry associative mesh, quality checks, mesh refinement- p Vs h refinements, Uniqueness of mapping - Jacobian matrix. Numerical integration –Gauss Quadrature in 1 & 2 dimension, Order of Gauss integration, full and reduced integration

Unit 5: 1D Steady State Heat Transfer Problems

Introduction to Galerkin weighted residual method, One dimensional steady-state heat transfer problem- Governing differential equation, Finite Element formulation using Galerkin's approach for composite wall and thin Fin, Essential and natural boundary conditions and solving for temperature distribution

Unit 6: Dynamic Analysis

Types of dynamic analysis, General dynamic equation of motion, lumped and consistent mass, Mass matrices formulation of bar, truss and beam element.

Undamped-free vibration- Eigenvalue problem, Evaluation of eigenvalues and eigenvectors (characteristic polynomial technique),

Text Books:

1. Chandrupatla T. R. and Belegunda A. D., Introduction to Finite Elements in Engineering, Prentice Hall India, 2002
2. Fundamental of Finite Element Analysis, David V. Hutton, Tata McGraw-Hill,
3. A First Course in the Finite Element Method, Daryl L. Logan, 2007.
4. Finite Element Analysis, G Lakshmi Narasaiah, B S Publications, 2008.
5. Finite Element Method with Applications in Engineering, Y. M. Desai, T. I. Eldho and A. H. Shah, Pearson Education, 2011
6. Text book of Finite Element Analysis, P., Seshu, PHI Learning Private Ltd., New Delhi, 2010.

Reference Books :

1. Finite Element Procedures, Bathe K. J., Prentice-Hall of India (P) Ltd., New Delhi.
 2. Concepts and Applications of Finite Element Analysis, R. D. Cook, et al. Wiley, India
 3. Finite Element Method using MATLAB, Kwon Y. W., Bang H., CRC Press, 1997
 4. MATLAB Guides to Finite Elements- An Interactive Approach, Peter Kattan, Springer, 2008.
 5. Finite element analysis, theory and application with Ansys, S. Moaveni, Prentice Hall
 6. The Finite Element Method and Applications in Engineering Using Ansys, Erdogan Madenci and Ibrahim Guven, Springer, 2006.
 7. Fundamental of Finite Element Analysis, David V. Hutton, Tata McGraw-Hill
- Practical Finite Element Analysis, Gokhale N. S., et al., Finite to Infinite, Pune, 2008.

List of experiments :



The term work shall consist of record of any three from 1 to 4* and any three from 5 to 9** assignments of the problems based on following topic-

1. Computer program for stress analysis of 1D bar using linear and quadratic elements. Show the variation of stress and strain within the element for linear and quadratic bar element.
2. Computer program for stress analysis of 2-D truss subjected to plane forces
3. Computer programs for (i) modal analysis and, (ii) stress analysis for 1-D beam (simply supported or cantilever beams)
4. Computer program for 1-D temperature analysis
5. Static stress concentration factor calculation for a plate with center hole subjected to axial loading in tension using FEA software.
6. Modal analysis of any machine component using FEA software.
7. Stress and deflection analysis of any machine component consisting of 3-D elements using FEA software.
8. Nonlinear elasto-plastic analysis of plate with hole using FEA software
9. Coupled Thermal-Structural Analysis using FEA software

Students can write the program in any of the programming language such as FORTRAN, C, C++, MATLAB, Python, VB.

Minimum number of elements considered should be 10 or more.

Validate results of the program with analytical method or FEA software such as Abaqus, ANSYS, Msc-Nastran, Optistruct/Radioss, Comsol-Multiphysics

**1. Students should do convergence study for all assignment problems.

2. Use different element types from element library, 3. If possible use submodel/symmetry option.
Macro mechanical Analysis of lamina using MATLAB; (iii) macro mechanical Analysis of laminate using MATLAB

Prepared by: Dr. A .R. Mache

BOS Member:

BOS Chairman:



BansilalRamnathAgarwal Charitable Trust's
Vishwakarma Institute of Information Technology, Pune-48
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Department of Mechanical Engineering

Professional Elective-IV
Computational Fluid Dynamics (MEUA40181B)

Teaching Scheme	Examination Scheme						
Credits:4 Lecture (L): 3hrs./week Tutorial (T): -- hr. Practical (P): 2 hrs./week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	25	-	125

Prerequisite: Fluid Mechanics, Heat transfer, Numerical methods, Programming Languages.

Course Objectives:

- Students should be able to model fluid / heat transfer problems and apply fundamental conservation principles.
- Students should be able to do discretize the governing equations by Finite Difference Method and Finite volume Method.
- Students should be able to solve basic convection and diffusion equations and understands the role in fluid flow and heat transfer.
- To prepare the students for research leading to higher studies.

Course Outcomes:

- After successful completion of the course, student will be able to
- Analyze and model fluid flow and heat transfer problems.
 - Generate high quality grids and interpret the correctness of numerical results with physics.
 - Solution of two dimensional steady and unsteady heat conduction equation using finite volume method
 - Able to analyse different boundary conditions.
 - Formulate two dimensional steady and unsteady heat convection-diffusion equation
 - Able to choose and apply proper turbulence model to solve fluid flow problems.

Unit I: Introduction of CFD

Introduction to Computational Fluid Dynamics, How CFD Code work, Applications of CFD, Steps for problem solving with CFD.

Unit II: Governing equations of CFD

Derivation and physical interpretation of governing equations (conservation of mass, momentum and energy) in differential form, Concept of substantial derivative, divergence and curl of velocity, Mathematical behavior of Governing Equations and boundary conditions.

Unit III: Solution to Conduction Equation

Introduction to FEA, FDM and FVM, Solution of two dimensional steady and unsteady heat conduction equation using finite volume method (Implicit and Explicit) with Dirichlet, Neumann, Robbin boundary conditions, Stability Criteria.

Unit IV: Solution to Advection Equation

Solution of two dimensional steady and unsteady heat advection equation using finite volume method (Implicit and Explicit) with Dirichlet BC, Stability Criteria, Introduction to first order upwind, CD,

Unit V: Solution to Convection-Diffusion Equation



Solution of two dimensional steady and unsteady heat convection-diffusion equation for slug flow, using finite volume method (Implicit and Explicit), Stability Criteria, 1-D transient convection-diffusion system, Peclet Number

Unit VI: Introduction to Turbulence Modeling

Introduction to turbulence models, Reynolds Averaged Navier-Stokes equations (RANS), One equation model (Derivation) and two equation model.

List of Practical:

1. One-dimensional steady state conduction meshing using finite volume method
2. Two-dimensional steady state conduction using finite volume method
3. Two-dimensional unsteady state conduction using finite volume method
4. Two-dimensional advection using finite volume method
5. One-dimensional conduction convection problem using finite volume method
6. Solution of Navier Stokes equation using SIMPLE algorithm for Lid Driven Cavity flow problem
7. Mini-project based on above practical's.

Text Books:

1. John D Anderson: Computational Fluid Dynamics- The Basics with Applications, McGraw-Hill
2. Hill
3. Atul Sharma, Introduction to Computational Fluid Dynamics: Development, Application and Analysis, Wiley
4. Suhas V. Patankar, Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing Corporation
5. A. W. Date, Introduction to Computational Fluid Dynamics, Cambridge Univ. Press, USA.
6. H. Versteeg, and W. Malalasekara, An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Pearson.
7. T. J. Chung, Computational Fluid Dynamics, Cambridge University Press.
8. J. Tu, G.-H. Yeoh and C. Liu: Computational Fluid Dynamics: A practical approach, Elsevier.
9. H. Schlichting and K. Gersten, Boundary-Layer Theory, Springer.

Reference Books :

1. H. Tennekes and J. L. Lumley, A First Course in Turbulence, MIT Press.
2. David C. Wilcox, Turbulence Modeling for CFD, DCW Industries

Prepared by: Dr. S. S. Kore

BOS Member:

BOS Chairman:

**Professional Elective-IV**
Reliability Engineering (MEUA40181C)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits : 4							
Lecture (L) : 3hrs./week							
Tutorial (T): -- hr.	20	30	20	30	25	-	125
Practical (P): 2 hrs./week							

Prerequisite: Engineering Mathematics, Manufacturing Processes and Design Engineering**Course Objectives:**

Understanding of basic principles of Reliability for ensuring sustainable product design. Application to system requirements, design, manufacturing and testing, with real-world examples. Understand in detail Asset Management, Maintenance, Quality and Productiveness.

Course Outcomes:

Upon completion of the course, students will be able to

- Calculate MTTF, MTBF, failure rate and hazard rate for life characteristic phases of system
- Analyze series, parallel, mixed configuration systems using probability concepts.
- Apply different reliability apportionment techniques to improve reliability of system.
- Calculate inherent, achieved, and operational availability of system.
- Perform FEMA, FMECA and Design of Experiments
- Apply different methods to test reliability.

Unit I: Fundamentals Concepts of Reliability

Reliability terminologies, Interrelationship of safety, quality and reliability, life characteristic phases, Introduction to maintainability, availability. Concepts of Failure, failure density, failure Rate, hazard rate, pdf, cdf. Modes of failure, Mean Time To Failure (MTTF), Mean Time Between Failure (MTBF), Numericals based on calculation of failure rate, hazard rate. Warranty Management and Life cycle cost.

Unit II: Probability Concepts and System Reliability

Basic probability concepts, Discrete and continuous probability distributions, Analysis of series, parallel, mixed configuration systems, Concept of k-out of n structure, Conditional probability method, delta-star method for conditional probability analysis, Tie-set, and Cut-Set method (Concepts and Numericals).

Unit III: System Reliability Analysis

Reliability Improvement- Redundancy, element redundancy, unit redundancy, standby redundancy (Numericals), Introduction to Reliability allocation or apportionment, reliability apportionment techniques: Equal apportionment, AGREE, ARINC, Minimum effort method (Numericals).

Unit IV: Reliability Management

Objectives and types of maintenance, Maintainability, system down time, availability - inherent, achieved, and operational availability (Numerical treatment). Introduction to Reliability Centered Maintenance. Design for maintainability and its considerations, Reliability and costs, Costs of Unreliability, Technology aspects in Reliability Management, BIT (Built in testing).

Unit V: Reliability in Design and Development

Reliability techniques- Failure mode, effects analysis (FMEA), Failure mode, effects, and criticality analysis (FMECA)- Case Studies, Basic symbols, Fault Tree construction and analysis, Introduction to Design of Experiments (DOE).

Unit VI: Reliability Testing

Introduction to reliability testing, Stress strength interaction, Testing for Reliability and Durability- Accelerated Life Testing and Highly Accelerated Life Testing (HALT), highly accelerated stress Screening (HASS). Reliability in manufacturing- Production FRACAS.



Lab Practice:

1. Calculation of MTTF, MTBF, failure rate and hazard rate for life characteristic phases of system using advanced Excel and/or Minitab software or Python
2. Assignment on analysis of series, parallel, mixed configuration systems using probability concepts.
3. Design of Experiments with ANOVA- One factor
4. Design of Experiments with ANOVA, Residual plot, Normal probability plot – Two factor analysis
5. Perform FEMA, FMECA of any mechanical system
6. Fault tree analysis of any mechanical system
7. Assessment of reliability of cutting tool during turning -I
8. Assessment of reliability of cutting tool during turning -II

Textbooks:

1. Kapur — Reliability in engineering Design, Wiley India
2. L. S. Srinath, Reliability Engineering, EWP , 4th Edition 2011

Reference Books:

1. Alessandro Birolini, Reliability Engineering Theory and Practice, Springer
2. S S. Rao, Reliability Based Design, McGraw Hill Inc. 1992

Prepared by: Dr. S. S. Chinchankar

BOS Member:

BOS Chairman:



BansilalRamnathAgarwal Charitable Trust's
Vishwakarma Institute of Information Technology, Pune-48
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Department of Mechanical Engineering

Professional Elective-IV
Design of Thermal System (MEUA40181D)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits:4 Lecture (L): 3hrs./week Tutorial (T): -- hr. Practical (P): 2 hrs./week	20	30	20	30	25	-	125

Prerequisite: Readers/students are expected to know all topics of basic engineering science courses in thermodynamics, fluid mechanics and heat transfer.

Course Objectives:

- To understand different kinds of heat exchangers, their working and applications
- To familiarize with different standards of heat exchangers design
- Students will be able to understand different methods of heat exchanger design

Course Outcomes:

After successful completion of the course Student will be able,

1. To classify different types of heat exchangers and select as per the applications
2. To analyze sizing and rating of heat exchangers with different methods
3. Understand the different shell and tube heat exchanger design standards and apply the knowledge for the design of shell and tube heat exchanger
4. To analyze different heat transfer enhancement techniques and calculate the heat transfer rate and pressure drop
5. To formulate the sizing and rating of existing Plate Fin Heat Exchanger
6. To understand physics of multiphase heat transfer and apply it for different applications

Unit I: Basics Heat Exchangers

Heat exchange mechanism, Classification of Heat Exchangers, Construction and working of tubular, Plate and Compact heat exchangers. Selection of heat exchangers, Applications of heat exchangers in different areas.

Unit II: Design of Heat Exchangers

Introduction to thermal and hydraulic aspects, Pressure drop and heat transfer considerations, Sizing and rating of heat exchangers. F-LMTD and NTU method.

Unit III: Shell and Tube Heat Exchangers

Basic components, Types of shell and tube heat exchangers, TEMA standards, Basic design methodology, Heat transfer and pressure drop calculations, Shell side calculations-KERN,s and Bell Delaware method.

Unit IV: Compact Heat Exchangers

Heat transfer enhancement, extended surfaces, Plate fin and tube fin heat exchangers- Applications and construction. Heat transfer and pressure drop calculations.

Unit V: Plate Fin Heat Exchangers

Plate fin heat exchangers- Types and applications, Construction and fabrication, Flow arrangement and design of PFHE.

Unit VI: Phase Change Heat Exchangers



Introduction to evaporators and condensers, construction, working, design and operational considerations and thermal analysis.

List of Practical:

1. Basic design methods and tube heat exchangers
2. TEMA standards and applications to STHEX
3. Analysis of shell & tube heat exchanger using different methods
4. Thermal Analysis of compact heat exchangers
5. Analysis of plate fin type heat exchangers
6. Fouling analysis of heat exchangers
7. Trial on heat pipe to determine performance parameters
8. Industrial visit to heat exchanger manufacturing company

Text Books:

1. Heat Transfer by F. Incropera and D. DeWitt or other basic undergraduate heat transfer textbook.
2. Kakac, Sadik, Hongtan Liu, and Anchasa Pramuanjaroenkij. *Heat exchangers: selection, rating, and thermal design*. CRC press, 2012. R K Shah, Fundamental of Heat Exchanger Design
3. Kay Kays and London, *Compact heat exchanger*, Krieger Pub Co.,, 1998

Reference Books :

1. Fundamentals of Heat Exchanger Design -Ramesh K. Shah, Dusan P. Sekulic, Wiley-India
2. Heat exchanger, Design, rating and Selection, Sadik Kakac, CRC Press
3. Process Heat Transfer/D. Q. Kern/ TMH
4. Heat Exchanger Design/ A. P. Fraas and M. N. Ozisick/ John Wiely& sons, New York.
5. Heat Exchangers Thermal Hydraulic Fundamentals and Design by S. Kakac, A. , Bergles, F. Mayinger, McGraw-Hill Book Company.

Prepared by: Dr. S. S. Kore

BOS Member:

BOS Chairman:



BansilalRamnathAgarwal Charitable Trust's
Vishwakarma Institute of Information Technology, Pune-48
(An Autonomous Institute Affiliated to Savitribai Phule Pune University)
Department of Mechanical Engineering

Professional Elective-V
Industrial Fluid Power (MEUA40182A)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits : 3 Lecture (L) : 3hrs./week Tutorial (T): -- hr. Practical (P): 2 hrs./week	20	30	20	30	25	-	125

Prerequisite: Engineering Mechanics, Engineering Mathematics, Fluid Mechanics and machines.

