BIRLA VISHVAKARMA MAHAVIDYALAYA

(ENGINEERING COLLEGE)

(AN AUTONOMOUS INSTITUTION)

VALLABH VIDYANAGAR – 388120, GUJARAT

AFFILIATED TO GUJARAT TECHNOLOGICAL UNIVERSITY

ACADEMIC REGULATIONS

AND

COURSES OF STUDY

FOR

FOUR YEAR DEGREE PROGRAMME LEADING TO

BACHELOR OF TECHNOLOGY (B.TECH.)

IN

MECHANICAL ENGINEERING (PDDC)

Implemented from the batch admitted in academic year 2019-20

Contents

Institute Vision

"Produce globally employable innovative engineers with core values."

Institute Mission

- Re-engineer curricula to meet global employment requirement.
- Promote innovative practices at all levels.
- Imbibe core values.
- Reform policies, systems and processes at all levels.
- Develop faculty and staff members to meet the challenges.

Core Values

Quality, Creativity, Team Work, Lifelong Learning, Pro-activeness, Cost Consciousness, Sharing, Transparency

B. Tech. Mechanical (PDDC) programme offered by Department of Mechanical Engineering

Programme Vision

"Produce globally employable innovative mechanical engineers with core values."

Programme Mission

- Design curricula to meet global employment requirement
- Promote innovative practices at all levels.
- Imbibe core values
- Develop faculty and staff members to meet the challenges

Program Educational Objectives (PEO's):

1. Apply fundamentals of mechanical engineering principles to solve problems.
2. Design mechanical systems.
3. Plan and manage production of components.
4. Carry out maintenance activities of mechanical systems.
5. Adapt state of the art technology related to mechanical engineering.

Program Outcomes (POs)

Engineering Graduates will be able to:

1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex mechanical engineering problems.
2. Identify, formulate, review research literature, and analyse complex mechanical engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design solutions for mechanical engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health & safety, cultural and societal & environmental considerations.
4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
5. Apply appropriate techniques, resources, modern engineering and IT tools including prediction and modelling to mechanical engineering activities with an understanding of their limitations.
6. Apply reasoning informed by the contextual knowledge to assess societal, health & safety, legal & cultural issues and the consequent responsibilities relevant to the professional mechanical engineering practice.
7. Understand the impact of the professional mechanical engineering solutions in societal and environmental contexts, demonstrate the knowledge of the same and need for sustainable development.
8. Apply ethical principles& commit to professional ethics and responsibilities & norms of the mechanical engineering practice.
9. Function effectiveness an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. Communicate effectively on mechanical engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. Demonstrate knowledge and understanding of the mechanical engineering and management principles and apply those to one's own work, as a member and leader in a team, to manage mechanical engineering projects in multidisciplinary environments
12. Recognize the need for, have the preparation and ability to engage in independent and life-long learning in the broadest context of mechanical engineering technological changes.

Program Specific Outcomes (PSO's):

1. Design and analyze mechanical equipment using conventional as well as computer aided design approach.
2. Manage production of mechanical engineering components using various conventional, non-conventional and computer aided manufacturing processes.
3. Manage mechanical engineering maintenance and operational activities in various industries.

Academic Regulations – PT.19

UNDER GRADUATE PROGRAMME
(PART TIME POST DIPLOMA DEGREE COURSE - **PDDC**)

PT.19.1 ADMISSION

PT.19.1.1 A candidate seeking admission to the four year degree programme for Bachelor of Technology must have eligibility as per the Gujarat Government/ACPC/GTU/CVM rules.

PT.19.1.2 Admission granted to an applicant is to be considered provisional until all the fees are paid and all the prescribed documents are in order. BVM Engineering College DISCLAIMS ALL RESPONSIBILITIES if any of the documents required as per ACPC/ Gujarat Technological University norms, which are not submitted or found unacceptable by it. The college will not accept responsibility for students who do not submit the expected examination/ registration forms in time.

PT.19.2 PROGRAMMES OF STUDY

PT.19.2.1 A student shall undergo the prescribed courses as given in the programme of studies to obtain his/her degree in which he/she is admitted. These courses for various programmes are listed in Annexure – I.

The syllabi for these courses are given in Annexure – II.

PT.19.3 COURSE LEVELS

PT.19.3.1 At the commencement of each semester a student shall register for the set of courses offered during the semester. For the registration process, refer PT.19.9.

PT.19.3.2 All courses offered are divided into four levels: Level 1 to Level 4. The levels correspond to successive years of study of a typical B. Tech. student, i.e. a regular student will complete his/her Level-1 courses during his/her first year, Level-2 courses during his/her second year, and so on.

PT.19.4 COURSE CATEGORIES

Courses taken by a student to complete his/her degree programme are divided into Humanities and Social Science, Basic Science, Engineering Science, Mandatory Courses, Professional Core Courses, Program Elective Courses, Project Work/Seminar/ Internship.

PT.19.4.1 PROGRAMME ELECTIVE COURSES

Each programme of studies contains a certain number of programme elective courses. Programme elective courses will be offered under each discipline at corresponding level from which a student may choose course(s).

PT.19.5 DEFINATION OF STATUS OF COURSES

PT.19.5.1 REGULAR COURSES

Each programme of studies contains a certain number of courses (including elective courses and mandatory non-credit courses) to be studied in respective semester decided by respective Board of Studies.

PT.19.5.2 BACKLOG COURSES

The courses in which student has not obtained letter grade DD or above / PP at first attempt (Refer PT.19.13).

PT.19.6 PRE-REQUISITES

PT.19.6.1 A student shall not be allowed to enroll for any course at Level-4 unless he/she has completed all his/her course requirements at Level-1 with acceptable grades (Refer PT.19.13).

PT.19.7 COURSE CREDITS

PT.19.7.1 Each course offered has **L-T-P** structure, where "**L"** means number of theory lecture hours per week, **T** means number of tutorial hours per week and "**P"** means number of practical hours per week.

PT.19.7.2 Total course credits for a course are obtained by adding credits of theory lectures, tutorials and practical together. e.g. 1 hr. Lecture = 1 credit, 1 hr. Tutorial = 1 credit & 1 hr. Practical = 0.5 credit.

PT.19.8 FACULTY COUNSELOR

PT.19.8.1 Each student is assigned to a Faculty Counselor who will advise and counsel him/her regarding the selection of courses to be registered in a given semester as well as monitor his/ her holistic growth.

PT.19.8.2 Each student must obtain approval for "Backlog" courses (Refer PT.19.5.2) from the Faculty Counselor.

PT.19.9 REGISTRATION

PT.19.9.1 To earn course credits in a semester a student must register for the courses at the commencement of the semester.

PT.19.9.2 At the commencement of each semester the first working day is designated as the Registration Day. A student must complete his/her registration formalities on that day as per the procedure laid down by the institute.

PT.19.9.3 A further period of 12 working days is designated as late registration period. During this period a student shall require to pay late registration fees, as decided by the institute from time to time to complete his/her registration. Late registration will only be permitted on genuine reasons, (Refer PT.19.12.3) subject to the approval of the Principal.

PT.19.9.4 Student shall not be permitted to attend classes without registration.

PT.19.9.5 The registration must be completed by the student in person.

PT.19.9.6 A student who has completed all the requirements for his/her B.Tech. degree (Refer PT.19.18) will not be allowed to register in any further courses.

PT.19.9.7 All registrations in every semester must be duly approved by the Principal.

PT.19.9.8 Student should obtain approval from Faculty Counsellor to register any Backlog courses within 10 days of declaration of results of the previous semester or first 10 days of the commencement of semester, whichever is later.

PT.19.9.9 Total number of credits for Backlog courses should not be more than sixteen.

PT.19.10 WITHDRAWAL

PT.19.10.1 Student may withdraw all the courses registered in a semester before four weeks of commencement of End Semester examination. Further, on genuine reasons (Refer PT.19.12.3) a student can withdraw at any time during the entire semester. In such cases NO FEES will be refunded. The letter grade "WD" will be awarded (Ref. 19.12.1).

PT.19.11 ASSESSMENT OF STUDENT PERFORMANCE IN A COURSE

PT.19.11.1 The performance of a student in a course will be evaluated based on (i) continuous assessment of theory and tutorial/practical work and (ii) end-semester theory and tutorial / practical examinations.

PT.19.11.2 The end- semester theory examination in a course has a weightage of 60 % of total theory marks. Out of the remaining 40 % of theory marks, 30 % of marks will be evaluated based on mid semester examination and remaining 10 % based on continuous assessment carried out during the semester as declared by the course coordinator in first week of beginning of the semester.

PT.19.11.3 The end-semester tutorial/practical examination in a course has a weightage of 40 percent of total tutorial/practical marks and continuous assessment of the same carries the remaining 60 % of total tutorial/practical marks. Tutorial/practical work (both end-semester and continuous) shall be evaluated on the basis of the following instruments of assessment: observation of experimental skills, reports, oral examination, quizzes, end-semester practical examination and attendance.

Continuous assessment (tutorial/practical) scheme is given below:

Term work	30 % (Equal weightage for every practical. At least 10 practical/tutorial need to be performed or mini project)
Quiz/Assignment/ Viva/ active learning component	30 %
Total	**60 %**

The respective Board of Studies shall decide the list of the courses in which end semester practical evaluation is feasible. In such courses evaluation shall be based on practical as well as viva for 40 % marks of end semester tutorial/practical. If practical performance is not feasible then 40 % of marks as end semester tutorial/practical evaluation will be based only on viva**.**

PT.19.11.4 The overall performance of a student in a course is assessed on the principle of "single head of passing", i.e., there will be a single grade for a course based upon the aggregate of marks obtained by the student in theory and tutorial/practical components in continuous assessment as well as end semester examination. However, a student must score minimum 35% marks in end semester theory and tutorial/practical examination to make himself/ herself gradable.

PT.19.12 EXAMINATIONS

PT.19.12.1 The end-semester examination for all courses offered in an academic year will be conducted by the institute for awarding 60 % of marks out of the total theory marks.

PT.19.12.2 No student shall be allowed to appear in the end semester examination unless he/she has attended 100% of theory and tutorial/practical classes of each course and will be awarded letter grade FA (Refer PT.19.13) in all the courses he/she has registered in the corresponding semester, except backlog courses.

However, a maximum 25 % relaxation in attendance is permissible with prior intimation along with required documents from concerned authorities. The relaxation includes medical, co-curricular and extra-curricular activities, genuine social engagements etc.

PT.19.12.3 The institute will conduct two continuous assessment of theory (mid semester examination) in a semester for each course for the evaluation of 30 % of total theory marks. The average marks of two mid semester examinations shall be considered as the final marks for mid semester examination.

A student who remains absent in any of the two mid semester examination for whatsoever reason(s) shall be awarded with zero marks in the respective mid semester examination.

