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Department of Mechanical Engineering

Scheme & Syllabus

of

Bachelor of Technology

Mechanical Engineering

From III to VIII Semester

Effective from Academic session 18-19

for B.Tech.- P& IE (Effective for student admitted in first year in 19-20)

Mechanical deptt. 20-21 III sem onwards

University Teaching Departments

Rajasthan Technical University, Kota

Minutes of Meeting
II Meeting (online) of Academic Council, University Departments, RTU, Kota
27 November, 2020, 3:30 pm

Ref. Number: **Date : 28-11-2020**

II Meeting of Academic Council, University Departments, RTU, KOTA was convened through online mode on 27-11-2020 at 3:30 PM using Google Meet under the Chairmanship of Prof. A.K. Mathur, Dean, Faculty Affairs. Following members were present:

1. Prof. B.P. Suneja
2. Prof. Rajiv Gupta
3. Prof. Dinesh Birla
4. Prof. S. R. Kapoor
5. Prof. V.K. Gorana
6. Prof. A.K. Chaturvedi
7. Prof. Vivek Pandey
8. Prof. K.S. Grover
9. Dr. R.K.Bayal
10. Dr S. D. Purohit
11. Dr. Sanju Tanwar
12. Shri Manoj Vaishnav
13. Shri Ashok Patni
14. Dr. Vikas Bansal (Member Secretary)

Following agendas related to academic has been discussed and resolved into the meeting:

Agenda 1: Modifications/ improvement in CBCS regulations for Undergraduate programmes

Looking towards the model curriculum provided by the AICTE and to improve the academics of University Departments, RTU, Kota in the prevailing situations, modifications may be made in the CBCS regulations. A committee was formed for modifications in CBCS regulation as decided in the meeting of Head of Departments held in the month of September 2020. The committee has recommended CBCSUG-2020 after incorporating modifications in CBCSUG-2017. CBCSUG-2020 may be affected from the students admitted in 2020-21 and onwards. Modified regulations (CBCSUG-2020) as enclose in Annexure-1 is submitted herewith for approval. These shall be affected from

Approved
Dean, FA & UD

the students admitted in 2020-21 and onwards after approval. Members are requested to approve.

Resolution: The Agenda was approved by the respected members. Following modifications were suggested and approved by the respected members in proposed CBCSUG-2020 by the committee (appointed on September 05, 2020 in the meeting of Head of Departments):

i. Industrial Training (as mentioned in Section 6 and other Sections of the proposed CBCSUG-2020) has been considered as Credit courses in place of non-graded core courses. Therefore, 5 non-graded units have been changed to 5 Credits.

ii. As suggested by HVC, SODECA, which was also non-graded core course (as mentioned in Section 6 and other Sections of the proposed CBCSUG-2020), has also been converted to Credit course. Therefore, 4 non-graded units of SODECA have been changed to 4 Credits of SODECA (Anandam).

iii. Above two changes have been resulted into change in the minimum credit requirement criterion (as mentioned in Section 4 and other Sections of the proposed CBCSUG-2020) for passing the B.Tech. degree. Now, minimum credit requirement is 164 Credits along with 11 non- graded units in place of 155 Credits along with 20 non- graded units as suggested by the committee (appointed on September 05, 2020 in the meeting of Head of Departments).

iv. In ADDITION of grades S and Z (as mentioned in Section 6 and other Sections of the proposed CBCSUG-2020), two more grades V for excellent performance and G for good performance has also been.

v. As mentioned in Appendix-1 and other Sections of the proposed CBCSUG-2020, In first year scheme, Engineering Mechanics and Introduction to Electrical and Electronics Engineering has been replace by Basic Mechanical Engineering, Basic Civil Engineering and Introduction to Electrical and Electronics Engineering. Students of CS, EC, EE, EIC, IT will study Basic Mechanical Engineering and Basic Civil Engineering. Students of CE, PE, PC will study Basic Mechanical Engineering and Introduction to Electrical and Electronics Engineering. Students of AE, ME, PIE will study Basic Civil Engineering and Introduction to Electrical and Electronics Engineering.

Anil K. Mathur

vi. As per the guidelines of AICTE and as suggested and approved in the UDAC meeting, Minor degree or Honours shall be added in the B. Tech. degree on completing courses of extra 20 credits in the inter-disciplinary specialization or Departmental specialization respectively. This provision has been placed in place of the option for both Minor degree and Honours (as mentioned in Section 5, Appendix-3 and other Sections of the proposed CBCSUG-2020) on clearing extra 40 credits as suggested by the committee (appointed on September 05, 2020 in the meeting of Head of Departments).

vii. Therefore, the minimum requirement for obtaining Minor degree or Honours (as mentioned in Section 5, Appendix-3 and other Sections of the proposed CBCSUG-2020) with B. Tech. Degree becomes 184 credit and 11 non-graded units.

viii. List of MOOC courses may also be prepared from the option available to the BOS other than 4 agency prescribed in the proposed CBCSUG-2020 (as mentioned in Section 5 and other Sections of the proposed CBCSUG-2020) by the committee. The list of MOOCS prepared by the BOS shall be approved by Dean UD.

ix. The provision for obtaining the grades in the MOOC COURSES as suggested by the committee and as mentioned in Section 5 and other Sections has been replaced by the following provision as suggested and approved by the Hon'ble members that In House examination / evaluation will be carried out for the MOOC COURSES as held for regular courses. The grading of the MOOC courses will be done on the basis of these examinations/evaluations. A Course Coordinator will be assigned for each MOOC COURSE.

x. Theory and Practical courses will be treated as separate courses.

xi. The provision of 'Self-study course' as mentioned at Sub. Section 4.11 of Section 4 of proposed CBCSUG-2020 has been deferred.

xii. The provision of 'Exit policy' as mentioned at Sub. Section 4.13 of Section 4 of proposed CBCSUG-2020 has been deferred till announced by AICTE and other regulating bodies.

Anil K. Mathur

xiii. Minimum number of students in Departmental Elective has been replaced by 'minimum of 10 or actual number of students admitted' in place of '10' (as mentioned in Section 3.3 and other Sections of the proposed CBCSUG-2020).

Agenda 2: To approve B. Tech. Curriculum applicable for students admitted in 2017-18

In pursuance of the CBCS Regulations, the teaching schemes have been revised form 2017-18 by the concerned BOS, these are placed for kind perusal of members (Annexure 2). Members are requested to approve.

Resolution: The Agenda was approved by the respected members.

Agenda 3: To approve B. Tech. Curriculum applicable for students admitted in 2018-19

In Academic session 2018-19, a revised teaching scheme for I and II semester in line with that in RTU was adopted on recommendation of the BOS and approval of the Vice Chancellor .

In the prevailing market conditions and as per the model curriculum provided by AICTE, it has been discussed in the meeting of Head of Departments held in the month of September 2020 to **include One MOOC courses each in VII and VIII semester aggregating to 7 Credit in the scheme for the students admitted in 2018-19.** 8-10 weeks of MOOC courses shall be considered for 3 credits and 12-16 weeks for MOOC courses shall be considered for 4 credits. A list of the MOOC courses shall be submitted by the respective BOS, two months before the start of the respective semester . The students have to select the MOOC courses from the list provided by the concerned BoS. The MOOCs courses available on the following site/platform will be recognized.

Initiative	Institution Behind Platform	Website Link
NPTEL	IIT Madras	nptel.ac.in/
mooKIT	IIT Kanpur	www.mookit.co/
IITBX	IIT Bombay	iitbombayx.in/
SWAYAM	MHRD and Microsoft	Swayam.gov.in

Approved
Dean, FA & UD

Only those MOOCs courses will be considered for fulfilling the requirement of the B.Tech. Degree, which have certification.

The student will inform in writing to respective Head of the Department about the MOOCs courses intended to register from the list provided by concerned BoS at the time of registration of other courses. The HOD shall verify the authenticity of the course as per points mentioned above. The student shall submit the certificate along with the credit earn to the HOD, who will ensure to submit the information about the credit and grade earn by the student during the semester (through the MOOCs courses) at the time of submission of other course grades. Before submitting the grade of MOOC course registered by the student, the HOD shall convert the grade of the MOOC course to the grading system of CBCS of University Departments. For conversion, first the grade of the course shall be converted to equivalent marks using the rules prevalent at the institute offering the MOOC course and then marks shall be converted to equivalent grade of CBCS of University Departments.

In pursuance of the CBCS Regulations, the revised teaching schemes are placed for kind perusal of members (Annexure 3). Members are requested to approve.

Resolution: The Agenda was approved by the respected members after having following modifications:

The provision for obtaining the grades in the MOOC COURSES as suggested above has been replaced by the following provision as suggested and approved by the Hon'ble members that In House examination / evaluation will be carried out for the MOOC COURSES as held for regular courses. The grading of the MOOC courses will be done on the basis of these examinations/evaluations. A Course Coordinator will be assigned for each MOOC COURSE.

Agenda 4: To approve B. Tech. Curriculum applicable for students admitted in 2019-20

In Academic session 2019-20, a revised teaching scheme for I and II semester in line with that in RTU was adopted on recommendation of the BOS.

Anil K. Mathur

Approved
Dean, FA & UD

In the prevailing market conditions and as per the model curriculum provided by AICTE, it has been discussed in the meeting of Head of Departments held in the month of September 2020 to **include One MOOC courses each in VII and VIII semester aggregating to 7 Credit in the scheme for the students admitted in 2019-20.** 8-10 weeks of MOOC courses shall be considered for 3 credits and 12-16 weeks for MOOC courses shall be considered for 4 credits. A list of the MOOC courses shall be submitted by the respective BoS, two months before the start of the respective semester . The students have to select the MOOC courses from the list provided by the concerned BoS. The MOOCs courses available on the following site/platform will be recognized.

Initiative	Institution Behind Platform	Website Link
NPTEL	IIT Madras	nptel.ac.in/
mooKIT	IIT Kanpur	www.mookit.co/
IITBX	IIT Bombay	iitbombayx.in/
SWAYAM	MHRD and Microsoft	Swayam.gov.in

Only those MOOCs courses will be considered for fulfilling the requirement of the B.Tech. Degree, which have certification.

The student will inform in writing to respective Head of the Department about the MOOCs courses intended to register from the list provided by concerned BoS at the time of registration of other courses. The HOD shall verify the authenticity of the course as per points mentioned above. The student shall submit the certificate along with the credit earn to the HOD, who will ensure to submit the information about the credit and grade earn by the student during the semester (through the MOOCs courses) at the time of submission of other course grades. Before submitting the grade of MOOC course registered by the student, the HOD shall convert the grade of the MOOC course to the grading system of CBCS of University Departments. For conversion, first the grade of the course shall be converted to equivalent marks using the rules prevalent at the institute offering the MOOC course and then marks shall be converted to equivalent grade of CBCS of University Departments.

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In pursuance of the CBCS Regulations, the teaching schemes are placed for kind perusal of members (Annexure 3). In pursuance of the CBCS Regulations, the revised teaching schemes are placed for kind perusal of members (Annexure 4). Members are requested to approve.

Resolution: The Agenda was approved by the respected members after having following modifications:

The provision for obtaining the grades in the MOOC COURSES as suggested above has been replaced by the following provision as suggested and approved by the respected members that In House examination / evaluation will be carried out for the MOOC COURSES as held for regular courses. The grading of the MOOC courses will be done on the basis of these examinations/evaluations. A Course Coordinator will be assigned for each MOOC COURSE.

Agenda 5: To approve B. Tech. Curriculum applicable from 2020-21 and onwards for first year

In pursuance of **the revised** CBCS Regulations, the teaching schemes are placed for kind perusal of members (Annexure 5). Members are requested to approve.

Resolution: The Agenda was approved by the respected members after following modifications:

In first year scheme Engineering Mechanics and Introduction to Electrical and Electronics Engineering has been replaced by Basic Mechanical Engineering, Basic Civil Engineering and Introduction to Electrical and Electronics Engineering. Students of CS, EC, EE, EIC, IT will study Basic Mechanical Engineering and Basic Civil Engineering. Students of CE, PE, PC will study Basic Mechanical Engineering and Introduction to Electrical and Electronics Engineering. Students of AE, ME, PIE will study Basic Civil Engineering and Introduction to Electrical and Electronics Engineering.

Agenda 6: To approve BOS of HEAS department.

Anil K. Mathur
Approved
Dean, FA & UD

In pursuance of CBCS Regulations, the BOS of HEAS department is placed for kind perusal of members (Annexure 6). Members are requested to approve.

Resolution: The Agenda was approved by the respected members.

Agenda 7: To approve policies and guidelines regarding academics and examination which are not in practice during pre COVID periods (Normal circumstances).

The extra ordinary situation arisen due to COVID-19, forces the administration to adopt some policies regarding academics and examination which are not in practice during pre COVID periods. Govt. of Rajasthan, Office of HVC and COE issued some guidelines for the academics and examination process. Members are requested to approve the same for University Departments, RTU, Kota.

Members are requested to approve.

Resolution: The Agenda was approved by the respected members.

Reporting Item:

There are no guidelines for preparation of grades for back /improvement examinations in the present CBCS regulations. A committee was formed and approved by HVC for addressing this issue. Following provisions were proposed by the committee and approved by HVC in 2019 (note-sheet enclosed):

a. If the back exam is conducted with main exam then the grading may be calculated with the main exam students.
b. In case the back exam is conducted separately, then the grading may be calculated along with the previous main exam. However, the grading of the students (awarded already) will remain unaffected.

Resolution: The Agenda was approved by the respected members.

Anil K. Mathur

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Dean, FA & UD

The meeting ended with a vote of thanks to The Chair

Dr Vikas Bansal
Member Secretary, UDAC)

Prof Anil Mathur
Chairman, UDAC

Copy to:

1. **PS to HVC for Approval in BOM**
2. **Members of UDAC**

Dr Vikas Bansal
Member Secretary, UDAC)

Prof Anil Mathur
Chairman, UDAC

Scheme for B.Tech.- Mechanical (Effective for student admitted in first year in 19-20)
Mechanical deptt. 20-21 III sem onwards

THEORY & PRACTICAL

Sem	Codes	Proposed Scheme- ME -UD	Credits	Contact hrs/wk			IA	End term	Total
				L	T	P			
III	3MEU1	Advanced Engineering Mathematics-I	4	3	1	0	50	100	150
	3MEU2	Engineering Thermodynamics	4	3	1	0	50	100	150
	3MEU3	Fluid Mechanics & Machines	3	3	0	0	50	100	150
	3MEU4	Mechanics of Solids	3	3	0	0	50	100	150
	3MEU5	Material Science and Engineering	3	3	0	0	50	100	150
	3MEU6	Manufacturing Processes	2	2	0	0	50	100	150
	3MEU11	Production Practice- I	2	0	0	3	50	25	75
	3MEU12	Mechanical Engg Drawing & CAD Lab	1	0	0	2	50	25	75
	3MEU13	Material Science and Testing Lab	1	0	0	2	50	25	75
	3MEU14	Fluid Mechanics Lab	1	0	0	2	50	25	75
	3MEU20	Extra Curricular & Discipline	1				50		50
		Sub- Total	**25**	**17**	**2**	**9**	**550**	**700**	**1250**

Sem	Codes	Proposed Scheme- ME -UD	Credits	Contact hrs/wk			IA	End term	Total
				L	T	P			
	4MEU1	Advanced Engineering Mathematics-II	4	3	1	0	50	100	150
	4MEU2	Kinematics of Machines	4	3	1	0	50	100	150
	4MEU3	Machining & Machine Tools	3	3	0	0	50	100	150
IV	4MEU4	I.C. Engines	3	3	0	0	50	100	150
	4MEU5	Industrial Engineering	3	3	0	0	50	100	150
	4MEU6	Design of Machine Elements- I	2	2	0	0	50	100	150
	4MEU11	Production Practice- II	2	0	0	3	50	25	75
	4MEU12	Machine Design Sessional-I	2	0	0	3	50	25	75
	4MEU13	Thermal Engineering Lab -I	1	0	0	2	50	25	75
	4MEU14	Basic Mechanical Engineering Lab	1	0	0	2	50	25	75
	4MEU20	Extra Curricular & Discipline	1	0	0	0	50		50
		Sub- Total	**26**	**17**	**2**	**10**	**550**	**700**	**1250**

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Sem	Codes	Proposed Scheme- ME -UD	Credits	Contact hrs/wk			IA	End term	Total
				L	T	P			
V	5MEU1	Heat Transfer	4	3	1	0	50	100	150
	5MEU2	Dynamics of Machines	4	3	1	0	50	100	150
	5MEU3	Operations Research	3	3	0	0	50	100	150
	5MEU4	Design of Machine Element-II	3	3	0	0	50	100	150
	5MEU5.1	Quality Assurance and Reliability	3	3	0	0	50	100	150
	5MEU5.2	Computational Fluid Dynamics							
	5MEU5.3	Management Information system (MIS)							
	5MEU6.1	Automobile Engineering	2	2	0	0	50	100	150
	5MEU6.2	CNC Machines & Programming							
	5MEU6.3	Introduction to Aeronautics							
	5MEU11	Heat Transfer Lab	2	0	0	3	50	25	75
	5MEU12	Machine Design Sessional-II	1	0	0	2	50	25	75
	5MEU13	Theory of Machines Lab	1	0	0	2	50	25	75
	5MEU14	Industrial Engineering Lab-I	1	0	0	2	50	25	75
	5MEU20	Extra Curricular & Discipline	1	0	0	0	50		50
		Sub- Total	**25**	**17**	**2**	**9**	**550**	**700**	**1250**

Sem	Codes	Proposed Scheme- ME -UD	Credits	Contact hrs/wk			IA	End term	Total
				L	T	P			
VI	6MEU1	Refrigeration and Air-conditioning	4	3	1	0	50	100	150
	6MEU2	Vibration Engineering	4	3	1	0	50	100	150
	6MEU3	Turbo Machines	3	3	0	0	50	100	150
	6MEU4	Measurement and Metrology	3	3	0	0	50	100	150
	6MEU5.1	Mechatronics and MEMS	3	3	0	0	50	100	150
	6MEU5.2	Project Management							
	6MEU5.3	Renewable Energy Systems							
	6MEU6.1	Computer Aided Design and Graphics	2	2	0	0	50	100	150
	6MEU6.2	Engineering Optimization							
	6MEU6.3	Experimental Fluid Mechanics							
	6MEU11	Production Engineering Lab	2	0	0	3	50	25	75
	6MEU12	Thermal Engineering Lab-II	2	0	0	3	50	25	75
	6MEU13	Vibrations and Maintenance Engineering Lab	1	0	0	2	50	25	75
	6MEU14	Mechatronics and MEMS Lab.	1	0	0	2	50	25	75
	6MEU20	Extra Curricular & Discipline	1	0	0	0	50		50
		Sub- Total	**26**	**17**	**2**	**10**	**550**	**700**	**1250**

Approved
Dean, FA & UD

Sem	Codes	Proposed Scheme- ME -UD	Credits	Contact hrs/wk			IA	End term	Total
				L	T	P			
VII	7MEU1	Finite Element Methods	4	3	1	0	50	100	150
	7MEU2	Steam Engineering and Power Generation	4	3	1	0	50	100	150
	7MEU3	Computer Integrated Manufacturing Systems	3	3	0	0	50	100	150
	7MEU4	Supply & Operations Management	3	3	0	0	50	100	150
	7MEU5.1	Modelling & Simulation	3	3	0	0	50	100	150
	7MEU5.2	Non Conventional Machining Methods							
	7MEU5.3	Fuel cells and Hybrid Engine Technologies							
	7MEU6X	MOOC COURSE	4						
	7MEU11	Programming with MATLAB & FEM	2	0	0	3	50	25	75
	7MEU12	CIMS Lab(CAM, IE & Simulation practicals)	1	0	0	2	50	25	75
	7MEU13	Project Stage- I	1	0	0	2	50	25	75
	7MEU14	Practical training & industrial visit	4	0	0	4	150	75	225
	7MEU20	Extra Curricular & Discipline	1	0	0	0	50		50
		Sub- Total	**30**	**15**	**2**	**11**	**600**	**650**	**1250**

Sem	Codes	Proposed Scheme- ME -UD	Credits	Contact hrs/wk			IA	End term	Total
				L	T	P			
		Option-A							
VIII	8MEU1.1	New Enterprise and Innovation Management	3	3	0	0	50	100	150
	8MEU1.2	Rapid Prototyping							
	8MEU2.1	Product Development and Launching	3	3	0	0	50	100	150
	8MEU2.2	Statistics for Decision Making							
	8MEU3.1	Engg Economics & Financial Management	3	3	0	0	50	100	150
	8MEU3.2	Data Analytics							
	8MEU4X	MOOC COURSE	3						
	8MEU13	Seminar	4	0	0	4	150	75	225
	8MEU14	Project Stage-2	12	0	0	18	350	175	525
	8MEU20	Extra Curricular & Discipline	1	0	0	0	50		50
		Sub- Total	**29**	**9**	**0**	**22**	**700**	**550**	**1250**

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Sem	Codes	Proposed Scheme- ME -UD	Credits	Contact hrs/wk			IA	End term	Total
				L	T	P			
VIII		**Option-B**							
	8MEU4X	MOOC COURSE	3						
	8MEU13	Seminar	4	0	0	4	150	75	225
	8MEU14	Major Project - Final Stage	21	0	0	36	500	475	975
	8MEU20	Extra Curricular & Discipline	1	0	0	0	50		50
		Sub- Total	**29**	**0**	**0**	**40**	**700**	**550**	**1250**

Anil K. Mathur

Approved
Dean, FA & UD

Department of Mechanical Engineering

Syllabus

of

Bachelor of Technology

Mechanical Engineering

From III to VIII Semester

for B.Tech.- Mechanical (Effective for student admitted in first year in 19-20)

Mechanical deptt. 20-21 III sem onwards

University Teaching Departments

Rajasthan Technical University, Kota

3MEU1: ADVANCED ENGINEERING MATHEMATICS -1

B.Tech. (Mechanical) 3rd semester

3L+1T

Unit	Contents	Contact hours
I	**Laplace Transform:** Definition and existence of Laplace transform, properties and formulae, unit step function, Dirac Delta function, Heaviside function, inverse Laplace transform, Convolution theorem, application of Laplace transform to ordinary differential equation, solution of integral equations.	**10**
II	**Fourier Transforms:** Fourier Complex, Sine and Cosine transform, properties and formulae, inverse Fourier transforms, Convolution theorem, application of Fourier transforms to partial ordinary differential equation (One dimensional heat and wave equations).	**9**
III	**Z-Transform:** Definition, properties and formulae, Convolution theorem, inverse Z-transform, application of Z-transform to difference equation.	**7**
IV	**Numerical Analysis:** Interpolation, difference operators- forward, backward, central, shift and average operators, Newton's forward and backward interpolation formulae, Gauss's forward and backward interpolation formulae, Stirling's formula, Lagrange interpolation formula for unequal intervals. Inverse interpolation.	**7**
V	Numerical differentiation by Newton's, Gauss's and Stirling's formula. Numerical integration: Trapezoidal Rule, Simpson's 1/3 and 3/8 Rule. Numerical solution of ODE of first order: Picard's method, Euler's method, Modified Euler's method, Runge-Kutta forth order method, Milne's Method.	**7**
	TOTAL	**40**

TEXT BOOK		**Pub**
1 **2** **3** **4**	Advanced Engineering Mathematics, Jain and Iyengar, Narosa Publications. Engineering Mathematics for semesters III and IV, C.B. Gupta, McGraw Hill Education, India. Advanced Engineering Mathematics, Denis Zill and Warren Wright, Jones & Bartlett India Private Limited. Advanced Engineering Mathematics,O'neil, Cengage Learning, India.	**2011** **2009** **2002** **2001**
REFERENCE BOOKS		
SN	Name of Authors /Books /Publisher	**Year of Pub.**
1	1. Advanced Engineering Mathematics, Irvin Kreyszig, Wiley, India. 2. Advanced Engineering Mathematics, M. Greenberg, Pearson Education, India. 3. Advance Engineering Mathematics, Potter, Oxford, India. 4. Engineering Mathematics, Pal and Bhunia, Oxford, India. 5. Higher Engineering Mathematics, B. V. Ramana, McGraw Hill Education, India. 6. Numerical Methods for Scientific & Engineering Computation, Jain and Iyengar, Jain, New Age International Publication, India. 7. A First Course in Numerical Methods, Uri M Asher and Chen Greif, SIAM Publication, India. 8. Introductory Methods of Numerical Analysis, S. S. Sastry, PHI Lerning, I 9. Numerical Methods for Engineers, Chapra, McGraw Hill Education,	

Course outcome

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

CO1: Know the basic concepts of integral transforms (Laplace and Fourier), Z-transform and difference operators along their fundamental properties.