Course Objectives:

- To study governing laws used in fluid power systems
- To study fluid power applications
- To study working principles of various components
- To study selection of different components
- To study how to design fluid power systems
- To study low cost automation

Course Outcomes:

By the end of the course, students will able to

1. Explain and analyze the performance of pumps used in hydraulic systems.
2. Explain the working principle of actuators, power units and reservoirs of hydraulic system.
3. Explain the construction and working principle of various control valves used in hydraulic system.
4. Analyze and select appropriate hydraulic circuits for industrial/mobile applications
5. Explain the working principle of various components and circuits of Pneumatic system.
6. Design Hydraulic and Pneumatic system according to system requirements by using manufacturing catalog.

Unit 1: Basics of Fluid Power and Pumps

Fluid power basics, advantages and limitations, fluid power distribution, standard symbols, energy loss in hydraulic systems.
Pumps - types, classification, principle of working and constructional details of vane pumps, gear pumps, radial and axial plunger pumps, screw pumps, power and efficiency calculations, and characteristics curves.

Unit 2: Actuators and Power Unit

Linear and rotary actuators- types, construction and characteristics. Cylinder mountings, cushioning of cylinders.
Power units and accessories - types of power units, reservoir assembly, constructional details.
Accumulators,
Intensifiers, Pressure and Temperature switches /sensors, level sensors.

Unit 3: Fluid Power Control

Direction control valves - center positions, methods of actuation, two stage valves, Flow control valves - pressure and temperature compensated. Pressure control valves - pressure reducing valve, sequence valve, unloading valve, brake valve, back pressure valve, counter balance valve, check valves, prefill valve, servo valves, cartridge valves, proportional valves.

Unit 4: Hydraulic Circuits and Contamination Control

Hydraulic circuits: Simple reciprocating, regenerative, speed control (meter in, meter out and bleed off), sequencing, synchronization, traverse and feed, automatic reciprocating, fail safe circuit, counter balance circuit, actuator locking, unloading circuit, motor breaking circuit etc.
Contamination control: Contamination, sources of contamination, suction strainer, filters, filtration, filter ratings.

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Unit 5: Pneumatics – Components, Control Valves and Circuits

Compressors - Types, principle of working and constructional details. Comparison of pneumatic with hydraulic power transmissions. Types of filters, pressure regulators, lubricators, mufflers, dryers, direction control valves, pneumatic actuators, shuttle valve, two pressure valve, quick exhaust valve and time delay valves, electro-pneumatics. Speed regulating methods, pneumatic circuits, reciprocating, cascading time delay etc. Application of pneumatics in low cost automation and in industrial automation.

Unit 6: System Analysis and Design

Calculation of piston velocity, thrust under static and dynamic applications, considering friction, inertia loads, design considerations for cylinders, Design of hydraulic/pneumatic circuits for practical application, selection of different components such as reservoir, control elements, actuators, accumulator, intensifier, filters, pumps. (Students are advised to refer manufacturers' catalogues for design and use simulation tool like Automation Studio for analysis).

Lab Practice:

Lab practice consist of any eight experiments of the following -

1. Test on Gear / Piston pump and plotting of performance characteristics.
2. Study and demonstration of various control valves (pressure / directional / flow)
3. Study and demonstration of compressed air generation and distribution system.
4. Study & demonstration of various hydraulic circuits on hydraulic trainer.
5. Study & demonstration of various pneumatic circuits on pneumatic trainer.
6. Industrial visit to automation system and report based on it.
7. Assignment on ISO symbols for different components of Hydraulic and Pneumatic system.
8. Assignment: Standard specifications of hydraulic/ pneumatic components using manufacturer's catalogues.
9. Design of simple hydraulic systems used in practice using manufacturers' catalogue and analysis using any suitable software.
10. Design of simple Pneumatic systems used in practice using manufacturers' catalogue and analysis using any suitable software.

Text books :

1. Esposito A, Fluid Power with application, Prentice Hall
2. Majumdar S.R, Oil Hydraulic system- Principle and maintenance ,Tata McGraw Hill
3. Majumdar S.R, Pneumatics Systems Principles and Maintenance ,Tata McGraw Hill
4. Stewart H. L, Hydraulics and Pneumatics , Taraporewala Publication

References books :

1. Pipenger J.J, Industrial Hydraulics, McGraw Hill
2. Pinches, Industrial Fluid Power, Prentice Hall
3. Yeaple, Fluid Power Design Handbook
4. Andrew A. Parr, Hydraulics and Pneumatics, Elsevier Science and Technology Books
5. ISO - 1219, Fluid Systems and components, Graphic Symbols
6. Standard Manufacturer's Catalogues

Prepared by: Dr. S. S. Kore

BOS Member:

BOS Chairman:



BansilalRamnathAgarwal Charitable Trust's
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Department of Mechanical Engineering

Professional Elective-V
Mechanical System Design (MEUA40182B)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits : 4 Lecture (L) : 3hrs./week Tutorial (T): -- hr. Practical (P): 2 hrs./week	20	30	20	30	25	-	125

Prerequisite: Engineering Mechanics, Manufacturing Process, Engineering Mathematics, SOM, TOM, DME, IC Engines.

Course objectives:

1. To develop competency for system visualization and design.
2. To enable student to design machine tool gearbox.
3. To enable student to design material handling systems.
4. Ability to apply the statistical considerations in design and analyze the defects and failure modes in components
5. To enable student to design cylinders, pressure vessels and internal engine components and to use IS code.
6. To enable student to study and understand automobile suspension system

Course Outcomes:

By the end of the course, students will be able

1. To design machine tool gearbox for various system.
2. To design belt conveyer system for material handling system.
3. To study different statistical methods/ techniques/ principles and apply it to mechanical components.
4. To Design various types of cylinders and pressure vessels.
5. To Understand the design concept and procedure for IC engine components.
6. To Understand the concept for automobile suspension system.

Unit I - Design of Machine Tool Gearbox

Introduction to machine tool gearboxes, design and its applications, basic considerations in design of drives, determination of variable speed range, graphical representation of speed and structure diagram, ray diagram, selection of optimum ray diagram

Unit II - Design of Belt conveyer system for material handling

System concept, basic principles, objectives of material handling system, unit load and containerization. Belt conveyors, Flat belt and troughed belt conveyors, capacity of conveyor, rubber covered and fabric ply belts, belt tensions, conveyor pulleys, belt idlers, tension take-up systems, power requirement of horizontal belt conveyors for frictional resistance of idler and pulleys.

Unit III – Design of Cylinder

Design of Cylinders:

Thin and thick cylinders, Lame's equation, Clavarino,,s and Bernie's equations, design of hydraulic and pneumatic cylinders, auto-frettagage and compound cylinders, (No Derivation) gasketed joints in cylindrical vessels

Unit IV- Design of Pressure Vessel

Design of pressure Vessel:



Modes of failures in pressure vessels, unfired pressure vessels, classification of pressure vessels as per I. S. 2825 - categories and types of welded joints, weld joint efficiency, stresses induced in pressure vessels, materials for pressure vessel, thickness of cylindrical shells and design of end closures as per code, nozzles and openings in pressure vessels, reinforcement of openings in shell and end closures - area compensation method

Unit V- Design of I. C. Engine components

Introduction to selection of material for I. C. engine components, Design of cylinder and cylinder head, construction of cylinder liners, design of piston and piston-pins, piston rings, design of connecting rod. Design of crank-shaft and crank-pin, (Theoretical treatment only).

Unit VI– Automobile Suspension System

Suspensions: Types of suspension linkages, types of suspension springs- leaf, coil, air springs, hydro gas, rubber suspension, interconnected suspension, self levelling suspension (active suspension), shock absorbers (hydraulic and air)

Text Books:

1. Bhandari V.B. —Design of Machine Elements, Tata McGraw Hill Pub. Co.Ltd.
2. Juvinal R.C, Fundamentals of Machine Components Design, Wiley, India

Reference Books:

1. Shigley J. E. and Mischke C.R., —Mechanical Engineering Design, McGraw Hill Pub.Co
2. M. F. Spotts, —Mechanical Design Analysis, Prentice Hall Inc.
3. Black P.H. and O. Eugene Adams, —Machine Design, McGraw Hill Book Co. Inc.
4. Johnson R.C., —Mechanical Design Synthesis with Optimization Applications, Von Nostrand Reynold Pub.
5. S.K. Basu and D. K. Pal, —Design of Machine Tools,, Oxford and IBH Pub Co.
6. Rudenko, Material Handling Equipment, M.I.R. publishers, Moscow
7. P. Kannaiah, Design of Transmission systems, SCIETCH Publications Pvt Ltd.
8. Pandey, N. C. and Shah, C. S., —Elements of Machine Design—, Charotar Publishing House.
9. Mulani, I. G., —Belt Conveyors
10. Singiresu S. Rao, Engineering Optimization: Theory and Practice, John Wiley & Sons.
11. M.V. Joshi, Process Equipment Design, Mc-Millan.
12. Design Data—, P.S.G. College of Technology, Coimbatore.
13. Bhandari, V. B. Machine Design data book, Tata McGraw Hill Publication Co. Ltd.
14. I.S. 2825: Code for unfired pressure vessels.



Lab Practice – Mechanical System Design (MEUA40182B)

Term work: Term work shall consist of

1. One design project

The design project shall consist of two imperial size sheets (Preferably drawn with 3D/2D CAD software) - one involving assembly drawing with a part list and overall dimensions and the other sheet involving drawings of individual components, manufacturing tolerances, surface finish symbols and geometric tolerances must be specified so as to make it working drawing. A design report giving all necessary calculations of the design of components and assembly should be submitted. Projects shall be in the form of design of mechanical systems including pressure vessel, conveyor system, multi speed gear box, I.C engine, etc.

2. Assignments

The assignment shall be internally presented in the form of power point presentation by a group of two or three students. A report of assignment (Max 8 to 10 pages) along with print out of PPT is to be submitted.

Each student shall complete any two of the following:

1. Design review of any product/ system for strength and rigidity considerations.
2. Design review of any product/system for manufacturing, assembly and cost considerations.
3. Design review of any product/system for aesthetic and ergonomic considerations.
4. Analysis of any product/system using reverse engineering.
5. Case study of one patent from the product design point of view.
6. Failure mode and effect analysis of one product/component.
7. Design of Experiments (DOE)
8. Selection of gear box for various mechanical system like epicyclic gear trains , differential gear boxes , speed reducer etc
9. Design of Human Powered system.
10. Application of composite material for different mechanical components.
11. Design of material handling system for specific / various applications such as chain and screw conveyors
12. Concurrent engineering

Prepared by: Prof.A.V.Salve

BOS Member:

BOS Chairman:

**Professional Elective-V**
Total Quality Management (MEUA40182C)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits : 4							
Lecture (L) : 3hrs./week							
Tutorial (T): -- hr.	20	30	20	30	25	-	125
Practical (P): 2 hrs./week							

Prerequisite: Engineering Mathematics, Manufacturing Processes, Manufacturing Technology.

- **Course Objectives:** To facilitate the understanding of total quality management principles and processes.

Course Outcomes:

After successful completion of the course, student will be able to

- Understanding the basic concepts of TQM and tools.
- Develop a thinking towards Quality systems and thinking.
- Understand the application and processes of the various Quality Awards.
- Acknowledge the importance of both internal and external customer.
- Understanding the concept of the PDSA, PDCA cycle and problem-solving method.
- Understand the structure and functions of quality council in order to drive TQM Implementation

Unit I: Introduction to Quality

Introduction to Quality, The History and Importance of Quality; Defining Quality; Quality in Management Framework, Control Charts Control Chart for Variable (X & R Chart) & Attribute (P & C Chart), Process capability, Statistical Process Control (Numerical).

Unit II: Total Quality In Organization

Total Quality in Organization- Quality and Quality System Thinking; Quality in Manufacturing; Quality in Service; Quality in Small Business; Quality in Public Sector.

Unit III: Philosophies and Framework

Philosophies and Framework - The Deming Philosophy; The Juran Philosophy; The Crosby Philosophy. Quality Management awards and Frameworks, The Malcolm Baldrige National Quality Award, International Quality awards and Programs, ISO 9000:2000. Evolution of Six Sigma, Baldrige Award

Unit IV: Focusing on Customers

Focusing on Customers the Importance of Customer Loyalty and Satisfaction; Creating Satisfied Customers; Customer Relationship • Acknowledge the importance of both internal and external customer • Focus on Customer satisfaction through defined quality processes. • Use of Deming Philosophy in customer 4 Management: Measuring Customer Satisfaction

Unit V: Continuous Process Improvement

Continuous Process Improvement- Juran Trilogy, Improvement Strategies, Types of Problems, The PDCA, PDSA cycle, Problem solving Methods, Kaizen, Reengineering

Unit VI: Leadership And Strategic Planning

Leadership and Strategic Planning - Leadership theory and practices, Creating the leadership system, Strategic Planning, leadership, strategy and organization structure, leadership for Quality; The Seven Management and Planning tools



List of Practical's (Any Eight)

Use of computational tools [such as Minitab / Mat lab / MS Excel] are recommended

- (1). Analyse the fault in given batch of specimens by using seven quality control tools for engineering application. Submission of these assignments USING STANDARD FORMATS.
 - (2). Determination of process capability from given components and plot variable control chart/ attribute chart.
 - (3) Red Bead experiment: Speculate the probability of distribution of beads w.r.t quantity of input, Quality of input, and analyze w.r.t application of 7 QC tools. Plot distribution graphs with qualitative statistics to substantiate data generated by red bead experimentation
 - (4). Case study on various tools in Total Quality Management (TQM).
 - (5). Design an alternative system for above using DFSS approach.
 - (6). Case study and presentation on PDCA Cycle with industry experience
- Funnel Experiment: To plan and study the effect of
- (7) Contingent adjustment of funnel at the end of last five experiments. Repeating to understand an of ans. Plot all scenarios.
 - (8) Continuous error correction, and study the role of compensation and under/overcompensations, and plot consistency
 - (9). Design of Experiments Software

Textbooks:

1. Dale H. Besterfield, Pearson, Total quality Management, Pearson Education
2. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012

Reference Books:

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.
2. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.
3. Janakiraman. B and Gopal.R.K., "Total Quality Management – Text and Cases", Prentice Hall (India) Pvt.Ltd., 2006.

Prepared by: Mr. A. A. Somatkar

BoS Member: Dr. S. S. Chinchankar

BoS Chairman: Dr .D N. Kamble



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Professional Elective-V

Automobile Engineering (MEUA40182D)

Teaching Scheme	Examination Scheme						
Credits:4 Lecture (L): 3hrs./week Tutorial (T): -- hr. Practical (P): 2 hrs./week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	25	-	125

Prerequisite: Strength of Materials, Theory of Machines, Machine Design, Workshop Practice I.

Course Objectives:

- To make the student conversant with fundamentals of automobile systems.
- To develop competencies in performance analysis of vehicles.
- To make the student conversant with automobile safety, and vehicle Standard.

Course Outcomes:

- After successful completion of the course, student will be able to Describe the function of each automobile component.
- To know different types of suspension and baking system.
- Estimation of steering kinematics of four-wheel vehicle.
- Analyse the tire ride properties for better vehicle performance.
- Identify the equation of motion used in vehicle to know the forces acting on it.
- Required to know safety parameters and emission standard of a vehicle.