However, if a student remains absent due to any of the following genuine reasons, for such students a special examination may be conducted by the department and marks obtained in the special examination will be considered as marks of the mid semester examination in which he/she has remained absent. Such student should obtain prior approval from the Principal.

a) A student is critically ill or injured and certified by Civil Surgeon.
b) Death of direct blood relation relative.
c) A student representing Gujarat state in national level events and/or India in International events organized by official boards.

However, such re-arrangement should be confined within the Academic Calendar of the respective semester.

PT.19.12.4 The institute will conduct only one continuous assessment of theory (mid semester examination) for all courses of the semester in the following cases.
a) First Semester of PDDC programme.
b) Corresponding semester of the year of transfer for transferred students or international students, if the admission of such students is five weeks later than commencement of academic calendar.

PT.19.12.5 No student shall be allowed to appear in the end semester examination of a course unless he/she has scored at least 35% marks in mid semester examination and will be considered in "NOT PERMITTED TO APPEAR (NPTA)" status for the respective course and letter grade "NA" will be awarded (Refer PT.19.13).

The NPTA student(s) shall appear in mid semester remedial examination of the next semester.

PT.19.12.6 The End Semester tutorial/practical examination shall be re-arranged for a student who is not able to appear in the regular schedule due to genuine reason(s) (Refer PT.19.12.3). Such student should obtain prior approval from the Principal.

However, such re-arrangement should be confined within the Academic Calendar of the respective semester.

PT.19.13 LETTER GRADES

PT.19.13.1 The overall performance of a student in credit courses is represented by a letter grade from AA to FP, FA, NA and WD with the following meaning and equivalent grade points:

LETTER GRADE	EQUIVALENT GRADE POINTS	REMARK
AA	10	Outstanding
AB	9	Excellent
BB	8	Very Good
BC	7	Good
CC	6	Average
CD	5	Satisfactory
DD	4	Pass
FP	0	Failure due to Performance
FA	0	Failure due to Attendance
NA	0	Not Permitted To Appear
WD	0	Withdrawal

PT.19.13.2 A credit course is said to be completed successfully, only if a letter grade DD or better (in grade points) is obtained in that course.

PT.19.13.3 The scheme of awarding letter grades and the letter grades awarded in each course are subjected to scrutiny and approval by the Academic Council.

PT.19.14 FAILURE IN A COURSE

PT.19.14.1 A student earns **zero** credit for a course when he/she gets letter grade FP, NA, FA or WD in that credit course.

PT.19.14.2 If letter grade FA is obtained in an elective course, the student may change the elective.

PT.19.14.3 A student with letter grade FA and WD in course(s) should re-register the courses in subsequent semester when offered.

PT.19.14.4 A student with letter grade FP should appear, at the earliest, in the end semester theory as well as practical/ viva exam and should obtain a letter grade DD or better (in grade points) in credit courses.

PT.19.15 SEMESTER PERFORMANCE INDEX (SPI)

PT.19.15.1 The performance of a student in a semester is expressed in terms of the semester Performance Index (SPI).

PT.19.15.2 The semester Performance Index is the weighted average of course grade points obtained by the student in the regular courses (Refer PT.19.6.1) registered in the semester. The weights assigned to course grade points are the credits carried by the respective courses.

That is,

$$SPI = \frac{\sum_{i=1}^{n} g_i c_i}{\sum_{i=1}^{n} c_i}$$

where, g_i is the equivalent grade point of i^{th} course,
c_i is the credit of the course
n is total number of regular courses registered by the student in a semester

PT.19.16 CUMULATIVE PERFORMANCE INDEX (CPI)

PT.19.16.1 The cumulative performance of student is expressed in terms of the Cumulative Performance Index (CPI). This index is defined as the weighted average of course grade points obtained by the student for all courses taken since his/her entry to the programme. The weights are defined in same way as in PT.19.15.2.

PT.19.16.2 If a student repeats a course, only the grade points obtained in the latest attempt are counted towards the Cumulative Performance Index (CPI).

PT.19.17 ADMISSION BY TRANSFER

PT.19.17.1 For a student admitted by transfer to the PDDC programme after completing part of his/her degree requirements elsewhere or under the previous academic regulations of BVM, he/she will be allowed to continue in subsequent level after completing all the requirements of previous levels of the respective institute or previous academic regulation. He/She will be exempted from all courses upto the completed levels. For these courses "EXEMPTED" status will be shown in the Transcript.

PT.19.17.2 The remaining requirements must be completed by the student as per PT.19.18.

PT.19.17.3 The CPI of such a student will be calculated only on the basis of the courses taken after transfer.

PT.19.18 REQUIREMENTS FOR THE AWARD OF B. Tech. DEGREE

PT.19.18.1 To be eligible for the award of the degree of Bachelor of Technology a student must earn total credits as prescribed by respective Board of Studies

PT.19.18.2 The total credits requirements for the degree of B. Tech. must be completed in not more than 16 semesters from the date of admission. However, for a student admitted by transfer the maximum permissible duration shall be 100 % more than the period prescribed for completion of the programme at the time of admission.

PT.19.19 AWARD OF CLASS

PT.19.19.1 The class awarded to a student with his B. Tech. degree is decided by his final CPI as per the following table:

FIRST CLASS WITH DISTINCTION	- CPI not less than 7.10
FIRST CLASS	- CPI less than 7.10 but not less than 6.50
SECOND CLASS	- CPI less than 6.50 but not less than 5.50
PASS CLASS	- CPI less than 5.50

A candidate who passes in all courses and all heads of passing in the examination shall be given a gracing of the required CPI subject to a maximum of CPI 0.10, for awarding second class/first class/first class with distinction, in concurrence with rules and guidelines of AICTE/ GTU.

PT.19.20 TRANSCRIPT

PT.19.20.1 The Transcript will be issued to the student as and when required and will contain a consolidated record of all the courses undergone by him/her, grades obtained and CPI upto the date of issue of transcript.

PT.19.20.2 Only last letter grade obtained in a course by the student upto the date of issue of transcript will be shown in the Transcript.

PT.19.21 EXAMINERS

PT.19.21.1 The respective board of studies shall appoint at least two examiners for end semester theory as well as practical/viva examination. For each end semester theory examination, there shall be two paper setters. One paper setter out of the two shall be from outside the institute (external examiner). The end semester practical examination of each subject shall be conducted by an internal (Examiner from the institute) and an external examiner. For 4^{th} level courses, each end semester theory examination evaluation shall be made by an internal and an external examiner. One of the internal examiner/s shall be appointed as convener who shall co-ordinate the examination procedure for end semester examinations of the respective subject.

PT.19.22 REVIEW OF ESE THEORY ANSWER BOOKS

PT.19.22.1 A student shall apply for review of end semester theory answer book(s) within 7 working days after declaration of semester results. The student will have to pay the fees for the same as decided from time to time.

The answer book(s) of the student(s) who has applied for the review will be shown to him/her.

If student is satisfied with the assessment then he/she shall sign the answer book with a remark "Seen and Satisfied".

If student is not satisfied with the assessment, then the respective Board of Studies shall appoint two examiners (Convener of original exam and a new examiner) for the review of the end semester examination (theory) both sections. Both examiners shall jointly review both the sections and marks awarded in the previous assessment shall be kept open.

The marks obtained by the candidate after the review shall be considered for grading, only if, the change in mark is more than or equal to 10% of total mark of End Semester (Theory) Examination.

If change in grade is found after review, the review fees shall be refunded.

PT.19.23 GRADING

PT.19.23.1 The office of Controller of Examinations shall prepare the histogram of each course for the purpose of grading after the completion of assessment of the course.

PT.19.23.2 The convener of the respective course shall grade the students based on the histogram provided by the Controller of Examinations.

PT.19.24 GRADE REVIEW

PT.19.24.1 The Academic Council shall appoint a Grade Review Committee for each semester. The Grade Review Committee shall comprise of following members:

(a) Principal
(b) All Board of Studies Chairman
(c) University Nominee
(d) Dean, Academics
(e) Associate Dean, Academics
(f) Controller of Examinations
(g) Joint Controller of Examinations
(h) Member Secretary, Academic Council
(i) Officer-in-Charge of Credit System

PT.19.24.2 The Grade Review Committee shall meet immediately after results of all courses are completed and review the grades awarded by the convener of respective course. The revision of the grade suggested by the Grade Review committee shall be considered as final grade and binding.

PT.19.24.3 The Grade Review Committee can grace upto 10 % of total marks of theory examination in marks of end semester theory exam to make a student gradable. However grace marks shall not be counted in the aggregate marks obtained by the student for the grade.

ANNEXURE – I: Programme of studies leading to the degree of the Bachelor of Technology - PDDC (Mechanical Engineering)

Semester 1

Sr. No.	Course Code and Course Title	L	T	P	H	C
1	**1PT01: ADVANCED CALCULUS**	3	0	0	3	3
2	**1PT02: PROGRAMMING FOR ENGINEERS**	1	0	4	5	3
3	**1PT03: ENGINEERING THERMODYNAMICS**	3	0	0	3	3
4	**1PT04: MECHANICS OF SOLIDS**	3	1	0	4	4
	Total	**10**	**1**	**4**	**15**	**13**

Semester 2

Sr. No.	Course Code & Course Title	L	T	P	H	C
1	**1PT05: LINEAR ALGEBRA AND FOURIER SERIES**	3	0	0	3	3
2	**1PT06: FLUID MECHANICS AND MACHINES**	3	0	2	5	4
3	**1PT07: MATERIAL SCIENCE AND METALLURGY**	3	0	2	5	4
4	**1PT08: FUNDAMENTALS OF MACHINE DESIGN**	3	0	2	5	4
	Total	**12**	**0**	**6**	**18**	**15**

Semester 3

Sr. No.	Course Code & Course Title	L	T	P	H	C
1	**2PT01: NUMERICAL METHODS AND STATISTICAL ANALYSIS**	3	0	0	3	3
2	**2PT02: MACHINING PROCESSES**	3	0	2	5	4
3	**2PT03: MECHANICAL MEASUREMENT AND METROLOGY**	3	0	2	5	4
4	**2PT04: INDUSTRIAL ENGINEERING AND QUALITY ASSURANCE**	3	0	0	3	3
	Total	**12**	**0**	**4**	**16**	**14**

Semester 4

Sr. No.	Course Code & Course Title	L	T	P	H	C
1	**2PT05: OPERATIONS RESEARCH**	3	1	0	4	4
2	**2PT06: KINEMATICS OF MACHINES**	3	0	0	3	3
3	**2PT07: HEAT TRANSFER**	3	0	2	5	4
4	PROGRAM ELECTIVE - I	3	0	2	5	4
	Total	**12**	**1**	**4**	**17**	**15**

Program Elective - I

1	**2PT41: PRODUCTION AND OPERATIONS MANAGEMENT**	3	0	2	5	4
2	**2PT42: NON-CONVENTIONAL ENERGY RESOURCES**	3	0	2	5	4
3	**2PT43: NON-TRADITIONAL MANUFACTURING PROCESS**	3	0	2	5	4