CO2: Calculate the transforms of standard functions and elementary sequences, and

work out numerical interpolation,
differentiation and integration.

CO3: Apply the integral transforms, Z-transform and numerical methods to variety of problems, including differential,
integral and difference equations.

CO4: Analyze the transforms and numerical tools needed to solve the practical problems in various branches of
engineering.

CO5:

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1 PSO2
CO1	3	2										1
CO2	3	2										
CO3	2	3										
CO4	2	3										
Average	**2.5**	**2.5**										**1.0**

3MEU2: ENGINEERING THERMODYNAMICS

B.Tech. (Mechanical) 3rd semester

3L+1T

Unit	Contents	Contact hours
I	**Basic Concepts and definitions of Thermodynamics**: System, Surroundings, Property, Energy, Thermodynamic Equilibrium, Process, work and modes of work.	2
	Zeroth and First Law of Thermodynamics: Zeroth of Thermodynamics, Temperature scale, First law of thermodynamics, First law analysis of some elementary processes. Steady and unsteady flow energy equations.	5
II	**Second Law of Thermodynamics:** Heat engine, Heat pump and refrigerator, Second law of thermodynamics, Equivalence of the Kelvin-Plank and Clausius statements. Reversible and Irreversible Processes, Carnot engine, Efficiency of a Carnot engine, Carnot principle, thermodynamic temperature scale, Clausis Inequality.	4
	Entropy: Entropy, Calculation of Entropy change, Principle of entropy increase. Temperature-Entropy diagram, Second law analysis of a control volume.	3
	Availability: Available energy, Loss in available energy, Availability Function, Irreversibility.	3
III	**Thermodynamic Properties of Fluids:** Pure substance, Concept of Phase, Graphical representation of p-v-T data, Properties of steam. Steam tables, Mollier chart	4
	Ideal Gas and Real Gas: Ideal gas, Real gas, Internal energy, enthalpy and specific heats of an ideal gas, equations of state, Dalton's law of partial pressures, Gibbs Dalton law, Thermodynamic properties of gas mixtures.	4
IV	**Thermodynamic Relations:** Thermodynamic variables, Independent and dependent variables, Maxwell's thermodynamic relations, Thermodynamic relations involving entropy, Thermodynamic relations involving enthalpy and internal energy, Joule-Thomson coefficient, Clapeyron equation.	4
	Power Cycles: Otto cycle, Diesel cycle, Dual cycle, Brayton cycle and Ericsson cycle.	5
V	Vapour power cycle: Rankine cycle, effect of operating conditions on its efficiency, properties of ideal working fluid in vapour power cycle	3
	Reheat cycle, regenerative cycle, bleeding extraction cycle, feed water heating co-generation cycle.	3
	TOTAL	40

TEXT BOOK		
1	Nag P.K., Engineering Thermodynamics, Tata Mc-Graw Hill	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub.**
1	Chattopadhyay P., Engg Thermodynamics, Oxford University Press.	2011
2	Van G.J. Wylen and Sonntag R.E., Fundamental of Thermodynamics, J Wiley	2003
3	Cengel Y.A. and. Boles M.A, Thermodynamics-An Engg. Approach, TMH	2011
4	Jones J.B.&.Dugan R.E, Engineering Thermodynamics, PHI	1996
5	Rao Y.V.C., An Introduction to Thermodynamics, Wiley Eastern Ltd.	1993
6	Moran M.J and H.N. Shapiro, Fundamentals of Engineering Thermodynamics, John Wiley and Sons	1996
7	Rogers, Gorden., Engineering Thermodynamics, Pearson Education	1996
8	Kroos & Potter, Thermodynamics for Engineers, Cengage learning	2015
9	Mishra, Engineering Thermodynamics, Cengage learning.	2015

Course outcome

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

CO1: Apply concepts of TD and Zeroth Law in solving numerical problems with relevant units.

CO2: Analyze and evaluate different forms work, heat and other properties by applying 1st Law of TD

CO3: Evaluate COP, EER, Efficiency, temperature and entropy by applying second law of TD and its corollaries.

CO4: : Illustrate problem solving procedure related to pure substances, ideal and real gases using PT, PV, TH diagrams

CO5: Correlate various thermodynamic variables in thermodynamic relations.

Evaluate vapour and gas power cycles, its components and summarize performance on the basis of different parameters

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1 PSO2
CO1	3	3	1									1
CO2	3	3	2	2								2
CO3	3	3	2	2			2					2
CO4	3	3	1									
CO5	3	3	1									
CO6	3	3	2	3			2					2
Average	**3.0**	**3.0**	**1.5**	**2.3**			**2.0**					**1.8**

3MEU3: FLUID MECHANICS & MACHINES

B.Tech. (Mechanical) 3rd Semester

3L+0T

UNIT	CONTENTS	CONTACT HOURS
I	**Fluid Properties**: Definition of a fluid, Viscosity-dynamic and kinematic, Surface Tension.	**3**
	Fluid Statics: Basic equation of fluid statics, Manometers, Force on plane areas and curved surfaces, center of pressure, Buoyant force, Stability of floating and submerged bodies.	**5**
II	**Fluid flow concepts and Basic control volume equations**: General control equation, conservation of mass, energy equation and its application, Momentum equation and its applications	**4**
	Basic governing differential equation: Reynolds transport equation, continuity equation, momentum equation, energy equation, Bernoulli's equation.	**4**
III	**Viscous flow:** Laminar flow through pipe and between parallel plate.	**4**
	Turbulent flow: Relation, Prandle mixing length, Losses in open and closed conduit	**4**
IV	Measurements:Pressure, velocity, flow measurement-orifices, venturimenter, orificemeter, nozzle meter, notches and weirs.	**3**
	Flow through pipe: Major and minor Losses in pipe, Hydraulic and energy gradient line, Network of pipes-series and parallel.	**5**
V	**Hydraulic Turbines:** Classification of hydraulic turbines, work done and efficiencies of Pelton, Francis and Kaplan turbines, Draft tube, Specific speed and unit quantities	**5**
	Hydraulic systems: Hydraulic press, Hydraulic accumulator, Hydraulic Intensifier, Hydraulic Ram, Hydraulic lift, Hydraulic coupling, Hydraulic torque convertor Gear pump.	**3**
	TOTAL	**40**

TEXT BOOK		
1	Yunus A. Cengel and Cimbala, Fluid Mechanics, Tata McGrawHill,	**2006**
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Streeter V.L., K.W. Bedford and E.B.Wylie , Fluid Mechanics , Tata McGraw Hill	**2010**
2	Robert W. Fox and Alan T. McDonald, Introduction to Fluid Mechanics, John Wiley & Sons.	**2009**
3	Potter, Mechanics of Fluids, Cengage Learning.	**2012**
4	Frank M. White, Fluid Mechanics, Tata McGraw Hill.	**2003**
5	John F. Douglas, Fluid Mechanics, Pearson Education.	**2007**
6	Munson, B. R., Young, D. F., & Okiishi, T. H. Fundamentals of Fluid Mechanics, Wiley	
7	Som, S. K., & Biswas, G. Introduction to fluid mechanics and fluid machines, Tata McGraw Hill.	**2010**
8	K.Subramaanya, Hydraulic Machines, McGrawhill,	**2013**
9	Modi and Seth, Fluid Mechanics and Hydraulic Machinery, Standard Book House	**1991**

Course outcome

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

CO1: Identify and calculate the key fluid properties used in the analysis of fluid behavior. Describe and apply the principles of pressure, pressure measurement, fluid statics, buoyancy and floatation.

CO2: Apply and deduce the concept of basic governing differential equation of conservation of mass, energy and momentum alongwith their application

CO3: Describe and analyze viscous and turbulent flow.

CO4: Understand and apply the principle of Bernoulliβ€™s equation for fluid flow measurement and to identify the major and minor energy losses that is involved in a fluid flow and their accountability.

CO5: Study and analysis of hydraulic turbines, Hydraulic press, Hydraulic accumulator, Hydraulic Intensifier, Hydraulic Ram, Hydraulic lift, Hydraulic coupling, Hydraulic torque convertor Gear pump.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1	PSO2
CO1	3	3	3	2									1
CO2	3	3	3	2									1
CO3	3	3	3	2									1
CO4	3	3	2	2			2						1
CO5	3	3	2	2			2						1
Average	**3.0**		**3.0**	**2.6**	**2.0**	**2.0**	**1.0**						

3MEU4: MECHANICS OF SOLIDS

B.Tech. (Mechanical) 3rd semester

3L+0T

Unit	Contents	Contact hours
I	**Stress and Strain:** Elementary definition of stress and strain, stress-strain relationship, elastic, plastic and visco-elastic behavior of common materials in tension and compression test, stress-strain curves, Hooke's law, Poisson's ratio, elastic constants and their relations for an isotropic hookean material, anisotropic and orthotropic materials.	3
	Tension, compression, shearing stress and strain, thermal stresses, composite bars, equations of static equilibrium, concept of free body diagram. Strain energy due to axial loading.	5
II	**Members Subjected to Flexural Loads:** Theory of simple bending, bending moment and shear force diagrams for different types of static loading and support conditions on beams.	4
	bending stresses, section modulus and transverse shear stress distribution in circular, hollow circular, I, Box, T, angle sections etc. Strain energy due to bending.	5
III	**Principal Planes, Stresses and Strains:** Members subjected to combined axial, bending and torsional loads, maximum normal and shear stresses, concept of equivalent bending and equivalent twisting moments, Mohr's circle of stress and strain.	5
	Theories of Elastic Failures: The necessity for a theory, different theories, significance and comparison, applications.	2
IV	**Torsion:** Torsional shear stress in solid, hollow and stepped circular shafts, angular deflection and power transmission capacity. Strain energy due to torsional loads.	4
	Stability of Equilibrium: Instability and elastic stability, long and short columns, ideal strut, Euler's formula for crippling load for columns of different ends, concept of equivalent length, eccentric loading, Rankine formulae and other empirical relations.	4
V	**Transverse Deflection of Beams:** Relation between deflection, bending moment, shear force and load, transverse deflection of beams and shaft under static loading, area moment method, direct integration method.	6
	Thin-walled Pressure Vessels: Stresses in cylindrical and spherical vessels	2
	TOTAL	40

TEXT BOOK		
1	Bansal, R. K., "A Textbook of Strength of Materials Laxmi Publications.	**2010**
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Timoshenko, S.P., and Gere, J.M., "Mechanics of Materials", 2nd Ed., CBS Publishers	**2002**
2	Crandall, S.H., Dahl, N.C., and Lardner, T.J., "An Introduction to the Mechanics of Solids", Tata McGraw-Hill	**1999**
3	Pytel and Kiusalaas, "Mechanics of Materials" Cengage Learning	**2011**
4	Harbola, "Engineering Mechanics", Cengage Learning	**2002**
5	Popov, E.P., Nagarajan, S., and Lu, Z. A., "Mechanics of Materials", 2nd Ed., Prentice-Hall of India	**2002**

Course outcome

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

CO1: Explain the fundamental concept of stress and strain, and the relationship between both in order to solve problems on principle of superposition, compound bars and thermal Stresses.

CO2: Apply the theory of simple bending to seek solution related to the pure and non-uniform bending of beams.

CO3: Analyze the members/structure subjected to combined loading and identify the principal planes/stress/strain.

CO4: Evaluate the torsional stress for various cases of shaft and determine buckling load for column of different end conditions.

CO5: Apply different methods to evaluate deflection of beam and carry out stress analysis of thin pressure vessels.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	P(
CO1	3	2		1								
CO2	3	2		1								
CO3	3	3	1	2								
CO4	3	3	1	1								
CO5	3	3	1	2								
Average	**3.0**	**2.6**	**1.0**	**1.4**								

3MEU5: MATERIAL SCIENCE AND ENGINEERING

B.Tech. (Mechanical) 3rd semester

3L+0T

Unit	Contents	Contact hours
I	Crystal structure – BCC, FCC and HCP, unit cell, crystallographic planes and directions, miller indices. Crystal imperfections, point, line, surface and volume defects.	4
	Frank Reed source of dislocation, Elastic & plastic modes of deformation, Bauschinger's effect, slip & twinning, strain hardening, cold/hot working recovery, re-crystallization and grain growth.	4
II	Classification of Engineering Materials: Solidification of metals and of some typical alloys, mechanism of crystallization (I) nuclear formation (ii) crystal growth, general principles of phase transformation in alloys, phase rule and equilibrium diag., equilibrium diagram of binary system having complete mutual solubility in liquid state and limited solubility in solid state, binary isomorphous alloy system, Hume-Rothery rule , binary system with limited solid solubility of terminal phase and in which solubility decreases with temperature and also alloy with a peritectic transformation, equilibrium diagof a system whose components are subject to allotropic change.	5
	Iron carbon equilibrium diagram, phase transformation in the iron carbon diagram, eutectic, peritectic, eutectoid and peritectoid reactions and microstructures.	3
III	Isothermal transformation diagrams –cooling curves superimposed on Isothermal Transformation diagram, critical cooling rate. (i) Formation of Austenite from	4

	Pearlite (ii) Transformation of Austenite into Pearlite.	
	Full annealing, stress relief, spheroidizing – normalizing, hardening and tempering of steel. Hardenability, Jominey end quench test – Austempering, martempering. Case hardening, carburising, nitriding, cyaniding, carbonitriding. Flame and Induction hardening.	**4**
IV	Non-Metallic Materials- Polymers – types of polymer, commodity and engineering polymers – Properties and applications of PE, PP, PS, PVC, PMMA, PET, PC, PA, ABS, PI, PAI, PPO,PPS, PEEK, PTFE Polymers. Urea and Phenol formaldehydes.	**4**
	Constitution of alloys: Solid solutions - substitutional and interstitial. Ferrous and Non Ferrous Metals- Effect of alloying additions on steel (Mn, Si, Cr, Mo, V, Ti & W) - stainless and tool steels – HSLA steel.	**4**
V	Mechanical Properties and Testing: Types of fracture, testing of materials under tension, compression and shear loads – hardness tests (Brinell, Vickers and Rockwell) Impact test Izod and charpy, fatigue and creep test.	**4**
	Classification of steels and cast iron constitution and properties. BIS stds. Engineering Ceramics – Properties and applications of Al2O3, SiC, Si3N4, PSZ etc. Fiber and particulate reinforced composites and resin plastics. Introduction to Nano materials- Nano structured materials. Nano clusters & Nano crystals.	**4**
		40

TEXT BOOK		
1	Material Science and Engg.An Introduction, William D.Callister, J Wiley	**2003**
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub.**
1	Material Science, Raghvan V., Prentice Hall India	**2012**
2	Principles of Material Science and Engineering, William F.Smith, TMH	**2008**
3	Engineering Physical Metallurgy, Lakhtin Y., Mir Publisher.	
4	Introduction to Engineering materials Tata McGraw-Hill Publications.	**2011**
5	Essentials of Material Science and Engineering, Askeland, Cengage	**2003**
6	Material Science and Engineering properties, Gilmore, Cengage Learning	**2015**

Course outcome

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

CO1: Explain and memorize concept of crystal structure, crystal defects and their effect on the properties of the different type of materials

CO2: Discuss analyze and draw the various types of Equilibrium diagrams. Evaluate the composition of various microstructures using Lever rule.

CO3: Illustrate the concept of heat treatment and explain the effect on properties of the material with different heat treatment processes

CO4: Compare and describe the properties of polymers, types of solid solutions and the effect of alloying elements on steels

CO5: Describe the various types of mechanical properties, methods of testing, classification of steel. Discuss the basic concept of engineering ceramics and nanomaterial

CO-PO Mapping

Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO1**	**PO1**	**P(**
CO1	3	3	1									

CO2	3	3	2	2	
CO3	3	3	2	1	2
CO4	3	3	2	1	2
CO5	3	3	2	1	2

3MEU6: MANUFACTURING PROCESSES

B.Tech. (Mechanical) 3rd semester
3L+0T

Unit	Contents	Contact hours
I	General Classification and Introduction to Manufacturing processes. **Foundry Technology**: Casting materials, Patterns: types, material and pattern allowances. Moulding sands; composition, preparation, properties and testing; Grain fineness; moisture content, clay content and permeability test. Core & core prints; Gating system: types, pouring basin, sprue, runner and risers; Melting, pouring and solidification.	4
	Principles and method of floor mould casting, shell mould casting, pit mould & loam mould casting; centrifugal casting, investment casting; Permanent mould casting. Casting defects; types, causes & remedy	5
II	**Forming Processes**: Classification; Hot working and cold working; principle, advantages, disadvantages and applications.	3
	Forging: Classification, drop forging and press forging methods and use; Forging dies; types, materials.	4
	Rolling: Characteristics and applications of hot rolling and cold rolling;	4
III	Extrusion; Work materials and products; Press tool works; Basic principles, system, operations and applications. Shearing; Parting, notching, trimming, nibbling, blanking and piercing,	4
	Drawing: wire drawing, tube drawing and deep drawing.	4
IV	**Metal Joining Processes**: Welding, Brazing and soldering, classification of welding process, Principle, characteristics and applications of gas welding, thermit welding, TIG and MIG welding; Resistance welding; Spot welding; Butt welding; Seam welding; Projection welding.	6
	Principles and process details of Forge welding; Friction welding; Diffusion welding; Welding defects; Types, causes, effects& remedy. Electrodes and Electrode Coatings	3
V	**Powder Metallurgy**: Properties and manufacturing of Powder, mechanical pulverization, sintering, Electrolytic Process, chemical reduction, atomization, compacting of powders sintering, adv.& applications of Powder metallurgy.	3
	TOTAL	40

TEXT BOOK		
1	Rao.P.N., Manufacturing Technology, Vol. 1,2 and 3, Tata McGraw Hill	2013
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub.**
1	Ghosh, A., & Mallik, A. K. 1986. Manufacturing Science: Ellis Horwood.	
2	Schey, Introduction to Manufacturing Processes, Tata McGraw Hill	1999
3	Kalpakjian, S., Schmid, S.,Manufacturing processes for engg materials, Pearson Education.	2000

4	Campbell, J. S. Principles of manufacturing materials & processes: TMH	**2008**
5	Heine, R.., Loper, C.R., and Rosenthal, P.C., "Principles of Metal casting", TMH	**1999**
6	Groover, M.P., Fundamentals of Modern Manufacturing: Materials, , PHI	**1976**
7	Kalpakjian, S. & Schmid S.R, Manufacturing Engg & Tech, Addison Wesley	**2007**
8	Little, R.L., Welding and welding technology Tata McGraw-Hill Education	**2000**

CO1: Basic knowledge of various manufacturing processes.
CO2:Evaluate different parameters and mechanics of the manufacturing process.
CO3: Analyze advantages, limitation and application of each process and compare among the available process.
CO4: Develop the ability to choose most appropriate manufacturing process, keeping in mind the design requirement, cost effectiveness, energy saving and productivity.
CO5: Apply manufacturing process solutions to the practice problems in the industry.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	2	3	3	3	-	-	-	-	-	-	-	-
C02	3	3	3	2	-	-	-	-	-	-	-	-
C03	3	3	3	3	-	-	-	-	-	-	-	-
C04	3	3	3	3	-	-	-	-	-	-	-	-
CO5	3	3	3	3	-	-	-	-	-	-	-	-

3MEU11: PRODUCTION PRACTICE-I

B.Tech. (Mechanical) 3rd Semester

0L+0T+3P

SN	NAME OF EXPERIMENT
	Machine Shop
1	To study lathe machine construction and various parts including attachments, lathe tools cutting speed, feed and depth of cut.
2	To perform step turning, knurling and chamfering on lathe machine as per drawing.
3	To perform taper turning (a) by tailstock offset method as per drawing (b) Using compound rest.
4	To prepare the job by eccentric turning on lathe machine.
5	To study shaper machine, its mechanism and calculate quick return ratio. To prepare a job on shaper from given mild steel rod.
	Foundry Shop
6	To prepare mould of a given pattern requiring core and to cast it in aluminium.
7	To perform moisture test and clay content test.
8	Strength Test (compressive, Tensile, Shear Transverse etc. in green and dry conditions) and Hardness Test (Mould and Core).
9	To perform permeability test
10	A.F.S. Sieve analysis test.
	Welding Shop
11	Hands-on practice on spot welding.
12	Hands-on practice on submerged arc welding
13	Hands-on practice on metal inert gas welding (MIG) and tungsten inert gas welding (TIG).

Course outcome

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

CO1: To learn parametric aspects of machining, working principle and machining process.

CO2: Learn and practice the machining operation and tools used in machining.

CO3: Understand and perform sand mould testing methods.

CO4: Learn and perform the gas, arc, spot welding operations.

CO5: Learn to operate the machine used in mechanical engineering workshop.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1
CO1	3	2	2			1					
CO2	3	3									
CO3	3	3				1					
CO4	3	3	2			2					
CO5	3	3	3			1					
Average	**3.0**	**2.8**	**2.3**			**1.3**					

3MEU12: MECHANICAL ENGINEERING DRAWING AND CAD LAB

B.Tech. (Mechanical) 3rd semester

0L+0T+3P

SN	CONTENTS
	Assembly drawing with sectioning and bill of materials of the following: Lathe tail stock, shaper tool head, swivel machine vice etc (1 drawing sheet of any assembly) Detailed part drawings from assembly drawing indicating fits, tolerances and surface finish symbols by referring BIS codes: Check-valve, Junction Valve etc Computer Aided Drafting: Introduction to different features of the CAD Software (AutoCAD/ProE/ Creo/Solidworks). At least one drawing problem related to a. 2-D Drafting. b. 3-D Modeling. c. 3-D Advanced Modeling. d. Assembly modeling. e. Feature Modification and Manipulation f. Detailing. g. Surface Modeling

TEXT BOOK		
1	Laxminarayan and M.L. Mathur,Machine Drawing ,Jain Brothers	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Gill P S, Machine Drawing, Kataria & Sons	**2009**
2	Basudeb Bhattacharya, Machine Drawing, Oxford University Press	**2011**
3	Dhawan, R.K., A Text Book of Machine Drawing, S. Chand & Company,	**1998**
4	Ostrowsky, O., Engineering Drawing with CAD Applications, ELBS,	**1995**
5	Siddeshswar N., P Kannaiah, VVS Shastry, Machine Drawing,TMH	**2001**

CO1: Develop and present the engineering drawings as per standards (BIS).
CO2: Construct assembly drawing of various machine mechanical systems.
CO3: Develop the skills for drafting using CAD software.
CO4: Construct the orthographic views and solid models using the software.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
CO1	2	1	-	-	-	-	-	-	-	-	-	1
CO2	3	3	-	-	-	-	-	-	-	-	-	2
CO3	3	2	2	-	3	-	-	-	-	-	-	3
CO4	3	2	2	-	3	-	-	-	-	-	-	3

3MEU13: MATERIAL SCIENCE AND TESTING LAB.