Unit 1- Introduction automobile Engineering

Automobile history and development, Classification, vehicle layout- engine location and drive arrangement, safety regulations, specifications of vehicles, Type of vehicle bodies, Chassis types, constructional details, Frames, sub frames, frameless vehicles, vehicle dimensions), details of chassis material, Vehicle life development cycle overview.

Unit II - Suspension System and Brakes

Sprung and unsprung mass, roll center, Types of suspension linkages, Type of springs- leaf, coil, air springs, hydro gas suspension, rubber suspension, interconnected suspension, self-leveling suspension (active suspension), damping and shock absorbers Types of brake systems - drum, disc, Operation- mechanical, hydraulic, air brakes, servo and power braking, Stopping distance, electronic brake force distribution (EBD), ABS.

Unit III - Steering Kinematics

Terminology, definitions – reference frame, toe-in, toe-out, wheel camber, caster and kingpin angle, steering offset, Steering geometry and types of gear box, power steering, equivalent mechanisms (front view / side view), anti-dive and squat geometry, roll center analysis, steering geometry, error, steering force and moments.

Unit IV- Tire Characteristics

Tire – types, axis system, mechanics of pneumatic tires - tire forces and moments, rolling resistance of tires, tractive (braking) effort and longitudinal slip (skid), cornering properties of tires, performance of tires on wet surfaces, ride properties of tires.

Unit V- Vehicle Performance

Equation of motion and maximum tractive effort, aerodynamic forces and moments, vehicle body moments, roll over, road performance curves, acceleration time and distance, gradability, Parameters,



vehicle resistances, power requirement for propulsion, stability of vehicles, vehicle testing on chassis dynamometer.

Unit VI- Vehicle safety and Standards

Types of active and passive safety, vehicle interior and ergonomics, NVH in automobiles. Types of vehicle maintenance, Electronic Stability Control (ESC), engine emission control by 3-way catalytic converter system, Emission norms (Euro & BS), Alternative energy sources.

List of Practical:

1. Vehicle layout of four-wheeler to study the different components.
2. Design of chassis of FSAE using any design software.
3. Demonstration of suspension system of a vehicle.
4. Assembly and disassembly of gear box.
5. Design and study of steering system of any four-wheeler.
6. Calculation of tire forces and moments.
7. Testing of vehicle parameter using any virtual software.
8. Study of front and rear axle of a vehicle.
9. Study of vehicle emission standards.

10. Industrial Visit.

Text Books:

12. Hans Hermann Braess, Ulrich Seiffen, handbook of Automotive Engineering, SAE Publications ISBN-10: 0768007836 ISBN-13: 978-0768007831.
13. A Textbook of Automobile Engineering by R.K. Rajput ISBN : 8170089913,978-8170089919
14. Joseph Heitner, Automotive Mechanics 2013 -C.B.S Publishers and Distributors ISBN-13: 9788176710152.
15. SAE Manuals and Standard.
16. Internal Combustion Engines by v Ganeshan ISBN : 1259006190, 978-1259006197
17. Automobile Mechanics -.N. K. Giri ISBN-10: 81-7409-216-1 ISBN-13: 978-81-7409-216-1.
18. Automobile Electrical Equipment -P. S. Kohali ISBN-10: 0074602160 ISBN-13: 9780074602164.
19. Narang G. B. S. Automobile Engineering - S. Chand and Company Ltd.
20. Singh Kripal - Automobile Engineering -Volume 2 New Chand Jain. EAN: 9788180141775.

Reference Books :

3. Road Vehicle Dynamics – Problems & Solutions, Rao & Dukkipati, SAE ISBN: 0768020514, 9780768020519.
4. Theory of Ground Vehicles, J.Y. Wong, John Wiley & Sons ISBN: 978-0-470-17038-0.
5. Fundamentals of Vehicle Dynamics, T.D. Gillespie, SAE ISBN-13: 978-1560911999. Kalpakjian and Schmid - Manufacturing Engineering and Technology, Prentice Hall, New Jersey, 2013

Prepared by: Prof.P.P.Rathod

BOS Member:

BOS Chairman:



Open Elective II Project Planning and Management (IOEUA40183A)							
Teaching Scheme	Examination Scheme						
Credits: 4	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 3 hrs./week							
Tutorial (T): NA							
Practical (P): 2 hrs./week	20	30	20	30	-	25	125
Course Objective(s): <ol style="list-style-type: none"> To impart knowledge of project life cycle. To introduce students to Project Identification Process, Project Initiation, Pre-Feasibility Study and Project feasibility Studies, To construct CPM, PERT network for a project. To introduce students to Steps in Risk Management, Risk Identification, Risk Analysis and Reducing Risks To introduce students to process of project Performance Measurement, Evaluation and closeout. 							
Course Outcomes: Upon completion of the course, students will be able to <ol style="list-style-type: none"> Understand what a Project is, Essential of Project Management. Understand the Project Identification Process, Project Initiation, Pre-Feasibility Study and Project feasibility Studies, Learn and Apply project planning and controlling techniques. Identify risks in a project and strategies for managing the project risks Understand project risk Management and Quality control in a project. Understand the process of project Performance Measurement, Evaluation and closeout. 							
Unit I: Basics of Project Management							
Introduction, Need, Project Management Knowledge Areas and Processes, Concept of Organizational Structure and types, The Project Life Cycle (preferably with case study), Essentials Project Management Principles.							
Unit II: Project Identification and Selection							
Introduction, Project Identification Process, Project Initiation, Pre-Feasibility Study, Feasibility Studies, Project Break-even point. Case study is preferred							
Unit III: Project Planning and controlling							
Introduction, Need for Project Planning, Work Breakdown Structure (WBS), LOB, CPM and PERT, Resource Allocation, Monitoring and Control of project, Crashing, Resource Leveling, Updating							
Unit IV: Project Risk Management							
Identifying potential risks in a project, categorizing of project risks, and defining the strategies for managing the project risks							
Unit V: Project Monitoring							
Project monitoring Progress reporting, review meetings and report. Common causes of schedule delays, measuring productivity, methods of enhancing productivity, issue in project delays, Concept of quality, aspects of quality, quality control and assurance, inspection, preparation of manuals and checklists							
Unit IV: Project Performance Measurement, Evaluation and closeout							



Introduction, Performance Measurement, Productivity, Project Performance Evaluation, Benefits and Challenges of Performance Measurement and Evaluation, Project Close-out, Steps for Closing the Project, Project Termination, and Project Follow-up. Case study is preferred

Term Work:

Assignments on all units

Textbooks:

1. Operations Research by Premkumar Gupta and D.S.Hira, S. Chand Publications (2014)
2. Project Management – K Nagrajan – New age International Ltd.
3. Project Management – Ahuja H.N. – John Wiley, New York.
4. Project Management-Planning and Control---Rory Burkey 4th ed.—Wiley,India.

Reference Books:

1. Project Risk Management - Bruce Barkley- McGraw-Hill, 2004



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Open Elective -II
Software Testing (IOEUA40183B)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits : 4 Lecture (L) : 3hrs./week Tutorial (T): -- hr. Practical (P): 2 hrs./week	20	30	20	30	-	25	125

Prerequisites :	
•	Software Engineering, Java Programming
Course Objectives :	
	<ul style="list-style-type: none">• To study and understand software testing terminologies and framework• To study and understand the basics of software testing life cycle• To study and understand test and defect management• To study and understand an automation testing• To study and understand an automation testing tools• To study and understand automation testing for web application
Course Outcomes :	
	After completion of the course, student will be able to <ol style="list-style-type: none">1. Understand complete software testing life cycle and various terms and technologies used in testing domain2. Demonstrate understanding of generating test plan and designing test cases3. Demonstrate understanding of test and defect management process4. Demonstrate understanding of automation testing5. Create test script and execute automated tests using Selenium IDE6. Create test script and execute automated tests using TestNG Framework
Unit I:	Introduction to Testing
	Why is testing necessary? What is testing? Role of Tester, Testing and Quality, Overview of Software Testing Life Cycle, V model, SDLC vs STLC, different stages in STLC, document templates generated in different phases of STLC, different levels of testing, different types of testing
Unit II:	Basics of test design techniques
	Static techniques, reviews, walkthroughs, Various test categories, test design techniques for different categories of tests. Designing test cases using MS-Excel.
Unit III:	Test and Defect Management
	Test Management: Documenting test plan and test case, effort estimation, configuration management, project progress management. Use of Testopia for test case documentation and test management. Defect Management Test Execution, logging defects, defect lifecycle, fixing / closing defects. Use of Bugzilla for logging and tracing defects.
Unit IV :	Basics of Automation testing
	Introduction to automation testing, why automation, what to automate, tools available for automation testing.
Unit V :	Automation testing using Selenium
	Understanding to Selenium, using Selenium IDE for automation testing, using Selenium Web driver for automation testing.



Unit VI :	Automation testing using TestNG Framework
Understanding TestNG framework, Automation testing using TestNG Framework.	
Text Books :	
1.	M G Limaye, "Software Testing Principles, Techniques and Tools", Tata Mcgraw Hill, ISBN: 9780070139909 0070139903
2.	Srinivasan Desikan, Gopalswamy Ramesh, "Software Testing Principles and Practices", Pearson, ISBN-10: 817758121X
Reference Books :	
1.	Naresh Chauhan, "Software Testing Principles and Practices ", OXFORD, ISBN-10: 0198061846. ISBN-13: 9780198061847
2.	Dr.K.V.K. Prasad , "Software Testing Tools", Dreamtech Press ISBN: 10:81-7722-532-4

Prepared by:

BOS Member:

BOS Chairman:



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Open Elective -II
5G Mobile Network (IOEUA40183C)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits : 4							
Lecture (L) : 3hrs./week							
Tutorial (T): -- hr.	20	30	20	30	-	25	125
Practical (P): 2 hrs./week							

Prerequisite: Students are expected to know the concepts studied in following courses:

- Basics of Analog and Digital Communication
- Basics of Mobile Communication
- Basics of Networking

Course Objectives:

- To understand evolution of 5G technologies with its challenges
- To describe 5G cellular structure and design to achieve appropriate gain
- To discuss fundamentals of 5G functional and physical architecture and its requirements
- To understand design principles for multi-user communications
- To design and interpret the 5g Use cases

Course Outcomes: At the end of this course, students will demonstrate the ability to

1. Understand evolution of 5G technologies with its challenges
2. Interpret the 5G cellular structure and design to achieve appropriate gain
3. Illustrate and explain the 5G functional and physical architecture and its requirements
4. Comprehend the Radio access technology in 5G
5. Understand Cooperation in 5G systems and analysis in terms of QOS
6. Design and analysis of 5G Use Cases

Unit- I: Drivers For 5G (6 Hrs)

Historical Trend for Wireless Communication - Mobile Communications Generations: 1G to 4G – Evolution of LTE Technology to Beyond 4G – Pillars of 5G – Standardization Activities -Use cases and Requirements – System Concept – Spectrum and Regulations: Spectrum for 4G – Spectrum Challenges in 5G – Spectrum Landscape and Requirements – Spectrum Access Modes and Sharing Scenarios(R1)

Unit- II: Small Cells for 5G Mobile Network(6 Hrs)

Introduction to Small Cells, WiFi and Femtocells as Candidate Small-Cell Technologies ,performance- Indoor and Outdoor, Capacity Limits and Achievable Gains with Densification , Gains with Multi-Antenna Techniques, Gains with Small Cells,Demand vs Capacity,Small Cell challenge (R1)

Unit –III: 5G Architecture And Channel Models(6 Hrs)



5G Architecture: Software Defined Networking, Network Function Virtualization , Basics about RAN Architecture ,High-Level Requirements for 5G Architecture ,Functional Architecture and 5G Flexibility ,Physical Architecture and 5G Deployment
5G wireless propagation channel models: Modeling requirements and scenarios, Channel model requirements, Propagation scenarios, The METIS channel models, Map-based model, Stochastic model(R2)

Unit IV : - 5G Radio-Access Technologies and Millimeter wave communication(6 Hrs)

Access design principles for multi-user communications, Multi-carrier with filtering: a new waveform, Non-orthogonal schemes for efficient multiple access, Radio access for dense deployments, Radio access for V2X communication
Millimeter Wave Communication: Channel Propagation – Hardware Technologies for mmW Systems – Deployment Scenarios – Architecture and Mobility – Beamforming – Physical layer Techniques.

Unit V: Cooperation for Next Generation Wireless Networks(6 Hrs)

Introduction to Cooperative Diversity and Relaying Strategies ,Cooperation and Network Coding,Cooperative ARQ MAC Protocols,PHY Layer Impact on MAC Protocol Analysis ,Impact of Fast Fading and Shadowing on Packet,Reception for QoS Guarantee,Impact of Shadowing Spatial Correlation

Unit VI: 5G Use Cases and Deployment(6 Hrs)

NB-IoT Devices, Smart Parking, Smart City, Smart Home, Message Queue Telemetry Transport (MQTT), MQTT telemetry. NB-IoT Baseline Deployment, Deployment bands and modes

Text Books :

1. Jonathan Rodriguez “Fundamentals of 5G Mobile Networks”,Wiley Publication
2. Afif Osseiran, Jose F . Monserrat, Patrick Marsch “5G Mobile and Wireless Communications Technology”, Cambridge University Press.
3. Hossam Fattah “5G LTE Narrowband Internet of Things(NB-IoT) ,CRC Press

Reference Books :

1. Fei Hu, “Opportunities in 5G Networks: A research& development perspective”, CRC Press
2. Krzysztof Wesolowski, “Mobile Communication Systems”, Wiley Student Edition
3. Mischa Schwartz, “Mobile Wireless Communications”, Cambridge University Press
4. AdityaJagannatham, “Principles of Modern Wireless Communication Systems”

List of Experiments:

After completion of this course student should be able to

1. NS-3 simulation basics. Basic client server paradigm
2. Study of TCP internals and the difference between each of the variants. NS-3 tracing mechanism
- 3.Study of Queues, packet drops and their effect on congestion window size
- 4.Study of Optimised Link State Routing(MANETS)
5. Study of 802.11 working with and without RTS/CTS. An insight into why its hard to setup efficient wireless networks.
6. Study of effect of Radio channel models transmission. An insight into Identifying the channel model that is more appropriate for each case (indoor, outdoor, LoS, NLoS, etc.).



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mmWave network simulator project implementation

Mini Project/Seminar (SCE)



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Open Elective -II
Cloud Computing (IOEUA40183D)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits : 4 Lecture (L) : 3hrs./week Tutorial (T): -- hr. Practical (P): 2 hrs./week	20	30	20	30	-	25	125

Prerequisites : Computer Networks

Course Objectives:

- To understand cloud computing concepts.
- To study supporting technologies of cloud.
- To study open research problems of cloud computing.
- To study various platforms for cloud computing.
- To explore the applications based on cloud computing.
- To study and evaluate the contemporary technologies in cloud computing.

Course Outcomes:

After completion of the course, student will be able to

- Summarize the basic concepts of cloud computing (Remember)
- Explore the supporting technologies of cloud computing (Understand)
- Analyze the challenges and opportunities in the cloud computing (Analyze)
- Use the cloud services for deployment of his own applications (Create)
- How technologies are interrelated and use with each other (Apply)
- To explore future trends of cloud computing (Evaluate)

UNIT I - Basics of Cloud Computing

Overview, Applications, Intranets and the Cloud. Your Organization and Cloud Computing- Benefits, Limitations, Security Concerns. Software as a Service (SaaS)- Understanding the Multitenant Nature of SaaS Solutions, Understanding SOA. Platform as a Service (PaaS)-IT Evolution Leading to the Cloud, Benefits of PaaS Solutions, Disadvantages of PaaS Solutions. Infrastructure as a Service (IaaS)-Understanding IaaS, Improving Performance through Load Balancing, System and Storage Redundancy

Case Study: Google Cloud Platform

UNIT II – Virtualization

Implementation Levels of Virtualization, Virtualization Structures/Tools and Mechanisms, Types of



Hypervisors, Virtualization of CPU, Memory, and I/O Devices, Virtual Clusters and Resource Management, Virtualization for Data-Center Automation.