Semester 5

Sr. No.	Course Code & Course Title	L	T	P	H	C
1	**3PT01: DYNAMICS OF MACHINES**	3	0	2	5	4
2	**3PT02: OIL HYDRAULICS AND PNEUMATICS**	3	0	2	5	4
3	**3PT03: METAL FORMING, JOINING AND FOUNDARY PRACTICES**	3	0	2	5	4
4	**3PT04: AUTOMOBILE ENGINEERING**	3	0	0	3	3
	Total	**12**	**0**	**6**	**18**	**15**

Semester 6

Sr. No.	Course Code & Course Title	L	T	P	H	C
1	**3PT05: DESIGN OF MACHINE ELEMENTS**	3	0	2	5	4
2	**3PT06: COMPUTER AIDED DESIGN**	3	0	2	5	4
3	**3PT07: INTERNAL COMBUSTION ENGINES AND TURBINES**	3	0	2	5	4
4	**3PT08: ENERGY CONSERVATION AND MANAGEMENT**	3	0	0	3	3
	Total	**12**	**0**	**6**	**18**	**15**

Semester 7

Sr. No.	Course Code & Course Title	L	T	P	H	C
1	**4PT01: MACHINE DESIGN**	3	0	2	5	4
2	**4PT02: PRODUCTION TECHNOLOGY**	3	0	2	5	4
3	**4PT03: REFRIGERATION, AIR CONDITIONING AND COMPRESSORS**	3	0	2	5	4
4	PROGRAM ELECTIVE – II	3	0	0	3	3
	Total	**12**	**0**	**6**	**18**	**15**

Program Elective – II

1	**4PT41: DESIGN OF PRESSURE VESSELS**	3	0	0	3	3
2	**4PT42: GAS DYNAMICS AND PROPULSIVE SYSTEMS**	3	0	0	3	3
3	**4PT43: DESIGN OF HEAT EXCHANGERS**	3	0	0	3	3
4	**4PT44: PROJECT MANAGEMENT**	3	0	0	3	3

Semester 8

Sr. No.	Course Code & Course Title	L	T	P	H	C
1	**4PT04: COMPUTER AIDED MANUFACTURING**	3	0	2	5	4
2	**4PT05: POWER PLANT ENGINEERING**	3	0	0	3	3
3	**4PT06: PRODUCT ENGINEERING**	3	0	2	5	4
4	PROGRAM ELECTIVE – III	3	0	2	5	4
	Total	**12**	**0**	**6**	**18**	**15**
	Total Credits Distribution	**94**	**2**	**42**	**138**	**117**

Program Elective –III

1	**4PT45: TURBOMACHINERY**	3	0	2	5	4
2	**4PT46: FINITE ELEMENT METHODS**	3	0	2	5	4
3	**4PT47: MACHINE TOOL DESIGN**	3	0	2	5	4
4	**4PT48: GEOMETRIC DIMENSIONING AND TOLERANCING**	3	0	2	5	4

ANNEXURE –II: Syllabi for the courses offered in programme of studies leading to the degree of Bachelor of Technology – PDDC (Mechanical Engineering)

1PT01: ADVANCED CALCULUS
CREDITS - 3 (LTP:3,0,0)

Course Objectives:
The basic necessity for the Foundation of Engineering & Technology being Mathematics, the main aim is, to teach Mathematical concepts, develop Mathematical skills & enhance thinking power of students.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	00	00	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	Evolutes and Involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions.	08
2	Rolle's theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; Differentiation of Hyperbolic and Inverse Hyperbolic functions, Successive differentiation, standard forms, Leibnitz's theorem and applications, power series, expansion of functions, Indeterminate forms and L'Hospital's rule; Maxima and minima.	08
3	Limit, continuity and partial derivatives, directional derivatives, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers; Gradient, curl and divergence.	10
4	Multiple Integration: double and triple integrals (Cartesian and polar), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes by (double integration) Center of mass and Gravity (constant and variable densities). Theorems of Green, Gauss and Stokes, orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds.	10
5	Sequence and Their Convergence, Convergence and Divergence of Infinite Series, Geometric Series, P-Test, A Necessary Condition for Convergence, Comparison Test, Ratio Test.	06
	Total	**42**

List of References:

1. Weir, M.D. et al., "*Thomas' Calculus" (*11*th Edition),* Pearson Education, 2008.
2. Grewal B. S., "*Higher Engineering Mathematics*", Khanna Publisher, New Delhi, (Latest Edition).
3. Sastry S. S., "*Engineering Mathematics – Vol. I and II*", Prentice Hall of India.
4. Stuart J., "*Calculus"*, Cengage Learning, India Pvt. Ltd. (2008).

Course Outcomes (COs):

On successful completion of the course, students will be able to:

1. Apply differential and integral calculus to notions of curvature and to improper integrals. Apart from some other applications they will have a basic understanding of Beta and Gamma functions.
2. The fallouts of Rolle's Theorem that is fundamental to application of analysis to Engineering problems.
3. Acquire knowledge of advanced differential calculus for single variable and their applications.
4. Get acquainted with the knowledge of functions of several variables.
5. Learn differential and integral calculus of several variables.
6. Apply knowledge of differential and integral calculus of several variables for engineering applications.

1PT02: PROGRAMMING FOR ENGINEERS
CREDITS - 3 (LTP:1,0,2)

Course Objective:

To enhance logical thinking and to impart basic programming skills.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
1	0	4	3	30	20	40	60	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction to Programming** Introduction to the idea of algorithm; Introduction to Programming (Flow chart/pseudocode); Computing Software: System Software, Languages, Tools;	2
2	**Vectors and Matrices** Creations of Vectors and Matrices, Mathematical Operations with Vectors and Matrices: Addition, Multiplication, Determinants, Matrix Inverse; Data Input/Output: Entering a Scalar, String, Vector and Matrix; Input/Output Data files	3

Unit No.	Topics	Teaching Hours
3	**Program Flow Control** Logical Operators, Writing and evaluation of conditionals and consequent branching, Iteration and loops.	3
4	**Basic Algorithm** Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs	5
5	**Functions** Functions (including using built in libraries), Function File, Sub function, Anonymous Function, Inline Function, Passing Array to function	(Laboratory)
6	**Plotting and Graphics** 2D Plotting: Annotations and Enhancements, Interactive Plotting, Animation; 3D Plotting: Lines, Surfaces;	(Laboratory)
	Total	**13**

List of References:

1. Edward B. Magrab and at. al., '*An Engineer's Guide to Matlab'*, Prentice Hall
2. Brian D. Hahn and Daniel T. Valentine, '*Essential MATLAB for Engineers and Scientists'*, Third Edition, ELSEVIER
3. E. Balaguruswamy, '*Programming in ANSI C'*, Tata McGraw-Hill

Course Outcomes (COs):

At the end of this course students will be able to …

1. To formulate simple algorithms for arithmetic and logical problems.
2. To translate the algorithms to MATLAB programs
3. To use vectors and matrices for mathematical operations
4. To implement conditional branching, iteration and recursions
5. To decompose a problem into functions
6. To apply programming to solve matrix addition and multiplication problems and searching and sorting problems.
7. To apply programming to solve simple numerical method problems, namely rot finding of function, differentiation of function and simple integration.

1PT03: ENGINEERING THERMODYNAMICS
CREDITS - 3 (LTP:3,0,0)

Course Objective:

To apply laws of thermodynamics to thermal engineering problems.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	00	00	100

Course Content:

Unit No.	Topics	Teaching Hours
1	**Basic Concepts**: Microscopic & macroscopic point of view, thermodynamic system and control volume, thermodynamic properties, processes and cycles, Thermodynamic equilibrium, Quasi-static process, homogeneous and heterogeneous systems, zeroth law of thermodynamics and different types of thermometers.	4
2	**First Law of Thermodynamics:** First law for a closed system undergoing a cycle and change of state, energy, PMM1, first law of thermodynamics for steady flow process, steady flow energy equation applied to nozzle, diffuser, boiler, turbine, compressor, pump, heat exchanger and throttling process, unsteady flow energy equation, filling and emptying process.	4
3	**Second Law Of Thermodynamics**: Limitations of first law of thermodynamics, Kelvin-Planck and Clausius statements and their equivalence, PMM2, refrigerator and heat pump, causes of irreversibility, Carnot theorem, corollary of Carnot theorem, thermodynamic temperature scale.	5
4	**Entropy:** Clausius theorem, property of entropy, inequality of Clausius, entropy change in an irreversible process, principle of increase of entropy and its applications, entropy change for non-flow and flow processes, third law of thermodynamics.	4
5	**Availability, Irreversibility :** Available and unavailable energy, available energy referred to a cycle, availability in non-flow and steady flow systems, reversibility and Irreversibility.	5
6	**P-v, P-T , T-s and h-s diagrams for a pure substance**	3
7	Maxwell's equations, TDS equations, Difference in heat capacities, ratio of heat capacities, energy equation, Joule-Kelvin effect and Clausius-Clapeyron equation.	4
8	**Liquefaction of Gases:** Liquefaction, Linde Hampson system, Cloude System, Analysis	3
9	**Properties of Gases And Gas Mixtures:** Avogadro's law, equation of state, ideal gas equation, Vander Waal's equation, reduced properties, law of corresponding states, compressibility	4

Unit No.	Topics	Teaching Hours
	chart, Gibbs-Dalton law, internal energy; enthalpy and specific heat of a gas mixtures.	
10	**Combustion of Fuels:** Combustion of air, combustion equations, minimum air requirement, excess air and air fuel ratio, wet and dry analysis of products of combustion, conversion of volumetric analysis by mass, Enthalpy of formation, Enthalpy of reaction, First law for reactive systems , Adiabatic flame temperature, Bomb calorimeter and Junker's gas calorimeter.	4
	Total	**42**

List of References:

1. P.K. Nag, "*Engineering Thermodynamics"*, 6th Edition, McGraw-Hill Education.
2. Van Wylen and Sonntag, "*Fundamentals of Classical Thermodynamics*", 2nd Edition
3. Yunus Cengel & Boles, "*Thermodynamics – An Engineering Approach"*, 4th Edition, McGraw-Hill Education ,
4. T D Eastop and A McConkey, "*Applied Thermodynamics*"
5. J P Holman, "*Thermodynamics"*, McGraw-Hill Education.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Apply first law of thermodynamics to thermal and fluid systems.
2. Interpret second law of thermodynamics, entropy, available energy and its applications.
3. Deduce thermodynamic relations.
4. Analyze Liquefaction systems.
5. Determine thermodynamic properties for non-reactive gas mixtures.
6. Analyze combustion process.

1PT04: MECHANICS OF SOLIDS
CREDITS - 4 (LTP:3,1,0)

Course Objective:

This course is to introduce the basic principles of engineering mechanics and Mechanics of deformable bodies with emphasis on their analysis and application to practical engineering problems.