B.Tech. (Mechanical) 3rd Semester

0L+0T+2P

SN	NAME OF EXPERIMENT
1	(a) Study of various crystals structures through models BCC, FCC, HCP, tetrahedral and octahedral voids. (b) Material identification of, say, 50 common items kept in a box.
2	Specimen preparation for metallographic examination /micro structural examination-cutting, grinding, polishing, etching.
3	Comparative study of microstructures of different given specimens (mild steel, gray C.I., brass, copper etc.)
4	Heat treatment experiments such as annealing, normalizing, quenching, case hardening and comparison of hardness before and after.
5	Study of Microstructure and hardness of steel at different rates of cooling. Microstructure examination of white cast iron.
6	To perform Tensile/Compressive/Shear/torsion test on a given material and to determine its various mechanical properties under tensile/compression/Shear/torsional loading
7	To determine Rockwell/ Vickers/Brinell hardness of a given material
8	To perform Impact test on a given material and to determine its resilience.
9	To study and perform Fatigue test on a given material and to determine fatigue strength of the material
10	To perform Bending test and to determine the Young's Modulus of Elasticity via deflection of beam.
11	Creep testing on creep testing machine

REFERENCE BOOKS		
SN	Name of Authors /Books /Publisher	**Year of Pub.**
1	Vander Voort, Metallography: Principles and Practice, McGraw-Hill,	**1984**
2	Prabhudev K.H., Handbook of Heat Treatment of Steels, TMH	**2000**
3	Suryanarayanan, A.V.K. "Testing of Metalic materials" TMH	**1993**
4	Abbaschian, Physical metallurgy principles, Cengage Learning	

CO1: Discuss and inspect different microstructure of selected materials.
CO2: Determine the material properties by different test.
CO3: Demonstrate the heat treatment processes on different materials.
CO4: Summarise the behaviours of materials on different situation and loads.
CO5: Apply the knowledge of material properties in material selection for any practical problem.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	3	3	3	-	-	-	-	-	-	-	-
C02	3	3	2	3	-	-	-	-	-	-	-	-
C03	3	3	3	3	-	-	-	-	-	-	-	-
C04	3	3	2	3	-	-	-	-	-	-	-	-
CO5	3	3	2	3	-	-	-	-	-	-	-	-

3MEU14: FLUID MECHANICS LAB

B.Tech. (Mechanical) 3rd Semester

0L+0T+2P

SN	NAME OF EXPERIMENT
1	Determination of Meta-centric height of a given body.
2	Determination of Cd, Cv & Cc for given orifice.
3	Calibration of contracted Rectangular Notch and / Triangular Notch and determination of flow rate.
4	Determination of velocity of water by Pitot tube.
5	Verification of Bernoulli's theorem.
6	Calibration and flow rate determination using Venturimeter & Orifice meter and Nozzle meter
7	Determination of head loss in given length of pipe.
8	Determination of the Reynold's number for laminar, turbulent and transient flow in pipe.
9	Determination of Coefficient for minor losses in pipes.
10	To study the velocity distribution in a pipe and also to compute the discharge by integrating the velocity profile.
11	To study the boundary layer velocity profile over a flat plate and to determine the boundary layer thickness.

Course outcome

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

CO1: to plot various performance curves of the machine elements

CO2: to perform different balancing operations

CO3: to determine the various operating parameters of oscillating machines

CO4: to study the gear operated systems

CO5:

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	P(
CO1	3	3	1	3								
CO2	3	3	1	2								
CO3	3	3	1	3								
CO4	3	1	1	2								
Average	**3.0**	**2.5**	**1.0**	**2.5**								

4MEU1: ADVANCED ENGINEERING MATHEMATICS -2

B.Tech. (Mechanical) 4th semester

3L+1T

Unit	Contents	Contact Hours
	Complex Analysis: Differentiability and Analytic functions, Cauchy-Riemann equations (Cartesian and Polar forms), Harmonic functions. Conformal mapping.	
	Complex Line integral, M-L inequality, Cauchy theorem, Morera's theorem, Cauchy integral formulae, Taylor series and Laurent series. Singularities and Zeros, residues at poles and infinity, residues at isolated	

	essential singular point, Cauchy residue theorem, evaluation of real definite integrals and improper integrals.	
	Special Functions: Legendre's function, Rodrigues formula, generating function, Simple recurrence relations, orthogonal property. Bessel's functions of first and second kind, generating function, simple recurrence relations, orthogonal property.	
	Statistics & Probability: Basic concepts of probability, conditional probability, Baye's theorem. Random variable and distributions: Discrete and continuous random variables, Moments, Expectation, Moment generating function, Binomial, Poisson and Normal distribution.	

TEXT BOOK		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Advanced Engineering Mathematics, Jain and Iyengar, Narosa Publications.	
2	Advanced Engineering Mathematics, Denis Zill and Warren Wright, Jones & Bartlett India Private Limited.	
3	Introduction to Probability and Statistics, Seymour Lipschutz and John J. Schiller, McGraw Hill Education, India.	
4	Advanced Engineering Mathematics,O'neil, Cengage Learning, India.	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Advanced Engineering Mathematics, Irvin Kreyszig, Wiley, India.	
2	Advanced Engineering Mathematics, M. Greenberg, Pearson Education, India.	
3	Advance Engineering Mathematics, Potter, Oxford, India.	
4	Engineering Mathematics, Pal and Bhunia, Oxford, India.	
5	Higher Engineering Mathematics, B.V. Ramana, McGraw Hill Education, India.	
6	Complex Variables and Applications, J.W. Brown & R.V. Churchill, McGraw Hill Education, India.	
7	Probability and Statistics, Murray Spiegel, John Schiller, R. AluSrinivasan, McGraw Hill Education, India.	
8	Engineering Mathematics,Paras Ram, CBS Publisher, India.	

CO1: Solve various functions through complex analysis.
CO2: Apply different series and theorem to solve complex integrals.
CO3: Understand various special functions.
CO4: Analyze various probability methods and distributions.

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2	2	2	-	-	-	-	-	-	-	-
CO2	3	2	1	2	-	-	-	-	-	-	-	-
CO3	3	3	3	2	-	-	-	-	-	-	-	-
CO4	3	2	2	3	-	-	-	-	-	-	-	-

4MEU2: KINEMATICS OF MACHINES

B.Tech. (Mechanical) 4th semester

3L+1T

Unit	Contents	Contact Hours
I	**Kinematics:** Elements, pairs , mechanisms, four bar chain and its inversions,	3
	velocity and acceleration, Klein's construction, coriolis component, instantaneous center method	5
II	Synthesis of mechanisms, pantograph, scott-Russel, Tchbeicheff straight line, indicator diagram mechanisms	5
	Automotive vehicle mechanisms: Overhead valve mechanism, Davis and Ackerman steering mechanism, Trifler suspension and Hooke's joint.	3
III	**Power transmission:** Belts and ropes, effect of centrifugal force, creep, chain drive	4
	Friction: Laws of static, dynamic and rolling friction, dry and viscous friction, inclined plane and screw jack, pivots and friction axis, bearing, Theory of film lubrication.	4
IV	**Brakes:** Band, block and band & block brakes, braking action, braking system of automobiles. **Clutches**	6
	Dynamometers: absorption and transmission type dynamometers, prony, rope and hydraulic dynamometers	2
V	**Cams:** Type of cams, displacement, velocity and acceleration curves for different cam followers consideration of pressure angle and wear, analysis of motion of followers for cams with specified contours.	8
	TOTAL	40

TEXT BOOK		
1	Rattan, S.S., "Theory of Machines", 2nd Ed., Tata McGraw Hill	2006
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Bevan, T., "Theory of Machines", Pearson Education.	2013
2	Uicker, J.J., Pennocle, G.R, and Shigley, J.E, "Theory of Machines and Mechanisms", 3rd Ed., Oxford University Press.	2009
3	Ambekar , A. G., "Mechanism And Machine Theory", Prentice-hall Of India	2007
4	Ghosh, A., "Theory of Mechanisms and Machines", Affiliated East West Press.	
5	Singh, S., "Theory of Machines", Pearson Education	2013
6	Stanisic., "Mechanisms and Machines-Kinematics, Dynamics & Synthesis", Cengage leasrning	2014

CO 1	Understand the mechanism and kinematic analysis of machines.
CO 2	Examine and understand the concept of steering mechanism used in automotive vehicles.
CO 3	Access the various methods of transmitting the power.
CO 4	Verify the laws of friction and study its applications in belt drive and clutch.
CO 5	Analyse the various mechanisms like gear train, slider crank, cam follower, belt drive, etc.

COURSE OUTCOME	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	2	3	1	-	-	-	-	-	-	-	-
C02	3	2	3	2	-	-	-	-	-	-	-	-
C03	3	2	2	2	-	-	-	-	-	-	-	-
C04	3	3	3	1	-	-	-	-	-	-	-	-
CO5	3	3	3	3	-	-	-	-	-	-	-	-

Approved
Dean, FA & UD

4MEU3: MACHINING AND MACHINE TOOLS

B.Tech. (Mechanical) 4th semester

3L+0T

Unit	Contents	Contact Hours
I	Classification of metal removal process and machines: Geometry of single point cutting tool and tool angles, tool nomenclature in ASA, ORS. Concept of orthogonal and oblique cutting.	
	Type of chips, Mechanics of metal cutting; interrelationships between cutting force, shear angle, strain and strain rate. Thermal aspects of machining and measurement of chip tool interface temperature.	
II	Concept of machinability, machinability index, factors affecting machinability, Different mechanism of tool wear. Types of tool wear (crater, flank etc), Concept of tool life.	
	Taylor's tool life equation. Introduction to economics of machining. Cutting fluids: Types, properties, selection and application methods	
III	Basic machine tools: Constructional configuration, estimation of machining time on lathe, drilling, shaping, milling, grinding, Gear cutting on milling, Gear hobbling.	
	Special Purpose Machine Tools: Automatic lathes, capstan and turret lathe machines, operational planning and turret tool layout, sequence of operations.	
IV	Introduction to Grinding and different methods of grinding, Abrasives; natural and synthetic, manufacturing and selection of grinding wheels, Wheel specifications. Honing, lapping, super-finishing.	
V	High Velocity Forming Methods: Definition; Hydraulic forming, Explosive forming, Electro-hydraulic forming, Magnetic pulse forming.	

TEXT BOOK		
1	Rao.P.N., Manufacturing Technology, Vol. 1,2 and 3, Tata McGraw Hill	**2013**
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Lal G.K., Introduction to Machining Science, New Age international Pub.	**2007**
2	Ghosh, A., & Mallik, A. K. 1986. Manufacturing Science: East West Press	**1999**
3	Schey, Introduction to Manufacturing Processes, Tata McGraw Hill	**2000**
4	Kalpakjian, S., & Schmid, S. R., Manufacturing processes for engineering materials, Pearson Education.	**2008**
5	Pandey & Singh, Production Engineering Science, Standard Publishers	**1999**
6	Stephenson, D. A., & Agapiou, J. S. Metal cutting theory and practice: CRC Taylor & Francis.	**2006**
7	Karl H.Heller, All About Machine Tools, Wiley Eastern Ltd., New Delhi	**1972**
8	Kalpakjian, S. & Schmid S.R, Manufacturing Engineering and Technology, Addison Wesley Pub. Co.	**2000**
9	Sen, G. C., & Bhattacharyya, A. Principles of Machine Tools: New Central Book Agency	**1988**
10	Bhattacharyya A, Theory & Practice of Metal Cutting, New Central Book	**2006**
11	Shan, H.S., Manufacturing Process, Pearson Education.	**2012**
12	Boothroyd, G., & Knight, W. A. Fundamentals of machining and machine tools: Taylor and Francis.	**2006**
13	Milton C. Shaw, Metal Cutting Principles, CBS Publishers.	**2005**

CO1: Acquires the fundamental knowledge and principles in material removal processes.
CO2: Demonstrate the fundamentals of machining, finishing, SPM processes and machine tools.
CO3: Evaluate the importance of input and output metal cutting parameters.
CO4: Learn about tool materials, cutting fluid and tool wear mode / mechanism.
CO5: Understand and analyse about high velocity forming methods.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	3	2	3	-	-	-	-	-	-	-	-
C02	3	3	3	2	-	-	-	-	-	-	-	-
C03	3	2	3	2	-	-	-	-	-	-	-	-
C04	3	3	3	3	-	-	-	-	-	-	-	-
CO5	3	2	3	2	-	-	-	-	-	-	-	-

4MEU4: I.C. ENGINES

B.Tech. (Mechanical) 4th Semester
3L+0T

Unit	Contents	Contact Hours
I	**History of IC engines**: Nomenclature, Classification & Comparison, SI & CI, 4stroke- 2 stroke, First Law analysis, Energy Balance. Fuel-air cycles, Actual cycles..	4
	Testing & Performance: Performance parameters, Measurement of operating parameters e.g. speed, fuel & air consumption, Powers, IHP, BHP, FHP, Efficiencies Thermal, Mechanical, Volumetric, Emission Measurement, Indian & International standards of Testing, Emission.	4
II	**Fuel & Combustion:** Combustion in CI & SI engines, Ignition Limits, Stages of combustion, Combustion parameters. Delay period and Ignition Lag, Turbulence and Swirl, Effects of engine variables on combustion parameters, abnormal combustion in CI & SI engines, Detonation & knocking, Theories of detonation, Control of abnormal combustion, Combustion chamber design principles, Types of combustion chamber.	4
	Fuel: Conventional Petroleum, structure, Refining Fuels for SI & CI engines, Knock rating, Additives, Fuels for Turbine & Jet Propulsion.	2
	Alternative Fuels: Methanol, Ethanol, Comparison with gasoline, Manufacturing, Engine performance with pure Methanol, Ethanol & blends, Alcohols with diesel engine, Vegetable oils, Bio gas.	2
III	**Engine Systems & Components:** Fuel System (SI Engine), Carburetion & Injection, process & parameters, properties of A/F mixture, Requirements of A/F ratios as per different operating conditions, Carburettors, types, Aircraft carburettor, comparison of carburetion & injection, F/A ratio calculations.	3
	CI engine: Mixture requirements & constraints, Method of injection, Injection systems, CRDI etc. system components, pumps injectors.	2
	Ignition system: Conventional & Modern ignition systems Magneto v/s Battery, CB point v/s Electronic ignition, Fuel Ignition Energy requirements. Spark advance, centrifugal, vacuum Firing order, spark plugs.	3
IV	**Engine Friction & Lubrication :** Determination of friction, Lubrication principles, Types of lubrication, Places of lubrication Bearings and piston rings etc., Functions of Lubrication, Properties, Rating and Classification of lubricating oil, Additives, Lubrication systems. Engine Cooling: Requirements of cooling, Areas of heat flow, High temperature regions of combustion chamber. Heat Balance, Cooling Systems, Air, Water Cooling, Cooling system components.	5
	Supercharging: Objectives, Thermodynamic cycle & performance of super charged SI & CI engines, Methods of super charging, Limitations, Two stroke engines: Comparison of 4s & 2s engines construction & valve lining scavenging. Process	3

	parameters, systems, supercharging of 2 stroke engines.	
V	**Dual & Multi fuel engines:** Principle, fuels, Combustion, performance Advantages, Modification in fuel system.	**4**
	Special Engines: Working principles of Rotary, Stratified charge, Free piston, Variable compression ratio engines.	**4**
		40

TEXT BOOK		
1	Mathur & Sharma, Internal Combustion Engines, Dhanpat Rai & Sons	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub. year**
1	Gupta H.N., Fundamentals of Internal Combustion Engines, PHI, India	
2	F.Edward Obert, Internal Combustion Engines, Harper and Raw Publisher.	
3	John B. Heyword, Internal Combustion Engines Fundamentals, McGraw Hill	
4	Lichty, Internal Combustion Engines, McGraw Hill.	
5	Gill, Smith, Ziurs, Fundamentals of Internal Combustion Engine, Oxford & IBH	
6	Rogowsky, IC Engines, International Book Co.	
7	Ganeshan, V., Internal Combustion Engine, Tata Mc Graw Hill.	
8	R. Yadav, I.C Engine, Central Publishing House, Allahabad	

CO1: Understand engineering involved in using engines, various testing and performance parameters.
CO2: Learn about characterstics and concept supercharging.
CO3: Examine various fuel supply systems and various ignition systems.
CO4: Apply principles of engine friction and different lubrication methods.
CO5: Analyse multi fuel engines, special engines.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
CO1	2	3	2	2	-	-	-	-	-	-	-	-
CO2	2	3	2	2	-	-	-	-	-	-	-	-
CO3	3	3	2	2	-	-	-	-	-	-	-	-
CO4	2	2	2	2	-	-	-	-	-	-	-	-
CO5	2	3	3	3	-	-	-	-	-	-	-	-

4MEU5: INDUSTRIAL ENGINEERING

B.Tech. (Mechanical) 4th semester
3L+0T

Unit	Contents	Contact Hours
I	Concept and definition of Industrial Engineering, Historical development of IE, Role of Industrial Engineer, Applications of IE. Concept of Productivity, Work Study and Productivity,	**3**
	Techniques of work study, basic procedure, approach to method study, method study charts and diagrams, principles of motion economy,	**4**
II	Work measurement; basic procedure, techniques: Stop watch time study and work sampling, rating, determination of standard time	**4**
	Evolution of Management Theory, scientific management, Contributions of Taylor, Fayol, Mayo to scientific management, Levels of Management, Administration and Management, fundamental functions of management, Decision making.	**4**
III	Business Forms and Organization: Forms of Business: Single proprietorship, partnership, joint stock company, co-operative society, State undertakings, Joint Stock Companies: Organization: meaning, Types of organization; Line, Functional, Line Staff organization and line Staff Committee organization, span of control.	**5**
	Finance & Financial Statements: Introduction, Needs of Finance, Kinds of Capital, Sources of fixed capital, Shares. Borrow capital, surplus profits.	**3**
IV	Sources of working capital and its management, Profit & Loss Statement, Balance	**5**

	Sheet, Financial ratios: Liquidity ratio, Profits investment ratio, equity ratio, inventory ratio.	
	Time value of money: Simple and compound interest, Time value equivalence, Compound interest factors, Cash flow diagrams, Calculation of time –value equivalences. Present worth comparisons, Comparisons of assets with equal, unequal life, comparison of deferred investments,	**4**
	Time value of money II: Future worth comparison, payback period comparison. Rate of return, internal rate of return, comparison of IRR with other methods	**3**
V	Depreciation: Causes, Basic methods of computing depreciation charges; Straight line, Sinking fund, Declining Balance and Sum of year's digits method.	**3**
	Breakeven analysis: Basic concepts, Linear Breakeven analysis for single product, Breakeven charts, Dumping.	**2**
	TOTAL	**40**

TEXT BOOK		
1	Motion and Time Study and Measurement of Work, Ralph, M Barnes , John Wiley and Sons.	2001
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub.**
1	Introduction to Work Study, George Kanawaty, ILO.	2002
2	Prasad, L.M., Principles and practice of Management, Sultan Chand	2015
3	Sushil Kumar Basu, K. C. Sahu, N. K. Datta, Works Organisation & Management, Oxford & IBH.	2002
4	Dexter S. Kimball, Principles of Industrial Organization, Read Books.	2009
5	Leon Pratt Alford, Henry Russell Beatty, Principles of Industrial Management, Revised Edition, Ronald Press Co.	2001
6	Essentials of Industrial Management, McGraw-Hill Industrial organization and management series, Lawrence L. Bethel, McGraw-Hill.	2003
7	Riggs, J.L., Bedworth, D.J., Randhawa, S.U., Engineering Economics, Tata McGraw-Hill.	2006
8	Raju, Industrial Engg and Management, Cengage learning	2015

CO1: **Learn** the basic concepts of industrial engineering.
CO2: G**ain understanding of procedure of work study, forms of business, financial aspect like time value of money, financial statement and depreciation.**
CO3: **Apply** the tool and techniques of work study, financial analysis for improvement of productivity.

Course outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
CO1	2	3	2	2	-	-	-	-	-	-	-	-
CO2	2	3	2	2	-	-	-	-	-	-	-	-
CO3	2	3	2	2	-	-	-	-	-	-	-	-

4MEU6: DESIGN OF MACHINE ELEMENTS – I

B.Tech. (Mechanical) 4th semester
3L+0T

UNIT	CONTENTS	CONTACT HOURS
I	**Materials**: Mechanical Properties and IS coding of various materials, Selection of material from properties and economic aspects.	3
	Manufacturing Considerations in Design: Standardization, Interchangeability, limits, fits tolerances and surface roughness, BIS codes, Design consideration for cast, forged and machined parts. Design for assembly.	4
II	**Design for Strength**: Modes of failure, Strength and Stiffness considerations, Allowable stresses, factor of safety, Stress concentration: causes and mitigation, fatigue failures.	4
	Design of Members subjected to direct stress: pin, cotter and keyed joints.	5
III	**Design of Members in Bending**: Beams, levers and laminated springs. **Design for stiffness of beam:** Use of maximum deflection formula for various end conditions for beam design	7
IV	**Design of Members in Torsion** **Shaft and Keys:** Design for strength, rigidity. Solid and hollow shafts. Shafts under combined loading. Sunk keys.	5
	Couplings*:* Design of muff coupling, flanged couplings: rigid and flexible	3
V	**Design of Threaded fasteners**: Bolt of uniform strength, Preloading of bolts: Effect of initial tension and applied loads, Eccentric loading	4
	Power screws like lead screw, screw jack	2
	Design of members which are curved like crane hook, body of C-clamp, machine frame etc.	3
	TOTAL	40

TEXT BOOK		
1	Bhandari, V. B., Introduction to Machine Design, McGraw Hill Education (India)	**2013**
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Bahl and Goel, Mechanical Machine Design, Standard Publishers Distributors	**2002**
2	Shigley, Joseph E., Mechanical Engineering Design, McGraw Hill Education (India)	**2002**
3	Sharma and Aggarwal, Machine Design, S.K.Kataria and Sons, Delhi.	**1997**
4	Sharma and Purohit, Design of Machine Elements, Prentice Hall India.	**2002**
5	Jindal U C, Machine Design, Pearson Education India	**2010**

CO 1	Learn the material properties, coding and consideration for selecting the material.
CO 2	Apply concept of FBD to identify the load on each machine element/members of mechanical system.
CO 3	Analyse the machine members under application of external load.
CO 4	Evaluate the size/dimension of the machine members on the basis of failure theories.
CO 5	Develop skills to design a mechanical system.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	1	1	2	-	-	-	-	-	-	-	-
C02	3	3	1	3	-	-	-	-	-	-	-	-
C03	2	3	1	3	-	-	-	-	-	-	-	-
C04	2	2	3	3	-	-	-	-	-	-	-	-
CO5	2	2	3	2	-	-	-	-	-	-	-	-

4MEU11: PRODUCTION PRACTICE-II

B.Tech. (Mechanical) 4th semester

0L+0T +3P

Unit	Name Of Experiment
1	To study of single point cutting tool geometry and to grind the tool as per given tool geometry.
2	To study the milling machine, milling cutters, indexing heads and indexing methods and to prepare a gear on milling machine.
3	To machine a hexagonal /octagonal nut using indexing head on milling machine.
4	To cut BSW/Metric internal threads on lathe machine.
5	a) To cut multi-start Square/Metric threads on lathe machine.
	b) Boring using a boring bar in a centre lathe.
6	Study of capstan lathe and its tooling and prepare a tool layout & job as per given drawing.
7	Demonstration on milling machine for generation of plane surfaces and use of end milling cutters.
8	Grinding of milling cutters and drills.
9	Exercise on cylindrical and surface grinders to machine surfaces as per drawing.
10	Cylindrical grinding using grinding attachment in a centre lathe

CO1: To know the practical aspects of machining, working principle and machining process.
CO2: Learn and practice the machining operation and tools used in machining.
CO3: Understand the foundry techniques.
CO4: Learn and perform the gas, arc, spot, welding operations.
CO5: Learn to operate the machine used in manufacturing.
CO6: To know the basic concept of production technology

Course Outcomes	P01	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	3	2	2	3	-	-	-	-	-	-	-	-
CO2.	3	3	-	3	-	-	-	-	-	-	-	-
CO3.	3	3	3	3	-	-	-	-	-	-	-	-

4MEU12: MACHINE DESIGN SESSIONAL-I

B.Tech. (Mechanical) 4th Semester

0L+0T+3P

Sn	Sessional Work	Contact Hours
1	Material selection and relevant BIS nomenclature	
2	Selecting fit and assigning tolerances	
3	Examples of Production considerations	
4	Problems on:	
	(a) Knuckle & Cotter joints	
	(b) Torque: Keyed joints and shaft couplings	
	(c) Design of screw fastening	
	(d) Bending: Beams, Levers etc.	
	(e) Combined stresses: Shafts, brackets, eccentric loading.	