Common Standards: The Open Cloud Consortium, Open Virtualization Format. Standards for Security. Case study : VirtualBox, vmware

UNIT III - Data Storage and Security in Cloud

Cloud file systems: GFS and HDFS, BigTable, HBase and Dynamo Cloud data stores: Datastore and Simple DB Cloud Storage-Overview, Cloud Storage Providers. Case study: Firebase. Securing the Cloud- General Security Advantages of Cloud-Based Solutions, Introducing Business Continuity and Disaster Recovery. Disaster Recovery- Understanding the Threats. Case study: Discuss research problems of cloud security

UNIT IV - Amazon Web Services

Services offered by Amazon Hands-on Amazon, EC2 - Configuring a server, Virtual Amazon Cloud, AWS Storage and Content Delivery Identify key AWS storage options Describe Amazon EBS Creating an Elastic Block Store Volume Adding an EBS Volume to an Instance Snap shooting an EBS Volume and Increasing Performance Create an Amazon S3 bucket and manage associated objects. AWS Load Balancing Service Introduction Elastic Load Balancer Creating and Verifying Elastic Load Balancer.

UNIT V - Ubiquitous Clouds and the Internet of Things

Introduction to Ubiquitous computing, Cloud Trends in Supporting Ubiquitous Computing, Performance of Distributed Systems and the Cloud, Enabling Technologies for the Internet of Things (RFID, Sensor Networks and ZigBee Technology, GPS), Innovative Applications of the Internet of Things (Smart Buildings and Smart Power Grid, Retailing and Supply-Chain Management)

UNIT VI -Future of Cloud Computing

Docker at a Glance: Process Simplification, Broad Support and Adoption, Architecture, The Docker Workflow. Docker compose file, Docker volume, Docker storage.

Kubernetes : introduction to Kubernetes, Features of Kubernetes, Kubernetes API, Basic Architecture, Minikube.



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Open Elective -II
Solar and Wind Energy (IOEUA40183E)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits: 4 Lecture (L): 3hrs./week Tutorial (T): -- hr. Practical (P): 2 hrs./week	20	30	20	30	-	25	125

Prerequisite: Basic Mechanical Engineering, Basic Electrical and Electronics Engineering and Heat Transfer

Course Objectives:

- To understand fundamentals of solar and wind energies.
- To understand constructions, working principle and design procedure of solar and wind power plants.
- To apply basic engineering principle to design a simple solar and wind power system.

Course Outcomes:

After successful completion of the course, student will be able to

1. Understand solar radiation and geometry principles.
2. Apply specifications of Solar Cell for different applications.
3. Recognize design process of solar pv system for domestic purpose.
4. Acknowledge Wind Data for site selection.
5. Identify types of Wind Plant for a given application.
6. Design miniature Mini/ Micro wind mill for Residential purpose.

Unit I : Solar Energy Basics

Present solar energy scenario in India, governing bodies (self-study), solar radiations and its measurements, solar constant, solar radiation geometry, solar radiation data, estimation of average solar radiation, solar radiation on tilted surface.

Unit II: Solar Cell Operation

Solar Spectrum, Solar Radiation Spectrum, Worked Problem - Total Irradiance, Solar Cell Fundamentals, Worked Problem - The I-V Characteristic, Solar Cell Types and Technologies, Multi-junctions. Conversion Efficiency Limitations, Worked Problem - Solar Cell under Concentration, From Cell to Module, Energy Audit of Home/Residence

Unit III: Design of Solar PV Systems

PV Sizing and Output, Orientation and Tilt, Temperature Dependent Output, Temperature Dependent Output as a Percent, Module and array conditions, Shading calculations using PV Watts, PV Sizing and output under different conditions, Inverter Sizing and Selection, Case Studies

Unit IV: Wind Energy and its assessment

Wind power scenario in India, Characteristics of Wind Energy: Wind movement, wind profile, roughness, effects of obstacles in wind path. wind data and site selection considerations, Comparison with Solar Energy, Types of Wind Turbine Blades, Blade Profile

Unit V: Wind Power Plants



Types of Wind Power Plants (WPPs): Small and large wind turbines; Horizontal and Vertical axis; Upwind and Downwind, One, Two and Three blades; constant and variable Speed; Geared, Direct-Drive and Semi-Geared (Hybrid) WPPs; WECS, WEGs, WTs, WPPs,
WPP Tower Types: Lattice; tubular: steel, concrete, hybrid, ladders, cables
WPP substation: Switchgear, transformers, electronic components.

Unit VI: Design and Control Aspects of Wind Mill/Plant

Design: horizontal and vertical axis wind turbines, blades, control mechanisms, drive train, tower, nacelle, foundation, choice of materials, manufacture, adaptation to different climates
Control: control targets, system modelling, control strategies (pitch and stall regulation), hardware
Systems: wind power parks, transports, erection, grid connection, operation, maintenance

List of Practical:

- 1: Design of solar food drier for domestic purpose referring existing system.
- 2: Measurement of Solar Insolation at Residence.
- 3: Design of Solar Pump for Farm Irrigation.
- 4: Design of solar photovoltaic system for domestic/ commercial building purpose.
5. Design of Solar Operated home appliance.
6. Case study on designing miniature wind mill for domestic purpose referring existing system.
7. Visit to Solar PV System/wind power system used in commercial building.

Text Books:

1. S. P. Sukhatme, 'Solar Energy: Principles of thermal collections and storage', McGraw Hill
2. G. D. Rai, 'Non-Conventional Energy Sources', Khanna Publisher
3. Tiwari G N. 'Solar Energy: Fundamentals, design, modeling and Applications', Narosa, 2002

Reference Books :

1. Mukund R. Patel, 'Wind And Solar Power Systems: Design, Analysis and Operation, Second Edition', CRC Press
2. Kreith And Kreider, Solar Energy Handbook, McGraw Hill
3. Ray Hunter, 'Wind Energy Conversion: From Theory to Practice', John Wiley and Son Ltd
4. Gary L Johnson, 'Wind Energy Systems', Prentice-Hall Inc., New Jersey
5. Martin O L Hansen, 'Aerodynamics of Wind Turbines', James & James/Earthscan.
6. Goswami D Y, Kreith F, Kreider J F, 'Principles of Solar Engineering', Taylor & Francis
7. Robert Gasch, 'Wind Power Plant Fundamentals, Design, Construction And Operations', Springer
8. C S Solanki, 'Solar Photovoltaic: Fundamentals, Technology And Applications', PHI Learning

Prepared by: Prof.A.V.Salve

BOS Member:

BOS Chairman:



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Open Elective -III
Business Analytics (IOEUA40184F)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits : 4 Lecture (L) : 3hrs./week Tutorial (T): -- hr. Practical (P): 2 hrs./week	20	30	20	30	-	25	125

Prerequisites :	
•	Database Management System
Course Objectives :	
•	To study and understand the importance of Business Intelligence and need of data Visualisation for Business Intelligence.
•	To study and understand the different components of analytics landscape and project cycle aligned with these components.
•	To study and understand different data transformations, data modelling steps and visualize the data on the data models.
•	To study and understand the ways of adding custom calculations needed and understanding the applications of different statistical concepts.
•	To study and understand the BI deployments, administration cycle of BI implementations using Power BI
•	To study and understand various topics and concepts in the areas of analytics and their industrial applications through study of different use cases.

Course Outcomes :	
After completion of the course, student will be able to	
1.	Describe the importance of Business Intelligence and need of data visualisation for Business Intelligence.
2.	Identify, describe, relate to the concepts of different components of analytics landscape and project cycle aligned with these components.
3.	Design and develop different data transformations, data models, analyse and visualize the data.
4.	Design and develop custom calculations based on business and technical needs and demonstrate and implement different statistical concepts.
5.	Author BI deployments, BI environments.
6.	Describe and compare industrial BI implementations, use cases and current and future trends.



Unit I:	Introduction to Analytics and Data Preparation
Introduction to Analytics: What is Analytics? Need of Analytics, Types of Analytics, Role of Analytics in Business Data Sources: Data Collection, Transactions Entry, Organizational Systems, Data Sources and Data Source Categories, Issues in Data and Need of Data Preparation Power BI Desktop: Need of visualisation, Different Visualisation tools, Why Microsoft Power BI? Installation and configuration of Power BI Desktop, Setup of required connector Data Visualization: What are KPIs? Dashboards, Reports and Scorecards, Types of Dashboards, Slicers and Filters, Setting interactivity, Drilldowns and Drill-through, Formatting your visualizations, Best practices of visualizations	
Unit II:	Data & BI Landscape and Project Cycle
Understanding Data and Databases: What is a database? What is a DBMS? What is SQL? What are tables? Organization of tables in databases, Types of Data, Database Keys, Relationships between tables, Joins and Unions, Type of Data: Structured, Unstructured and Semi-structured BI Architecture: BI Architecture, Data Security and Governance, Administration BI Project Lifecycle: Requirements Understanding, Data Understanding, Data Integration and Data warehouse, Reporting and Analysis, Dashboard development, Deployment, Documenting, Project Team and Roles, Challenges in Projects	
Unit III:	Data Preparation and Data Modelling
Data Integration and Data Warehouses: What is Data Integration? Need of Data Integration, ETL, what is Data Warehouse? Need of Data Warehouse, Facts and Dimensions Star Schema and Snowflake Schema, Data Marts Need of Data Preparations: What is Data Preparation? Joining data, Appending Data, New Calculations, Removing Inconsistencies, Transposing Data Transformation [Basics]: Merging and Appending Data, Filtering, Cleaning Data, Fixing Errors, Transforming Data, Aggregating Data Data Modelling: Setting Relationships, Creating Data Models	
Unit IV :	Custom Calculations And Analytics
Data Transformations [Advanced]: Pivot/Unpivot data, Split data, Handling inconsistent data, Conditional Column, Custom column Calculations: Introduction to DAX, Calculated Column, Calculated Measures, M-Query calculations, YTD, QTD, MTD calculations, Moving Averages and Running Total Statistical Analysis: Central Tendency: Mean, Mode, Median, Dispersion: Variance and Standard Deviation, Summarization data by using histogram	
Unit V :	Power BI Deployment, Administration And Mobility
Power BI Deployment: Overview of Power BI Service, Publishing reports to Power BI Service, Understanding the Power BI Service User Interface, Creating Dashboards in Power BI Service, Subscriptions, Comments and Data Driven Alerts, authoring reports within Power BI Service, sharing dashboards across your organization, Configuring Power BI Gateway, scheduling automated refresh of your reports using Data Gateway	



Power BI Mobile: Creating Dashboards for Mobiles, using dashboards and reports using Mobile App

Power BI Advanced Features: Using NLP to creating dashboards, Influencers, Delivering Insights, Explain Analysis

Unit VI : Industry Analytics Landscape

Tableau Overview: Introduction to Tableau, Tableau Products, Tableau architecture, Installation and Setup of Tableau Desktop, Visualizing with Tableau, Tableau online and Tableau server, Publish and share reports on Tableau online

Applications of Business Intelligence: Manufacturing Use Cases, Retail Use Cases, Marketing use Cases, Banking use cases, Future Trends of Analytics

Text Books :

1	"Business Intelligence Guidebook: From Data Integration To Analytics" by Rick Sherman, Elsevier Inc.
2	"Successful Business Intelligence, Second Edition: Unlock The Value Of BI & Big Data" by Cindi Howson, McGraw Hill Edition
3	"Data Analytics For Beginners: Your Ultimate Guide To Learn And Master Data Analysis. Get Your Business Intelligence Right – Accelerate Growth And Close More Sales" by Victor Finch
4	Data Strategy: How To Profit From A World Of Big Data, Analytics And The Internet Of Things" by Bernard Marr, KoganpagePublicaitons, Auva Press

Reference Books :

1	"Performance Dashboards – Measuring, Monitoring, And Managing Your Business" by Wayne Eckerson, John Wiley & Sons, Inc
2	"Business Intelligence Roadmap: The Complete Project Lifecycle For Decision-Support Applications" by Larissa T. Moss & Shaku Atre, Addison-Wesley information Technology Series
3	"Artificial Intelligence: Building Intelligent Systems" by Dr. Parag Kulkarni, Dr. Prachi Joshi, PHI publication (for understanding of concepts)

List of Assignments:

1	Creating multiple sample tables and joining them in Power BI
2	Connecting to data source and transforming data in Power BI
3	Connecting to data source and creating data models by establishing relationships
4	Connecting to data source and visualizing and analysing data
5	Connecting to data source and creating custom calculations
6	Deploying the dashboards and reports to Power BI Service
7	Administering and using advanced features of Power BI Service
8	Creating Mobile layouts in Power BI Desktop

Prepared by:

BOS Member:

BOS Chairman:

**Open Elective -III**
Quantum Computing (IOEUA40184B)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits : 4 Lecture (L) : 3hrs./week Tutorial (T): -- hr. Practical (P): 2 hrs./week	20	30	20	30	-	25	125

Prerequisites :	
<ul style="list-style-type: none">Data Structures and Algorithms, Programming in Python / C#, Machine Learning and Data Science Basics, Neural Networks and Deep Learning Basics, Information Theory and Models of Computation, Classical Fourier Transform	
Course Objectives :	
<ul style="list-style-type: none">To provide introduction and necessary expertise to the learner in the upcoming discipline of Quantum Computing and Machine Learning.To enable the students to learn Quantum Computing and Quantum Machine Learning in practical-oriented learning sessions so that he/she can independently use existing open-source Quantum Computing Hardware and Software Frameworks.To teach the students to develop hybrid solutions by applying Quantum Machine Learning to potential business application areas.To study Quantum Information Theory and Quantum Computing Programming Model of Computation.To study Quantum Algorithms and apply these to develop hybrid solutions .To study Quantum Concepts necessary for understanding the Quantum Computing Paradigm and compare the available hardware and software infrastructure and frameworks made available open source by major players in the Industry and Academia.	
Course Outcomes :	
After completion of the course, student will be able to	
<ol style="list-style-type: none">Explain the working of a Quantum Computing program, its architecture and programming model.Develop quantum logic gate circuits.Develop quantum algorithm(s).Program quantum algorithm on major toolkits.Develop Hybrid Solutions in Quantum Machine Learning for potential applications / use cases.Compare existing features provided by potential hardware and software infrastructure and frameworks service providers.	