Teaching and Assessment Scheme:

Teaching Scheme			Credits	Assessment Scheme				
L	T	P	C	Theory Marks		Practical Marks		Total Marks
				ESE	CE	ESE	CE	
3	1	0	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Fundamentals of Statics**: **Coplanar concurrent and non-concurrent force system: Resultant, Equilibrant, Free body diagrams.** Coplanar concurrent forces: Resultant of coplanar concurrent force system by analytical and graphical method, Law of triangle of forces, Law of polygon of forces, Equilibrium conditions for coplanar concurrent forces, Lami's theorem. Coplanar non-concurrent forces: Moments & couples, Characteristics of moment and couple, Equivalent couples, Force couple system, Varignon's theorem, Resultant of non-concurrent forces by analytical method, Equilibrium conditions of coplanar non-concurrent force system	05
2	**Friction** Theory of friction, Types of friction, Static and kinetic friction, Cone of friction, Angle of repose, Coefficient of friction, Laws of friction, Application of theory of friction: Friction on inclined plane, ladder friction, wedge friction, belt and rope friction.	07
3	**Centroid and moment of inertia:** Centroid: Centroid of plane areas and volumes, Examples related to centroid of composite geometry, Pappus – Guldinus first and second theorems. Moment of inertia of planar cross-sections: Derivation of equation of moment of inertia of standard lamina using first principle, Parallel & perpendicular axes theorems, polar moment of inertia, and radius of gyration of areas. Examples related to moment of inertia of composite geometry,	07
4	**Columns and Struts:** Buckling of columns, different end conditions, effective length, least radius of gyration, Euler's and Rankine's formulae	05
5	**Simple stresses & strains:** Basics of stress and strain: Application of normal stress & strains: Homogeneous and composite bars having uniform & stepped sections subjected to axial loads and thermal loads, analysis of homogeneous prismatic bars under multidirectional stresses. **Principle stresses:** Two dimensional system, stress at a point on a plane, principal stresses and principal planes, Mohr's circle of stress, ellipse of stress and their applications.	07
6	**Bending stresses in Beams and curved bars:** Flexural stresses **:** Theory of simple bending, Assumptions, derivation of equation of bending, neutral axis, determination of bending stresses, section modulus of rectangular & circular (solid & hollow), I, T, Angle, channel sections. Bending stresses in curved bars: Pure bending of curved bars of I-section, circular section, crane hooks, stresses in curved bars of small initial curvature.	08
7	**Thin & Thick cylinders:** Thin seamless cylindrical shells, Riveted boiler shells, wire-bound thin pipes, and thick cylindrical shells.	06
	Total	**45**

List of References:

1. S. B. Junnarkar and H. J. Shah, "*Applied Mechanics*", Charotar Publishing House Pvt. Ltd.
2. S. B. Junnarkar and H. J. Shah, "*Mechanics of Structure Vol. I*", Charotar Publishing House Pvt. Ltd.
3. P. J. Shah, "*Mechanics of Solids*", S. Chand, New Delhi.
4. R. S. Khurmi, *"Engineering Mechanics*", S. Chand, New Delhi.
5. N. K. Arora, "*Mechanics of Solids*", Books India Publications, Ahmedabad.
6. M. N. Patel, P. V. Patel, C. S. Sanghvi, J. S. Thakur, "*Mechanics of Solids*", Mahajan Publishing House, Ahmedabad.

Course Outcome:

After learning the course the students should be able to:

1. Apply fundamental principles of mechanics & principles of equilibrium to simple and practical problems of engineering.
2. Know basics of friction and its importance through simple engineering applications.
3. Determine centroid and moment of inertia of a different geometrical shape and able to understand its importance.
4. Understand the different types of stresses and strains developed in the members subjected to axial, bending, shear.

1PT05: LINEAR ALGEBRA AND FOURIER SERIES
CREDITS - 3 (LTP:3,0,0)

Course Objectives:

The basic necessity for the Foundation of Engineering & Technology being Mathematics, the main aim is, to teach Mathematical concepts, develop Mathematical skills & enhance thinking power of students.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	00	00	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	Matrices: addition and multiplication by scalar, matrix multiplication; Linear systems of equations (homogeneous and nonhomogeneous), rank of a matrix, determinants, Cramer's Rule, inverse of a matrix, Gauss elimination and Gauss-Jordan elimination.	10
2	Vector Space, linear dependence of vectors, basis, dimension; Linear transformations (maps), range and kernel of a linear map, rank and nullity, Inverse of a linear transformation, rank-nullity theorem, composition of linear maps, Matrix associated with a linear map.	12

Unit No.	Topics	Teaching Hours
3	Eigenvalues, eigenvectors, symmetric, skew-symmetric, and orthogonal Matrices, eigen bases. Diagonalization; Inner product spaces, Gram-Schmidt orthogonalization.	10
4	Periodic function, Fourier series, Functions of any period, Even and odd functions, Half-range Expansion, Parseval's theorem.	10
	Total	**42**

List of References:

1. Howard A. and Chris R., "*Elementary Linear Algebra*", John Wiley & Sons, 2005.
2. Grewal B. S., "*Higher Engineering Mathematics*", Khanna Publisher, New Delhi, (Latest Edition).
3. Bali N. P. and Goyal M., "*Engineering Mathematics*", Laxmi Publication (Latest Edition).

Course Outcomes (COs):

On successful completion of the course, students will be able to:

1. Solve system of linear equations using different tools of linear algebra for the problems arising in the field of engineering.
2. Understand the concepts like vector space, Eigen values and Eigen vector and their application in various subjects of engineering.
3. Understand and apply use of linear transformation arising in different subject of engineering.
4. Do expansion of functions in terms of basic trigonometric functions.
5. Adapt tools of Fourier series and half range series for expansion of various functions for learning advanced engineering mathematics.

1PT06: FLUID MECHANICS AND MACHINES
CREDITS - 4 (LTP:3,0,1)

Course Objective:

1. To develop the governing equations for fluid flow by using conservation principles and apply them to practical problems.
2. To apply principles of Fluid Mechanics to analyze Fluid machines.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Content:

Unit No.	Topics	Teaching Hours
1	**Fluid Statics and Kinematics:** Hydrostatic force acting on plane surface, types of fluid flow, frames of reference, discharge and mean velocity, continuity equation, continuity equations in three dimensions, velocity and acceleration, streamlines and the stream functions, velocity potential and potential function, relation between stream function and velocity potential; flow nets, linear translation, linear deformation, angular deformation, circulation and vorticity, stream function and velocity potential for uniform flow, vortex flow.	6
2	**Fluid dynamics:** Introduction, Euler's equation of motion along a stream line, Mechanical energy of a flowing fluid –Bernoulli's theorem, kinetic energy correction factor, principle of venturimeter and orifice meter, pitot tube, theory of small orifices discharging to atmosphere, elementary theory of notches and weirs, Momentum equation, momentum correction factor.	8
3	**Dimensional Analysis and Similarities:** Dimension, Units, dimension reasoning, dimensional quantities, dimensional homogeneity, Buckingham π-theorem, dimensionless numbers, use of dimensionless numbers in experimental investigation, geometric similarity, dynamic similarity, kinematic similarity, model testing-Model laws, Undistorted and Distorted models.	4
4	**Viscous Flow:** Reynolds experiment, flow of viscous fluid through circular pipe- Hagen Poiseuille formula, Navier-Stokes equation of motion, Flow of viscous fluid between two parallel fixed plates, methods of measurement of viscosity	4
5	**Turbulent Flow:** Introduction to major and minor losses in flow through pipe, expression for coefficient of friction – Darcy-Weisbach Equation, Moody's diagram, resistance of smooth and rough pipes shear stress and velocity distribution in turbulent flow through pipes.	4
6	**Compressible Flow:** Basic equations for one dimensional compression, Pressure wave propagation, sound velocity in fluid, Mach number, Stagnation properties.	3
7	**Hydraulic Turbines:** Classification; moment of momentum equation to estimate work done on blade; Construction, working and analysis of Pelton, Francis and Kaplan turbine; Efficiencies of turbine; Governing, Performance, Cavitation and Scale effect of hydraulic turbine.	7
8	**Hydraulic Pumps:** Classification; Construction of roto-dynamic pumps, manometric head, efficiencies and performance of centrifugal pump; pressure rise in pump impeller; multistage pump; cavitation in pump.	6
	Total	**42**

List of References:

1. Frank .M. White, "*Fluid Mechanics",* McGraw Hill Publishing Company Ltd.
2. Streeter V.L., Benjamin Wylie, "*Fluid Mechanics*", McGraw Hill Book Co., New Delhi.
3. D.S. Kumar, *"Fluid Mechanics and Fluid Power Engineering",* S. K. Kataria & Sons
4. R.K. Bansal*, "Fluid Mechanics and Hydraulic Machines",* Laxmi Publications
5. Munson, *"Fundamentals of Fluid Mechanics",* Wiley India Pvt. Ltd
6. S K Som, Gautam Biswas, S Chakraborty, *"Introduction to Fluid Mechanics and Fluid Machines"*, Tata McGraw-Hill Education, 3rd edition, 2013
7. Yunus Cengel & John Cimbala, *"Fluid Mechanics: Fundamentals and Applications"*, Tata McGraw Hill, New Delhi.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Apply kinematics and dynamics of practical fluid flow problems.
2. Use concept of dimensional analysis.
3. Apply practical situations of viscous flow and turbulent flow.
4. Outline compressible fluid flow problems.
5. Analyze performance of hydraulic turbine and its sizing.
6. Outline roto-dynamic pumps for construction, operation, performance and sizing.