TEXT BOOK	
1. Design Data Book, PSG College of Technology	

CO 1	Know the material properties, coding and design consideration for selecting the material.												
CO 2	Apply the concept of FBD to evaluate the loads on a machine element.												
CO 3	Learn the efficient design criteria (design for strength and stiffness).												
CO 4	Apply the concept of designing under static load to various machine elements like shaft, shaft coupling, pin-joints, levers, etc.												
Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	
CO1	3	1	1	1	-	-	-	-	-	-	-	-	
CO2	3	3	2	1	-	-	-	-	-	-	-	-	
CO3	2	3	3	2	-	-	-	-	-	-	-	-	
CO4	3	3	3	3	-	-	-	-	-	-	-	-	

4MEU13: THERMAL ENGINEERING LAB

B.Tech. (Mechanical) 4th semester
0L+0T +2P

Unit	Name Of Experiment
1	Study of working of four stroke petrol engine and four stroke diesel engine with the help of cut section models
2	Study of working of two stroke petrol and two stroke diesel engine with the help of cut section models.
3	To draw valve timing diagram for a single cylinder diesel engine.
4	Study of various types of boilers.
5	Study of various types of mountings and accessories.
6	Demonstration of steering system and measurement of steering geometry angles and their impact on vehicle performance.
7	Study of braking system with specific reference to types of braking system, master cylinder, brake shoes.
8	Study of transmission system including clutches, gear box assembly and differential.
9	Study of fuel supply system of a petrol engine (fuel pump and simple carburetor)
10	Study of fuel supply system of a Diesel engine (fuel pump and fuel injector)
11	Study of Ignition systems of an IC Engine (Battery and Magneto ignition system) and Electronic ignition system.
12	Study of Lubrication system of an IC Engine (mist, splash and pressure lubrication)
13	Study of cooling systems of an IC Engine (air cooling and water cooling)

4MEU14: BASIC MECHANICAL ENGINEERING LAB

B.Tech. (Mechanical) 3rd Semester
0L+0T+2P

SN	LABORATORY WORK
	Exposure to a wide range of applications of mechanical engineering through a variety of activities, including hands-on assembly and disassembly of machines, such as, bicycle, sewing machine, pumps, engines, air-conditioners, machine-tools, amongst others; observational study of complex systems via cut sections, visits, videos and computer simulations; design of simple machines/systems including specifications formulation; visits to industries.
	Note: Student will be required to submit written report indicating the learning achieved by Hands on assembly/Disassembly.

Course outcome

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

CO1: Demonstrate and explain the wide range of applications of basic mechanical engineering systems

CO2: Explain the construction of various mechanical machines by assembly disassembly, cut sections and animations.

CO3: Determine and identify the specifications of mechanical machines.

CO4:

CO5:

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	P(
CO1	2	2	1									
CO2	2	2	1		2							
CO3	2	2	1		2							
Average	**2.0**	**2.0**	**1.0**		**2.0**							

5MEU1: HEAT TRANSFER

B.Tech. (Mechanical) 5th Semester
3L+1T

UNIT	CONTENTS	CONTACT HOURS
I	**Introduction:** Heat transfer processes, conduction and radiation. Fourier's law of heat conduction, thermal conductivity, thermal conductivity of solids, liquids and gases, effect of temperature on thermal conductivity. Newton's law of cooling, definition of overall heat transfer coefficient. General parameters influence the value of heat transfer coefficient.	4
	Conduction: General 3-Dimensoinal conduction equation in Cartesian, cylindrical and spherical coordinates; different kinds of boundary conditions; nature of differential equations; one dimensional heat conduction with and without heat generation; electrical analogy; heat conduction through composite walls; critical thickness of insulation	3
II	**Heat transfer from extended surfaces:** Governing differential equation of fin, fin efficiency and effectiveness for different boundary conditions.	3
	Unsteady state heat conduction for slab, cylinder and sphere, Heisler chart.	2
	Convection: Review of Navier – Stokes and energy equation, hydrodynamic and thermal boundary layers; laminar boundary layer equations; forced convection appropriate non dimensional members; effect of Prandtl number; empirical relations for flow over a flat plate and flow through pipes.	4
III	**Natural convection:** Dimensional analysis, Grashoff number, boundary layers in external flows (flow over a flat plate only), boundary layer equations and their solutions, heat transfer correlations.	4
	Heat transfer with change of phase: Nature of vaporization phenomena; different regimes of boiling heat transfer; correlations for saturated liquid vaporization; condensation on flat plates; correlation of experimental results, drop wise condensation.	4
IV	**Heat exchanger:** Types of heat exchangers, arithmetic and logarithmic mean temperature differences, heat transfer coefficient for parallel, counter and cross flow type heat exchanger; effectiveness of heat exchanger, N.T.U. method, fouling factor. Constructional and manufacturing aspects of Heat Exchangers.	8
V	**Thermal Radiation:** Plank distribution law, Krichoff's law; radiation properties, diffuse radiations; Lambert's law. Radiation intensity, heat exchange between two black bodies heat exchanger between gray bodies. Shape factor; electrical analogy; reradiating surfaces heat transfer in presence of reradiating surfaces.	8
		40

TEXT BOOK		
1	J.P. Halman, Heat Transfer, Mc Graw Hill	
REFERENCE BOOKS		

SN	Name of Authors /Books /Publisher	Year of Pub.
1	Incropera and Dewitt, Fundamental of Heat and Mass transfer, John Wiley	2007
2	Cengel, Heat and Mass transfer, Mc Graw Hill	2011
3	M.Thirumaleshwar, Fundamental of Heat and Mass Transfer, Pearson Education	2006
4	Ozisik, Heat and Mass Transfer, Mc Graw Hill	2009
5	Rolle, Heat and Mass Transfer, Cengage learning	2016

CO1: Understand the modes of heat transfer.
CO2: Evaluate the performance factors to select the process and product of heat transfer.
CO3: Optimize the heat exchangers.
CO4: Demonstrate and examine the existing correlations.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	3	2	2	-	-	-	-	-	-	-	-
C02	3	3	3	3	-	-	-	-	-	-	-	-
C03	3	3	3	2	-	-	-	-	-	-	-	-
C04	2	3	3	2	-	-	-	-	-	-	-	-

5MEU2: DYNAMICS OF MACHINES

B.Tech. (Mechanical) 5th semester
3L+1T

Unit	Contents	Contact hours
I	**Governors:** Comparison between flywheel and governor, Types of governor, Watt, Porter, Proell, Hartnell and spring controlled governors, sensitiveness of governors, stability of governors, isochronous and hunting, governor effort, power, controlling force diagram.	8
II	**Gyroscope:** Principle of gyroscopic couple, effect of gyroscopic couple and centrifugal force on aeroplanes, ships and vehicle taking a turn, stabilization of sea vessels, stability of four wheeled vehicle moving in a curved path, curved path with banking, stability of two wheeled vehicle, gyroscopic effect on inclined rotating disc	5
	Inertia force analysis: Velocity and acceleration of slider crank and four bar mechanism, inertia force, piston thrust and forces on connecting rod, turning moment diagram, flywheel.	3
III	**Gears:** Classification, terminology, law of gearing, velocity of sliding, gear tooth profile, comparison of cycloidal and involute tooth profile, standard interchangeable tooth profile, length of path of contact, arc of contact, contact ratio, interference, undercutting, minimum number of teeth on pinion in contact with gear or rack, bevel, helical and spiral gears.	9
IV	**Gear Trains**: Simple, compound, reverted and epicyclic gear trains, analytical, tabular, graphical and vector methods for finding velocity ratio, gear boxes- sliding and constant mesh, synchromesh and differential gear box.	7
V	**Balancing:** Need of balancing, Balancing of rotating masses, single plane, different planes, balancing of reciprocating masses, single cylinder engine, multi-cylinder inline engines, V-engines, concept of direct and reverse cranks, partial balancing of locomotives, IC engines, V engines and balancing machines.	8
	TOTAL	**40**

TEXT BOOK		
1	Rattan, S.S., "Theory of Machines", 2nd Ed., Tata McGraw Hill.	2006
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Bevan, T., "Theory of Machines", Pearson Education.	**2013**
2	Uicker, J.J., Pennocle, G.R, and Shigley, J.E, "Theory of Machines and Mechanisms", 3rd Ed., Oxford University Press.	**2009**
3	Ambekar , A. G., "Mechanism And Machine Theory", Prentice-hall Of India	**2007**
4	Ghosh, A., "Theory of Mechanisms and Machines", Affiliated East West Press.	
5	Singh, S., "Theory of Machines", Pearson Education	**2013**

CO1: To understand different types of machine elements and mechanisms.
CO2. Demonstrate the various principles involved in the working of machine elements.
CO3: Acquire the knowledge of standard gearing practice and able to compare and analyze various gear profiles and types.
CO4: Implement & Examine the concept of balancing for machine elements.
CO5: Compute & Evaluate the performance of machine elements.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	3	3	3	-	-	-	-	-	-	-	-
C02	3	2	2	2	-	-	-	-	-	-	-	-
C03	3	3	2	3	-	-	-	-	-	-	-	-
C04	3	3	2	1	-	-	-	-	-	-	-	-
CO5	3	3	2	3	-	-	-	-	-	-	-	-

5MEU3: OPERATIONS RESEARCH

B.Tech. (Mechanical) 5th semester
3L+0T

Unit	Contents	Contact hours
I	**Overview of Operations Research**	1
	Linear Programming: Applications and model formulation, Graphical method, Simplex method, duality and Sensitivity analysis.	4
	Transportation Model and Assignment Model including travelling salesman problem.	4
II	**Integer Linear Programming:** Enumeration and cutting Plane solution concept, Gomory's all integer cutting plane method, Branch and Bound Algorithms, applications of zero-one integer programming.	5
	Replacement Models: Capital equipment replacement with time, group replacement of items subjected to total failure.	3
III	**Queuing Theory**: Analysis of the following queues with Poisson pattern of arrival and exponentially distributed service times, Single channel queue with infinite customer population, Multichannel queue with infinite customer population,	3
	Competitive Situations and Solutions: Game theory, two person zero sum game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy, approximate solution, and simplified analysis for other competitive situations. Application of linear programming	4
IV	Theory of Decision making: Decision making under certainty, risk and uncertainty. Decision trees.	5
	Deterministic Inventory control models: functional role of inventory, inventory costs, model building, Single item inventory control model without shortages, with shortage and quantity discount. Inventory control model with uncertain demand, service level, safety stock, P and Q systems, two bin system. Single period model. Selective Inventory control techniques.	4
V	**Probabilistic Inventory control models:** Instantaneous demand without setup cost and with setup cost, Continuous demand without setup cost	4
	Simulation: Need of simulation, advantages and disadvantages of simulation method of simulation. Generation of Random numbers, Generation of Normal Random numbers. Use of random numbers for system simulation. , Monte Carlo simulation, simulation language ARENA, Application of simulation for solving queuing Inventory Maintenance, Scheduling and other industrial problems	4
	TOTAL	40

TEXT BOOK		
1	Operations Research, Ravindran, Phillips and Solberg, Wiley India.	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Introduction to Operations Research, Hillier F.S. and Lieberman G.J., CBS Publishers.	
2	Operations Research, Taha H.A., Pearson Education	
3	Linear Programming and Network Flows, Bazaraa, Jarvis and Sherali, Wiley India.	
4	Principles of Operations Research, Wagner H.M., Prentice Hall of India.	
5	Operations Research, Gupta and Heera, S. Chand Publications.	

CO1: Discuss the concepts of operations research modelling approaches by formulating and solving engineering and managerial situations as LPP

CO2: Evaluate engineering and managerial situations as Transportation and Assignment problems.

CO3: Explain game and queuing theories.

CO4: Illustrate decision theory and estimate inventory management policy

CO5: Simulate and analyze engineering and managerial problems.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1	PSO2
CO1	3	3	2	1	1								
CO2	3	3	3	3	2								
CO3	3	3	3	2	2								
CO4	3	3	3	1	2								
CO5	3	3	3	3	3								
		Average		**3.0**		**3.0**		**2.8**		**2.0**		**2.0**	

5MEU4: DESIGN OF MACHINE ELEMENTS- II

B.Tech. (Mechanical) 5th Semester

3L+0T

UNIT	CONTENTS	CONTACT HOURS
I	**Fatigue Considerations in Design:** Variable load, loading pattern, endurance stresses, Influence of size, surface finish, notch sensitivity and stress concentration.	**3**
	Goodman line, Soderberg line, Design of machine members subjected to combined, steady and alternating stresses.	**3**
	Design for finite life, Design of Shafts under Variable Stresses, Bolts subjected to variable stresses.	**2**
II	**Design of IC Engine components:** Piston, Cylinder, Connecting Rod and Crank Shaft.	**8**
III	Design of helical compression, tension, torsional springs, springs under variable stresses.	**4**
	Design of belt, rope and pulley drive system,	**4**
IV	**Design of gear teeth:** Lewis and Buckingham equations, wear and dynamic load considerations.	**4**
	Design and force analysis of spur, helical, bevel and worm gears, Bearing reactions due to gear tooth forces.	**4**
V	**Design of Sliding and Journal Bearing:** Methods of lubrication, hydrodynamic, hydrostatic, boundary etc. Minimum film thickness and thermal equilibrium.	**4**
	Selection of anti-friction bearings for different loads and load cycles, Mounting of the bearings, Method of lubrication.	**4**
	TOTAL	**40**

TEXT BOOK		
1	Design of Machine Elements, Bhandari V.B, 3rd Ed., Tata McGraw-Hill, New Delhi	2010
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Machine Design, Sharma and Aggarwal, Kataria and Sons, Delhi.	**1997**
2	Mechanical Engg Design, Shigley, Mischke, Budynas and Nisbett, Tata McGraw-	**2002**

	Hill	
3	PSG Design Data Book, P.S.G. College of Technology, Coimbatore.	**1966**
4	A Text Book of Machine Design, Karwa A., Laxmi Publication.	**2002**
5	Machine Design, Hall, Holwenko and Laughlin, Schaum's Outlines Series, Tata McGraw Hill.	

CO 1	To account the static and dynamic loading conditions in different materials.
CO 2	To design for various components and analyse the stresses induced in them.
CO 3	To conduct the force analysis on different power transmitting components.
CO 4	To apply and examine the elements under different operating conditions.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	3	3	3	-	-	-	-	-	-	-	-
CO2	3	3	3	3	-	-	-	-	-	-	-	-
CO3	3	3	3	3	-	-	-	-	-	-	-	-
CO4	3	3	3	3	-	-	-	-	-	-	-	-

5MEU5.1: QUALITY ASSURANCE AND RELIABILITY

B.Tech. (Mechanical) 5th semester

3L+0T

UNIT	CONTENTS	CONTACT HOURS
I	The meaning of Quality and quality improvement dimensions of quality, history of quality methodology, quality control, Quality of design and quality of conformance, Quality policy and objectives, Economics of quality.	5
	Modeling process quality: Describing variation, frequency distribution, continuous and discrete, probability distributions, pattern of variation, Inferences about process quality: sampling distributions and estimation of process parameters. Analysis of variance.	4
II	Statistical Quality Control: Concept of SQC, Chance and assignable causes of variation, statistical basis of control chart, basic principles, choice of control limits, sample size and sampling frequency, analysis of patterns on control charts. The magnificent seven.	4
	Control chart for variables,: X-bar and R charts, X-bar and S charts, control chart for individual measurement. Application of variable control charts.	4
III	Control chart for attributes: control chart for fraction non conforming P-chart, np-chart, c-chart and u-chart. Demerit systems, choice between attribute and variable control chart. SPC for short production runs. Process capability analysis using histogram and probability plot, capability ratios and concept of six sigma.	7
IV	Quality Assurance: Concept, advantages, field complaints, quality rating, quality audit.	2
	Acceptance Sampling: Fundamental concepts in acceptance sampling, operating characteristics curve. Acceptance sampling plans, single, double and multiple sampling plans, LTPD, AOQL, AOQ.	4
	Introduction to Quality systems like ISO 9000 and ISO 14000.	2
V	Reliability and Life Testing- Failure models of components, definition of reliability, MTBF, Failure rate, common failure rate curve, types of failure, reliability evaluation in simple cases of exponential failures in series, paralleled and series-parallel device configurations, Redundancy and improvement factors evaluations. Introduction to Availability and Maintainability	4
	Introduction to Taguchi Method of Design of Experiments, Quality loss function.	4
	TOTAL	**40**

TEXT BOOK		
1	Introduction to Statistical Quality Control, Douglas C. Montgomery, 2nd Edition, Wiley.	1991
2	Charles E. Ebeling, An introduction to reliability and maintainability engineering, Tata McGraw-Hill Education.	2004
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Quality Planning and Analysis, J.M.Juran and F.M. Gryna, McGraw Hill	
2	Quality Control, Dale H. Besterfield, 8th Edition, Pearson/Prentice Hall	2008
3	Statistical Quality Control, E. L. Grant and Richard S. Leavenworth, TMH	2000
4	Fundamentals of Quality Control and Improvement, Amitava Mitra, 2nd Edition, Prentice Hall	1998
5	Design and Analysis of Experiments, 5th Edition, Douglas C. Montgomery, Wiley-India	2007

Course outcome

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

CO1: Discuss the fundamental of quality and various probablity distribution.

CO2: practice various tools and techniques of SQC.

CO3: Construct various control charts and analyse process capability

CO4: Identify quality assurance and implement acceptance sampling.

CO5: Experimental work using DOE and taguchi.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1 PSO2
CO1	3	2		3	2							1
CO2	3	2	1	2	2	1						2
CO3	3	2	2	3	1							1
CO4	3	2	1	3	1	2						1
CO5	2	2	2	3	2							2
Average	**2.8**	**2.0**	**1.5**	**2.8**	**1.6**	**1.5**						**1.4**

5MEU5.2: COMPUTATIONAL FLUID DYNAMICS

B.Tech. (Mechanical) 5th semester
3L+0T

Introduction:Importance and applications of CFD in diverse fields; Different types of partial differential equations — hyperbolic, parabolic, elliptic and mixed types; Fundamental concepts of CFD.

Governing equations: Continuity, momentum and energy equations in conservative and non-conservative forms; Governing equations in boundary layers and inviscid flows; Initial and boundary conditions.

Discretization: Concept and need of discretization of differential equations; Different discretization techniques — finite difference, finite element and finite volume methods and their comparison; Fundamentals of FDM, forward, backward and central difference, ADI scheme, applications to simple problems such as transient one-dimensional and two-dimensional conduction; Stability criterion, errors, consistency, optimum step size.

Grid generation: Types of grid; Structured, unstructured and hybrid mesh in 2d & 3d, their relative merits and regions of application; Coordinate transformation; Elliptic grid generation; Grid independence test; Adaptive grids, modern developments in grid generation.

Calculation of flow field: Methods of solution, simple 1d computations using different methods; Convergence criterion; Implicit and explicit algorithms; Pressure and velocity corrections; Vorticity-stream function method; Solution of turbulent flows and turbulence modelling.