Unit I:	Introduction to Quantum Computing (6 hours)
Motivation for studying Quantum Computing, Major players in the industry (IBM, Microsoft, Rigetti, D-Wave etc.), Origin of Quantum Computing, Overview of major concepts in Quantum Computing, Qubits and multi-qubits states, Bra-ket notation, Bloch Sphere representation, Quantum Superposition, Quantum Entanglement	
Unit II:	Mathematical Foundation of Quantum Computing (4 hours)
Matrix Algebra: basis vectors and orthogonality, inner product and Hilbert spaces, matrices and tensors, unitary operators and projectors, Dirac notation, Eigen values and Eigenvectors.	
Unit III:	Building Blocks for Quantum Program (8 hours)
Architecture of a Quantum Computing platform, Hybrid Approach for Application Development, Details of q-bit system of information representation: Bloch Sphere, Multi-qubits States, Quantum superposition of qubits (valid and invalid superposition), Quantum Entanglement, Useful states from quantum algorithmic perspective e.g. Bell State, Operation on qubits: Measuring and transforming using gates, Quantum Logic gates and Circuit: Pauli, Hadamard, phase shift, controlled gates, Ising, Deutsch, swap etc., Programming model for a Quantum Computing Program, Steps performed on classical computer, Steps performed on Quantum Computer, Moving data between bits and qubits, Models of Computation used by key players as OEMs in Quantum Computing	
Unit IV :	Quantum Algorithms (8 hours)
Basic techniques exploited by quantum algorithms, Amplitude amplification, Quantum Fourier Transform, Phase Kick-back, Quantum Phase estimation, Quantum Walks, Major Algorithms, Shor's Algorithm, Grover's Algorithm, Deutsch's Algorithm, Deutsch -Jozsa Algorithm, OSS Toolkits for implementing Quantum program, IBM quantum experience, Microsoft Q#, Rigetti PyQuil (QPU/QVM) OR Cambridge Quantum Computing, Google's Tensorflow Quantum, Amazon Bracket, D-Wave Frameworks	
Unit V :	Machine Learning and Deep Learning (6 hours)
Machine Learning, Deep Learning and Artificial Intelligence Basics, Machine Learning Algorithms, Deep Learning Algorithms, Evolutionary Learning Algorithms	
Unit VI :	Quantum Machine Learning (10 hours)
Quantum Machine Learning and Quantum AI, Quantum Neural Networks, Quantum Natural Language Understanding, Quantum Cryptography, Application Domains for Quantum Machine Learning: Chemistry/Material Science, Space Tech, Finance related Optimisation Problems, Swarm Robotics, Cybersecurity	
Text Books :	
1	Quantum Machine Learning (What Quantum Computing Means to Data Mining) by Peter Wittek, University of Borås, Sweden - Elsevier Publications
2	Principles of Quantum Artificial Intelligence by Andreas Winchert, Instituto Superior Técnico - Universidade de Lisboa, Portugal - World Scientific Publishing, British Library Cataloguing-in-Publication Data
Reference Books :	
1	Michael A. Nielsen, "Quantum Computation and Quantum Information", Cambridge University Press.



2	David McMahon, "Quantum Computing Explained", Wiley
3	IBM Quantum Experience: https://quantumexperience.ng.bluemix.net https://quantum-computing.ibm.com/docs/
4	Microsoft Quantum Development Kit https://www.microsoft.com/en-us/quantum/development-kit
5	Forest SDK PyQuil: https://pyquil.readthedocs.io/en/stable/
6	Amazon Bracket Documentation on AWS: https://aws.amazon.com/braket/
7	D-Wave Systems Documentation: https://docs.dwavesys.com/docs/latest/index.html

Prepared by:

BOS Member:

BOS Chairman:



BansilalRamnathAgarwal Charitable Trust's
Vishwakarma Institute of Information Technology, Pune-48
(An Autonomous Institute Affiliated to Savitribai Phule Pune University)
Department of Mechanical Engineering

Open Elective -III
Business Intelligence (IOEUA40184C)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits : 4 Lecture (L) : 3hrs./week Tutorial (T): -- hr. Practical (P): 2 hrs./week	20	30	20	30	-	25	125

Prerequisites :	
• Database Management System	
Course Objectives :	
<ul style="list-style-type: none">• To study and understand the importance of Business Intelligence and need of data Visualisation for Business Intelligence.• To study and understand the different components of analytics landscape and project cycle aligned with these components.• To study and understand different data transformations, data modelling steps and visualize the data on the data models.• To study and understand the ways of adding custom calculations needed and understanding the applications of different statistical concepts.• To study and understand the BI deployments, administration cycle of BI implementations using Power BI• To study and understand various topics and concepts in the areas of analytics and their industrial applications through study of different use cases.	

Course Outcomes :	
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- After completion of the course, student will be able to
7. Describe the importance of Business Intelligence and need of data visualisation for Business Intelligence.
 8. Identify, describe, relate to the concepts of different components of analytics landscape and project cycle aligned with these components.
 9. Design and develop different data transformations, data models, analyse and visualize the data.
 10. Design and develop custom calculations based on business and technical needs and demonstrate and implement different statistical concepts.
 11. Author BI deployments, BI environments.
 12. Describe and compare industrial BI implementations, use cases and current and future trends.



Unit I:	Introduction to Analytics and Data Preparation
Introduction to Analytics: What is Analytics? Need of Analytics, Types of Analytics, Role of Analytics in Business	
Data Sources: Data Collection, Transactions Entry, Organizational Systems, Data Sources and Data Source Categories, Issues in Data and Need of Data Preparation	
Power BI Desktop: Need of visualisation, Different Visualisation tools, Why Microsoft Power BI? Installation and configuration of Power BI Desktop, Setup of required connector	
Data Visualization: What are KPIs? Dashboards, Reports and Scorecards, Types of Dashboards, Slicers and Filters, Setting interactivity, Drilldowns and Drill-through, Formatting your visualizations, Best practices of visualizations	
Unit II:	Data & BI Landscape and Project Cycle
Understanding Data and Databases: What is a database? What is a DBMS? What is SQL? What are tables? Organization of tables in databases, Types of Data, Database Keys, Relationships between tables, Joins and Unions, Type of Data: Structured, Unstructured and Semi-structured	
BI Architecture: BI Architecture, Data Security and Governance, Administration	
BI Project Lifecycle: Requirements Understanding, Data Understanding, Data Integration and Data warehouse, Reporting and Analysis, Dashboard development, Deployment, Documenting, Project Team and Roles, Challenges in Projects	
Unit III:	Data Preparation and Data Modelling
Data Integration and Data Warehouses: What is Data Integration? Need of Data Integration, ETL, what is Data Warehouse? Need of Data Warehouse, Facts and Dimensions Star Schema and Snowflake Schema, Data Marts	
Need of Data Preparations: What is Data Preparation? Joining data, Appending Data, New Calculations, Removing Inconsistencies, Transposing	
Data Transformation [Basics]: Merging and Appending Data, Filtering, Cleaning Data, Fixing Errors, Transforming Data, Aggregating Data	
Data Modelling: Setting Relationships, Creating Data Models	
Unit IV :	Custom Calculations And Analytics
Data Transformations [Advanced]: Pivot/Unpivot data, Split data, Handling inconsistent data, Conditional Column, Custom column	
Calculations: Introduction to DAX, Calculated Column, Calculated Measures, M-Query calculations, YTD, QTD, MTD calculations, Moving Averages and Running Total	
Statistical Analysis: Central Tendency: Mean, Mode, Median, Dispersion: Variance and Standard Deviation, Summarization data by using histogram	
Unit V :	Power BI Deployment, Administration And Mobility
Power BI Deployment: Overview of Power BI Service, Publishing reports to Power BI Service, Understanding the Power BI Service User Interface, Creating Dashboards in Power BI Service, Subscriptions, Comments and Data Driven Alerts, authoring reports within Power BI Service, sharing dashboards across your organization, Configuring Power BI Gateway, scheduling automated refresh of your reports using Data Gateway	
Power BI Mobile: Creating Dashboards for Mobiles, using dashboards and reports using Mobile App	



Power BI Advanced Features: Using NLP to creating dashboards, Influencers, Delivering Insights, Explain Analysis

Unit VI : Industry Analytics Landscape

Tableau Overview: Introduction to Tableau, Tableau Products, Tableau architecture, Installation and Setup of Tableau Desktop, Visualizing with Tableau, Tableau online and Tableau server, Publish and share reports on Tableau online

Applications of Business Intelligence: Manufacturing Use Cases, Retail Use Cases, Marketing use Cases, Banking use cases, Future Trends of Analytics

Text Books :

1	"Business Intelligence Guidebook: From Data Integration To Analytics" by Rick Sherman, Elsevier Inc.
2	"Successful Business Intelligence, Second Edition: Unlock The Value Of BI & Big Data" by Cindi Howson, McGraw Hill Edition
3	"Data Analytics For Beginners: Your Ultimate Guide To Learn And Master Data Analysis. Get Your Business Intelligence Right – Accelerate Growth And Close More Sales" by Victor Finch
4	Data Strategy: How To Profit From A World Of Big Data, Analytics And The Internet Of Things" by Bernard Marr, KoganpagePublicaitons, Auva Press

Reference Books :

1	"Performance Dashboards – Measuring, Monitoring, And Managing Your Business" by Wayne Eckerson, John Wiley & Sons, Inc
2	"Business Intelligence Roadmap: The Complete Project Lifecycle For Decision-Support Applications" by Larissa T. Moss & Shaku Atre, Addison-Wesley information Technology Series
3	"Artificial Intelligence: Building Intelligent Systems" by Dr. Parag Kulkarni, Dr. Prachi Joshi, PHI publication (for understanding of concepts)

List of Assignments:

1	Creating multiple sample tables and joining them in Power BI
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5	Connecting to data source and creating custom calculations
6	Deploying the dashboards and reports to Power BI Service
7	Administering and using advanced features of Power BI Service
8	Creating Mobile layouts in Power BI Desktop

Prepared by:

BOS Member:

BOS Chairman:



BansilalRamnathAgarwal Charitable Trust's
Vishwakarma Institute of Information Technology, Pune-48
 (An Autonomous Institute Affiliated to Savitribai Phule Pune University)
Department of Mechanical Engineering

Open Elective -III
Robotics (IOEUA40184A)

Teaching Scheme	Examination Scheme						
Credits:4 Lecture (L): 3hrs./week Tutorial (T): -- hr. Practical (P): 2 hrs./week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	-	25	125
Prerequisite: NA							
Course Objectives:							
<ul style="list-style-type: none"> • To acquire basic understanding of Industrial Robots and its technological applications • To understand peripherals of Robotic system and their use. 							
Course Outcomes:							
Upon completion of the course, students will be able to							
<ol style="list-style-type: none"> 1. Recognize and differentiate between different types of Robots, and their features. 2. Understand industrial applications of Robots. 3. For the given industrial application students will be capable of selecting the appropriate Robot considering all the parameters. 4. Understand different concepts related to industrial Robotics like Robot programming methods, end effectors, sensors, actuators etc. 							
Unit I: Fundamental of Robotics							
Evolution of Robots, Types of Robots, Reason behind use of Robot, Robot Uses cases, Advantages of Robot, Disadvantages of Robot, Defining Robot, Laws of Robotics, Future of Robot,							
Unit II: Performance Specifications of Industrial Robots							
DOF of Robot, Joints and Links in Robot, Singularity in Robots, Industrial Applications of Robot, Selection parameters and Robot Specification.							
Unit III: Insight Industrial Robot							
Actuators: Pneumatic, Hydraulic and Electric, Brakes, Transmission, Gears, Soft limits and Hard Limits. Controller, Teach Pendant, End Effectors, Fixtures, Pneumatic System, Communication between System Peripherals.							
Unit IV: System Peripherals							
Controller, Teach Pendant, End Effectors, Field Sensors, Fixtures, Communication between System Peripherals, Pneumatic System, PLC, SCADA, IIOT.							
Unit V: Robot Programming							
Robot Programming Concepts, Programming Methods, Offline Programming, Programming Languages, Program Organization, Writing Robot Program of Instructions, Robot Simulation, Coordinate Systems.							



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Unit VI: Social Issues Related to Robotics

Reasons for installing Robots, Economic costs and benefits of installing industrial Robots, Acceptability of industrial Robots by the workforce, Employment and Other social issues of Robotics.

Text/Reference Books :

01. Mikell P Groover, Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, "Industrial Robotics, Technology programming and Applications", McGraw Hill, 2012.
02. Craig. J. J. "Introduction to Robotics- mechanics and control", Addison- Wesley, 1999.
03. Saeed B. Niku, " Introduction to Robotics – Analysis, Systems and Application" : PHI 2006
04. D J Todd, "Fundamentals Of Robot Technology" Kogan Page, 1986

Practical :

1. System Peripherals
2. Jogging in Different Modes and their Differences
3. Path Planning
4. Robot Programming

Extended Support from iRobotics:

01. Internship: After the conduction of subject, iRobotics may provide an internship opportunity to some students subject to vacancy and eligibility.

02. Project Assistance: iRobotics will provide the project assistance to some students group in Robotics and Automation.

Lecturers:

1. Pranav Lad : Head, Research and Development Department, iRobotics
2. Sopan Kadam : Senior Robotic Engineer, Application Department, iRobotics
3. Rohit Ekatpure : Senior Robotics Engineer, Proposal Department, iRobotics



Intellectual Property Rights (MEUA40185)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits: 2 Lecture (L): 2 hrs./week Tutorial (T): hr. Practical (P): - hrs./week	-	-	50	-	-	-	50

Course objectives:

- The course is designed to introduce fundamental aspects of Intellectual property Rights.
- The course introduces all aspects of the IPR Acts.
- It also includes case studies to demonstrate the application

Course outcomes:

Upon completion of course, students will be able to

1. Demonstrate and develop awareness and impact of patent law on their academics and professional life.
2. Understand the procedure of patent filing.
3. Understand and aware importance of trade mark in industry.
4. Apply knowledge to read the patent document.

Unit 1: Overview of Intellectual Property

Introduction and the need for intellectual property right (IPR) IPR in India – Genesis and Development IPR in abroad Some important examples of IPR

Unit II : Patents

Macro economic impact of the patent system, Patentability, Types of IP tools, Copyright, trademarks, Patent databases, Patent document and its search, Rights of a patent,

Unit III : Patent Search

Searching a patent, Patent database, Patent free database. Patent structure, Patent grants Procedure in India, Different layers of the international patent system (National, Regional and international options). Copyright- Definition of copyright, Content of copyright, What are related rights, Rights covered by copy right.

Unit IV : Trademark

Definition of trademark, Rights of trademark, Kind of signs can be used as trademarks, Types of trademark function, Protection of trademark, Trademark registration.

Text Books :

1. Resisting Intellectual Property by Halbert ,Taylor & Francis Ltd ,2007
2. Industrial Design by Mayall, McGraw Hill
3. Intellectual Property Rights Under WTO by T. Ramappa, S. Chand
4. Encyclopedia of Ethical, Legal and policy issue in Biotechnology by T. M. Murray and M. J. Mehlman, John Wiley and Sons 2000.



Reference Books :

1. Nanotechnology Intellectual Property Rights: Research, Design, and Commercialization by Dr. S. K. Jabade, CRC Press
2. Product Design by Niebel, McGraw Hill
3. Introduction to Design by Asimov, Prentice Hall
4. Intellectual Property in New Technological Age by Robert P. Merges, Peter S. Menell, Mark A. Lemley

Prepared by: Dr. D.A.Kamble/Dr.S.S.Kore

BoS Member:

BoS Chairman:

**Department of Mechanical Engineering****Project Work (MEUA40186)**

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits : 5							
Lecture (L) : -- hrs./week							
Tutorial (T): -- hr.	100	-	-	-	50	-	150
Practical (P): 10 hrs./week							

Prerequisite: All Mechanical Engineering Subjects till semester VI

Course objectives:

To train the students to apply their engineering knowledge to real life problem solving. And to plan, implement and execute project work to satisfy the stated objectives of the project

Course Outcomes:

By the end of the course, students will be able to

1. Identify, formulate and solve problems related to mechanical engineering
2. Work in a group as a part of multidisciplinary team with professional responsibility.
3. Design a system, component or process to meet desired needs within realistic constraints.
4. Review literature and finalize problem statement.
5. Plan activity schedule and implementation in a given time span.
6. Prepare and present technical report.
7. Apply modern design and analysis tools.

Individual project may have different POs based on the nature of project

The students in a group of not more than FOUR will work under the guidance of the faculty member on the project work undertaken by them. The completion of work, the submission of the report and assessment should be done at the end of BE semester I/II.