1PT07: MATERIAL SCIENCE AND METALLURGY
CREDITS - 4 (LTP:3,0,1)

Course Objective:

To understand the behavior of materials through structure-property-performance relationships.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction to Materials Science**: Significance of Materials Science, Advanced materials, Engineering needs of modern materials, Levels of internal structure like macro, micro, crystal and atomic and their correlated properties, Methods/Tools to reveal the different levels of structure, Review of Service and Processing Properties of materials, Criterion for selection of materials for engineering applications through Structure-Properties-Performance correlationships.	07

Unit No.	Topics	Teaching Hours
2	**Atomic and Crystal Level**: Structure-Property Co-relationship at microstructure levels for metals and alloys, Examples from the practice correlating atomic and crystal structure level.	06
3	**Micro Structure Level**: Structure property co-relationship at microstructure levels for metals and alloys, Examples from the practice correlating atomic and crystal structure level.	05
4	**Iron-Iron-Carbide Equilibrium Diagram**: Allotropy of Iron, Phases of the Iron-Iron Carbide equilibrium diagram and their properties, Reactions of the Iron-Iron Carbide equilibrium system, Alloy groups (Wrought Irons, Steels and cast Irons) of Iron-Iron Carbide equilibrium system and their characteristics in general, Transformation studies of eutectoid, hypo-eutectoid and hypereutectoid steels, their resultant microstructures and hence correlated properties and applications. Classification of Plain Carbon steels IS/ISO Codification, Different specifications and designations of steels. Wrought Irons- microstructures, properties and applications. Cast Irons: Iron-Iron Carbide and Iron-Carbon diagrams, Graphitization, Transformations resulting into White Cast Irons, Grey Cast Irons, Malleable Cast Irons, S. G. Irons, Alloy Cast Irons. Their microstructures and correlated properties and applications. IS/ISO Codification	08
5	**Heat Treatment of Plain Carbon Steels**: Time-Temperature transformations- isothermal and continuous in plain carbon steels, Annealing: Objectives of different types of annealing like, Full, Process, Stress relief, Spherodizing etc, with Thermal cycle, resultant structure, Applications. Normalizing: Aim, Thermal cycle and Time-temperature transformations, resultant structure and applications. Hardening and Tempering: Aim, features of martensitic transformation, need for tempering, different types of tempering operations, resultant structures and applications, Hardenability, Surface Hardening Methods: Carburizing, Nitriding, Carbo-Nitriding, Cyaniding, Induction, Flame Hardening.	08
6	**Non Destructive Testing of Materials**: Definition of non-destructive testing, Non-destructive testing methods like Dye Penetrant, Radiography, Magnetic Particle, Ultrasonic, Eddy Current with their Principle of non-destructive testing, Characteristic features, variables of the test, sensitivity, relative merits, demerits and applications.	08
	Total	**42**

List of References:

1. Donald R. Askeland, Donald R, Phule, Pradeep P, "*The Science and Engineering of Materials*", Cengage Learning
2. Avner, Sidney H., "*Introduction to Physical Metallurgy*", 2nd Edition, Tata-McGraw Hill.
3. William D. Callister, Jr., David G. Rethwisch., "*Materials Science and Engineering An*

Introduction", 8th Edition John Wiley & Sons
4. Yu Lakhtin, "*Engineering Physical Metallurgy*", MIR Publishers.
5. Smith, W. F. "*Principles of Materials Science and Engineering*", McGraw Hill
6. Baldev Raj, T. Jayakumar and M. Thavasimuthu: "*Practical Non-Destructive Testing*", Narosa Pub. House.
7. George F. Vander Voort (editor): ASM Handbook Vol. 9: "*Metallography and Microstructure,*" ASM International 2004.
8. Robert E.Reed-Hill: "*Physical Metallurgy Principles*", Affiliated East West Press New Delhi.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Select engineering materials on the basis of structure-property-performance relationship.
2. Correlate behavior of materials at atomic and crystal level.
3. Correlate behavior of materials at microstructure level.
4. Interpret iron-iron carbon diagram.
5. Apply the knowledge of heat treatment of plain carbon steels to get the desired properties for given applications.
6. Illustrate characteristics, capabilities and applications of NDT methods like liquid penetrant test, ultrasonic testing, radiography, eddy current testing, magnetic particle inspection.

1PT08: FUNDAMENTALS OF MACHINE DESIGN
CREDITS - 4 (LTP:3,0,1)

Course Objective:

To apply principles of design to decide shape and dimensions of a mechanical component.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Design Considerations for Machine Members:** Definition and understanding of various types of design, Design procedure, Selection of materials based on properties and I.S. coding of various materials, Factor of safety, Types of stresses, Theories of Failures: Distortion energy (Von Mises), Maximum shear stress, Maximum principal stress, Coulomb-Mohr theory, Selection and Use of theories of failures, Stress concentration and methods of relieving stresses, Eccentric loading.	05

Unit No.	Topics	Teaching Hours
2	**Temporary Joints:** Design of Threaded Joints: Basic types of screw fastening, Cap and Set screw, Bolt of Uniform strength, locking devices, Terminology of Screw thread, Designation of screw threads as per IS:4218, Simple and Eccentric loading, Torque requirement for bolt tightening, Elastic analysis of bolted joints. Design of Cotter joints and Knuckle joint.	08
3	**Permanent Joints**: Design of Riveted Joints: Strength and efficiency of joints, Caulking and Fullering, Longitudinal and Circumferential lap joints, Eccentrically loaded riveted joints. **Design of Welded Joints:** Design for various loading conditions in torsion, shear and direct load, Eccentrically loaded welded joints.	08
4	**Short and Long Columns:** Compressive axial loading of columns and struts, Slenderness ratio, Compressive stress and buckling of members, Effect of end conditions; Euler's Formula, applications, validity and limitations; Rankine's Formula, Johnson's Equation; Eccentric loading of long columns.	05
5	**Power Screws:** Types of power screw threads, Design of screw with different types of threads used in practice, Design of nuts, Design of C-clamp, Design of screw jack, Design of toggle jack.	06
6	**Design of Shafts And Keys:** Design of solid and hollow shaft for transmission of torque, bending moment and axial forces, Design of shaft for rigidity and stiffness. Design of different types of keys, Splines.	06
7	**Levers:** General procedure for design of levers, Design of lever for safety valve, Design of bell crank lever, Design of rocker arm for exhaust valves, Design of foot lever.	04
8	**Limits, Fits and Tolerances:** Introduction, Basic definitions, Maximum Metal Condition, Least Metal Condition, Linear and angular tolerances, Tolerance grades, Fundamental deviations, Types of fits and its basis, Types of gauges. **Introduction to GD & T:** Basic terminology of GD & T, Different tolerance characteristics, symbols and tolerance modifiers, Different aspects of datum, Parameters of surface texture and qualifications, Roughness and Machining symbols indication on drawings, Surface Lay Indication.	**
	Total	**42**

**** Will be covered in laboratory classes.**

List of References:

1. Bhandari V, "*Design of Machine Elements*", 4th Edition, Tata McGraw-Hill Book Co, 2016.
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett "*Mechanical Engineering Design*", 9th Edition, Tata McGraw-Hill, 2011.
3. Robert C. Juvinall and Kurt M. Marshek, "*Fundamentals of Machine Design*", 4th Edition, Wiley, 2005.
4. R L Norton, "*Machine Design an Integrated Approach*", Prentice Hall, 1998.
5. Spottes, M.F., "*Design of Machine Elements*", Prentice Hall 1994.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Apply various considerations for design of mechanical components.
2. Design cotter and knuckle joints.
3. Design riveted and welded joints.
4. Design of components based on long columns theory.
5. Design power screws for various applications.
6. Design shafts and keys for various applications.
7. Design levers for various applications.
8. Apply concepts of Geometrical and Dimensional Tolerances.

2PT01: NUMERICAL METHODS AND STATISTICAL ANALYSIS
CREDITS - 3 (LTP: 3, 0, 0)

Course Objective:

To introduce numerical techniques used in engineering analysis.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	0	0	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Error Analysis** Floating point number representation, Round-off errors and truncation errors in numerical computation, error propagation, and numerical instability.	05

Unit No.	Topics	Teaching Hours
2	**Roots of Equations:** Bracketing Methods: Bisection method, Regula-Falsi method, Open Methods: Newton-Raphson method, Secant method, Brent's Methods, Multiple roots, Error Analysis.	05
3	**Solution of Simultaneous Linear Equations:** Gauss Elimination with backward substitution, Gauss-Jordon and Gauss Seidel method, LU Decomposition and Matrix Inversion, Error Analysis and System Condition.	04
4	**Polynomial Interpolation:** Lagrange methods, Forward/Backward/Central Difference Operators, Properties of Operators, Newton's forward and backward interpolation formulae, Gauss's forward and backward difference formulae, Interpolation with unequal interval: Newton's divided difference formula. Case Studies	07
5	**Numerical Integration and Differentiation:** Trapezoidal rule, Simpson's 1/3 and 3/8 rule, Gauss quadrature. Newton's Forward-difference, Backward-difference and Divided-difference formula. Case Studies.	05
6	**Numerical Solution of Ordinary Differential Equations:** Initial-Value and Boundary-Value Problems, Single Step and Multi-Step Methods, Taylor series method, Euler's method, Euler's modified method, Runge-Kutta method of 2nd, 3rd and 4th orders, Multistep methods: Predictor and Corrector methods, Case Studies.	06
7	**Probability and Statistics:** Review of fundamental concepts of probability and sampling theorems, Conditional probability, Standard deviation function of Discrete and Continuous distributions, Normal, Poisson and Binomial distributions, Linear Regression analysis and curve fitting.	08
	Total	**40**

List of References:

1. Steven Chapra and Raymond Canale*, "Numerical Methods for Engineers",* 6th edition, Tata McGraw-Hill.
2. Balagurusamy E.*, "Numerical Methods",* Prentice Hall of India.
3. Steven C Chapra*, "Applied Numerical Methods with MATLAB",* 3rd edition, Tata McGraw Hill Publishing Co Ltd.
4. Sastry S. S., *"Introductory Methods of Numerical Analysis",* 5th edition, Prentice Hall of India.
5. Rao V. Dukkipati*, "Applied Numerical Methods Using MATLAB",* New Age International Publishers.
6. *Erwyn Kreyszig, "Advanced Engineering Mathematics", 10th edition, John Wiley and Sons, 2008.*

Course Outcomes (COs):

At the end of this course students will be able to …

1. Evaluate errors associated with computations.
2. Demonstrate the numerical techniques for root finding.
3. Demonstrate the numerical techniques for accurate and efficient solution of linear system of equation.
4. Demonstrate the numerical techniques to interpolate data-points.
5. Apply numerical techniques to solve integration and differentiation equation used in mechanical engineering.
6. Apply probability and techniques to practical problems in mechanical engineering.

2PT02: MACHINING PROCESSES
CREDITS - 4 (LTP: 3, 0, 1)

Course Objective:

To understand the basics of machining processes and the machine tools

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	150
3	0	2	4	60	40	20	30	

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Basic Machine Tools and Metal Cutting Principles:** Classification of machining processes and machine tools, Basic motions in various machines tools, Cutting tool materials, Cutting fluids, Different types of cutting tools, Nomenclature of single point and multi point cutting tools, Concept of cutting speed, feed, depth of cut and MRR for various machine tools.	05
2	**Turning Operations:** Lathe operations, Methods of taper turning, Thread cutting, milling, gear cutting and grinding on lathe. Classification of lathes, Constructional details/elements of engine lathe, Accessories and attachments, Specifications, Capstan and Turret lathes: Construction details, Operations and applications. Alignment tests of lathes.	09
3	**Drilling and Allied Operations:** Fundamentals of drilling, reaming, tapping, boring operations, Construction of drilling machines, Types of drilling machines, Twist drill, tap and reamer geometry, Alignment tests of drilling machine. Horizontal and vertical boring machines, Jig boring machines and construction features.	06