TEXT BOOKS:-
"Computational Fluid Dynamics – The basics with applications", J. D. Anderson Jr., McGraw-Hill
"Computational Fluid Flow and Heat Transfer", K. Muralidhar& T. Sundarajan, Narosa Publishing House

REFERENCE BOOKS:-
"Numerical Computation of Internal and External Flows", C. Hirsch, Butterworth-Heinemann
"Fundamentals of Engineering Numerical Analysis", P. Moin, Cambridge Univ. Press
"Numerical Methods for Engineering Application", J. H. Ferziger, Wiley
"Computational Methods for Fluid Dynamics", J. H. Ferziger& M. Peric, Springer
"Computational Fluid Dynamics", T.J. Chung, Cambridge University Press

CO1: Define and formulate the given fluid problem and heat transfer problem.
CO2: Discuss the concept of discretisation to fluid flow and heat transfer problems.
CO3: Understand and Apply the Finite difference method for solving the fluid flow and heat transfer problems.
CO4: Evaluate and use Finite volume method for solving the fluid flow and heat transfer problems.
CO5: Apply the knowledge of computational fluid dynamics in chemical and paint industries.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	3	1	2	1	-	-	-	-	-	-	-
C02	3	3	3	3	-	-	-	-	-	-	-	-
C03	3	2	2	1	2	-	-	-	-	-	-	-
C04	2	2	1	2	3	-	-	-	-	-	-	-
CO5	2	3	3	2	2	-	-	-	-	-	-	1

5MEU5.3: MANAGEMENT INFORMATION SYSTEM

B.Tech. (Mech) 5th semester
3L+0T

UNIT	CONTENTS	CONTACT HOURS
I	Organisation & Types, Decision Making, Data & information, Characteristics & Classification of information,	3
	Cost & value of information, Various channels of information & MIS.	2
II	Foundation of Information System : Introduction to Information System in Business Fundamentals of Information System, Solving Business Problems with Information System,	4
	Concept of Balanced MIS, Effectiveness & Efficiency Criteria. Tool and Techniques of MIS- dataflow diagram, flow chart etc.	4
III	Business application of information technology, electronic commerce, Internet, Intranet, Extranet & Enterprise Solutions, Information System for Business Operations,	5
	Information system for managerial Decision Support, Information System for Strategic Advantage	5
IV	Managing Information Technology, Enterprise & Global Management, Security & Ethical Challenges, Planning & Implementing Change..	4
	Reports: Various types of MIS reports, GUI & Other Presentation tools	4
V	Advanced concepts in information system: Enterprise Resource Planning: introduction, various modules like Human Resources, Finance, Accounting, Production & Logistics.	5
	Supply Chain Management, CRM, Procurement Management System Object Oriented modeling case studies.	4
	TOTAL	**40**

TEXT BOOK		
1	Information systems for Modern Management, G.R.Murdick, Prentice Hall of India	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Management Information systems, S.Sadagopan, Prentice Hall of India	
2	Management Information Systems, Effy Oz, Cengage Learning	
3	Management Information Systems, James A O Brien, Irwin McGraw Hill	
4	Management Information Systems, Laudon and Laudon, Prentice Hall of India	

5MEU6.1: AUTOMOBILE ENGINEERING

B.Tech. (Mechanical) 5th semester
3L+0T

UNIT	CONTENTS	CONTACT HOURS
I	**Frame & Body:** Layout of chassis, types of chassis frames and bodies, their constructional features and materials.	3
	Clutches: single plate, multi-plate, cone clutch, semi centrifugal, electromagnetic, vacuum and hydraulic clutches. Fluid coupling. **Brakes:** Classification and function; Mechanical, hydraulic, vacuum air and self engineering brakes; Brake shoes and lining materials.	5
II	**Gear Boxes**: Sliding mesh, constant mesh, synchromesh and epicyclic gear boxes, Automatic transmission system; Hydraulic torque converter	4
	Drives: Overdrive, Propeller shaft, Universal joints, Differential; Rear axle drives. Hotchkiss and torque tube drives; Rear axle types; Front wheel and All wheel drive.	4
III	**Wheels and Tyres**:Tyre types, Tyre construction; Tyre inflation pressure, Tyre wear and their causes; Re-treading of the tyre,	2
	Steering system: steering gear boxes, Steering linkages, Steering mechanism, Under and Over steering. Steering Geometry, Effect of camber, caster, king pin inclination, toe in and toe out; Power steering; Integral and linkage types	3
	Suspension system: objective and requirements, Suspension spring, front and rear suspension systems, Independent suspension system Shock absorbers.	3
IV	**Automotive Electrical System:** Battery construction, Charging and testing, battery types, Starting and Battery Charging System: Starter motor construction, types of drive, Alternator construction, regulation and rectification.	4
	Ignition System: Magneto and coil ignition systems, System components and requirements, Automotive lighting: Wiring systems Electrical instruments; head lamp, electric horn, fuel level indicator.	4
V	**Automotive Air Conditioning:** Introduction, Loads, Air conditioning system Components, Refrigerants, Fault Diagnosis.	4
	Automotive Safety: Safety requirements, Safety Devices, Air bags, belts, radio ranging, NVS (Night Vision System) GPS (Global Positioning System)	4
	TOTAL	40

TEXT BOOK		
1	RP SHARMA,A Course in Automobile Engineering,Dhanpat Rai & Sons	
2	P S Gill,A Text book of Automobile Engineering,KATSON Books VOL 1&2	2010
3	Kirpal Singh,Automobile Engineering, Standard	2003
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	R K Rajpoot,A Text book of Automobile Engineering,Laxmi Publications	2007
2	Jornsen Reimpell, Helmut Stoll,The Automotive Chassis: Engineering Principles,Jurgen Betzler (P) Ltd,	2001

5MEU6.2: CNC MACHINES AND PROGRAMMING

B.Tech. (Mechanical) 5th semester

3L+0T

UNIT	CONTENTS	CONTACT HOURS
I	Introduction: Definition of NC, Applications of NC ,Historical Developments in Automation,Classification of NC Systems,Comparison of NC and Conventional Machines,Advantages of NC	8
II	NC Hardware: Architecture of NC Systems, Design Considerations, Mechanical Elements, Structure, Guideways and Slides, Guideway Elements, Transmission Systems, Spindle Unit, Coolant system, Lubrication System, Tool and work Changing Mechanisms, Electrical Elements, Drives, Sensors, Control Loops, Computing Elements/ Firmware, Interpolators	8
III	NC Software: Introduction, Manual Part Programming, Computer-Assisted Part Programming, Language Based , Geometric Modeling Based, Automatic Part Program Generation,	8
IV	CAPP Systems, 5 Axis Programming, Post-Processing, Programming Robots and CMMs	4
	NC Simulation, Kinematic simulation, Volumetric simulation, Applications of Volumetric NC Simulation, Verification	4
V	Advanced Topics:, Adaptive Control, Off-line adaptive control, Various optimisation criteria, Hardware Based AC, Software Based AC, Tooling and Instruments for NC Special Considerations in High Speed Cutting (HSC) and Die Sinking, Rapid Product Development, CAM, FMS, CIM	8
	TOTAL	**40**

TEXT BOOK		
1	Krar S. and Gill A., CNC: Technology and Programming, McGraw Hill	1990
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Koren Y., Computer Control of Manufacturing Systems, Tata McGraw Hill.	1983
2	Pressman R.S. and Williams J.E., Numerical Control and Computer-Aided Manufacturing, John Wiley & Sons	1977,
3	Jones B.L.,Introduction to Computer Numerical Control, John Wiley & Sons.	1986
4	Kral I.H., , Numerical Control Programming in APT, Prentice-Hall	1986
5	Chang C.H. and Melkanoff M.A., ,NC Machine Programming and Software Design, Prentice-Hall	1986

Course outcome

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

CO1: Implementation and Examine applications and advantages of CNC machines and technology.

CO2: Recognize about the CNC machine tool Structure.

CO3: Knowledge of basic programming codes and calculation of CNC Machining Parameters.

CO4: Preparation of CNC program for CNC Lathe & Milling

CO5: Demonstrate and verify NC softwareβ€™s, Sensors, NC modeling & Simulation and Robotics.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1	PSO1	PSO2
CO1	3	1												

CO2	3	1		2		2
CO3	3	3	2	3		2
CO4	3	3	3	3		2
CO5	3	3	3	3		2
Average	**3.0**	**2.2**	**2.7**	**2.8**		**2.0**

5MEU6.3: INTRODUCTION TO AERONAUTICS

B.Tech. (Mechanical) 5th semester

3L+0T

Unit	Contents	Contact Hours
I	**History of aviation and space flight**: Brief history of flight vehicle development with emphasis on key ideas: Indian aerospace activities Classification of aircraft and space vehicles; Functions of major components of airplane and space vehicles **Standard Atmosphere:** Definition of altitude, the hydrostatic equation, Relation between geopotential and geometric altitudes, Definition of standard atmosphere, Pressure, Density & temperature altitudes	8
II	**Airfoils and Wings:** Introduction of principles of flights: Principles of generation of lift, Basic characteristics of airfoils, NACAnomenclature, propagation of sound, Lift, drag and moment coefficients, centre of pressure,Attached Flow and Separated Flow,Bluff bodies v/s streamlined body, airfoil. Lift generation, significance of L/D ratio. Aerodynamic forces. Types of Drag, Infinite and Finite Wings, Pressure Coefficientprimary control surfaces- Elevator, Aileron, stabilators and rudder. Secondary control surfaces-Trim Tabs, Flaps, Spoilers, Air-Brakes, Slats-Slots.	8
III	**Airplane Performance:** Introduction, Equation of motion, Thrust required for level unaccelerated flight, Thrust available and maximum velocity, Power required for level unaccelerated flight, Power available and maximum velocity for jet engine and reciprocating engine-propeller combination, Altitude effect on power required and available, Rate of climb, Gliding flight, Absolute and service ceilings, Time to climb, Range & endurance for propeller driven airplane and jet engine driven airplane, take-off and landing	8
IV	**Principles of Stability and Control:** Introduction, Definitions of Stability & Control, Moments on Airplane, Absolute angle of attack, Criteria for longitudinal static stability	4
V	**Aircraft structure and propulsion** General types of construction, Monocoque, semi-monocoque and geodesi cconstruction, Typical wing and fuselage structure. Mechanism of thrust production – propellers – jet engines. Basic ideas about piston, turboprop and jet engines, Use of propeller and jets for thrust production. Comparative merits, Principles of operation of rocket, types of rockets and typical applications.	8
	TOTAL	40

TEXT BOOK		Year of Pub.
1	Anderson, J. D., Introduction to Flight, McGraw-Hill Professional	2005
REFERENCE BOOKS		
Sr	**Name of Authors /Books /Publisher**	
1	Anderson, J. D., The Aeroplane, a History of its Technology, AIAA Edu. Series,	2002
2	Ojha S.K., Flight Performance of Aircraft, AIAA Education Series,	1995
3	Kermode,A.C., 'Flight without Formulae', McGraw Hill,	1987.
4	Shevell,R.S., Fundamentals of flights, Pearson education	2004.

5MEU11: HEAT TRANSFER LAB.

B.Tech. (Mechanical) 5th Semester
0L+0T+3P

SN	NAME OF EXPERIMENT
1	To Determine Thermal Conductivity of Insulating Powders.
2	To Determine Thermal Conductivity of a Good Conductor of Heat (Metal Rod).
3	To determine the transfer Rate and Temperature Distribution for a Pin Fin.
4	To Measure the Emissivity of the Test plate Surface.
5	To Determine Stefan Boltzmann Constant of Radiation Heat Transfer.
6	To Determine the Surface Heat Transfer Coefficient For Heated Vertical Cylinder in Natural Convection.
7	Determination of Heat Transfer Coefficient in Drop Wise and Film Wise condensation.
8	To Determine Critical Heat Flux in Saturated Pool Boiling.
9	To Study and Compare LMTD and Effectiveness in Parallel and Counter Flow Heat Exchangers.
10	To Find the Heat transfer Coefficient in Forced Convection in a tube.
11	To study the rates of heat transfer for different materials and geometries
12	To understand the importance and validity of engineering assumptions through the lumped heat capacity method.

CO1: Analyze basic principles of heat transfer for various heat transfer applications.
CO2: Evaluate and optimize the heat transfer systems.
CO3: Evaluate the performance of different heat exchangers.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	3	3	3	-	-	-	-	-	-	-	-
C02	3	3	3	3	-	-	-	-	-	-	-	-
C03	3	3	3	3	-	-	-	-	-	-	-	-

5MEU12: MACHINE DESIGN SESSIONAL –II

B.Tech. (Mechanical) 5th Semester
0L+0T+3P

SN	SESSIONAL WORK
	Problems on:
1	Fatigue loading.
2	Helical compression, tension and torsional springs design.
3	Curved Beams.
4	Preloaded bolts and bolts subjected to variable stresses.
5	Belt, Rope and Chain drive system.
6	Gear Design.
7	Sliding contact bearing design.
8	Anti-friction bearing selection
CO 1	Account the static and dynamic loading conditions in different materials.
CO 2	Understand and apply the concept of design for fatigue wear, finite life cycles, etc.
CO 3	Examine the various machine elements under different operating conditions.
CO 4	Design for the machine elements like shaft gears, bearings, springs, etc.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	2	1	1	-	-	-	-	-	-	-	-
CO2	3	3	2	1	-	-	-	-	-	-	-	-
CO3	3	3	3	2	-	-	-	-	-	-	-	-
CO4	3	3	3	3	-	-	-	-	-	-	-	-

5MEU13: THEORY OF MACHINES LAB

B.Tech. (Mechanical) 5th Semester

0L+0T+2P

SN	NAME OF EXPERIMENT
1	To verify the torque relation for gyroscope.
2	To plot force vs. radius and lift vs. speed curves for governors.
3	To plot pressure distribution curves on a journal bearing.
4	To perform wheel balancing.
5	To perform static and dynamic balancing on balancing set up.
6	To determine mass moment of inertia of a flywheel.
7	Study of a lathe gear box.
8	Study of a sliding mesh automobile gear box.
9	Study of a planetary gear box.
10	To determine co-efficient of friction using two roller oscillating arrangement.
11	Study of various cam-follower arrangements.To plot displacement v/s angle of rotation curve for various cams
12	Perform study of the following using Virtual Lab http://www.vlab.co.in/ a) Position, velocity and acceleration analysis of Grashof four bar mechanism b) Position, velocity and acceleration analysis of Slider Crank mechanism

CO 1	To plot various performance curves of the machines elements.
CO 2	To perform different balancing operations.
CO 3	To determine the various operating parameters of oscillating macines.
CO 4	To study the gear operated systems.

Course Outcomes	P01	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	3	3	1	3	-	-	-	-	-	-	-	-
CO2.	3	3	1	2	-	-	-	-	-	-	-	-
CO3.	3	3	1	3	-	-	-	-	-	-	-	-
CO4.	3	1	1	2	-	-	-	-	-	-	-	-

5MEU14: INDUSTRIAL ENGINEERING LAB-I.

B.Tech. (Mechanical) 5th Semester
0L+0T+2P

SN	SESSIONAL WORK	CONTACT HOURS
1	Case study on X bar charts and process capability analysis	
2	PChart: (a)Verify the Binomial Distribution of the number of defective balls by treating the balls with a red colour to be defective. (b) Plot a P-chart by taking a sample of n=20 and establish control limits	
3	To plot C-chart using given experimental setup	
4	Operating Characteristics Curve: (a) Plot the operating characteristics curve for single sampling attribute plan for n = 20 ; c = 1 , 2 , 3 Designate the red ball to defective. (b) Compare the actual O.C. curve with theoretical O.C. curve using approximation for the nature of distribution	
5	Distribution Verification: (a) Verification of Normal Distribution. (b) To find the distribution of numbered cardboard chips by random drawing one at a time with replacement. Make 25 subgroups in size 5 and 10 find the type of distribution of sample average in each case. Comment on your observations	
6	Verification of Poisson distribution	
7	Central Limit Theorem: (a) To show that a sample means for a normal universe follow a normal distribution (b) To show that the sample means for a non normal universe also follow a normal Distribution.	
8	Solve problems using available Statistical Process Control software in lab	

CO1: Learn the statistical basics of control charts and sampling.
CO2: Construct the control charts, OC curves and evaluate the process performances.
CO3: Apply the SQC methods to problems using SPC software.

Course Outcomes	P01	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	3	3	-	3	-	-	-	-	-	-	-	-
CO2.	3	2	-	3	-	-	-	-	-	-	-	-
CO3.	3	3	-	3	2	-	-	-	-	-	-	2

6MEU1: REFRIGERATION AND AIR CONDITIONING

B.Tech. (Mechanical) 6th Semester

3L+1T

UNIT	CONTENTS	CONTACT HOURS
I	**Introduction:** Refrigeration and second law of Thermodynamics, Refrigeration effect and unit of Refrigeration, Heat pump, reversed Carnot cycle. **Vapour Compression Refrigeration System:** Analysis of simple vapour compression Refrigeration cycle by p-h and T-S diagram. Effect of operating conditions	5
	Multiple Evaporator and compressor system: Application, air compressor system, Individual compressor, compound compression, cascade system. Application, air compressor systems, individual compressor, compound compression, cascade system.	3
II	**Gas Cycle Refrigeration:** Limitation of Carnot cycle with gas, reversed Brayton cycle, Brayton cycle with regenerative heat exchanger.	4
	Air cycle for air craft: Necessity of cooling of air craft, Basic cycle, boot strap, regenerative type air craft refrigeration cycle.	4
III	**Other refrigeration systems** (description only): Vapour absorption refrigeration system, Electrolux refrigerator, Lithium Bromide - Water system, Water vapour refrigeration system, Vortex tube refrigeration system, thermo electric refrigeration system.	4
	Refrigerants: Classification, Nomenclature, selection of Refrigerants, global warming potential of CFC Refrigerants. Refrigeration Equipments: Compressor, condenser, evaporator, expansion devices, types & working.	4
IV	**Psychrometry:** Psychrometric properties, psychometric relations, pyschrormetric charts, psychrometric processes, cooling coils, By-pass factor, Apparatus Dew point temperature and air washers.	5
	Human Comfort: Mechanism of body heat losses, factors affecting human comfort, effective temperature, comfort chart.	3
V	**Cooling load calculations:** Internal heat gain, system heat gain, RSHF, ERSHF, GSHF, cooling load estimation, heating load estimation, psychrometric calculation for cooling.	5
	Selection of air conditioning: Apparatus for cooling and dehumidification, Air conditioning system, year round air conditioning.	3
	TOTAL	**40**

TEXT BOOK		
1	Arora, C.P., Refrigeration and Air Conditioning, Tata McGraw Hill	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Stoecker W.F., "Refrigeration & Air Conditioning" McGraw Hill Publication.	**2000**
2	Andrew D. Althouse., "Modern Refrigeration & Air Conditioning" GoodHeart-Willcox Co.	**2002**
3	Jorden & Priester, Refrigeration & Air Conditioning, Prentice Hall of India.	**2003**
4	Roy J. Dossat, Principal of Refrigeration, Pearson Education, New Delhi.	**2014**
5	Edward G. Pita, Air Conditioning Principles and Systems, Pearson Education, New Delhi.	**2003**
6	Jain V.K., Refrigeration & Air Conditioning, Tata McGraw Hill New Delhi.	2004

CO1: Understand the concepts of refrigeration and air conditioning.
CO2: Evaluate & select the refrigerants for any process and product.
CO3: Determine the comfort cooling and heating conditions.
CO4: Analyse and compute the air conditioning system

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	3	2	2	-	-	-	-	-	-	-	-
C02	3	2	3	2	-	-	-	-	-	-	-	-
C03	3	3	3	2	-	-	-	-	-	-	-	-
C04	3	3	3	2	-	-	-	-	-	-	-	-

Approved
Dean, FA & UD

6MEU2: VIBRATION ENGINEERING

B.Tech. (Mechanical) 6th semester
3L+1T

Unit	CONTENTS	Contact Hours
I	**Introduction to Sound:** Frequency dependent human response to sound, Sound pressure dependent human response, Relationship among sound power, sound intensity and sound pressure level.	2
	Introduction to Noise: Auditory and Non auditory effects of Noise, Major sources of the noise, Industrial noise sources, Industrial noise control strategies.	3
	Introduction to Vibration: Importance and scope of vibrations, terminology and classification, Concept of Degrees of freedom, Harmonic motion, vectorial representation, complex number representation, addition.	3
II	**Undamped Single Degree of Freedom System:** Derivation of equation of motion for one dimensional longitudinal, transverse and torsional vibrations without damping using Newton's second law, D' Alembert's principle and Principle of conservation of energy, Compound pendulum and centre of percussion.	3
	Damped vibrations of single degree of freedom systems: Viscous damping, under-damped, critically damped and over-damped systems, Logarithmic decrement.	3
	Vibration characteristics of Coulomb damped system and Vibration characteristics of Hysteretic damped systems.	2
III	**Forced Vibrations of Single Degree of Freedom Systems:** Forced vibration with constant harmonic excitation, Steady state and transient parts, Frequency response curves and phase angle plot, Forced vibration due to excitation of support.	4
	Vibration Isolation and Transmissibility: Force transmissibility, Motion transmissibility, Forced vibration with rotating and reciprocating unbalance, Materials used in vibration isolation.	4
IV	**System with Two Degrees of Freedom:** principle mode of vibration, Mode shapes, Undamped forced vibrations of two degrees of freedom system with harmonic excitation, Vibration Absorber, Undamped dynamic vibration absorber and centrifugal pendulum absorber	5
	Critical Speed of Shaft: Critical speed of a light shaft without damping, critical speed of shaft having multiple discs, secondary critical speed.	3
V	**Many Degrees of Freedom Systems (Exact analysis)**: Equation of Motion, The matrix method, Eigen Values and Eigen Vectors, Method of influence Coefficients and Maxwell's reciprocal theorem. Torsional vibrations of multi rotor system, vibrations of geared system, Generalized coordinates and coordinate coupling **Many Degrees of Freedom Systems (approximate methods**): Rayleigh's, Dunkerley's, Stodola's and Holzer's methods	5
	Vibrations of continuous systems: Transverse vibration of a string, Longitudinal vibration of a bar, Torsional vibration of a shaft.	3
	TOTAL	**40**

TEXT BOOK		
1	Rao S.S., "Mechanical Vibrations", Pearson Education, 2nd Indian reprint.	2004
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Publ**
1	Ambekar A.G., "Mechanical Vibrations and Noise Engineering", PHI	2006
2	Kelly, S.G., "Mechanical Vibrations, Theory and Applications, Cengage Lrg	2013
3	Thomson, W.T., and Dahleh, M.D., Padmanabhan, C., "Theory of Vibrations with Applications", Pearson Education.	2014
4	Meirovitch, L., "Elements of Vibration Analysis", Tata McGraw-Hill	2006
5	Tongue, B.H., "Principles of Vibration", Oxford Publication	2007

CO 1	Understand the concept of frequency, sound pressure level and their effects on humans.											
CO 2	Evaluate the cases of natural and forced vibration effects.											
CO 3	Know the effects of damping on vibration analysis.											
CO 4	Apply the knowledge of evaluating the frequency of systems involving various degree of freedom.											
Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	3	3	1	-	-	-	-	-	-	-	-
C02	3	2	1	-	-	-	-	-	-	-	-	-
C03	3	3	1	1	-	-	-	-	-	-	-	-
C04	3	3	2	1	-	-	-	-	-	-	-	-

6MEU3: TURBOMACHINES

B.Tech. (Mechanical) 6th Semester
3L+0T

UNIT	CONTENTS	Contact Hours
I	**Basic Concepts of Turbo Machines:** Definition & classification of Turbo machine, Basic laws and governing equations: continuity equation, steady flow energy equation(1st law of thermodynamics),2nd law of thermodynamics applied to turbo machines, Newton's 2nd law of motion applied to turbomachines - Euler's pump equation and Euler's turbine equation	4
	Dimensional analysis applied to hydraulic machines, power coefficient, flow coefficient, head coefficient, non-dimensional specific speed, Range of specific speeds for various turbo machines, Dimensional analysis applied to compressible flow machines, pressure ratio as a Function of temperature ratio, mass flow rate parameter and speed parameter	4
II	**Centrifugal Compressors and Fans:** Components and description, velocity iagrams, slip factor, energy transfer, power input factor, stage pressure rise and loading coefficient, pressure coefficient, degree of reaction, Centrifugal compressor characteristic, surging, rotating Stall and Choking	3
III	**Axial Flow Compressors and Fans:** Basic constructional features, Advantages of axial flow compressors, working principle, velocity triangle, elementary theory, stage work, work done factor, stage loading, degree of reaction; vortex theory, simple design calculations, introduction to blade design, cascade test, compressibility effects, operating characteristics	3
	Reciprocating Compressors: Basic constructional features, working principle, work done calculation, single and double acting compressors	2
IV	**Centrifugal Pumps:** Main parts, work done and velocity triangles, slip and slip factor, pump losses and efficiencies, minimum starting speed, net positive suction head, performance curve.	3
V	**Axial Flow Pumps:** Description, velocity triangles, work done on the fluid, energy transfer, axial pump characteristics, cavitation.	3
	Reciprocating Pumps: Classification, component and working, single acting and double acting, discharge, work done and power required, coefficient of discharge, indicator diagram, slip, effect of friction and acceleration, theory of air vessels.	2
	TOTAL	**40**

TEXT BOOK		
1	Gas turbines, V. Ganesan, Tata McGraw-Hill	2011
2	Subramanya, K., Hydraulic Machine, Tata McGraw Hill	2013

REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	Pub. Year
1	Principle of Turbo Machinery, Turton R.K., Springer Publication	1994
2	Fundamentals of Turbo Machinery, William W., John Wiley and Sons.	2008
3	Turbo Machinery Basic Theory and Application, Logan E.J.	1981
4	Principles of Turbo Machinery, Shepherd Dennis G., Mac Millan Pub, N.York.	1956
5	TurboMachines, A Valan Arasu, Vikas Publishing House Pvt. Ltd.	2009
7	Gas turbine theory, Cohen and Saravanamutto, Pearson Educational Pub.	2009
8	Hydraulic Machine: Turbines and Pumps, Nazarov N.T., Springer New York.	2003
9	Gas Turbine Theory, Cohen and Roger, Pearson Education.	
10	Hydraulic Machinery, Jagdish Lal, Metropolitan Books.	