The project work could be of the following nature:

- Design/development and Fabrication of models. Machines and prototypes based on new ideas, robotic and automation systems, Experimental set ups. Test rigs equipments.
- Thermal Systems
- Energy audit conservation studies
- Extensive computational analysis of problems relevant to mechanical engineering.
- CAD/CAM/CAE
- Modeling/simulation of product(s). mechanism(s) or system(s) and its validation or comparison with available bench mark results

A report containing maximum 50 pages shall be submitted based on the project. Report should contain following points:

- Background, need and scope of the project,
- Project specifications,
- Activities involved in the project and activity plan.
- Study of literature and basic theory.

Prepared by: Prof. P.R. Anerao

BoS Member:

BoS Chairman:



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Department of Mechanical Engineering

Professional Elective-VI
Power Plant Engineering (MEUA42181A)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits : 4							
Lecture (L) : 3hrs./week							
Tutorial (T): -- hr.	20	30	20	30	-	25	125
Practical (P): 2 hrs./week							

Pre-Requisites: Thermodynamics and Heat Transfer

Course Objectives:

1. To study the power generation scenario, the components of thermal power plant, improved Rankin cycle, Cogeneration cycle
2. To understand details of steam condensing plant, analysis of condenser, the an environmental impacts of thermal power plant, method to reduce various pollution from thermal power plant
3. To study layout, component details of hydroelectric power plant, hydrology and elements , types of nuclear power plant
4. To understand components; layout of diesel power plant , components; different cycles ; methods to improve thermal efficiency of gas power plant
5. To study the working principle , construction of power generation from non-conventional sources of energy
6. To learn the different instrumentation in power plant and basics of economics of power generation.

Course Outcomes:

On completion of the course, students will be able to -

- 1) Describe the power generation scenario, the layout components of thermal power plant and analyze the improved Rankin cycle, Cogeneration cycle
- 2) Analyze the steam condensers, recognize the an environmental impacts of thermal power plant and method to control the same
- 3) Recognize the layout, component details of hydroelectric power plant and nuclear power plant
- 4) Realize the details of diesel power plant, gas power plant and analyze gas turbine power cycle
- 5) Emphasize the fundamentals of non-conventional power plants
- 6) Describe the different power plant electrical instruments and basic principles of economics of power generation.

Unit 1 - Thermal Power Plant

Introduction: General layout of modern power plant with different circuits, working of thermal power plant, coal classification and its CV, high pressure boilers (Latest three), Rankine cycle with reheat and regeneration (Separate Numerical with Mollier Diagram) , Cogeneration power plant (with numerical)

Unit 2 Steam Surface Condenser and Cooling Tower

Steam Condenser: Necessity of steam condenser, Classification, Cooling water requirements,



Condenser efficiency, Vacuum efficiency,(Numerical) Cooling towers (Performance Parameters), air Leakage, Effects of Air Leakage on condenser performance, (Numerical Treatment)

Unit 3 – Hydroelectric Power Plant:

Introduction, Site Selection, Advantages and Disadvantages of HEPP, Hydrograph, Flow duration curve, (Numerical) Mass Curve, Classification of HEPP with layout.

Nuclear Power Plants: Elements of NPP, Nuclear reactor & its types, fuels moderators, coolants, control rod, classification of NPP, N-waste disposal (No Numerical)

Unit 4 - Gas Turbine Power Plant

Layout of Gas Turbine Power Plant with Important Systems, Brayton Cycle analysis, Thermal Efficiency, Work ratio, maximum & optimum pressure ratio, Isentropic Efficiency of Compressor and Turbines, Inter-cooling, reheating, & regeneration cycle, (Separate Numerical) Combined power cycle plant. Layout of Diesel Power Plant/ DG Set

Unit 5 - Non-Conventional Power Plants

Wind Power Plant: Introduction, wind availability measurement, types of wind machines, site selection, and wind power generation.

Solar Power Plant : Low & High Temperature Solar Power Plant, Photovoltaic Power System (Case Study), Heliostat, Challenges in commercialization of Non-Conventional Power Plants.

Unit 6 Power Plant Instrumentation

Generator, Transformers, Exciters, Switch Gear, Circuit breakers, Protective Devices and Control Systems, Boiler Instrumentation and Control

Term-Work

The Term-Work shall consist of any eight experiments

- 1) Study of High Pressure boilers.
- 2) Visit to thermal Power plant /Co-generation Power plant to understand layout and specifications of main components.
- 3) Visit to any Non-Conventional Power Plants.
- 4) Trial on steam power plant.
- 5) Simulated performance of Steam Power plant with suitable software.
- 6) Simulated performance of Gas Turbine Power plant.
- 7) Trial on Diesel Power Plant to understand performance parameters by Graphs.
- 8) Power plant Instrumentation.

Case study on Solar/Wind with numerical or suitable software.

Text Books

- 1) P.K.Nag, —Power Plant Engineering, McGraw Hill Publications New Delhi.
 - 2) Mahesh M Rathore, - Thermal Engineering, Tata McGraw Hill, New Delhi
- S.P.Sukhatme, —Solar Energy, Tata McGraw-Hill Publications, New Delhi (Latest Edition)

Reference Books :

1. Domkundwar & Arora, —Power Plant Engineering, Dhanpat Rai & Sons, New Delhi.
2. R.K.Rajput, —Power Plant Engineering, Laxmi Publications New Delhi.
3. R.Yadav , —Steam and Gas Turbines, Central Publishing House, Allahabad.
4. Cengel Boles, Thermodynamics An Engineering approach, The Tata McGraw Hill, New Delhi
5. G.D.Rai, — Non-Conventional Energy Sources, Khanna Publishers, Delhi



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Department of Mechanical Engineering

Professional Elective-VI
Noise Measurement and Control (MEUA42181B)

Teaching Scheme	Examination Scheme						
Credits:3 Lecture (L): 3hrs./week Tutorial (T): -- hr. Practical (P): -- hrs./week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	-	25	125
Prerequisite: Applied Mathematics, Theory of Machines ,Dynamics of Machinery, Mechanical Vibrations.							
Course Objectives: <ol style="list-style-type: none">1. To know the fundamentals of acoustics and Indian standards of Noise2. To know the sound absorbing materials and its practical applications.3. To know the measurement and control techniques of vibration and noise.4. To understand the effect of noise on human comfort and environment.							
Course Outcomes: <p>Upon completion of the course, students will be able to</p> <ol style="list-style-type: none">1. Apply the knowledge of acoustics in practice.2. Apply the knowledge of noise measurement techniques.3. Analyze the sources, effects of noise and vibration.4. Explain the measurement and control techniques of Vibration and Noise.5. Explain the acoustic material characterization.6. Explain the importance of noise regulation.							
Unit I : Fundamental of sound							
Introduction to Sound, Sound propagation, Quantification of sound- frequency and wave length ,Sound levels and decibels, sound power level sound pressure level, Sound intensity level, Octave & 1/3 octave bands, A weighting, Sound field, Sound reflection ,absorption and transmission - concept & governing equation with correlation of each other, Loudness. Introduction to noise, Noise induced hearing losses.							
Unit II: Noise measurement and instrumentation							
Noise measuring instruments- microphones, types of microphones Sound pressure measurement, Sound power measurement, Sound intensity measurement , Measurement of sound transmission loss ,sound level meter, sound frequency analyser, noise dosimeter, recorder, calibrators. Sound intensity probes, Acoustic exciters, Data acquisition system, Digital signal processing, sampling, aliasing and resolution.							
Unit III: Noise Source Identification and Analysis							
Introduction to anechoic chamber and reverberation chamber, , Frequency and order domain analysis, Sound intensity and sound power mapping ,Introduction to array techniques - Acoustic holography & beam forming.							
Unit IV: Major source of noise- Automotive and non-Automotive							
Major Sources of noise, noise due to construction equipment and domestic applications, Interior Noise of Automobiles - Interior noise sources, Structure borne noise, airborne noise. Industrial noise, industrial noise control- strategies, noise control at the source, noise control at the path, Acoustic barriers, noise control at the receiver. Active noise control techniques.							



Unit V: Passive Noise Treatments

Ducts & Mufflers – Types of mufflers, performance parameters – acoustics and backpressure, Reactive and absorptive silencers and Overall design considerations.

Acoustic Material Characterization – Sound transmission, absorption and damping, Behaviour of acoustic material with respect to sound absorption and transmission, Standard methods for evaluating sound absorption coefficient and transmission loss, Types of sound absorbers, Prediction of transmission loss and flanking transmission, Damping materials and their applications.

Unit VI: Noise Regulations

Non auditory and auditory effect noise on human beings, Noise standards and limits in India, Ambient emission noise standards in India, Hazardous noise exposure – legal aspects, Day night sound level ,Noise specifications for automotive vehicles – pass-by & stationary and Noise specifications for generator sets, fire crackers and household articles, warning devices.

List of Practical:

1. Measurement of noise parameters like frequency, sound pressure level (dB) of any system by using microphone.
2. Noise Measurement & analysis using appropriate instrument. Analysis of SPLsignature using any analysis software package
3. Determination of Airflow resistivity of foam material using Airflow resistivity instrument
4. Determination of sound absorption coefficient of acoustic material by using impedance tube
5. Determination of transmission loss of reactive silencer by using impedance tube.

Assignments:

- 1) Determination of gear noise- numerical
- 2) Determination of fan noise- numerical

Text Books:

1. Rao S. S. —Mechanical Vibrations, Pearson Education Inc. New Delhi. (ISBN 978-0-13-212819-3)
2. Grover G. K. —Mechanical Vibrations, New Chand and Bros.,Roorkee (ISBN-10: 9788185240565)
3. Clarence W. de Silva , “Vibration Monitoring, Testing, and Instrumentation “,CRC Press, 2007(ISBN 9781420053197)
4. David A.Bies and Colin H.Hansen “Engineering Noise Control: Theory and Practice “Spon Press, London, 2009 (ISBN 0-203-16330-3)
5. C.Sujatha “ Vibration and Acoustics : MaGrawhill Publication 2010(ISBN 10: 0070148783)
6. M.L.Munjal –“ Acoustics of Ducts and Mufflers” Willy publications(ISBN 9780471847380)
7. A.G.Ambekar – “Mechanical Vibration and Noise Engineering” PHI publications.(ISBN. 9788120329003)

Reference Books :

1. Bell, L. H. and Bell, D. H., Industrial Noise Control – Fundamentals and Applications, Marcel Dekker Inc.(ISBN 10: 0824790286)
2. Meirovitch, —Elements of Mechanical Vibrations, McGraw Hill(ISBN-10: 0070413401)
3. Ver, Noise and Vibration Control Engineering, Wiley India Pvt. Ltd, New Delhi(ISBN: 978-0-471-44942-3)
4. Bies, D. and Hansen, C. —Engineering Noise Control - Theory and Practice, (ISBN 9781498724050 - CAT# K25710)
5. Kelly S. G. —Mechanical Vibrations—, Schaum's outlines, Tata McGraw Hill Publishing



BansilalRamnathAgarwal Charitable Trust's

Vishwakarma Institute of Information Technology, Pune-48
(An Autonomous Institute Affiliated to Savitribai Phule Pune University)

Department of Mechanical Engineering

Co. Ltd., New Delhi (ISBN 13: 9780070616790)

6. Allan G. Piersol ,Thomas L. Paez “Harris’ Shock and Vibration Handbook” , McGraw-Hill ,
New Delhi, 2010(ISBN: 0071508198)

7. William Thomas and Marie Dillon Dahleh-Theory of Vibration with Applications. Pearson
Publishing,2007(ISBN-10: 013651068)



Open Elective IV
Engineering Economics (IOEUA42182A)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits: 3							
Lecture (L): 2 hrs./week							
Tutorial (T): 1 hr/week	20	30	20	30	-	25	125
Practical (P): -hrs/week							

Prerequisite: Students are expected to know the concepts studied in following courses:

1. Basic Maths

Course Objectives:

- To learn the basics of economics and cost analysis relevant to engineering
- To identify conditions for present worth comparison and future worth comparison and find appropriate solutions for the information challenges.
- To learn and calculate the Rate of interest, different costs and overheads, profit and loss accounts

Course Outcomes: At the end of this course, students will demonstrate the ability to

1. Understand the economics and cost analysis
2. Compare present worth and future worth
3. Identify rate of return and different taxes
4. Calculate profit and loss

Unit- I: Introduction (6 Hrs)

Engineering and Economics, Law of demand and supply, Theory of the Firm and Market Structure. Basic Macro-economic Concepts (including GDP/GNP/NI/Disposable Income), Law of returns, Interest and Interest factors: Interest rate, Simple interest, Compound interest, Cash - flow diagrams, Personal loans and EMI Payment. Price Indices(WPI/CPI),

Unit- II: Present-Worth and Annual Worth Comparisons(6 Hrs)

Present-Worth Comparisons: Conditions for present worth comparisons, Basic Present worth comparisons, Present-worth equivalence, Net Present worth, Future-worth comparison, Pay-back comparison, Exercises, Discussions and problems. Equivalent Annual-Worth Comparison methods, Situations for Equivalent Annual-Worth Comparisons, Consideration of asset life, Comparison of assets with equal and unequal lives, Use of shrinking fund method.

Unit –III: Rate-Of-Return And Depreciation(6 Hrs)

Rate of return, Minimum acceptable rate of return, Investment Analysis – NPV, ROI, IRR, Payback Period, Time value of money, Components of costs such as Direct Material Costs, Direct Labor Costs Causes of Depreciation, Basic methods of computing depreciation charges, Tax concepts, corporate income tax.

Unit IV: Finance and Banking(6 Hrs)

Statements of Financial Information: Introduction, Source of financial information, Financial statements, Balance sheet, and Profit and Loss account, relation between Balance sheet and Profit and Loss account. Financial Institutions, Finance Commissions, Budget Analysis. Indian Banking, Role of Reserve bank of India International Economy



Text Books :

- 1 Leland T. Blank and Anthony J. Tarquin , “Engineering Economy” 4th Edition ,McGraw Hill Publication .
- 2 Chan S. Park “Contemporary Engineering Economics”, 3rd Edition,PHI Publications.
- 3 Dr.K.K.Dewett and M. H. Navalur ,” Modern Economic Theory”RevisedEdition,S Chand Publication.

Reference Books :

- 1.V. Mote, S. Paul, G. Gupta(2004), Managerial Economics, Tata McGraw Hill
2. Misra, S.K. and Puri (2009), Indian Economy, Himalaya

List of Tutorials:

1. Study of cash flow diagram and interest rates
2. Study of Present worth Comparison
3. Study of Annual worth Comparison
4. Study of Investment Analysis
- 5.Study of Financial statements and Balance sheet



Open Elective- IV

Computational Biology (IOEUA42182B)

Teaching Scheme	Examination Scheme						
Credits: 3	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 2 hrs./week Tutorial (T): 1 hr/week Practical (P): -hrs/week	20	30	20	30	-	25	12 5

Prerequisites :	
•	
Course Objectives :	
•	To study and understand the concept of information generation from protein sequences, DNA sequences, whole genome.
•	To study information extraction from large databases and Computer modelling
•	To study and understand various elements of computational biology such as genomic networks, algorithms, and models.
•	To design and develop current applications of computational biology.
Course Outcomes :	
	Students will be able to:
1.	Demonstrate the concept of information generation from protein sequences, DNA sequences, whole genome.
2.	Extract information from large databases and to use this information in computer modelling.
3.	Evaluate various elements of computational biology such as genomic networks, algorithms, and models
4.	Design and develop current applications of computational biology.
Unit I:	Introduction
Molecular Biology Introduction, Cell, Nucleus, Genes, DNA, RNA, Proteins, And Chemical structure of DNA, RNA, Transcription and Translation Process. Protein Structure and Functions, Nature of Chemical Bonds Molecular Biology tools, Polymerase chain reaction [6 Hrs]	
Unit II:	Sequence Alignment
Simple alignments, Gaps, Scoring Matrices, Global and Local Alignments, Smith-Waterman Algorithm, Multiple sequence Alignments, Gene Prediction, Statistical Approaches to Gene Prediction	
Unit III:	Genome Algorithms



Genome Rearrangements, Sorting by Reversals, Block Alignment and the Four-Russians Speedup, Constructing Alignments in Sub-quadratic Time, Protein Sequencing and Identification, the Peptide Sequencing Problem

Unit IV: Microarray Data Analysis

Microarray technology for genome expression study, Image analysis for data extraction, Data analysis for pattern discovery, gene regulatory network analysis

Text Books :

1	<ul style="list-style-type: none">• Dan E. Krane, Michael L. Raymer, "Fundamental Concepts of Bioinformatics," Pearson Education, Inc. Fourth Edition, 9780805346336.• Harshvardhan P. Bal, "Bioinformatics Principles and Applications", Tata McGraw-Hill, seventh reprint, 9780195692303.
2	<ul style="list-style-type: none">• Teresa Attwood, David Parry-Smith, "Introduction to Bioinformatics", Pearson Education Series, 9788180301971

Reference Books :

1	<ul style="list-style-type: none">• R. Durbin, S. Eddy, A. Krogh, G. Mitchison., "Biological Sequence Analysis: Probabilistic Models of proteins and nucleic acids", Cambridge University Press 9780521629713.,
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List of Assignment:

List of lab assignment will be framed by the subject teacher based on theory syllabus.