Unit No.	Topics	Teaching Hours
4	**Shaping, Planning, and Slotting operations:** Shaping, planning and slotting operations, Shaper: Working principle, Classification of shapers, Principal parts of shaper, Shaper mechanisms, Shaper operations Planer: Working principle, Difference between shaper and planer Slotter: Principal parts, Operations performed on slotter. **Broaching and Sawing Machines:** Fundamentals of broaching, broaching tool terminology, Types of broaching machines, Advantages and limitations of broaching. Sawing: Operation, Saw blades, Types of sawing machines.	07
5	**Milling Operations:** Principle of milling: Concept of up-milling and down-milling, Types of milling machines, Construction details of column and knee type milling machine, Types of milling cutters, Different types of milling operations: gang milling, progressive milling, Cutting conditions in milling, Accessories and attachments, Indexing, Helical milling operation and its set up, Alignment tests of milling machine.	08
6	**Grinding Machines and Abrasives:** Characteristic of grinding process, Classification of grinding machines, Operations and applications of surface, cylindrical and center less grinding processes, Dressing, truing and balancing of grinding wheels, Abrasives, Grinding wheel designation and selection. **Super Finishing Processes:** Lapping, honing, buffing, and polishing: Characteristics, machining and applications.	07
	Total	**42**

List of References:

1. Hajra Choudhury S. K., Bose H. K., and Hajra Choudhury A. K., "*Elements of Workshop Technology*" (Vol. II, 12th Edition), Media promoters and Publishers Pvt. Ltd.
2. Raghuwanshi B. S., A Course in "*Workshop Technology*" (Machine Tools Vol.II), Dhanpat Rai & Sons.
3. W.A.J. Chapman, "*Workshop Technology*" (Vol. I, II & III).
4. Rao P. N., "*Manufacturing Technology"* (Vol. 2), Tata McGraw-Hill.
5. HMT, "*Production Technology*", Tata Mc GrawHill.
6. J P Kaushish, "*Manufacturing Processes*", PHI Learning Pvt. Ltd.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Describe the conditions required for metal cutting, including tool geometry.
2. Explain the working of general purpose machine tools.
3. Comprehend basic mechanisms such as drive, speed, feed and indexing mechanisms for general purpose machine tools.
4. Select the cutting parameters in the context of machining time and material removal rate
5. Explain finishing and super finishing processes.
6. Inspect the alignment of lathe, drilling and milling machine.

2PT03: MECHANICAL MEASUREMENT AND METROLOGY
CREDITS – 4 (LTP: 3, 0, 1)

Course Objective:

To introduce techniques and instrumentation used in mechanical measurement and Metrology

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Basic Concepts of Measurements:** Introduction to measurement and measuring instruments, Methods of measurement, Modes of measurement, generalized measuring system and functional elements, instruments and its classifications, Sensors & Transducer and its classification, Static and dynamic performance characteristics of measurement devices, sources of error in measurement, classification and elimination of errors, calibration, uncertainty in measurements.	05
2	**Measurement of Displacement, Velocity/Speed, Acceleration Force, Torque, Power and Strain**: Working principal of Resistive potentiometer, Linear variable differential transducers, Electro Magnetic Transducers, Tachometers: Mechanical, Electrical, Photoelectric and Stroboscope, Accelerometers: Piezoelectric, Seismic, Strain gauge accelerometer. Hydraulic force meter, Pneumatic force meter, Strain gauge load cell, Cantilever beams, Proving rings, and Linear variable differential transformers. Measurement of torque and power: Prony brake dynamometer, Rope brake dynamometer, Hydraulic dynamometer, Eddy current dynamometer, Torsion bar dynamometer, Servo-controlled dynamometer. Measurement of strain: Mechanical strain gauges, electrical strain gauges, strain gauge: materials, gauge factors, theory of strain gauges and method of measurement, bridge arrangement, temperature compensation.	08
3	**Temperature, Pressure and Flow Measurements :** Methods of temperature Measurement; Expansion thermometers: Bi-metallic, Liquid in glass; Filled System thermometers; Electrical temperature measuring instrument: Thermocouples, RTD, Thermistors; Pyrometers; Calibration of temperature measuring instruments.	09

Unit No.	Topics	Teaching Hours
	Pressure standards and methods of pressure measurement; Elastic pressure transducers; Measurement of Vacuum; Force balance pressure gauges; Electrical pressure transducers; Calibration of pressure measuring instruments. Flow measurement: Rotameter, magnetic, ultrasonic, turbine flow meter, hot – wire anemometer, Laser Doppler Anemometer (LDA).	
4	**Linear & Angular Measurements and comparators:** Introduction to metrology, Standards of Measurement Linear measuring instruments: Classification, Least count, engineer's steel rule, Calipers, Vernier caliper and types, Vernier height gauge, Vernier depth gauge, Micrometers, Types of micrometers, Bore gauge, Telescopic gauge, Slip gauges, Limit gauges, calibration of linear measuring instruments , Dial Gauge. Angular and taper measuring instruments: Protractors, Sine bars, Sine centre, Angle gauges, Spirit level, Clinometers, Angle dekkor, Measurement of taper shafts and holes. Functional Requirements, Classification, Mechanical Comparators, Mechanical Optical Comparators, Electrical Comparators, Pneumatic Comparators.	08
5	**Metrology of Gears & Screw threads and Surface finish:** **Measurement of tooth thickness**: Gear tooth Vernier, Constant chord method, Addendum comparator method and Base tangent method, Measurement of tooth profile: Tool maker's microscope, profile projector, Involute tester, Measurement of pitch, Measurement of run out, Lead and Backlash checking. Measurement of concentricity, Alignment of gears. **Screw Thread Measurement**: Errors in threads, screw thread gauges, measurement of element of the external and internal threads, thread calliper gauges. Surface Metrology Concepts and terminology, Analysis of surface traces, Specification of surface Texture characteristics, and Method of measuring surface finish: Stylus system of measurement, Stylus probe instruments, Wave length, frequency and cut off, other methods for measuring surface roughness: Pneumatic method, Light Interference microscopes, Mecrin Instruments.	08
6	**Introduction to Advanced Metrology:** Precision Instrumentation based on Laser Principals, Coordinate measuring machines (CMM): Structure, Modes of Operation, Probe, Operation and applications. Optical Measuring Techniques: Optical Square. Basics of Optical Interference and Interferometry, Optoelectronic measurements.	04
	Total	**42**

List of References:

1. D.S. Kumar, *"Mechanical Measurement & Control",* 4th Edition, Metropolitan Book Co, New Delhi, 2006.
2. B.C. Nakra and K.K. Choudhary, *"Instrumentation measurement and analysis*", 3rd Edition, McGraw Hill Education (India) Private Limited, New Delhi, 2009.
3. A.K.Sawhney and Puneet Sawhney, *"Mechanical Measurement and Instrumentation and Control",* 12th Edition, Dhanpat Rai & Co, 2009.
4. S. K. Singh, *"Industrial Instrumentation and Control",* 3rd Edition, McGraw Hill Education (India) Private Limited, New Delhi, 2009.
5. Thomas G. Beckwith, Roy D. Marangoni and John H. Lienhard V, *"Mechanical Measurements*" (6th Edition) 6th Edition, by, Published by Addison Wesley.
6. I C Gupta, *"Engineering Metrology",* Dhanpat Rai Publications.
7. Bentley, *"Engineering Metrology and Measurements*", Pearson Education.
8. J. P Halman, "*Experimental Methods for Engineers",* 8th Edition, McGraw Hill Education (India) Private Limited, New Delhi, 2012.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Interpret characteristics of measuring instruments.
2. Apply measurement techniques for various physical quantities.
3. Use instruments for linear and angular measurement
4. Use devices for gear, screw threads and surface finish measurements.

2PT04: INDUSTRIAL ENGINEERING AND QUALITY ASSURANCE
CREDITS - 3 (LTP: 3, 0, 0)

Course Objective:

1. To select appropriate plant location and layout.
2. To apply the concept of productivity and work-study.
3. To understand different aspects of quality assurance and their applications.

Teaching and Assessment Scheme:

Teaching Scheme (Hours Per Week)			Credits	Assessment Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	00	00	100

Course Content:

Unit No.	Topics	Teaching Hours
1	**Plant Location Selection and Layout:** Nature of location decision, Importance of plant location, Dynamic nature of plant location, Choice of site for selection, Comparison of location, types of plant layout and selection of layout, Quantitative methods of plant layout:	08

Unit No.	Topics	Teaching Hours
	CRAFT and CORELAP, Relationship diagrams, Principles factors governing flow pattern, travel chart.	
2	**Productivity and Work Study:** Definition of productivity, application and advantages of productivity improvement tools, reasons for increase and decreases in productivity. Areas of application of work study in industry, Reaction of management and labor to work study. *Method Study:* Objectives and procedure for methods analysis, Recording techniques: String Diagram, Operations Process Chart, Flow Process Chart, Flow diagram, Man-Machine, Multiple Activity Chart, Travel Chart, and Two Handed process chart, Therbligs, Micro-motion and macro-motion study: Principles of motion economy, SIMO chart, Normal work areas and work place design. *Work Measurement:* Objectives, Work measurement techniques – time study, work sampling, pre-determined motion time standards (PMTS) Determination of time standards	12
3	**Job Evaluation and Wage Plan:** Objective, Methods of job evaluation, job evaluation procedure, merit rating (Performance appraisal), method of merit rating, wage and wage incentive plans, Non monitory incentives.	05
4	**Inspection and Statistical Quality Control and Quality Assurance:** Inspection – functions, types, objectives, inspection test plans and benefits, quality control principles, Concepts of quality circles, Total quality management, 5'S, PDCA cycle, concept of Zero Defect, Basic Concept ISO 9000, ISO 14000 and QS 9000, Six sigma: Concept, Principle, Methodology, Scope, Advantage and limitations. SQC Concept, variable and attributes, normal distribution curves and its property charts for variable and attributes and their applications and interpretation (analysis) process capability. Acceptance sampling, sampling plans, OC curves and AOQ curves, quality control plans Quality assurance, Quality audit.	10
5	**Industrial Legislation:** Need for Industrial legislation, Factories act 1948, Industrial dispute act 1947, The Indian trade unions act 1926, Industrial employment act 1946, Payment of wage act 1936, Workmen compensation act 1923, Payment of bonus act 1965, Employees provident fund scheme 1952.	03
6	**Ergonomics:** Scope and objectives of ergonomics, Man-machine interface, anthropometry, Application of human factors in engineering, Work place design.	04
	Total	**42**

List of Reference:

1. Banga and Sharma, "*Industrial Engineering and Production Management"*, Khanna

Publishers
2. Barnes, R.L., "*Motion and Time Study, Design & Measurement of Work"*, 7th edition, John Wiley & Sons, New York, 1980
3. Currie R.M, "*Work Study"*, 4th edition, ELBS & Pitman, London, 1977
4. M. Mahajan, "*Industrial Engineering and Production Management"*, 2nd edition, Dhanpat Rai & CO. (P) LTD, 2002.
5. M. Mahajan, "*Statistical Quality Control*", 3rd edition, Dhanpat Rai & CO. (P) LTD, 2002.
6. Martand Telsang, "*Industrial Engineering and Production Management"*, 2nd edition, S Chand & company, 2002.
7. International Labour Organisation (ILO), *"Introduction to Work study"*, Oxford and IBH Publishing.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Select an appropriate plant location and develop optimized plant layout.
2. Apply the concepts of productivity and work-study.
3. Evaluate job and wage plans using different methods.
4. Analyze the concept of inspection and quality assurance to enhance productivity.
5. Understand industrial legislation.
6. Explain the concepts of ergonomics in designing of various product.