CO 1	Learn the basic laws and governing equation of hydraulic machines.											
CO 2	Analyse the flow phenomenon and characteristics of components.											
CO 3	Demonstrate and examine the operating aspects of different hydraulic machines.											
CO 4	Apply and evaluate the performance parameters of various components of machine.											
Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	3	3	-	-	-	-	-	-	-	-	-
C02	3	2	2	-	-	-	-	-	-	-	-	-
C03	3	3	3	-	-	-	-	-	-	-	-	-
C04	3	3	2	-	-	-	-	-	-	-	-	-

6MEU4: MEASUREMENT & METROLOGY

B.Tech. (Mechanical) 6th semester

3L+0T

UNIT	CONTENTS	CONTACT HOURS
I	**Concept of measurement:** General concept of measurement, Need for measurement, Generalized measuring system, Units, Standards, Sensitivity, Readability, Range of accuracy, Precision, Accuracy Vs precision, Uncertainty.	4
	Repeatability and reproducibility, Errors in measurement, Types of error, Systematic and random error, Calibration, Interchangeability.	3
II	**Linear and angular measurements:** Linear measuring instruments: Vernier caliper, Micrometer, Interval measurements:- Slip gauges, Checking of slip gauges for surface quality, Optical flat, Application of limit gauges	3
	Comparators:- Mechanical comparators, Electrical comparator, Optical comparator, Pneumatic comparator;	2
	Sine bar, Use of sine bar, Limitations of sine bars, Sources of error in sine bars, Bevel protractor, Applications of bevel protractor.	4
III	**Form measurement:** Introduction, Screw thread measurement, Thread gauges, Measurement of gears: Gear errors.	4
	Surface finish measurement:-Introduction, Elements of surface texture, Analysis of surface finish, Methods of measuring surface finish, Straightness measurement, Flatness testing, Roundness measurements	4
IV	Coordinate measuring machine (CMM):-Types of CMM, Features of CMM,Computer based inspection,	3
	Measurement of power, flow and temperature related properties Measurement of force, Accelerometer, Load cells, Bourdon tube. **Torque measurement:** Torque measurement using strain gauges, Torque measurement using torsion bars,Mechanical dynamometers.	5
V	**Measurement of flow:** Variable area meters – rotameter, Hot wire anemometer, Pitot tube. Temperature measurement, Bimetallic strip, Thermocouples (Thermo electric effects), Thermistors, Pyrometers	4
	TOTAL	4
		40

TEXT BOOK		
1	G.K. Vijayaraghavan & R. Rajappan, Engineering Metrology and Measurements, A.R.S. Publications, Chennai, Fourth Edition June	2009
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Mechanical Measurements , Beckwith T.G. ,N.L. Buck, and R.D. Marangoni , Addison Wesley	2014
2	Dimensional Metrology . Khare & Vajpayee, Oxford & IBH	2011
3	Engineering Metrology, Jain R.K., Khanna Publishers	2012
4	Metrology & Precision Engineering , Scarr, McGraw Hill	2011
5	Handbook of Industrial Metrology, ASTME	2014
6		

Course outcome

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

CO1: Describe the basic concepts of measurement & measuring system.

CO2: Learn the various types of measuring instruments & their uses.

CO3: Identify & classify the measurement process for a particular application.

CO4: Apply the concepts for measuring the properties of the system.

CO5: Illustrate the measurement such as power, torque flow and temperature.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1	PSO2
CO1	3		3										
CO2	3	3	3	2									
CO3	3	3	3	2									
CO4	3	3	3	2									
CO5	3	3		2	1								
Average	**3.0**	**3.0**	**3.0**	**2.0**	**1.0**								

6MEU5.1: MECHATRONICS AND MEMS

B.Tech. (Mechanical) 6th semester

3L+1T

Unit	CONTENTS	Contact Hours
I	**Overview of Mechatronics**: Historical perspective, Definition, Applications, Block diagram of Mechatronic system, Functions of Mechatronics Systems, Systems Engineering, Verification Vs Validation, Benefits of mechatronics in manufacturing	**2**
	Electrical and Electronic Systems: Electrical circuits and Kirchhoff's laws, Network Theorems and AC circuit Analysis, Transformers, Analog Devices, Signal Conditioning, Digital Electronics, Data Acquisition systems.	**3**
II	**Modeling, Analysis and Control of Physical Systems:** Basics of System Modeling: LTI and LTV systems, Need for modeling, Types of modeling, Steps in modeling, Building blocks of models, Modelling of one and two degrees of freedom systems, Modeling of Electro-mechanical systems, Mechanical Systems, Fluid systems, Thermal systems; Dynamic Responses, System Transfer Functions, State Space Analysis and System Properties, Stability Analysis using Root Locus Method, Stability Analysis using Bode Plots, PID Controllers (with and without Time Delay)	**3**
III	**Sensors and Actuators**: Static characteristics of sensors and actuators, Position, Displacement and Proximity Sensors, Force and torque sensors, Pressure sensors, Flow sensors, Temperature sensors, Acceleration sensors, Level sensors, Light sensors, Smart material sensors, Micro and Nano sensors, Selection criteria for sensors, Actuators: Electrical Actuators (Solenoids, Relays, Diodes, Thyristors, Triacs, BJT, FET, DC motor, Servo motor, BLDC motor, AC motor, Stepper motors), Hydraulic and Pneumatic actuators, Design of Hydraulic and Pneumatic circuits, Piezoelectric actuators, Shape memory alloys.	**4**
IV	**Microprocessors, Microcontrollers and Programmable Logic Controllers**: Logic Concepts and Design, System Interfaces, Communication and Computer Networks, Fault Analysis in Mechatronic Systems, Synchronous and Asynchronous Sequential Systems, Architecture, Microcontrollers, Programmable Logic Controllers (PLCs): Architecture, Number Systems Basics of PLC Programming, Logics, Timers and Counters, Application on real time industrial automation systems.	**5**
V	**Micro-Electro Mechanical Systems (MEMS):**History, Effect of scaling, Fabrication techniques: Oxidation, Sputter disposition, CVD, Lithography, Etching, Wafer bonding,	**5**

	LIGA, DRIE, Applications: Lab on chip	
	Case Studies: Design of pick and place robot, Car engine management system, Automated manufacturing system, Automatic camera, Automatic parking system, Safety devices and systems.	**3**
	TOTAL	**40**

TEXT BOOK		**Ed.**
1	W.Bolton,Mechatronics,Electroniccontrolsystemsinmechanicalandelectricalengineering,PearsonEducation,5/e,2011.	2004
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub Year .**
2	JamesJAllen,MicroElectroMechanicalSystemsDesign,CRCPress.	2013
3	DavidG.AlcaiatoreandMichelB.Histand,IntroductiontoMechatronicsandMeasuringSystems,Mc.GrawHillInt.Edition,3/e,	2006
4	CraigK.C.andStolfi,F.R.,IntroductiontoMechatronicSystemDesignwithApplications,IEEEEducationalActivitiesDepartment,.	1994
5	RobertH.Bishop.TheMechatronicsHandbook, CRCPress,2/e	2007

Course outcome

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

CO1: Discuss overview of mechatronics and MEMS with their applications.

CO2: Classify different sensors and actuators .

CO3: Construct control on mechatronics system.

CO4: Apply signal conditioning and discuss data acquisition system.

CO5: Develop various mechatronics system .

CO-PO Mapping

Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO1**	**PO1**	**PO1**	**PSO1**	**PSO2**
CO1	3	3	2	2	1	1		1						
CO2	3	2	1	1										
CO3	3	2	2	2										
CO4	3	2	2	2										
CO5	3	3	3	3	2		1		1			1		
Average	**3.0**	**2.4**	**2.0**	**2.0**	**1.5**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**			

6MEU5.2: PROJECT MANAGEMENT

B.Tech. (Mechanical) 6th semester

3L+0T

UNIT	**CONTENTS**	**CONTACT HOURS**
I	Introduction to Project Management Project management: concepts & types of projects, project organizations; Project management knowledge area. Project life cycle	**8**
II	Project appraisal Concept, Types of appraisal: Technical, Economic, Financial,	**7**

	Social appraisal of the Industrial Projects, Numerical on Economic, financial appraisals Project scope management and break down structure Project scope, creating work break down structure (WBS); responsibility matrix , Activity relationship, Sequencing, activity duration, schedule development, Resource estimation , allocation & Leveling.	
III	Project networking: Project networking, Networking techniques, critical path methods-CPM, PERT, network analysis, Network cost models -Crashing	**8**
IV	Project Quality Management: Definition of -Project quality planning, quality assurance and quality control, Tools and techniques for project Quality planning, quality assurance and quality .	**8**
V	Project Risk management Project Risk Management: risk identification, risk quantification Measuring risk; Contingency planning; scheduling resources; reducing project duration; Project Performance analysis and closure Project performance evaluation: Concept of earned value ', Schedule & cost Variance S' curves for project completion and cost comparison;	**7**
	TOTAL	**40**

TEXT BOOK
1. Project Management – Clifford F Gray , Erik W Larson- Mc Grawhill.
REFERENCE BOOKS
Name of Authors /Books /Publisher
1. Project management (core text book) – Samual J. Mantel, Scott M. shafer 2. Project management & control –Singh & Narendra 3. Pert & CPM – Dr BC Punmia, KK Khendelwal- Laxmi publication 4. Project management – Desai, Vasant 5. Project Management – K P Sharma- National publishing house- Dehli 6. Project Management – M R Agrawal 7. Fundamentals of Project Management - James P Lewis, Heritage 8.Prasanna Chandra, Projects: Planning, Analysis, Financing, Implementation & Review, Tata Mc-Graw Hill, 2002 9.John M. Nicholas, Project Management for Business, Engineering and Technology, Elsevier publications, 2008. 10.Goel B.S., Production and Operations Management, Pragati Prakashan, Merrut, 21 Edition, 2009

6MEU5.3: RENEWABLE ENERGY SYSTEMS

B.Tech. (Mechanical) 6th semester

3L+1T

Unit	CONTENTS	Contact Hours
I	Global and National scenarios, Form and characteristics of renewable energy sources. **Solar Energy:** Solar radiation, its measurements and prediction, Solar thermal collectors, flat plate collectors, concentrating collectors, Basic theory of flat plate collectors, solar heating of buildings, solar still, solar water heaters, solar driers, conversion of heat energy in to mechanical energy, solar thermal power generation systems.	**2**
	Solar Photovoltaic: Principle of photovoltaic conversion of solar energy, types of solar cells and fabrication, **Photovoltaic applications:** battery charger, domestic lighting, street lighting, water pumping, power generation schemes	**3**
II	**Wind Energy:** Atmospheric circulations, classification, factors influencing wind, wind shear, turbulence, wind speed monitoring, Betz limit, WECS- classification, characteristics, applications.	**3**
III	**Ocean Energy:** Ocean energy resources, ocean energy routes, Principles of ocean thermal energy conversion systems, ocean thermal power plants, Principles of ocean wave energy conversion and tidal energy conversion.	**4**
IV	**Other Sources:** Nuclear fission and fusion, Geothermal energy- Origin, types of geothermal energy sites, site selection, geothermal power plants, Magneto-hydro-dynamic (MHD) energy conversion, Formation of biomass, photosynthesis, Biomass resources and their classification, Chemical constituents and physicochemical characteristics of biomass, Biomass conversion processes.	**5**
V	**Fuel Cells:** Thermodynamics and electrochemical principles, Basic design, types, applications. **Hydrogen Energy:** Economics of hydrogen, Production methods.	**5**
	TOTAL	**40**

TEXT BOOK		**Ed.**
1	Power Generation through Renewable Source of Energy, Rai and Ram Prasad, Tata McGraw-Hill, New Delhi.	2004
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub Year .**
2	Renewable Energy Sources and Conversion Technology, Bansal, Kleemann and Meliss, TMH	2013
3	Solar Energy: Fundamental and Applications, H. P. Garg J Prakash, TataMcGraw-Hill	2006
4	Solar Energy: Principles of Thermal Collection and Storage, S P Sukhatme, TMH	1994

CO 1	To understand the various renewable systems
CO 2	To learn the various sources of renewable energy
CO 3	To examine the operating conditions of systems
CO 4	To explore the systems and apply for various purposes

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	3	2	1	-	-	-	-	-	-	-	-
C02	3	2	1	2	-	-	-	-	-	-	-	-
C03	3	3	2	1	-	-	-	-	-	-	-	-
C04	3	3	1	2	-	-	-	-	-	-	-	-
CO5	3	2	3	2	-	-	-	-	-	-	-	-

6MEU6.1: COMPUTER AIDED DESIGN AND GRAPHICS

B.Tech. (Mechanical) 6th semester

3L+0T

UNIT	CONTENTS	CONTACT HOURS
I	**Overview of Computer Graphics:** Picture representation, Coordinate Systems, Raster Scan Display, DDA for line generation and Bresenham's algorithm for line and circle generation; Graphics standards: GKS, IGES, STEP, DXF. Different types of models.	5
	Parametric representation of plane curves: line, circle, ellipse, parabola and hyperbola.	4
II	**Parametric representation of Space Curves:** Cubic spline curve, Bezier Curve and B Spline Curves. Blending of Curves.	4
	Parametric representation of Surfaces: Hermite Bicubic surfaces, Bezier surfaces and Bspline surfaces.	4
III	**Solid Representation:** B-rep. and CSG. Comparison between three types of models.	7
IV	**Two and Three Dimensional Transformation of Geometric Models:** Translation, Scaling Reflection, Rotation and Shearing, Homogeneous Representation, Combined Transformation.	4
	Projection of Geometric models: Parallel and Perspective Projection.	4
V	**Clipping:** Point clipping, Line clipping, Cohen- Sutherland algorithm etc., Viewing transformation.	4
	Hidden line and surface removal: Techniques and Algorithms. Shading and Rendering.	4
	TOTAL	40

TEXT BOOK		
1	Zeid and Sivasubramanian,CAD/CAM: Theory and Practice, Tata McGraw Hill	
2	Rogers and Adams, Mathematical Elements for Computer Graphics, Tata McGraw Hill	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Rao P.N., CAD / CAM Principles and Applications, McGraw Hill.	2004
2	Pao Y.C., Elements of Computer Aided Design and Manufacturing, John Wiley and Sons.	1984
3	Alavala C.R., CAD/CAM: Concepts and Applications, Prentice Hall of India.	2008
4	Xiang and Plastock, Computer Graphics, Schaum's Outlines, Tata McGraw Hill.	2007

CO1: Learn basic concepts of geometric modeling.

CO2: Acquire the theory of mathematical representation of geometric entities like curves and surfaces.

CO3: Access the solid modeling concept.

CO4: Learn the various algorithms to display geometric model realistically.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	2	2	2	-	-	-	-	-	-	-	-
C02	2	3	3	2	-	-	-	-	-	-	-	-
C03	3	3	2	2	-	-	-	-	-	-	-	-
C04	2	2	3	2	-	-	-	-	-	-	-	-

6MEU6.2: ENGINEERING OPTIMIZATION

B.Tech. (Mechanical) 6th semester
3L+0T

UNIT	CONTENTS	CONTACT HOURS
I	**Introduction**- Engineering Applications of Optimization-Statement of an Optimization Problem-Classification of Optimization Problems- Optimization Techniques	5
II	**Classical Optimization Techniques**-Single-Variable Optimization-Multi variable Optimization with No Constraints-Multivariable Optimization with Equality Constraints- Multivariable Optimization with Inequality Constraints-Transportation	4
III	**Nonlinear Programming I**: 1DMinimization Methods-Unimodal Function, Elimination Methods-Unrestricted Search, Exhaustive, Dichotomous Search-Interval Halving Method- Fibonacci Method-Golden Section Method, Interpolation Methods-Quadratic, Cubic Interpolation Method - Direct Root Methods-Newton Method-Quasi-Newton, Secant Method	7
IV	**Nonlinear Programming II**: Unconstrained Optimization Techniques-Direct Search Methods- Indirect Search (Descent) Methods, Non-linear Programming III: Constrained Optimization Techniques- Direct Methods-Indirect Methods, Geometric Programming, Dynamic Programming, Integer Programming –Integer Linear Programming -Stochastic Programming.	4
V	**Modern Methods of Optimization**- Genetic Algorithms-Simulated Annealing-Particle Swarm Optimization- AntColony Optimization-Optimization of Fuzzy Systems- Neural- Network- Based Optimization, Practical Aspects of Optimization	4
	TOTAL	**40**

TEXT BOOK		
1	Kalyanmoy Deb, “Optimization for Engineering design –algorithms & examples”, PHI, New Delhi	1995
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Singiresu S.Rao, “Engineering optimization– Theory and practices”, John Wiley and Sons,	1998.
2	Garfinkel, R.S. and Nemhauser, G.L., “Integer programming”, John Wiley & Sons,	1972.

CO1: **Describe** the basic concepts of engineering optimization.
CO2: **Solve** the problems using different techniques of optimization.
CO3: **Understand and implement** the modern methods of optimizations.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	2	2	-	1	-	-	-	-	-	-	-	-
C02	3	3	2	2	1	-	-	-	-	-	-	-
C03	3	3	2	1	3	-	-	-	-	-	-	-

6MEU6.3: EXPERIMENTAL FLUID MECHANICS

B.Tech. (Mechanical) 6th semester

3L+0T

OBJECTIVES:

To make the students learn basic wind tunnel measurements and flow visualization methods, flow measurement variables and data acquisition method pertaining toexperiments in aerodynamics.

UNIT	CONTENTS	CONTACT HOURS
I	**BASIC MEASUREMENTS IN FLUID MECHANICS** Objective of experimental studies – Fluid mechanics measurements – Properties of fluids –Measuring instruments – Performance terms associated with measurement systems – Direct measurements - Analogue methods – static pressure and total temperature measurement– Flow visualization – Components of measuring systems – Measurements in boundary layers.	5
II	**WIND TUNNEL MEASEUREMENTS** Characteristic features, operation and performance of low speed, transonic, supersonic and special tunnels - Power losses in a wind tunnel – Instrumentation and calibration of wind tunnels – Turbulence- Wind tunnel balance – Principle and application and uses – Balance calibration.	4
III	**FLOW VISUALIZATION AND ANALOGUE METHODS** Visualization techniques – Smoke tunnel – Hele-Shaw apparatus - Interferometer – Fringe-Displacement method – Shadowgraph - Schlieren system – Background Oriented Schliren(BOS)system.	7
IV	**PRESSURE, VELOCITY AND TEMPERATURE MEASUREMENTS** Pitot-Static tube characteristics - Velocity measurements - Hot-wire anemometry – Constant current and Constant temperature Hot-Wire anemometer – Hot-film anemometry – Laser Doppler Velocimetry (LDV) – Particle Image Velocimetry (PIV) – Pressure Sensitive Paints – Pressure measurement techniques - Pressure transducers – Temperature measurements.	4
V	**SIGNAL CONDITIONING AND UNCERTAINTY ANALYSIS** Signal conditioning – Types of signals, Fourier Analysis, Analysis of periodic signals – Estimation of measurement errors – Systematic and random errors, Error analysis and uncertainty propagation – Uncertainty calculation - Uses of uncertainty analysis.	4
	TOTAL	**40**

TEXT BOOK		
1	Rathakrishnan, E., "Instrumentation, Measurements, and Experiments in Fluids," CRC Press	1995
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub.**
1	Robert B Northrop, "Introduction to Instrumentation and Measurements", Second Edition, CRC Press,	1998.

CO1: Measure and evaluate the fluid properties.
CO2: Compute the performance of hydraulic applications.
CO3: Understand the visualization techniques.
CO4: Evaluate & optimize the fluid flow system.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	3	2	3	-	-	-	-	-	-	-	-
C02	3	3	3	3	-	-	-	-	-	-	-	-
C03	3	3	3	3	-	-	-	-	-	-	-	-
C04	3	3	3	3	-	-	-	-	-	-	-	-

6MEU11: PRODUCTION ENGINEERING LAB.

B.Tech. (Mechanical) 6th Semester
0L+0T+3P

SN	NAME OF EXPERIMENT	CONTACT HOURS
1	Study of various measuring tools like dial gauge, micrometer, vernier caliper and telescopic gauges.	
2	Measurement of angle and width of a V-groove by using bevel protector..	
3	(a) To measure a gap by using slip gauges (b) To compare & access the method of small-bore measurement with the aid of spheres.	
4	Measurement of angle by using sine bar.	
5	(a) Measurement of gear tooth thickness by using gear tooth vernier caliper. (b) To check accuracy of gear profile with the help of profile projector.	
6	To determine the effective diameter of external thread by using three-wire method.	
7	To measure flatness and surface defects in the given test piece with the help of monochromatic check light and optical flat.	
8	To check the accuracy of a ground, machined and lapped surface - (a) Flat surface (b) Cylindrical surface.	
9	Find out Chip reduction co-efficient (reciprocal of chip thickness ratio) during single point turning.	
10	Forces measurements during orthogonal turning.	
11	Torque and Thrust measurement during drilling.	
12	Forces measurement during plain milling operation.	
13	Measurement of Chip tool Interface temperature during turning using thermocouple technique.	

CO1: To understand the science of measurement using measuring instrument.
CO2: To learn the modern measuring tools used in industry / shop floor.
CO3: Practice and apply measuring tool to measure angles, gap, forces, thrust and torque.
CO4: Understand and analyse about surface finishing of product.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	-	-	-	-	-	-	-
CO2	3	3	2	2	3	-	-	-	-	-	-	-
CO3	3	3	3	2	1	-	-	-	-	-	-	-
CO4	3	3	2	2	-	-	-	-	-	-	-	-

6MEU12: THERMAL ENGINEERING LAB-II

B.Tech. (Mechanical) 6th Semester

0L+0T+3P

SN	LABORATORY WORK/NAME OF EXPERIMENT
1	To perform constant speed load test on a single cylinder diesel engine and to plot performance curves: indicated thermal efficiency, brake thermal efficiency, mechanical efficiency Vs. Brake power, and heat balance sheet.
2	To estimate the Indicated Power, Friction Power and Mechanical Efficiency of a multi-cylinder Petrol Engine. (Morse Test)
3	Analysis of engine exhaust gases using Orsat apparatus / gas analyzer.
4	To study refrigeration cycle, determination of coefficient of performance of cycle and tonnage capacity of refrigeration unit.
5	To determine the COP and tonnage capacity of a Mechanical heat pump.
6	To study various controls used in Refrigeration and Air conditioning system.
7	Determination of dryness fraction of steam.
8	Study and Performance of Simple Steam Turbine
9	Performance characteristics of Pelton wheel turbine.
10	Performance characteristics of Francis turbine.
11	Performance characteristics of Kaplan turbine.
12	Performance characteristics of variable speed centrifugal pump.
13	Performance characteristics of rated speed centrifugal pump.