Open Elective –IV

Software Quality Assurance System (IOEUA42182C)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits: 3 Lecture (L): 2 hrs./week Tutorial (T): 1 hr/week Practical (P): -hrs/week	20	30	20	30	-	25	125

Prerequisites : Software Engineering, Java Programming

Course Objectives :

- To study and understand software testing terminologies and framework
- To study and understand the basics of software testing life cycle
- To study and understand test and defect management
- To study and understand an automation testing
- To study and understand an automation testing tools
- To study and understand automation testing for web application

Course Outcomes :

After completion of the course, student will be able to

1. Understand complete software testing life cycle and various terms and technologies used in testing domain.
2. Demonstrate understanding of generating test plan and designing test cases.
3. Demonstrate understanding of test and defect management process.
4. Demonstrate understanding of automation testing.
5. Create test script and execute automated tests using Selenium IDE.

Unit I: Introduction to Testing

Why is testing necessary? What is testing? Role of Tester, Testing and Quality, Overview of Software Testing Life Cycle, V model, SDLC vs STLC, different stages in STLC, document templates generated in different phases of STLC, different levels of testing, different types of testing

Unit II: Basics of test design techniques

Static techniques, reviews, walkthroughs, Various test categories, test design techniques for different categories of tests. Designing test cases using MS-Excel.

Unit III: Test and Defect Management

Test Management: Documenting test plan and test case, effort estimation, configuration management, project progress management. Use of Testopia for test case documentation and test management. **Defect Management** Test Execution, logging defects, defect lifecycle, fixing / closing defects. Use of Bugzilla for logging and tracing defects.

Unit IV : Basics of Automation testing

Introduction to automation testing, why automation, what to automate, tools available for automation testing. Understanding to Selenium, using Selenium IDE for automation testing, using Selenium Web driver for automation testing.



List of assignment:

With intent to get some exposure in the software testing domain, students apply Technical, Behavioral, Process concepts learnt in the course by executing near real-life project and working in teams (project teams will ideally comprise of 4 members)

There will be 3 projects:

Project 1: Use of Testopia for test case management.

The project will consists of test plan, test design for a sample web application and maintaining Requirement Traceability Matrix using the tool

Project 2: Use of Bugzilla for defect management.

The project will include execution of tests designed in previous project, identifying, logging and tracing the defect and maintaining the Requirement Traceability Matrix

Project 3: Use of Selenium for automation testing.

The project will consists of identifying which tests from project 1 can be automated, then creating script for those tests using tool, executing the tests with the help of tool and generating report for the tests cases.

Text Books :

1.	M G Limaye, "Software Testing Principles, Techniques and Tools", Tata Mcgraw Hill, ISBN: 9780070139909 0070139903
2.	Srinivasan Desikan, Gopalswamy Ramesh, "Software Testing Principles and Practices", Pearson, ISBN-10: 817758121X

Reference Books :

1.	Naresh Chauhan, "Software Testing Principles and Practices ", OXFORD, ISBN-10: 0198061846. ISBN-13: 9780198061847
2.	Dr. K. V. K. Prasad , "Software Testing Tools", Dreamtech Press ISBN: 10:81-7722-532-4



Open Elective-IV
Technology and Financial Management (IOEUA42182D)

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits : 3 Lecture (L) : 2hrs./week Tutorial (T): -- 1hr. Practical (P): -- hrs./week	20	30	20	30	-	25	125

Prerequisite: Statistical and quality control

Course objectives:

The rapid strides in competitiveness in global markets, it is felt that successful corporate managers will be those who can take advantage of the growing sophistication of financial markets, cost accounting, management of projects, human resources and quality. To make mechanical engineers a successful corporate manager in their professional career this course is introduced.

Course Outcomes:

By the end of this course, students will

1. Understand the importance of budget and impact of it.
2. Implement various costing techniques.
3. Learn analysis of engineering economics.
4. Implement various Human Resource and quality management techniques.

Unit 1 - Finance

Definition and scope of finance; Real & financial assets, Investment Decision, Financing decisions, Dividend decisions and liquidity decisions. Long term financing, Primary & secondary capital markets, Role of merchant banking, Types of shares and debentures. Need, sources and functions - Investment banks, portfolio management, Domestic institutional investors, ADB, IMF, World bank and IMF, Importance of finance Methods of capital budgeting, Production, sales, production cost budget and flexible budget along with the numerical problems related to these budgets.

Unit 2 – Costing

Concept of cost centre and profit centre, Elements of cost with illustrations. Procedure/Methodology, limitations of absorption costing along with numerical problems. Marginal costing concept, CVP analysis along with numerical problems, Applications and limitations of marginal costing. Methodology, Recording cost in contracts, value and profit of contract, Profit of incomplete contracts along with numerical problems. Meaning, stages and flow of costs in ABC, classification of activities, advantages and limitations (No numerical problems) Characteristics, procedures, process costing having no opening and closing WIP along with numerical problems.

Unit 3 – Engineering Economic Analysis

Macro and micro economics differences and price theory. Law of demand and supply, Elasticity of demand, Methods to measure elasticity, Exceptions to the law of demand and assumptions. Utility analysis & indifferent curve analysis, Marshalian law of diminishing marginal utility, Income effect and substitution effect Law of production, Law of variable proportion, Law of return to scale for



long term production Monopoly, oligopoly, monopolistic and pure competition & their equilibrium
Inflation and its effect on business and economy, types Importance of foreign trade & hedging
Balance of payments – exchange rates, Fixed and flexible exchange rates

Unit 4 - Human Resource and Quality Management

Definition of HR and personnel management, significance and the differences. Describe the HR manager's role. Objectives, importance & process of manpower planning. Merit rating methods, need and benefits. Need, importance and methods of training & development. Meaning of retirement and separation, types of separation like VRS, resignation, sacking etc., Meaning and fundamentals of Organizational Behavior (OB), OB models MBO, Process of MBO and benefits.

Characteristics of quality, TQM principles and critical processes, TQM cycle, Deming fourteen points of QM, PCDA, Juran ten steps to quality improvement and trilogy diagram Concept of Kaizen Concept and components of JIT, push and pull system, Kanban, Critical success factors in JIT, Application of JIT and JIT cycle Quality management system, ISO – 9001-2000 series, Objectives, principles and categories ISO 14000 family of standards, Benefits of implementing ISO 14000.

Tutorial Assignment

Case Study on each unit.

Text Books

1. Pandey, Financial Management, Tata McGraw-Hill publications, New Delhi. ISBN: 812591658X.
2. A.R. Aryasri, Managerial Economics and Financial Analysis, Tata McGraw-Hill Publications, New Delhi. ISBN: 0070078033

Reference Books :

1. Prasanna Chandra, Financial Management, Tata McGraw-Hill publications, ISBN:0070656657
2. Jawaharlal, Cost Accounting, Tata McGraw-Hill publications, New Delhi. ISBN: 0070221626.
3. K. K. Dewett, Modern Economic Theory, S. Chand publications, New Delhi. ISBN: 8121924634.
4. J. Juran, Juran's Quality handbook, McGraw-Hill International. ISBN: 0-07-034003-X.
5. Sahay and Saxena, World Class Manufacturing, McMillan publications, New Delhi. ISBN: 9780333934746.
6. Vohra, Quantitative Techniques in Management, ISBN: 0070611939.
7. C.B. Mamoria, Personnel Management, Himalaya publishing house, ISBN: 8178669951.
8. French & Bell, Organizational Behavior, ISBN: 013242231X.



OPEN ELECTIVE – IV

**Non-Destructive Techniques and Engineering Diagnosis
(IOEUA42182E)**

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits: 3 Lecture (L): 2 hrs./week Tutorial (T): NA Practical (P): 2 hrs./week	20	30	20	30	-	25	125

Prerequisite: Applied Physics, Basic Electronics, Engineering Chemistry

Course Objectives: The course will help students

1. To **understand** basic concepts and need of health monitoring.
2. To **recognize** the purpose of specific nondestructive technique and **interpret** its results for damage evaluation.

Course Outcomes:

Upon completion of the course, students will be able to

1. **Understand** and **explain** the need for health monitoring in the field of engineering.
2. **Explain** working principle and applications of transducers under stress.
3. **Demonstrate** use of ultrasonic pulse velocity technique for damage detection.
4. **Demonstrate** use of acoustic emission technique for damage detection.

Unit I: Concept of Health monitoring

Basic concepts of health monitoring with regard to structures, machines and electronic components.

Unit II: Transducers

Introduction, types of transducers, working principle of transducers, applications of transducers to various fields of engineering.

Unit III: NDT - Ultrasonic pulse velocity

Introduction, working principle of ultrasonic pulse velocity technique, application to various fields of engineering.

Unit IV: NDT- Acoustic Emission

Introduction, working principle of acoustic emission technique, application to various fields of engineering.

Term Work:

- 1) At least two assignments on each unit
- 2) Demonstration of NDT for damage detection

Reference Books:

1. Ian R. Sinclair – “Sensors and Transducers”
2. Christian u. Grosse and Masayasu Ohtsu -“Acoustic emission Testing” Basics for Research – Applications in Civil Engineering.
3. IS13311 (Part1):1992 “Non-destructive testing of concrete - methods of test” Part 1 Ultrasonic Pulse Velocity

**Open Elective V****Inferential Statistics for Data Science (IOEUA42183A)**

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits: 3							
Lecture (L): 2 hrs./week							
Tutorial (T): -1 hr/week	20	30	20	30	-	25	125
Practical (P): - hrs/week							

Prerequisite: Readers/students are expected to know the following concepts:

1. Basics of Probability

Course Objectives:

- To equip students with the basic understanding of the fundamental concept of data and the nature of data sets
- To understand the fundamentals of probability distributions and their application for data analysis
- To derive the conclusions from the data sets with Bayesian and Inferential statistics

Course Outcomes:

1. Comprehend and correlate the nature and central tendency of given data sets using appropriate probability distribution for the given data set.
2. Implement the fundamentals of Bayesian statistics to find out probability of unknown parameters of statistical model
3. Analyze and conclude the hypothesis using inferential statistical tests
4. Evaluate the prominent characteristics of data sets with exploratory data analysis methods

Unit- I : Understanding Data and probability distributions**(6 HRs)**

Understanding Data, Frequency Tables, Distributional Shapes, Central Tendency
Describing Spread: Range, Interquartile Ranges and Standard Deviation ,Measuring Data
,Measurements of Central Tendency, Measurements of Dispersion, Bi-variate Data and Covariance
,Pearson Correlation Coefficient, Uniform Distribution, Binomial Distribution, Poisson Distribution,
Normal Distribution, Normal Distribution - Formulas and Z Scores

Unit-II : Bayesian Statistics(6 HRs)

Likelihood function and maximum likelihood, The minimaxity, Computing the MLE, Computing the MLE: examples ,Continuous version of Bayes' theorem, Priors and prior predictive distributions
Prior predictive: binomial example, Posterior predictive distribution, Bernoulli/binomial likelihood with uniform prior, Conjugate priors

Unit III: Inferential analysis**(6 HRs)**

Central limit theorem and Hypothesis Testing , t-tests,Sensitivity Analysis ,chi square test, Correlation-values and confidence intervals, Use Analysis of Variance (ANOVA) or Analysis of Covariance (ANCOVA),Regression analysis



Unit IV: Exploratory Data Analysis(6 HRs)

Univariate data: measures of center and spread, transformations, visualization. – Bivariate data: Simple regression, curve fitting, – Trivariate/Hypervariate data: Multiple regression, model selection, principal components. – Binary responses: Logistic regression, residuals. – Categorical data: Contingency tables, correspondence analysis. – Distance data: Multi-dimensional scaling, non-linear dimensionality reduction. – Graph data: Descriptive statistics, spectral methods, visualization.

Text Books :

1. **Sahu**, Pradip Kumar, **Pal**, SantiRanjan, **Das**, Ajit Kumar, “Estimation and Inferential Statistics”, Springer
2. S.C. Gupta and V. K. Kapoor : Fundamentals of Mathematical Statistics, Sultan Chand and Sons, 88, Daryaganj, New Delhi, 2.
3. Manoj Kumar Srivastava, Abdul Hamid Khan, Namrata Srivastava, “Statistical Inference, Theory of estimation”, PHI

Reference Books :

1. George Casella, Roger Berger,” Statistical Inference “, CENGAGE Learning, Second Edition
2. Malcom O, Asadoorian, Demetri Kantarelis, “Essentials of Inferential Statistics”, University Press of America

Tutorials : Tutorials can be done using Python/R

1. Study of Hypothesis testing(One sample t test, z test)
2. Analysis of variance (ANOVA)
3. To study Linear regression to predict the outcome of a variable
4. Study of outlier in Predictive analysis
5. Finding the most important predictor variable in a dataset for feature Selection
6. Model selection and analysis for a real world dataset
7. Study of Logistic Regression
8. To build an application: Time series forecasting

**Open Elective-V****E- Commerce (IOEUA42183B)**

Teaching Scheme	Examination Scheme						
	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Credits: 3 Lecture (L): 2 hrs./week Tutorial (T): -1 hr/week Practical (P): - hrs/week	20	30	20	30	-	25	125

Prerequisites :	
•	
Course Objectives :	
•	Demonstrate an understanding of the foundations and importance of E-commerce
•	Understand the impact of Information and Communication technologies, especially of the Internet in business operations
•	Comprehend risk, legal issues and privacy in E-Commerce and Assess electronic payment systems 4. Analyze the critical building blocks of E-Commerce and different types of prevailing business models employed by leading industrial leaders
•	Evaluate the opportunities and potential to apply and synthesize a variety of ECommerce concepts and solutions to create business value for organizations, customers, and business partners.
Course Outcomes :	
1.	Demonstrate an understanding of the foundations and importance of E-commerce
2.	Understand the impact of Information and Communication technologies, especially of the Internet in business operations
3.	Comprehend risk, legal issues and privacy in E-Commerce and Assess electronic payment systems 4. Analyze the critical building blocks of E-Commerce and different types of prevailing business models employed by leading industrial leaders
4.	Evaluate the opportunities and potential to apply and synthesize a variety of ECommerce concepts and solutions to create business value for organizations, customers, and business partners.
Unit I:	Introduction
E-Commerce: meaning advantages & disadvantages, incentives for engaging in electronic commerce, impact of e-commerce on business and e business, electronic commerce framework, types of e-commerce, web background	
Unit II:	Risk and Legal Issues in E-Commerce

**Department of Mechanical Engineering**

Risks and barriers in the adoption of e-business environment, the impact of ICT in contemporary business operations, entrepreneurial development in e-commerce, cloud computing and e-Commerce, e-commerce in India – laws for e-commerce in India, cryptocurrency and e-commerce

Unit III: Ethical and Social and Political issues related to Electronic Commerce

Protecting privacy, protecting Intellectual property, copyright, trademarks and patents, taxation, and encryption policies

Unit IV: E-Commerce Business Models

Key element of a business model, major B2C business models, major B2B business models, business models in emerging e-commerce areas E-Government: issues in e-governance applications, benefits, and reasons for the introduction of e-governance, e-governance models

Text Books :

1	Kenneth C Laudon, Carol G. Traver, "E-Commerce", Pearson Education, ISBN 97881317812.
2	• Doing Business on the Internet E-COMMERCE (Electronic Commerce for Business): S. Jaiswal, Galgotia Publications, ISBN 9788175153059.
3	• E-Business, Bookseller Code (AG) OXFORD, 1st edition ParagKulkarni, SunitaJainabadkar&PradipChande, ISBN 9780198069843.