2PT05: OPERATIONS RESEARCH
CREDITS - 4 (LTP: 3, 1, 0)

Course Objective:

To apply various optimization techniques for decision making.

Teaching and Assessment Scheme:

Teaching Scheme (Hours Per Week)			Credits	Assessment Scheme				
L	T	P	C	Theory Marks		Practical Marks		Total Marks
				ESE	CE	ESE	CE	
3	1	0	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Basics of Operations Research:** History, definition, operations research models, phases of implementing operations research in practice. **Linear Programming Problem(LPP)**: Introduction, Formulation, Graphical solution, Simplex method, Artificial variable techniques: Big-M and Two-phase methods, Special cases: degeneracy, multiple optima, unbounded solution, infeasible solution, Concept of Primal and Dual problems, Economic analysis of dual, Sensitivity analysis.	8

Unit No.	Topics	Teaching Hours
2	**Transportation Model:** LPP formulation of transportation problem, Initial feasible solution: North-West Corner rule, Least-cost method, Vogel's approximation method, Optimal solution: Stepping stone method, Modified Distribution (MODI) method, Special cases: unbalanced transportation problems, profit maximization, degeneracy, alternate optimal solutions, prohibited transportation routes, transshipment problems.	4
3	**Assignment Model:** LPP formulation of assignment problem, Hungarian method for solution and optimization, Special cases: alternate optimal solution, restrictions on assignment, maximization, crew layover problem, travelling salesman problem.	4
4	**Game Theory:** Introduction, Terms used in Game Theory, Game with pure strategies, Game with mixed strategies, Dominance theory, Algebraic method, Graphical solution of 2xn and mx2 games, Linear programming approach for game theory.	5
5	**Project Management:** Introduction to PERT and CPM, Terms used in network analysis, Network diagram, Fulkerson's rule, Concept of floats, PERT, Project cost analysis: Crashing of network, Resource smoothing and Resource leveling.	7
6	**Replacement Models:** Objective, Replacement of capital equipment which deteriorate with time (value of money unchanging and changing), Replacement of items that fail suddenly, Group replacement policy.	4
7	**Inventory Management:** Objectives of inventory management, Inventory classification, Inventory costs, EOQ, Inventory models with deterministic demand: Purchase model without and with quantity discount, Manufacturing model, Model with planned shortages, Inventory with safety stock, Inventory models with probabilistic demand, ABC analysis of inventory.	6
8	**Queuing Theory:** Terms used in queuing theory, Kendall's notation, Classification of queuing models, Preliminary analysis of single server models with infinite and finite queues.	4
	Total	**42**

List of References:

1. Vohra N. D., "*Quantitative Techniques in Management*", 4th ed., Tata McGraw Hill
2. Sharma J. K., "*Operations Research: Theory and Applications*", Macmillan India Ltd.
3. Taha H. A., "*Operations Research – An Introduction*", 9th ed., Prentice Hall India
4. Wagner H. M., "*Principles of Operations Research*", Prentice Hall India
5. Gupta P. K., Hira D.S., "*Operations Research*", S Chand Publishers

Course Outcomes (COs):

At the end of this course students will be able to…

1. Formulate and obtain the optimal solution for Linear Programming problems.
2. Determine the optimal solution for Transportation problems.
3. Determine the optimal solution for Assignment problems.
4. Determine the best strategy and value of the given game model.
5. Plan, Schedule and Control the given project.
6. Decide an optimal replacement period/policy for a given item/equipment/machine.
7. Understand the need of inventory management
8. Choose the appropriate queuing model for a given practical application.

2PT06: KINEMATICS OF MACHINES
CREDITS - 3 (LTP: 3, 0, 0)

Course Objective:

To analyze mechanisms and machines for desired motions.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	00	00	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction of Mechanisms and Machines:** Concepts of Kinematics and Dynamics, Classification of mechanisms, Basic kinematic concepts and definitions, Degree of freedom, Mobility, Kutzbach criterion, Gruebler's criterion, Grashof's Law, Kinematic inversions of four-bar chain and slider-crank chains.	05
2	**Kinematics of Mechanisms:** Displacement, Velocity and Acceleration analysis of simple mechanisms, Graphical method – velocity and acceleration analysis of simple mechanisms, Coriolis component of acceleration.	07
3	**Belt, Rope and Chain Drives:** Introduction, belt and ropes drives, Selection of belt drive, Types of belt drives, Materials used for belts and ropes, Slip and creep of belt, Tensions for flat belt drive, Angle of contact, Centrifugal tension, Maximum tension of belt, Classification of chain drives, Types of chains.	08

Unit No.	Topics	Teaching Hours
4	**Gears and Gear Trains:** Gears: Law gearing, Characteristics of involute and cycloid action, Spur gear terminology and definitions, Interference and undercutting, Center distance variation, Minimum number of teeth, Contact ratio, Helical, Bevel, Worm, Rack and Pinion gears. Gear Trains: Simple, Compound, Reverted and Epicyclic.	08
5	**Cams and Followers:** Classification of cams and followers, Nomenclature, Displacement diagrams of follower motion, Different cam profiles. Introduction to cams with specified contours: tangent and circular arc cams.	07
6	**Friction in Machine Elements:** Classification of clutches, Torque transmission capacity, Considerations for uniform wear and uniform pressure theory, Analysis of clutches: single plate, multi-plate, cone and centrifugal clutches. Classification of brakes, Braking effect, Analysis of mechanical brakes: Block brake, Band brake, Band and block brake, Internal expanding shoe brake.	07
	Total	**42**

List of References:

1. Ratan S. S., "*Theory of Machines*", McGraw-Hill publishing Co.
2. Singh V. P., "*Theory of Machines*", Dhanpat Rai & Co. (P) Ltd.
3. Singh Sadhu, "*Theory of Machines*", Pearson Education, Inc.
4. Ambekar A. G., "*Mechanism and Machine Theory*", Prentice-Hall of India Pvt. Ltd.
5. Jagdishlal, "*Theory of Machines*", Metropolitan Book.
6. Norton R. L., "*Kinematics and Dynamics of Machinery*", Tata McGraw-Hill Publishing Co. Ltd.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Identify different types of motions and determine degrees of freedom.
2. Analyze the position, velocity, and acceleration of mechanisms
3. Analyze belts, ropes and chain drives.
4. Evaluate kinematics of gears and gear trains.
5. Analyze cam-follower mechanisms.
6. Analyze friction devices such as different types of clutches and brakes.

2PT07: HEAT TRANSFER
CREDITS - 4 (LTP: 3, 0, 1)

Course Objective:

To analyze heat transfer variables using various fundamental law of heat transfer.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	**150**

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Fundamental:** General laws of heat transfer, modes of heat transfer, effect of temperature on thermal conductivity of different solids, liquids and gases.	3
2	**Conduction:** Fourier law, derivation of generalized heat conduction equation in Cartesian, cylindrical and spherical coordinates and its reduction to specific cases, heat conduction through plane, cylinder, spheres, and composite walls, electrical analogy, critical radius of insulation for cylinder and sphere, overall heat transfer coefficient. Transient heat conduction: Lumped heat capacity analysis, time constant, types of fin, heat flow through rectangular fin, infinitely long fin, fin insulated at the tip and fin losing heat at the tip, efficiency and effectiveness of fin, Biot number, Estimation of error in temperature measurement in a thermometer well	11
3	**Convection:** Newton's law of cooling, dimensional analysis applied to forced and free convection, dimensionless numbers and their physical significance, momentum and energy equations on flat plate for free convection and also its integral form of equations, thermal and hydrodynamic boundary layer, Blasius solution for laminar boundary layer, General solution of Von-Karman integral momentum equation, empirical correlations for free and forced convection	9
4	**Radiation**: Absorptivity, Reflectivity and Transmissivity, black, white and grey bodies, emissive power and emissivity, laws of radiation – Planck, Stefan-Boltzmann, Wein's displacement law, Kirchhoff's law, intensity of radiation and solid angle, Lambert's cosine law Radiation heat exchange between black bodies, shape factor, heat exchange between non-black bodies- infinite parallel planes and infinite long concentric cylinders, radiation shield, heat exchange between two gray surfaces, electrical analogy	8
5	**Heat Exchanger:** Classification, heat exchanger analysis, LMTD for parallel and counter flow exchanger, condenser and evaporator, overall heat transfer coefficient, fouling factor, correction factors for multi pass arrangement, effectiveness and number of transfer unit for parallel and counter flow heat exchanger, introduction of heat pipe and compact heat exchanger	7

Unit No.	Topics	Teaching Hours
6	**Boiling and condensation:** Introduction, general aspects of boiling heat transfer, pool boiling and its regimes, factors affecting nucleate boiling, boiling correlations, flow patterns in flow boiling. General aspects of condensations, film wise and drop wise condensations, Nusselt analysis.	4
	Total	**42**

List of References:

1. R K Rajput, "*Heat and Mass Transfer*", Revised Edition 3rd, S.Chand Publication, 2011.
2. Yunus Cengel, "*Heat and Mass Transfer: Fundamentals and Application*", 5th Edition, McGraw Hill, 2014.
3. P.K. Nag, "*Heat & Mass Transfer*", Revised Edition 3rd, McGraw Hill, 2011.
4. A. F. Mills and V.Ganesan, "*Heat Transfer*", 2nd Edition, Pearson Education, 2009.
5. J P Holman, "*Heat Transfer*", 10th Edition, McGraw Hill, 2009.
6. Dutta, Binay K, "*Heat Transfer: Principles and Applications*", 14th Edition, PHI Publication, 2015.
7. Incropera and Dewitt, "*Fundamental of Heat and Mass Transfer*", 6th Edition, Wiley Publication, 2011.

Course Outcomes (COs):

At the end of semester student will be able to …

1. Outline basics of heat transfer.
2. Apply laws of conduction to heat transfer problems.
3. Apply laws of convection to heat transfer problems.
4. Use radiation laws to solve heat transfer problems.
5. Analyze heat exchanger.
6. Explain boiling and condensation.