CO 1	To perform and evaluate the efficiencies of thermal systems
CO 2	To estimate the various performance parameters of system
CO 3	To study the performance of different rotating and reciprocating systems
CO 4	To determine the operating characteristics of thermal systems.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	2	3	-	2	-	-	-	-	-	-	-	-
C02	2	3	-	2	-	-	-	-	-	-	-	-
C03	3	1	-	-	-	-	-	-	-	-	-	-
C04	3	2	-	2	-	-	-	-	-	-	-	-

6MEU13: VIBRATION & MAINTENANCE ENGINEERING LAB.

B.Tech. (Mechanical) 6th Semester

0L+0T+2P

SN	NAME OF EXPERIMENT
1	To verify relation $T = 2\pi\sqrt{(l/g)}$ for a simple pendulum.
2	To determine radius of gyration of compound pendulum.
3	To determine the radius of gyration of given bar by using bifilar suspension.
4	To determine natural frequency of a spring mass system.
5	Equivalent spring mass system.
6	To determine natural frequency of free torsional vibrations of single rotor system. i. Horizontal rotor ii. Vertical rotor
7	To verify the Dunkerley's rule.
8	Performing the experiment to find out damping co-efficient in case of free damped torsional vibration
9	To conduct experiment of trifler suspension.
10	Harmonic excitation of cantilever beam using electro-dynamic shaker and determination of resonant frequencies.

11	Study of Vibration measuring instruments.
12	Perform study of the following using Virtual Lab http://www.vlab.co.in/
13	Forced Vibration of a Cantilever Beam with a Lumped Mass at Free End: To calculate the natural freq and damping ratio for forced vibration of a single DOF cantilever beam system, experimentally; and compare the results with theoretical values.
14	Harmonicaly Excited Forced Vibration of a Single DOF System: To analyze the forced vibration response of a single DOF system at diff damping ratio and frequency ratio.
15	Perform study of the following using Virtual Lab http://www.vlab.co.in/
16	Forced Vibration of a Cantilever Beam with a Lumped Mass at Free End: To calculate the natural freq and damping ratio for forced vibration of a single DOF cantilever beam system, experimentally; and compare the results with theoretical values.
17	Harmonicaly Excited Forced Vibration of a Single DOF System: To analyze the forced vibration response of a single DOF system at diff damping ratio and frequency ratio.

CO 1	Determine the radius of gyration of different systems.
CO 2	Evaluate the cases of natural and forced vibration effects and develop the understanding of practical processes
CO 3	Know the effects of damping on vibration analysis.
CO 4	Apply the knowledge of evaluating the frequency of systems involving various degree of freedom.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	2	1	-	1	-	-	-	-	-	-	-	-
CO2	2	2	1	2	-	-	-	-	-	-	-	-
CO3	2	2	1	2	-	-	-	-	-	-	-	-
CO4	2	2	1	2	-	-	-	-	-	-	-	-

6MEU14: MECHATRONICS AND MEMS LAB.

B.Tech. (Mechanical) 6th Semester **Max. Marks: 50**

SN	NAME OF EXPERIMENT
1	**UsingTransducersKit :-** • CharacteristicsofLVDT • Principle&CharacteristicsofStrainGauge • CharacteristicsofSummingAmplifier • CharacteristicsofReflective OptoTransducer
2	**MobileRobot** • Programfor OperatingBuzzerBeep • ProgramforOperatingMotion control • Programfor OperatingDirectioncontrol • Programfor OperatingWhitelinefollowerfor thegiven arena
3	**PLC PROGRAMMING** • LadderprogrammingonLogicgates,Timers&counters • LadderProgramming fordigital &Analogysensors • Ladderprogramming forTrafficLightcontrol,Water level control andLift controlModules
4	**MATLABProgramming** • Sampleprogrammeson Matlab • Simulation and analysisofPIDcontrollerusingSIMULINK

CO1	Measure load, displacement and temperature using analogue and digital sensors.
CO2	Develop programs for control of traffic lights, water level ,lift sand conveyor belts.
CO3	Simulate and analyse PID controllers for a physical system using MATLAB.
CO4	Develop pneumatic and hydraulic circuits using available software

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	2	-	-	-	-	-	-	-	-
CO2	2	-	3	1	3	-	-	-	-	-	-	-
CO3	2	-	3	1	3	-	-	-	-	-	-	2
CO4	2	-	3	3	3	-	-	-	-	-	-	2

7MEU1: FINITE ELEMENT METHODS

B.Tech. (Mechanical) 7th semester **Max. Marks: 150**

3L+0T **Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	Introduction to FEM and its applicability, Review of :Matrix algebra, Gauss elimination method, Uniqueness of solution, Banded symmetric matrix and bandwidth.	4
	Structure analysis: Two-force member element, Local stiffness matrix, coordinate transformation, Assembly, Global stiffness matrix, imposition of Boundary conditions, Properties of stiffness matrix	4
II	One-dimensional Finite Element Analysis: Basics of structural mechanics, stress and strain tensor, constitutive relation, Principle of minimum Potential, General steps of FEM, Finite element model concept / Discretization, Derivation of finite elements, equations using potential energy approach for linear and quadratic 1-D bar element,	5
	shape functions and their properties, Assembly, Boundary conditions, Computation of stress and strain.	3
III	Two Dimensional Finite Element Analysis: Finite element formulation using three nodded triangular (CST) element , Plane stress and Plain strain problems,	4
	Shape functions, node numbering and connectivity, Assembly, Boundary conditions, Isoparametric formulation of 1-D bar elements,	2
	Numerical integration using gauss quadrature formula, computation of stress and strain.	2
IV	Finite Element Formulation from Governing Differential Equation: Method of Weighted Residuals, Collocation, Sub domain method, Least Square method and Galerkin's method,	5
	Application to one dimensional problems, one-dimensional heat transfer, etc. introduction to variational formulation (Ritz Method.)	3
V	Higher Order Elements: Lagrange's interpolation formula for one and two independent variable, Convergence of solution, compatibility, element continuity, static condensation, p and h methods of mesh refinement, Aspect ratio and element shape,	5
	Application of FEM, Advantages of FEM, Introduction to concept of element mass matrix in dynamic analysis.	3
	TOTAL	**40**

TEXT BOOK		
1	Seshu P.,"Text Book of Finite Element Analysis", Prentice Hall India	**2003**
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Dixit, U. S., "Finite Element Methods for Engineers" Cengage Learning	**2003**
2	Finite Element Procedure in Engineering Analysis, Bathe K.J., Prentice Hall India.	**2001**
3	An Introduction to the Finite Element Method, Reddy J.N., Tata McGraw-Hill, New Delhi	**1993**
4	Concepts & Applications of Finite Element Analysis, Cook and Plesha, Willey India New Delhi.	**2007**
5	Introduction to Finite Elements in Engineering, Chandupatla and Belegundu, Prentice Hall India.	**1999**

CO1: Develop system level matrix equations from a given mathematical modelof a field problem
CO2: Analyse engineering problems in structural, heat transfer and fluid flow by FEM
CO3: Determine parameters of interest for a potential field problem,using triangular and quadrilateral elements use
CO4: Examine the parameters to assess the performance and suggest modification in system design.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	3	3	1	-	-	-	-	-	-	-	1
C02	3	3	3	2	-	-	-	-	-	-	-	-
C03	3	3	3	2	-	-	-	-	-	-	-	-
C04	3	3	3	2	-	-	-	-	-	-	-	2

7MEU2: STEAM ENGINEERING AND POWER GENERATION

B.Tech. (Mechanical) 7^{h}Semester **Max. Marks: 150**
3L+1T **Exam Hours: 3**

Unit	Contents	Contact hours
I	**Steam generators:** Classification of Boilers, water and fire tube boilers, High pressure boilers, Advantages of high pr. Boilers, Natural and forced circulation boilers, Water wall.	4
	Steam drum internal, steam super heaters, Economizers, air preheater, induced, forced and balanced draught boilers, Fluidized bed boilers	4
II	Definition and type of nozzle and diffuser equation of continuity, sonic velocity, mach no. and stagnation properties, the steady flow energy equation for nozzles, momentum energy equation for flow through steam nozzles nozzle efficiency, effect of friction, nozzle for uniform pressure drop, throat pressure for maximum discharge or chock flow, critical pressure ratio, design of nozzle and diffuser.	8
III	**Steam Turbines:** Principle and working of steam turbines, type of turbines, compounding for pressure and velocity. Overview and difference of various type of turbine, different types of governing of turbines.	3
	Impulse turbine: The effect of blade friction on velocity diagram. Force, work and power, Blade or diagram efficiency, Gross stage efficiency, steam speed to blade, speed ratio for optimum performance, turbine performance at various loads	5
IV	**Impulse reaction turbine:** Velocity diagram and work done, degree of reaction, Parson turbine, blade efficiency, gross stage efficiency comparison of enthalpy drop in various stages, size of blades in impulse reaction turbines for various stages of impulse reaction and impulse turbine.	5
	Regenerative Feed Heating Cycles: Introduction, Ideal regenerative feed heating cycle, Regenerative heating cycles and their representation on T-s and h-s Diagram, Representation of actual process on T-s andh-s Diagram Regenerative cycles, types of feed heating arrangements, Optimum feed water temperature and saving in Heat Rate. direct contact and surface heaters.	4
V	**Reheating of steam**: Practical reheating and Non- reheating cycles, advantage and disadvantages of reheating, reheat regenerative cycle, regenerative water extraction cycles.	4
	Process heat and by product power cycle, pass out turbine, Binary vapour cycle. Condensers.	3
		40

TEXT BOOK		
1	Steam, Gas Turbine and Power Plant Engineering, Yadav R., CPH Allahabad	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub.**
1	A Practical Guide to Steam Turbine, Heinz P. Bloch, McGraw Hill Publication	**1995**

2	Steam Turbines: Design Application and Rerating, Heinz P. Bloch, McGraw Hill	**1996**
3	Steam Turbine: Theory and Design, Shlykhin P., University press of Pacific.	**2006**
4	Steam Turbine: Theory and Construction, Wilde and Salter, Merchant Books.	**2007**
5	Power Plant Engineering, Nag P.K., Tata McGraw-Hill, New Delhi.	**1992**
6	Thermal Science & Engineering, Kumar D.S., S.K.Kataria & Sons	**2006**
7	Engineering Thermodynamics, Nag P.K., Tata McGraw-Hill, New Delhi	**1998**
8	Fundamentals of Classical Thermodynamics, G J Van Wylen, Willey Eastern	**1959**
9	Engineering Thermodynamics, Cengel & Boles, Tata McGraw-Hill, New Delhi.	**2006**
10	Engineering Thermodynamics, Chottopadhyay P., Oxford University Press.	**2009**

CO1: Learn about the economics of power plants.
CO2: Learn about site selection and the working cycles of different power plants.
CO3: Learn how to analyze and compare the performance of various power plants.
CO4: Students learns and apply general theories of renewable energy to improve power generation.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	3	3	2	-	-	-	-	-	-	-	-	-
C02	3	3	2	-	-	-	-	-	-	-	-	-
C03	3	3	2	-	-	-	-	-	-	-	-	-
CO4	3	3	2	-	-	-	-	-	-	-	-	-

7MEU3: COMPUTER INTEGRATED MANUFACTURING SYSTEMS

B.Tech. (Mechanical) 7th semester **Max. Marks: 150**
3L+0T **Exam Hours: 3**

Unit	CONTENTS	Contact hours
I	**Introduction to CIM:** Overview of Production Systems, the product cycle, Automation in Production Systems, computer's role in manufacturing, sources and types of data used in manufacturing. The Beginning of CAM: Historical Background,	**2**
	Numerical Control (NC): Basic components of an NC system, coordinate system and motions control systems. Computer Numerical Control (CNC): features of CNC, machine control unit, CNC software. Direct Numerical Control and Distributed Numerical Control. Applications, advantages and disadvantages of NC. Adaptive control of machining system.	**3**
II	NC Part programming: Manual and computer assisted part programming, Part programming with APT. NC part programming using CAD/CAM software. NC cutter path verification.	**8**
III	Computer Aided Process Planning: Traditional Process Planning, Retrieval process planning system, Generative Process Planning, Machinability data systems, computer generated time standards.	**4**
	Group Technology: Introduction, part families, part classification and coding, coding system and machining cells.	**4**
IV	Computer Aided Production Management Systems: Introduction to computer aided PPC, Introduction to computer aided inventory management, manufacturing resource planning (MRPII), computer process monitoring and shop floor control, computer process control.	**6**
	Computer Aided Quality Control; Computer in quality control, contact inspection methods, Non contact inspection methods, optical and non optical computer aided testing.	**2**
V	Computer Aided Material Handling; Computer control on material handling, conveying, picking. Ware house control, computerized material handling for automated inspection and assembly.	
	Computer Integrated Manufacturing Systems: Introduction, types special	**5**

	manufacturing systems, flexible manufacturing systems (FMS).	
	Collaborative Engineering; Introduction, Faster Design throughput, Web based design, Changing design approaches, extended enterprises, concurrent engineering, Agile and lean manufacturing.	3
	TOTAL	**40**

TEXT BOOK		
1	Mikell P. Groover, , Automation, Production Systems, and Computer-Integrated Manufacturing, 3rd ed., Pearson/Prentice Hall,	2008
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	James A. Rehg and Henry W. Kraebber, 2005, Computer-Integrated Manufacturing, 3rd ed., Pearson/Prentice Hall,	
2	Nanua Singh, 1996, Systems Approach to Computer-Integrated Design and Manufacturing, John Willey & Sons.	
3	Computer Aided Manufacturing, Chang, Wysk &Wang, Pearson Edu.	
4	CAD/CAM: Principles and Applications, P.N. Rao, McGraw Hill	
5	Computer Control of Manufacturing Systems,Y. Koren, McGraw Hill	
6	Computer aided Manufacturing, Rao, Tiwari and Kundra, TMH.	
7	Computer Numerical Control: Machining and Turning Centres, Quesada and Jeyepoovan, PearsonEducation	

CO1	Understand the effect of manufacturing automation strategies and derive production metrics.
CO2	Analyze automated flow lines and assembly systems, and balance the line.
CO3	Demonstrate automated material handling and storage systems for a typical production system
CO4	Develop CNC programs to manufacture industrial components.
CO5	Explain CAPP systems for rotational and prismatic parts.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	-	1	2	-	-	-	-	-	-
CO2	3	3	1	1	2	-	-	-	-	-	-
CO3	2	2	3	2	2	-	-	-	-	-	-
CO4	2	2	3	2	2	-	-	-	-	-	-
CO5	2	2	2	3	3	-	-	-	-	-	-

7MEU4: SUPPLY AND OPERATIONS MANAGEMENT

B.Tech. (Mechanical) 7th semester **Max. Marks: 150**

3L+0T **Exam Hours: 3**

Unit	Contents	Contact Hours
I	Introduction to operations management (OM), the scope of OM; Historical evolution of OM; Trends in business; the management process. Operations Strategy, Competitiveness and Productivity	3
	Demand Forecasting: components of forecasting demand, Approaches to forecasting: forecasts based on judgment and opinion, Time series data. Associative forecasting techniques, Accuracy and control of forecasts, Selection of forecasting technique.	4
II	Product and Service design, Process selection, Process types, Product and process matrix, Process analysis.	3
	Capacity Planning: Defining and measuring capacity, determinants of effective capacity, capacity strategy, steps in capacity planning process, determining capacity requirements, Capacity alternatives, Evaluation of alternatives; Cost-Volume analysis.	2
III	Facility Location: Need for location decisions, factors affecting location, qualitative and quantitative techniques of location. Facilities layout: Product, Process, Fixed	4

	position, combination and cellular layouts; line balancing. Material Handling	
	Planning levels: long range, Intermediate range and Short range planning, Aggregate planning: Objective, Strategies, and techniques of aggregate planning. Master scheduling; Bill of materials, MRP; inputs processing and outputs, and overview of MRPII , use of MRP to assist in planning capacity requirements, Introduction to ERP	**4**
IV	Techniques of production control in job shop production, batch production and mass production systems. sequencing: priority rules, sequencing jobs through two work centers, scheduling services	**4**
	Introduction to Just-in-time (JIT) and Lean Operations: JIT production, JIT scheduling, synchronous production, Lean operations system	**4**
V	Supply Chain Management (SCM): Need of SCM, Bullwhip effect, Elements of SCM, Logistics steps in creating effective supply chain, Purchasing and supplied management.	**3**
	Project Management: Nature of projects, project life cycle, Work breakdown structure, PERT and CPM, Time-Cost trade-offs: Crashing. Resource allocation, leveling	**5**
	TOTAL	**40**

TEXT BOOK		
1	Stevenson, Operations Management, Tata McGraw Hill.	2009
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub.**
1	Roberta S. Russell, Bernard W. Taylor, Operations Management, John Wiley	2010
2	Joseph S. Martinich, Production And Operations Management, John Wiley	2008
3	S.N. Chary, Production and Operations Management, Tata McGraw Hill	2009
4	Norman Gaither, Greg Frazier, Operations Management, Thomson Learning	2002

CO1: **Describe** the basic concepts of operations management and production systems
CO2: **Analyse** and **solve** the problems of production planning, scheduling & control.
CO3: **Understand** the concepts of MRP, JIT and SCM.
CO4: **Solve** the problems using project management & reliability.

Course Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
C01	1	1	2	-	-	-	-	-	-	-	-	-
C02	1	3	3	3	-	-	-	-	-	-	-	-
C03	1	3	3	3	2	-	-	-	-	-	-	-
C04	1	1	2	3	1	-	-	-	-	-	-	-

7MEU5.1: MODELING AND SIMULATION

B.Tech. (Mechanical) 7th semester **Max. Marks: 150**

3L+0T **Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	**Physical modeling :** Concept of system and environment, continuous and discrete system, linear and nonlinear system, stochastic activities, static and dynamic models, principles used in modeling, Basic simulation modeling,	4
	Role of simulation in model evaluation and studies, Advantages and Disadvantages of simulation. Modeling of Systems, iconic analog. Mathematical Modeling	4
II	**Computer system simulation:** Technique of simulation, Monte Carlo method, experimental nature of simulation, numerical computation techniques, continuous system models, analog and hybrid simulation, feedback systems,	4
	Buildings simulation models of waiting line system, Job shop, material handling and flexible manufacturing systems	4
III	**Probability concepts in simulation:** Stochastic variables, discrete and continuous probability functions, random numbers, generation of random numbers,	4
	Variance reduction techniques, Determination of the length of simulation runs, Output analysis.	4
IV	**System dynamics modelling:** Identification of problem situation, preparation of causal loop diagrams and flow diagrams, equation writing, level and rate relationship.	5
	Simulation of system dynamics model.	3
V	**Verification and validation:** Design of simulation experiments, validation of experimental models, testing and analysis.	4
	Simulation languages comparison and selection, study of SIMULA, DYNAMO, STELLA, POWERSIM. Simulation softwares.	4
	TOTAL	**40**

TEXT BOOK		
1	Simulation Modeling and Analysis, Law A.M., McGraw Hill.	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Discrete-Event System Simulation, Banks and Carsan, Prentice Hall of India	
2	Simulation Modeling and Analysis with ARENA, Altiok and Melamed, Academic Press	
3	Simulation with ARENA, Keltan, Sadowski and Turrock, McGraw Hill	
4	Simulation Modeling and ARENA, Rossetti and Taha, John Wiley and Sons	
5	Dynamic Systems: Modeling, Analysis and simulation, Finn Hangen, Tapir Academic Press	

7MEU5.2: NON CONVENTIONAL MACHINING METHODS

B.Tech. (Mechanical) 7th semester **Max. Marks: 150**
3L+0T **Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	Introduction and classification of advanced machining process, consideration in process selection, difference between traditional and non-traditional process, Hybrid process.	3
	Abrasive finishing processes: AFM, MAF (for Plain and cylindrical surfaces).	4
II	**Mechanical advanced machining process**: Introduction, Mechanics of metal removal, process principle, Advantages, disadvantages and applications of AJM,USM,WJC.	6
III	**Thermo electric advanced machining process**: Introduction, Principle, process parameters,advantages, disadvantages and applications about EDM, EDG,	4
	LBM, PAM, EBM	6
IV	**Electrochemical and chemical advanced machining process**: ECM, ECG, ESD, Chemical machining,	5
	Anode shape prediction and tool design for ECM process. Tool (cathode) design for ECM Process.	3
V	Intorduction to Micro and nanomachining,	5
	TOTAL	40

TEXT BOOK		
1	Modern Machining Process, Pandey and Shan, Tata McGraw Hill	1980
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Advance Machining Process, Jain V.K., Allied Publishers Ltd.	2002
2	Non Traditional Manufacturing Process, Gary F. Bevedict, Marcel Dekker Inc New York.	1987
3	Non-Conventional Machining Process, Mishra P.K., Narosa Publishing House	2006
4	Non-Conventional Machining Process, J.A. McGeough	1988
5	Nano and Micromachining, J. Paulo Davim, and Mark J. Jackson, Wiley-ISTE	2008

7MEU5.3: FUEL CELL AND HYBRID ENGINE TECHNOLOGY

B.Tech. (Mechanical) 7th semester **Max. Marks: 150**

UNIT	CONTENTS	CONTACT HOURS
I	Introduction and types of Fuel cell: Introduction : the rational behind fuel cell development, basic principle of fuel cell, operational of fuel cell, efficiency of fuel cell, co generation of heat and power, important reaction such as hydrogen oxidation, methonal oxidation etc	3
	Types of fuel cell: DMFC (direct methanol fuel cell),PAFC (phosphoric acid fuel cells), MCFC (molten carbonate fuel cells), SOFC (solid oxide fuel cells)	4
II	Fuel processing and application of fuel cells: Fuel processing- general, producing hydrogen from alcohol, producing hydrogen from hydrocarbon, hydrogen from other sources, Gas cleanup, reformer system, hydrogen storage system Engineering	6
III	fuel cell engineering, vehicle cell design, stack engineering fuel processing system application: stationary power, propulsion of vehicle, portable application	4
	Electric Vehicle: Introduction, working. Electric car motors, electric car batteries, charging system of electric car, magna charge system. conversion system for transmission.	6
IV	Hybrid vehicle: Introduction, working. Power split devices. Hybrid car performance, gasoline hybrid structure. Gasoline Vs electric power	6
	Transmission components of hybrid vehicle. Advantage and limitation. Different types of hybrid vehicle.	4
V	Solar Vehicles: Introduction and working, photovoltaic cell, solar cell. Energy lose in solar cell. Solar powering house. Solar cost, anatomy of solar cells	7
	TOTAL	40

TEXT BOOK		
1	Electric and Hybrid Vehicles: Design Fundamentals, Second Edition, By Iqbal Husain, CRC press	2009
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Fuel cell technology, N. Sammes, Springer	2012
2	Microbial Fuel Cell, Bruce E. Logan , Willey publication	2008
3	Principle of Fuel Cell, Xiangeo Li, CRC Press	2006
4	Hydrogen fuel cells for road vehicles, corbo et.al, springers	2007
5	Electrical vehicle technology, James laraminie, Wiley	2008

7MEU11: Programming with MATLAB and FEM

B.Tech. (Mechanical) 7th Semester

SN	LABORATORY WORK/NAME OF EXPERIMENT
1	Laboratory work for the solution of solid mechanics problems, heat transfer problems, and free vibration problems **by using FE packages such as NASTRAN/ANSYS/SIMULIA/ABAQUS**
2	Introduction of GUI of the software in the above mentioned areas realistic problems.
3	Analysis of beams and frames (bending and torsion problems)
4	Plane stress and plane strain analysis problems
5	Problems leading to analysis of axisymmetric solids
6	Problems leading to analysis of three dimensional solids (a) Heat transfer problems (b) Modal analysis problem
7	One Dimensional problems of Finite Element Method Note: (These exercises may be performed by any of the following Advanced CAD Software such as Pro E /Unigraphics/ AotoCAD Inventor)
	Laboratory work for the solution of solid mechanics problems, heat transfer problems, and free vibration problemsby writing own code for finite element analysis using **MATLAB for:**
1	Plane stress and plane strain analysis problems
2	Modal Analysis problem
3	Numerical Analysis Problems

7MEU12: CIMS Lab (CAM & INDUSTRIAL ENGINEERING)

B.Tech. (Mechanical) 7th Semester

SN	NAME OF EXPERIMENT
1	To prepare part programming for plain turning operation.
2	To prepare part program for turning operations using turning cycle.
3	To prepare part program for threading operation.
4	Toprepare part program for gear cutting using mill cycle.
5	To prepare part program for multiple drilling in X and Z axis using drilling cycle.
	Case Study on the following:
1	Work Methods Design
2	Process Control Charts
3	Materials Management
4	Capacity Planning
5	Problems from Probability and statistics, Operations research, Inventory control, Quality control etc can be solved using software's available in the lab e.g. SPSS, TORA, LINDO under **Engineering Applications** lab.