Reference Books :

1	P. T. Josef, "Electronic Commerce- A managerial perspective" Prentice-Hall International, ISBN 8120320891.
2	• Kamlesh K. Bajaj, Debjani Nag, "Electronic Commerce: The cutting edge of business", Tata McGraw-Hill Publishing Co. Ltd, 2000, ISBN 9780070585560.
3	• Jeffrey F. Rayport, Bernard J. Jaworski, "e-Commerce", Tata McGraw Hill, 2002, ISBN 9780072510249.
4	• Pete Loshin, Paul A. Murphy, "Electronic Commerce", Jaico Publishing House, 2000, ISBN 9788172246662.
5	• Ravi Kalakota, Andrew B. Whinston, "Frontiers of Electronic Commerce", Addison Wesley, 2002, ISBN 0201845202

List of Assignments:

1	Study of different e-Commerce Platform e.g. Prestashop, WooCommerce, Kickstart, OpenCart or any other. Installation of any one EC platform (Any one you want)
2	Adding categories, product and product details, attributes, tags to the e-commerce development tool you have chosen in activity 1.
3	Adding header, footer, slider and any other design as per your project to the e-commerce development tool you have chosen in activity 1
4	Adding theme and various module management to the e-commerce development tool you have chosen from activity 1
5	Restoring DB, payment taxes promotion discount to the e-commerce development tool you have chosen from activity 1
6	Adding order management to the e-commerce development tool you have chosen from activity 1

**Open Elective-V**
Rural Technology (IOEUA42183C)

Teaching Scheme:	Examination Scheme					
	CIE	ISE	SCE	ESE	PR/OR/TW	Total
Credits : 3						
Lectures / Week :2 Hrs/week						
Practical/ week : 2Hrs/week	20	30	20	30	25	125

Pre-requisites: -**Course objectives:**

- Understand theories and practices in the rural development model.
- Learn and analyze rural life and rural economy.
- Understand different measures and technologies used in rural development.
- To participate in visits and case studies for better understanding for rural development and its impact on overall economy.

Course Outcomes:

On completion of the course, student will be able to–

1. Understand rural development model
2. Learn different measures in rural development and its impact on overall economy
3. Understand and learn importance of technologies in rural and community development
4. Understand challenges and opportunities in rural development

UNIT-I INTRODUCTION TO RURAL DEVELOPMENT

Concepts and connotations, Basic Elements, Growth Vs. Development, Why rural development, Rising expectations and development, Development and Change, Human beings as cause and consequences of development.

RURAL ECONOMY OF INDIA - Introduction, size and structure, The characteristics of rural sector, The role of agricultural sub-sector, The role of non-agricultural sub-sector, Challenges and opportunities.

UNIT - II: RURAL DEVELOPMENT – MEASURES AND PARADIGMS

Measures Of Development - Introduction, Measures of level of rural development, Measures of income distribution, Measures of development simplified, Concepts and measures of rural poverty

Paradigms Of Rural Development - Introduction, The modernization theory, The dependency theory of Marxist School, Rosenstein- Rodan's theory of 'Big Push', Lewis' model of economic development, The human capital model of development, The Gandhian Concept of Rural Development theories from other social sciences.

UNIT - III TECHNOLOGIES FOR RURAL DEVELOPMENT



Using Water Resources - Water quality testing, Water filtering ,Extraction from Groundwater ,Pumps Rope and washer pump ,Manuel pumps, Treadle pump, Irrigation for agriculture, Channel systems, Sprinkler systems, Drip systems Water diversion ,Water storage

Building Infrastructures, Creating Energy - Basic energy uses , Energy Sources - Firewood, Solar Energy, Hydroelectricity, Hydromechanical, Wind Energy, Energy Storage,Connecting to the Electrical Network, Environmental Considerations

UNIT-IV COMMUNITY DEVELOPMENT – RURAL ENTREPRENEURSHIP

- Introduction, Service Learning and community development, Theory and practice of community development, Community development issues. The diverse meaning of community development, The knowledge base of community development, International community development,

Different forms of Rural Entrepreneurship, Significance , Business planning for a new venture: the concept of planning paradigm, Forms of business enterprises-Sole proprietorship, partnership and corporations, Product and Process development, Marketing analysis and competitive analysis, strategies; Financial resources; debt financing, banks and financial institutions and other non-bank financial sources; Government programmes : direct loan assistance and subsidies; Industrial and legal issues for rural enterprises

Text Books:

1. “Rural Development: Principles, Policies and Management” - Katar Singh , Sage Publications
2. “Introduction to Community Development - Theory, Practice and Service Learning”, Edited by J W Robinson, Sage Publications
3. G. N. Tiwari, Solar Energy: Fundamentals, Design, Modeling and Applications, Narosa, 2002.
4. “Fundamentals of Entrepreneurship”, H. Nandan, Third Edition, PHL Learning Pvt. Ltd.,
5. “Monetary Economics-Institutions, Theory and Policy” , First Edition, S B Gupta, S Chand Publications, ISBN - 9788121904346

Reference Books:

1. KURUKSHETRA” - A Journal on Rural Development
2. “Energy conversion” , R. Y. Goswami, Frank Kreith, CRC Press, 2007.
3. “Solar Energy: Fundamental and Application” , H. P. Garg and S. Prakash,Tata McGraw Hill, 1997.
4. “Technologies for Sustainable Rural Development: Having Potential of Socio Economic Upliftment” , TSRD 2014 , edited by Jai Prakash Shukla, Allied Publishers Pvt. Ltd.

Practical List: Rural Technology



Case Studies and Field Visit:

1. **Use of ICT in Rural and agricultural development** - Education, Healthcare, Agriculture, Business, Resource Mapping, Digital and Social Media Marketing
2. **Decision Support Systems for soil conservation and farm management**
3. **Waste Management and Sanitation**
4. **Water management : Watershed Management** - Water-Cup Competition by Paani Foundation, Community Safe Water Solutions
5. **Energy resources**
6. **Role of Micro-Finance institutions in rural development:** Visit to a 'Woman Self help group' nearby and study of its functioning and its role in development.
7. **Visit to model villages in nearby region** - Ralegan-Siddhi, Dist - Ahemadnagar, Hiware Bazar Dist - Ahemadnagar, Tikekarwadi - Dist. - Pune, Buchekarwadi Dist- Pune etc.



Open Elective- V
Product Design Engineering (IOEUA42183D)

Teaching Scheme	Examination Scheme						
Credits:3 Lecture (L): 2hrs./week Tutorial (T): 1 hr. Practical (P): -- hrs./week	CIE	ISE	SCE	ESE	PR/OR	TW	Total
	20	30	20	30	-	25	125
Prerequisite: Basic Engineering Science , Material Science, Engineering Metallurgy, Manufacturing processes, Machine Design, Computer Aided Engineering							
Course Objectives: <ul style="list-style-type: none">• To understand basic techniques for particular phases of product development.• To understand basic Customer needs, satisfaction and commercialization of product.• To understand Forward and Reverse Engineering and its role in designing a product							
Course Outcomes: <p>Upon completion of the course, students will be able to</p> <ul style="list-style-type: none">• Describe an engineering design and development process.• Design product as per customer needs and satisfaction.• Apply engineering, scientific, and mathematical principles to execute a design from concept to finished product.• Analyze methods and processes of Forward and Reverse engineering and methods of Design for manufacturing and analysis.							
Unit I : Introduction to Product Design							
Definition of product design, Essential Factors for product design, Modern approaches to product design, Characteristics of Successful Product Development, Innovative Thinking, Challenges to Product Development, product development versus product design. Customer Needs and Satisfaction.							
Unit II: Product Development Process							
Product development process- Identification of customer needs- customer requirements, product development process flows, Product specifications, concept development and concept generation, concept selection, concept screening, concept scoring, concept testing.							
Unit III: Reverse Engineering							
Introduction of reverse engineering, Product Teardown Process, Tear Down Methods, Force Flow Diagrams, Measurement and Experimentation, Applications of Product Teardown, Benchmarking Approach and Detailed Procedure, Tools Used in Benchmarking, Indented Assembly Cost Analysis, Function –Form Diagrams, Trend Analysis, Setting Product Specifications, Introduction to Product Portfolio and Product Architecture.							
Unit IV: Design for X							
Design for manufacture, Design for assembly, Design for robustness, Design for safety, Design for reliability, Design for environment, Design for piece part production, manufacturing cost analysis. Local, Regional and Global issues, basic life cycle assessment - basic method, Design Failure mode effect analysis.							



List of Tutorial Assignment:

- 1) Design of concept of Innovative product.
- 2) Development of concept of Innovative product using any modelling software.
- 3) Development of standard process for gathering customer needs related to new product.
- 4) Prepare product development process flows for new innovative product.
- 5) Application of reverse engineering technique using benchmarking of product.
- 6) Application for design for manufacturing and assembly.

Text Books:

1. Product Design-Techniques in Reverse Engineering and New Product Development, Kevin Otto, Kristion Wood, Pearson Education, ISBN 978-81-7758-821-7.
2. Karl T.U. And Steven D.E., Product Design and Development, McGraw Hill, Ed 2000
3. K. Chitale; R.C. Gupta, Product Design and Manufacturing, Prentice Hall India.

Reference Books :

1. Dieter George E., Engineering Design McGraw Hill Pub. Company, 2000
2. Grieves, Michael, Product Lifecycle Management McGraw Hill
Bralla, James G., Handbook of Product Design for Manufacturing, McGraw Hill Pub



OPEN ELECTIVE – V
Numerical Methods (IOEUA42183E)

Teaching Scheme	Examination Scheme						
Credits: 3	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 2 hrs./week							
Tutorial (T): NA	20	30	20	30	-	25	125
Practical (P): 2 hrs./week							

Course Objective:

- To prepare the students to apply numerical methods to solve differential equations, integrations and simultaneous equations and perform regression analysis.

Course Outcomes:

Upon completion of the course, students will be able to

- Apply curve fitting techniques; carry out regression and interpolation analysis of any engineering problem.
- Solve simultaneous equations using numerical technique.
- Perform numerical integration for any engineering problem.
- Solve differential equation of any engineering problem using numerical technique.

Unit I: Curve Fitting, Regression and Interpolation

Curve fitting with Linear Equation, Criteria for a Best Fit, Linear Least Square Regression, Linear Regression Analysis, Coefficient of Determination, Polynomial Regression, Multiple Linear Regression, Lagrange's Interpolation, Newton's Forward Interpolation, Hermit Interpolation, Inverse Interpolation

Unit II: Simultaneous Equations

Gauss Elimination Method, Partial Pivoting, Gauss Seidel Method, Gauss Jordan Method and Thomas Algorithms for Tridiagonal Matrix.

Unit III: Numerical Integration

Trapezoidal rule, Simpson's Rule ($1/3^{\text{rd}}$ and $3/8^{\text{th}}$), Gauss Quadrature 2 point and 3 point method, Double Integration- Trapezoidal Rule, Simpson's $1/3^{\text{rd}}$ Rule

Unit IV: Numerical Solution of Differential Equations

Euler Method, Modified Euler Method (Iterative), Runge-Kutta Fourth Order Method, Simultaneous Equations using Runge-Kutta Second Order Method, Introduction to Finite Difference Method.

Term Work:

Students are required to submit at least two assignments on each unit.

Textbooks:

- Numerical methods- Rao V. Dukkipati- New Age International Publishers
- Introductory Methods of Numerical Analysis- S. S. Sastry - University Press

Reference Books:

- Numerical Methods in Engineering with Python 3 – Jaan Kiusalaas-Cambridge University Press
- Numerical Methods -S. Balachandra Rao and C.K.Santha, University Press

List of Tutorial Assignments:



1	Study of different e Commerce Platform e.g. Prestashop, Woo Commerce, Kickstart, OpenCart or any other. Installation of any one EC platform (Any one you want)
2	Adding categories, product and product details, attributes, tags to the e commerce development tool you have chosen in activity 1.
3	Adding header, footer, slider and any other design as per your project to the e commerce development tool you have chosen in activity
4	Adding theme and various module management to the e commerce development tool you have chosen from activity 1
5	Restoring DB, payment taxes promotion discount to the e commerce development tool you have chosen from activity 1
6	Adding order management to the e commerce development tool you have chosen from activity 1

Vishwakarma Institute of Information Technology, Pune-48
(An Autonomous Institute Affiliated to Savitribai Phule Pune University)
Department of Mechanical Engineering

[Introduction to Research] (MEUA42184)

Teaching Scheme	Examination Scheme						
Credits: 2	CIE	ISE	SCE	ESE	PR/OR	TW	Total
Lecture (L): 1 hr./week	-	-	-	-	-	25	25
Tutorial (T): NA							
Practical (P): 2 hrs./week							
Course Objective:							
<ul style="list-style-type: none"> • To study fundamental concepts of Research • To study Technical Writing 							
Course Outcomes:							
Upon completion of the course, students will be able to							
<ol style="list-style-type: none"> 1. Describe the basics of research methodology 2. Write research article in conference or journal 							
Unit I : Introduction to Research							
Overview of Research, Meaning of Research, Objectives, Types, Research Approaches, Significance, Research Methods vs Methodology, Research and Scientific Methods, Research Process. Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Techniques involved in defining a problem Data Collection, Preparation and analysis							
Unit II: Technical Writing and Research Ethics							
Technical Presentation and Technical Writing, Why Technical Writing, Layout of Technical Report/Article, Abstract, Introduction, Literature Survey-Overview of Literature Survey-Searching literature, Sources of Literature, Literature Survey and Reviewing Literature, Organizing Literature, Some Terminology-ISBN, ISSN, DOI, Bib TeX, Strategies to Search Keyword search, Backward and Forward Chronological Search, Adding References to document, New Findings, Experimental Details, Results and Discussion. Plagiarism tools, Publication process of Technical articles							
Term Work:							
List of Assignments:							
<ol style="list-style-type: none"> 1 Assignment based on Data Collection and Data Preparation Process 2 Assignment based on statistical tools. 3 Adding References in Research paper using BibTeX Referencing in Latex or Using Bibliography citations in Microsoft word. 4 Project: Write AND Publish a Research Article. 							
Textbooks:							
S. Kothari C.R., Research Methodology (2nd Ed.), New Age International, (2004); ISBN(13): 978-81-224-1522-3 2.							
Reference Books:							
<ol style="list-style-type: none"> 1. Berkman, Elliot T., A Conceptual Guide to Statistics Using SPSS, Sage Publications, 2011; ISBN: 978-1-4129-7406-6 2 Kumar, Ranjit, 2. Research Methodology (3rd Ed); Sage Publications, 2011; IBSN: 978- 1- 8492-0301-2 							