7MEU13: PROJECT STAGE –I

Course outcome

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

CO1: Identify a real life problem or industrial problem.

CO2: Collect and analyse possible solutions, examine technical and economic feasibility of the solution.

CO3: Design promising solution considering environment and sustainability.

CO4: Prepare DPR(Detailed Project Report) and present.

CO5: Grasp the norms for performing in team.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1
	PSO1	PSO2										
CO1	2	3			1	1	2	1	3	1	2	3
CO2	2	3	3	1	1	1	2	1	3		2	3
CO3	2	3	3	3	2	2	3	1	3		3	3
CO4	2	2	1	1	1			1	2	3	2	3
CO5								1	3	2	1	2
Average	**2.0**	**2.8**	**2.3**	**1.7**	**1.3**	**1.3**	**2.3**	**1.0**	**2.8**	**2.0**	**2.0**	**2.8**

7MEU14: PRACTICAL TRAINING AND INDUSTRIAL VISIT

Course outcome

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

CO1: Explore the recent technological development through visiting the industries

CO2: Discover the various theoretical aspects in real time industrial scenario

CO3: Simulate and practice the concept in real situations

CO4: Collect data and prepare reports on the experiments/field visit

CO5:

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1
	PSO1	PSO2										
CO1	1	1				1	2		2	3		2
CO2	2	2	1		2	2	1		2	2	2	3
CO3	2	3	2	2	3	1	1	1	2	2	2	2
CO4	2	2	1	3	3	1			2	3	2	2
Average	**1.8**	**2.0**	**1.3**	**2.5**	**2.7**	**1.3**	**1.3**	**1.0**	**2.0**	**2.5**	**2.0**	**2.3**

8MEUA1.1: NEW ENTERPRISE AND INNOVATION MANAGEMENT

B.Tech. (Mechanical) 8th semester

3L+0T

Unit	CONTENTS	Contact Hours
I	Entrepreneurship: Entrepreneurship and enterprise: Concept, role in economic development. Entrepreneurial competencies: awareness, assessment and development. Simulation exercise on goal setting in entrepreneurship. Entrepreneurial & Intrapreneurial mind. International entrepreneurship opportunities. Starting the venture: Generating business idea – sources of new ideas, methods of generating ideas, creative problem solving, opportunity recognition; environmental scanning, competitor and industry analysis; feasibility study – market feasibility, technical/operational feasibility, financial feasibility.	**8**
II	Business Plan: Emerging Business Opportunities-sources & assessment. Business Plan: Concepts, Methods, analysis & interpretation. Functional plans: Marketing plan – marketing research for the new venture, steps in preparing marketing plan,contingency planning; organizational plan – form of ownership, designing organization structure,job design, manpower planning; Financial plan: cash budget, working capital, proforma income Statement, proforma cash flow, proforma balance sheet, break even analysis.	**7**
III	Sources of finance: Sources of external finance, short term as well as long term, Debt or equity financing, commercial banks, venture capital; financial institutions supporting entrepreneurs; legal issues –intellectual property rights patents, trade marks, copy rights, trade secrets, licensing; franchising.	**8**
IV	Start Up: Institutional support to start up and incentives for SSI. Statutory obligation in starting a unit (general like Income Tax, VAT, CST or GST, Service tax, excise and customs, labour laws, etc. Start up strategies. Dealing with outside agencies like consultant, contractors, etc. Key marketing issue of new venture. Starting a franchising business. Starting an e-commerce venture. Buying arunning business. Managing growing venture: Growth, objective and strategy. Managing growth. Assessing resource from external sources, for financing growth including public issue, merger, amalgamation, joint venture, collaboration & selling business.	**8**
V	Innovation Management: an introduction, organizational setups that facilitate innovations. Management of research and development. Strategic alliances and network. Incubators and Accelerators.	**7**
	TOTAL	**40**

TEXT BOOK
1 Hisrich, Robert D., Michael Peters and Dean Shephered, Entrepreneurship, Tata McGraw Hill,New Delhi.
REFERENCE BOOKS
Name of Authors /Books /Publisher
1. Barringer, Brace R., and R., Duane Ireland, Entrepreneurship, Pearson Prentice Hall, New Jersy,USA. 2. Lall, Madhurima, and Shikha Sahai, Entrepreneurship, Excel Book, New Delhi. 3. Charantimath, Poornima, Entrepreneurship Development and Small Business Enterprises,Pearson 4. Paul Trot, Innovation Management and New Product Development, Pearson Education 5. P Narayana Reddy, Entrepreneurship : Text and Cases, Cengage 6. Murdick, Ross & Claggett. Information Systems for Modern Management,. PHI of India.

CO1: **Understand** entrepreneurship and entrepreneurial process and its significance in economic development.
CO2: **Develop** an idea of the support structure and promotional agencies assisting ethical entrepreneurship.
CO3: **Identify** entrepreneurial opportunities, support and resource requirements to launch a new venture within legal and formal framework.
CO4: **Develop** a framework for technical, economic and financial feasibility.
CO5: **Evaluate** an opportunity and prepare a written business plan to communicate business ideas effectively.
CO6: **Understand** the stages of establishment, growth, barriers, and causes of sickness in industry to initiate appropriate strategies for operation, stabilization and growth.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	1	-	-	3	-	-	3
CO2	-	-	-	-	-	-	1	2	-	1	-	1
CO3	-	-	-	-	-	2	3	2	2	2	1	2
CO4	-	-	-	-	-	-	2	-	-	1	2	2
CO5	-	-	-	-	-	3	-	2	-	3	1	2
CO6	-	-	-	-	-	-	-	2	2	2	2	3

8MEUA1.2: RAPID PROTOTYPING

B.Tech. (Mechanical) 8th semester **Max. Marks: 150**
3L+0T **Exam Hours: 3**

Contents	Contact Hours
Overview of Rapid Product Development (RPD). Product Development Cycle;	**3**
Definition of RPD; Components of RPD. Rapid Prototyping (RP);Principle of RP; Technologies and their classifications;	**4**
Selection of RP process; Issues in RP; Emerging trends.	**4**
Rapid Tooling (RT);Introduction to RT, Indirect RT process-Silicon rubber molding, Epoxy tooling, Spray metal tooling and Investment Casting, Direct RT processes-Laminated Tooling, Powder Metallurgy based technologies, Welding based technologies, Direct pattern making (Quick Cast, Full Mold Casting),	**4**
Emerging Trends in RT, Reverse Engineering: Geometric data acquistion,3D reconstruction, Applications and Case Studies, Engineering applications, Medical applications.	**3**
Processing Polyhedral Data: Polyhedral BRep modeling, STL format, Defects and repair of STL files,	**3**
Overview of the algorithms required for RP&T and Reverse Engineering-slicing, support generation, feature recognisation etc.	**3**
TOTAL	**40**

TEXT BOOK		
1	C.K. Chua , K.F. Leong , C.S. Lim, Rapid Prototyping: Principles And Applications, World Scientific Publishing Co Pte Ltd; 3rd Revised	2008
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
2	Ali K. Kamrani , Emad Abouel Nasr,Rapid Prototyping: Theory And Practice (Manufacturing Systems Engineering Series) ,Springer-Verlag New York Inc	2006
3	Stucker, David W. Rosenand Ian Gibson, Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, And Direct Digital Manufacturing, Springer New York.	2014
4	Neil Hopkinson , Richard Hague , Philip Dickens, Rapid Manufacturing: An Industrial Revolution For The Digital Age 1st Edition,Wiley New York;	2005
5	Chee Kai Chua, Kah Fai Leong, 3d Printing And Additive Manufacturing: Principles And Applications , Fourth Edition Of Rapid Prototyping, World Scientific Publishing Company;	, 2014

8MEUA2.1: PRODUCT DEVELOPMENT AND LAUNCHING

B.Tech. (Mechanical) 8th semester

3L+0T

UNIT	CONTENTS	CONTACT HOURS
I	**Importance of New Product:** Definition-importance-Development Process, Importance of new product for growth of enterprise, Definition of product and new product,	2
	Responsibility for new product development, Demands on product development team, Classification of products from new product development point of view- Need based/Market pull products, Tech. push, Platform based, Process based and customized products,	3
	New product development process and organization, Generic product development process for Market Pull Products, Modification of this process for other types of products.	3
II	**Need Analysis:** Problem Formulation Establishing economic existence of need, Need Identification and Analysis, Engineering Statement of Problem, Establishing Target Specification.	8
III	**Generation of Alternatives and Concept Selection:** Concept generation- a creative process, Creativity, Road Elects to creative thinking-Fear of criticism and Psychological set,	4
	Tools of creativity like brain storming, Analogy, Inversion etc., Creative thinking Process, Concept feasibility and Concept Selection, Establishing Engineering Specification of Products.	4
IV	**Preliminary and Detailed Design:** Design Review Preliminary design-Identification of subsystems, Subsystem specifications, Compatibility, Detailed design of subsystems, component design,	6
	Preparation of assembly drawings, Review of product design from point of view of Manufacturing, Ergonomics and aesthetics.	2
V	**Management of New Product:** Development and Launch New Product Management's Challenges, Maintaining focus, Promotion of Right Culture, Management of Creativity, Top Management attention, Design Team Staffing and Organization, Setting key mile stone, Identification of Risk Areas, Project Execution and Evaluation Product Launch Strategies,	8
	TOTAL	**40**

TEXT BOOK		
1	Product Design and Manufacturing, Chitale and Gupta. McGraw Hill.	
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Product Design and Development, Ulrich and Eppinger, McGraw Hill	**2003**
2	Project Management in New Product Development, Barkley B.T., Tata McGraw Hill.	**2008**
3	Product Management, Anandan C., McGraw Hill.	**2009**
4	Engineering Design Methods, Cross, Nigel, John Wiley and Sons.	**1995**
5	Product Design and Manufacture, Lindbeck, J.R., Prentice Hall of India.	**1995**

Course outcome

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

CO1: Explain the process of product development.

CO2: Analyse the need for a product and its economic existence.

CO3: Select a concept or product through feasibility study of different identified

solution.

CO4: Prepare the specifications and detailed design of components considering manufacturing aspects ,ergonomics and aesthetics.

CO5: Define new product management and launch strategies.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1 PSO1 PSO2
CO1	1	1	3	2	1	2	2		1			
CO2	1	2	3	2	1	2	2		1	1		
CO3	1	3	3	2	2	2	2		1	1		
CO4	2	3	3	2	1	2	1		1			
CO5	2	1	1	1	1	2			2		3	
Average	**1.4**	**2.0**	**2.6**	**1.8**	**1.2**	**2.0**	**1.8**		**1.2**	**1.0**	**3.0**	

8MEUA2.2: STATISTICS FOR DECISION MAKING

B.Tech. (Mechanical) 8th semester

3L+0T

Unit	Contents	Contact Hours
I	Introduction - Statistical Terminology: Descriptive statistics or exploratory data analysis, inferential statistics, population, sample, variable, parameter, statistic, random sample.	3
	Collecting Data: Historical data, types of studies (comparative, descriptive or noncomparative, observational, experimental),sample surveys, sampling and nonsampling errors, bias, representative sample, judgment sampling, quota sampling, simple random samples, sampling rate, sampling frame, stratified random sampling, multistage cluster sampling, probability-proportional-to-size sampling, systematic sampling.	4
II	Summarizing and Exploring Data: Variable types (categorical, qualitative, nominal, ordinal, numerical, continuous, discrete, interval, ratio), summarizing categorical data (frequency table, bar chart, Pareto chart, pie chart), summarizing numerical data (mean, median), skewness, outliers, measures of dispersion (quantiles, range, variance, standard deviation, interquartile range, coefficient of variation) standardized z-scores, histogram, bivariate numerical data (scatter plot, simple correlation coefficient, sample covariance), straight line regression, summarizing time-series data, data smoothing, forecasting techniques.	4
	Basic Concepts of Inference: Estimation, hypothesis testing, point estimation, confidence interval estimation, estimator, estimate, bias and variance of estimator, mean square error, precision and standard error, confidence level and limits, null and alternative hypothesis, type I and II error, acceptance sampling, simple and composite hypothesis, P-value, one-sided tests.	4
III	Inference for Single Samples: Inference for the mean (large samples), confidence intervals for the mean, test for the mean, sample size determination for the z-interval, one-sided and two -sided z-test, inference for the mean (small samples), t distribution.	4
	Inference for Two Samples: Independent sample design, matched pair design, pros and cons of each design, side by side box plots, comparing means of two populations, large sample confidence interval for the difference of two means, large sample test of hypothesis for the difference of two means, inference for small samples (confidence intervals and tests of hypothesis).	4
IV	Inference for Proportions and Count Data: Large sample confidence interval for proportion, sample size determination for a confidence interval for proportion,	3
	Large sample hypothesis test on proportion, comparing two proportions in the independent sample design, Chi-square statistic	4
V	Simple Linear Regression and Correlation: Dependent and independent variables, probability model for simple linear regression, least squares fit, goodness of fit of the LS line, sums of squares, analysis of variance, prediction of future observation, confidence and prediction intervals,	4
	Multiple Linear Regression: Probability model for multiple linear regression, least squares fit, sums of squares.Use Excel, R, and MATLAB® in the class.	4
	TOTAL	**40**

TEXT BOOK		
1	Ajit Tamhane and Dorothy Dunlop "Statistics and Data Analysis: From Elementary to Intermediate" Prentice Hall	1999
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Pub.**
1	Richard Levin, David S. Rubin, Statistics for Managements, PHI	1988
2	J. K. Sharma, Statistics for Management, Pearson Education India	2001

8MEUA3.1: ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT

B.Tech. (Mechanical) 8th semester

3L+0T

Unit	Contents	Contact Hours
I	Introduction to Engineering Economics: Definitions, Concepts of Macro and Micro Economics, Types of goods, Concept of economic and non- economic activities, Time Value of Money, Interest Calculations, Equivalence, Simple and Compound Interest, Cash Flows: Estimation and Diagramming.	**8**
II	Introduction to Factors and Their Use: Single Payment Factors (F/P and P/F), Uniform Series Present Worth Factor and Capital Recovery Factor (P/A and A/P), sinking Fund Factor and Uniform Series Compound Amount Factor (A/F and F/A), Standard Factor Notation and Use of Interest Tables, Present Worth, Future Worth and Equivalent Uniform annual Worth Calculations, Calculations of Unknown Interest Rates and Unknown Years.	**7**
III	Present Worth and Capitalized Cost Evaluation: Present Worth Comparison of Equal and Different Life Alternatives, Life Cycle Cost, Capitalized Cost Calculations . Rate of Return: Calculations Using PW and AW Equations	**8**
IV	Benefit/Cost Analysis: Classification of Benefits, Costs and Dis benefits, Calculations for a Single Project, Alternative Selection by B/C Analysis. Laws of Demand& Supply: Law of Demand, Demand Function, Types of Demand, Determinants of Demands, Demand Elasticity, Methods of Demand Forecasting, Law of Supply. Factors of Production: Production Function, Factors of Production, Division of Labour, Localization of Industry, Capital and Capital formation, Scales of Production, Production Analysis – Long & Short Run. Laws of returns: Laws of Returns, Utility, Law of Diminishing Marginal Utility.	**8**
V	Market Structures: Introduction to different market structures (perfect competition, monopoly, monopolistic competition, oligopoly). Introduction to Financial Management: Forms of Business Organization, Introduction to financial management, Organization of the financial management functions, Business Environment, Tax Environment, and Financial Environment, Budgeting Fundamentals. Financial Statements: Accounting Systems, Profit and Loss Accounts, Drawing of Balance Sheet and Ratio Analysis, Income statement, Trend analysis, Common size, and Index analysis. Flow of funds statement, Cash Flow Analysis. Product Costing: Costing based on fixed and variable costs, Break-Even Analysis, Profit –Volume Ratio, Costing based on direct and indirect costs, Overheads apportionment and absorption, Different Models of Depreciation. Working Capital: Issues with working capital, Financing current assets, combining liability structure and current asset decisions. Capital budgeting. Financing: Intermediate and long-term financing. Private placement, initial financing, signaling effects, secondary market, bonds and their features, long term debit instruments. Term loans and leases. Provision of loan agreements, equipment financing, Lease financing and its evaluation.	**7**
	TOTAL	**40**

TEXT BOOK
1 Kumar, Vijay. Accounting for Management. Tata McGraw-Hill.
REFERENCE BOOKS
Name of Authors /Books /Publisher
1. Engineering Economy, Laland T. Blank and Anthony J. Tarquin, McGraw Hill International Editions – Industrial Engineering Series. 2. Modern Economic Theory, Dewett and Verma, S. Chand & Sons 3. Managerial Economics, G S Gupta, Tata McGraw-Hill, New Delhi 4. Fundamentals of Financial Management, Van Horne, J C and Wachowicz, J M, Pearson Education Asia(2002). 5. Financial Management -Theory and practice, PrasannaChandra, TMH, 5 thedition, 2001. 6. Financial Management – Theory and practice, I.M.pandey, VikasPublishingHina 2002.

7. Managerial Economics, Petersen, C & Lewis, W.C.:, PHI
8. Managerial Economics, Hailstones, Thomas J. and Rathwell, John C., Prentice Hall International.
9. Engineering Economics, Perk, Contemporary 3rd Ed, PHI
10. Engineering Economics, Panneerselvam, PHI
11. Financial Management and Policy, Van Horne, 12/e, PHI, 2002.
12. Principles of Corporate Finance, Breally and Myers, 7/e, TMH, 2002.
13. Fundamentals of Corporate Finance, Ross, Westerfield and Jordan, 6/e, TMH,2002.
14. Corporate Finance, Damodaran, John Wiley & Sons, 2002.

8MEUA3.1: DATA ANALYTICS

B.Tech. (Mechanical) 8th semester
3L+0T

UNIT	CONTENTS	CONTACT HOURS
I	Introduction to Multivariate Statistics-Degree of Relationship among Variables-Review of Univariate and Bivariate Statistics-Screening Data Prior to Analysis-Missing Data, Outliers, Normality, Linearity, and Homoscedasticity.	**4**
II	Multiple Regression- Linear and Nonlinear techniques- Backward-Forward-Stepwise- Hierarchical regression-Testing interactions (2way interaction) - Analysis of Variance and Covariance (ANOVA & ANCOVA) - Multivariate Analysis of Variance and Covariance (MANOVA & MANCOVA).	**3**
III	Logistic regression: Regression with binary dependent variable -Simple Discriminant Analysis- Multiple Discriminant analysis-Assessing classification accuracy- Conjoint analysis (Full profile method).	**4**
IV	Principal Component Analysis -Factor Analysis- Orthogonal and Oblique Rotation-Factor Score Estimation-Multidimensional Scaling-Perceptual Map-Cluster Analysis (Hierarchical Vs Nonhierarchical Clustering).	**4**
V	Latent Variable Models an Introduction to Factor, Path, and Structural Equation Analysis- Time series data analysis (ARIMA model) – Decision tree analysis (CHAID, CART) - Introduction to Big Data Management.	**4**
	TOTAL	**39**

TEXT BOOK		
1	Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. "Multivariate data analysis", (7th edition). Pearson India.	2015
REFERENCE BOOKS		
SN	**Name of Authors /Books /Publisher**	**Year of Pub.**
1	Tabachnick, B. G., & Fidell, L. S., "Using multivariate statistics", (5th edition). Pearson Prentice Hall	2001
2	Gujarati, D. N. , "Basic econometrics", Tata McGraw-Hill Education.	2012
3	Malhotra, N. K., " Marketing research: An applied orientation", 5/e. Pearson Education India.	2008
4	Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. " Applied multiple regression/correlation analysis for the behavioral sciences", Routledge..	2013
5	Han, J., Kamber, M., & Pei, J. "Data mining: concepts and techniques: concepts and techniques", Elsevier.	2011

8MEU13: SEMINAR

Course outcome

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

CO1: Review of recent industrial developments and scientific innovations.

CO2: compile informations from different sources in comprehensive manner

CO3: prepare technical report

CO4: present the identified development/innovations

CO5:

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1
	PSO1	PSO2										
CO1	1	3	1				1	1	3	1		3
CO2	1	1							3	3		1
CO3	1	1					1	1	3	3		2
CO4	1	1			2				3	3		1
Average	**1.0**		**1.5**	**1.0**	**2.0**	**1.0**	**1.0**	**3.0**	**2.5**		**1.8**	

8MEU14: PROJECT STAGE -II

Course outcome

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

CO1: Arrange necessary resources and prepare project plans

CO2: Develop the required product/solution considering technical/financial viability

CO3: Test and validate the solutions based on experiment and field trials

CO4: Prepare project report and present results/solution

CO5:

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1
	PSO1	PSO2										
CO1	1					1	2	1	2	2	3	3
CO2	2	2	3	1	2		1	1	3	2	2	3
CO3	2	2	1	3	2		1	1	3	2	1	3
CO4	2		1	1	1			1	2	3	1	3
Average	**1.8**	**2.0**	**1.7**	**1.7**	**1.7**	**1.0**	**1.3**	**1.0**	**2.5**	**2.3**	**1.8**	**3.0**

8MEU20: DISCIPLINE AND EXTRA CURRICULAR ACTIVITIES

Course outcome

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

CO1: Recognize their strength and those of others to work towards a shared vision (leadership)

CO2: Develop and sustain healthy and meaningful relationship with others (Interpersonal skills)

CO3: Identify and address the needs of the community collaboratively to facilitate positive social change (Social Responsibility)

CO4: Generate innovations through experimentation with novel ideas, forms, and methods (Critical and creative thinking)

CO5: Act as a disciplined citizen with ethical and moral values

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1
	PSO1	PSO2										
CO1						2	1	3	2	1		2
CO2						2	1	2	3	3		1
CO3						3	2	2	2	2		2
CO4	3	2	2	2	2		1		2	1		2
CO5						2	1	3	1	1		2
Average	**3.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.3**	**1.2**	**2.5**	**2.0**	**1.6**		**1.8**