2PT41: PRODUCTION AND OPERATIONS MANAGEMENT
CREDITS - 4 (LTP: 3, 0, 1)

Course Objective:

To illustrate concepts and processes involved in the management of production and operations pertaining to manufacturing

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	**150**

Course Contents:

Unit No.	Topic	Teaching Hours
1	**Introduction:** Functional subsystems of organizations, system concept of production, types of production system, productivity, strategic management, Gross Domestic Product (GDP) and its impact, world class manufacturing Product Design and Analysis: What is Product Design and Analysis?, New product development concepts, process planning and design, process design, value analysis/ value engineering, standardization, simplification, make or buy decision, ergonomic consideration in product design, concurrent engineering	06
2	**Forecasting**: Nature and use of forecast, source of data, forecasting models	04
3	**Line Balancing**: Concept of mass production system, objective of assembly line balancing, rank positional weight method, model for assembly line balancing, stochastic assembly line balancing **Line of Balance(LOB):** application areas, inputs of LOB, steps of LOB	04
4	**Materials management and Inventory control**: Integrated materials management, components of Integrated materials management, inventory control, models of inventory, operations of inventory systems, quantity discount, implementation of purchase inventory model, purchasing management, stores management	05
5	**Capacity planning and Investment Decisions**: Capacity planning, investment decisions Aggregate planning and master production scheduling: aggregate planning, master production plan/ schedule. Materials Requirement Planning (MRP): Product structure/ bill of materials (BOM), MRP concept, lot sizing in MRP I, MRP II Production Planning and Control (PPC): Introduction, Scheduling Single Machine Scheduling: concept, rules to minimize (a) mean flow time (b) maximum lateness, methods to minimize tardiness, introduction to parallel processors under single machine scheduling Flow shop scheduling: Johnson's rule, branch & bound technique, CDS heuristic, Palmers heuristic Job shop scheduling: introduction, schedule generation, heuristic procedures, two job and M-machine scheduling.	14
6	**Modern Production Management Tools:** Just-in time, CIM & FMS, TQM, ISO 9000 series, Poke Yoke, Kaizen, Business Process Engineering, Supply Chain Management, Lean Six Sigma Manufacturing, Quality Function Deployment, ERP	9
	Total	**42**

List of References:

1. Buffa, Sarin, "Modern Production/Operations management", John Wiley and Sons, 2007.
2. Aswathappa, K., Bhat, S., "Production and Operations management", Himalaya Publication House, 2010
3. Bedi, K. "Production and Operations management" (2nd edition).Oxford Higher Education, 2007
4. Paneerselvam, R., "Production and Operations management" (3rd edition),PHI Leaning, 2012
5. Mahadevan, B., "Operations management: Theory and Practice" (2nd edition). Pearson Education India, 2010
6. Stevenson, W. J., "Operations Management" (12th edition), McGraw-Hill, 2014.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Explain various concepts involved in product design and development
2. Explain forecasting in the context of business
3. Explain the requirement of line balancing and line of balance in production systems
4. Manage materials and inventory
5. Explain the process of planning and scheduling
6. Differentiate various modern production management tool.

2PT42: NON-CONVENTIONAL ENERGY RESOURCES
CREDITS - 4 (LTP: 3, 0, 1)

Course Objective:

To illustrate non-conventional energy sources and its effective technologies.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				
L	T	P	C	Theory Marks		Practical Marks		Total Marks
				ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction:** Energy Consumption & Standard of living, Forms of Energy, Classification of Energy Resources, Application of non-conventional energy sources, Energy scenario	4

Unit No.	Topics	Teaching Hours
2	**Solar Energy:** Solar radiation - beam and diffuse radiation, solar constant, earth sun angles, attenuation and measurement of solar radiation, local solar time, derived solar angles, sunrise, sunset and day length. flat plate collectors, concentrating collectors, Solar air heaters-types, solar driers, storage of solar energy-thermal storage, solar pond , solar water heaters, solar distillation, solar still, solar cooker, solar heating & cooling of buildings, photo voltaic - solar cells & its applications	10
3	**Wind Energy:** Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components, various types and their constructional features; wind data and site selection considerations	4
4	**Biomass Energy:** Biomass conversion technologies, Biogas generation plants, Classification, advantages and disadvantages, constructional details, site selection, digester design consideration, filling a digester for starting, maintaining biogas production, Fuel properties of bio gas, utilization of biogas. Introduction of Bio – Diesel, extraction, Bio mass Gasification	8
5	**Geothermal Energy:** Estimation and nature of geothermal energy, geothermal sources and resources like hydrothermal, geo-pressured hot dry rock, magma. advantages, disadvantages and application of geothermal energy, prospects of geothermal energy in India **Ocean Energy:** Tidal Energy-Principle of working, performance and limitations. Wave Energy-Principle of working, performance and limitations. Ocean Thermal Energy-Availability, theory and working principle, performance and limitations	10
6	**Miscellaneous Technologies:** **Magneto Hydrodynamic Power Conversion:** Principle of working of MHD Power plant, performance and limitations. **Fuel Cell:** Principle of working of various types of fuel cells and their working, performance and limitations **Hydrogen Energy:** Hydrogen Production methods, Hydrogen storage, hydrogen transportation, utilization of hydrogen gas, hydrogen as alternative fuel for vehicles.	6
	Total	**42**

List of References:

1. G. D. Rai, "*Non-Conventional Energy Sources*", 4th Edition, Khanna Publishers, 2000
2. S.P.Sukhatme, "*Solar Energy*",3rd Edition, Tata Mc Graw Hill Education Pvt Ltd, 2008
3. B H Khan , " *Non-Conventional Energy Resources*", 2nd Edition, Tata Mc Graw Hill Education Pvt Ltd, 2011
4. S.Hasan Saeed and D.K.Sharma, "*Non-Conventional Energy Resources*",3rd Edition,S.K.Kataria & Sons, 2012
5. G.N.Tiwari and M.K.Ghosal, "*Renewable Energy Resource: Basic Principles And Applications*", Narosa Publishing House,2004

Suggested Web pages:

1. http://nptel.ac.in/courses/Webcoursecontents/IIScBANG/notused/NonConventional%20Energy%20Systems-/Learning%20Materail%20-%20NCES.pdf
2. https://beeindia.gov.in/content/energy-auditors

Course Outcomes (COs):

At the end of this course students will be able to …

1. Identify energy demand and relate with available energy resources.
2. Analyze solar energy technologies.
3. Outline the wind energy sources.
4. Analyze harnessing of biomass energy.
5. Outline the geothermal and ocean energies.
6. Describe magneto hydrodynamics, hydrogen energy and fuel cell technology.

2PT43: NON-TRADITIONAL MANUFACTURING PROCESS
CREDITS - 4 (LTP: 3, 0, 1)

Course Objective:

1. Acquire a functional understanding of non-traditional manufacturing Processes and Impart knowledge on various energy involved in non-traditional machining process.
2. Know about various process parameters and their influence on performance and their applications.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction:** History of nontraditional machining, Classification of nontraditional machining processes	2
2	**Thermal Processes** Electro-discharge Machining: Mechanism of material removal, machining system, EDM-Spark Circuits, material removal rates, surface integrity, Heat-affected zone, applications, process control, EDM automation, environmental impact, Electrical Discharge Milling, Wire EDM	9

Unit No.	Topics	Teaching Hours
	Laser Beam Machining: Material removal mechanism, types of Lasers, LBM equipment, process characteristics, applications Electron Beam Machining: Basic equipment and metal removal mechanism, process characteristics, applications Plasma Beam Machining: Machining systems, material removal rate, accuracy and surface quality, applications Ion Beam Machining: Introduction, material removal rate, accuracy and surface effects, applications	
3	**Mechanical Processes** Ultrasonic Machining: Definitions, characteristics, machining system, material removal process, design of acoustic horns, factors affecting material removal rate, dimensional accuracy and surface quality, applications Water Jet Machining: Introduction, machining system, process parameters, applications Abrasive Jet Machining: Introduction, machining system, material removal rate, applications. Abrasive Water Jet Machining: Process Characteristics, machining system, process capabilities, applications	7
4	**Chemical Processes and Electrochemical Processes** Chemical Milling: Introduction, tooling for CHM, process parameters, material removal rate, accuracy and surface finish, applications. Photochemical Milling: Introduction, process description, applications Electrochemical Machining: Principles of electrolysis, theory of ECM, ECM equipment, basic working principles, process characteristics, process control, applications, micro-ECM, environmental impacts. Electrochemical Drilling, Shaped Tube Electrolytic Machining, Electrostream (capillary) Drilling, Electrochemical Jet Drilling, Electrochemical Deburring	15
5	**Hybrid Machining Processes** Hybrid Electrochemical Processes: Electrochemical Grinding, Electrochemical Honing, Electrochemical Superfinishing, Electrochemical Buffing, Ultrasonic-Assisted ECM, Laser-Assisted ECM. Hybrid Thermal Processes: Electro-erosion Dissolution Machining, Electro-discharge Grinding, Abrasive Electro-discharge Machining, EDM with Ultrasonic Assistance, Electrochemical Discharge Grinding, Brush Erosion-Dissolution Mechanical Machining	5
6	**Additive Manufacturing** Basics and definitions: Principle of layer-based technology, advantages, classification	8

Unit No.	Topics	Teaching Hours
	Rapid Prototyping Process Chain: 3D Modeling, Data Conversion and Transmission, Checking and Preparing, model building, postprocessing Rapid prototyping techniques: Stereolithography, Solid Ground Curing (SGC), Fused Deposition Modeling (FDM), Selective Laser Sintering (SLS), Three-dimensional printing, Laminated Object Modeling (LOM). Rapid manufacturing, and Rapid tooling	
	Total	**46**

List of References:

1. Jain V. K., "*Advanced Machining Processes",* Allied Publishers, New Delhi
2. Mishra P. K, "*Non-conventional Machining",* Narosa Publishing House
3. Hassan El-Hofy, "*Advanced Machining Processes: Nontraditional and Hybrid Machining Processes"*, McGraw-Hill Co., New York (2005)
4. Benedict, Gary F., "*Non-Traditional Manufacturing Processes"*, Marcel Dekker Inc., New York (1987)
5. Pandey, P. C. and Shan, H. S., "*Modern Machining Processes"*, Tata McGraw Hill Co, New Delhi (1980)
6. Chua C. K., Leong, Lim, "*Rapid Prototyping Principles and Applications"*, 2nd edition, John Wiley and Sons.
7. Pham D. T. and Dimov S.S., "*Rapid Manufacturing"*, Springer

Course Outcomes (COs):

At the end of this course students will be able to …

1. Understand the need of Non Traditional Machining Processes and able to Classify various processes.
2. Recognize the role of thermal energy in non-traditional manufacturing processes.
3. Recognize the role of mechanical energy in non-traditional manufacturing processes.
4. Understand the concept of machining the hard material using chemical energy and electrochemical energy.
5. Understand the need and concept of different hybrid machining processes.
6. Identify the need and capabilities of additive manufacturing processes.

3PT01: DYNAMICS OF MACHINES
CREDITS - 4 (LTP: 3,0,1)

Course Objective:

1. To analyze the effects of forces on motion of system components used in mechanisms.
2. To analyze the effects of unbalance and vibrations on the systems.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	150
3	0	2	4	60	40	20	30	

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Dynamic Force Analysis:** Equation of motion using Newton-Euler and Energy methods, D'Alembert's principle, Dynamic analysis of slider-crank mechanism, Engine force analysis, Turning moment on crank shaft, Dynamically equivalent system, Inertia of connecting rod, Turning moment diagrams. Flywheels: types of flywheels, fluctuation of speed and energy, coefficient of fluctuation of speed and energy, dimensions of flywheel rim, flywheels of punching press	07
2	**Balancing:** Balancing of rotating masses: Concept of static and dynamic balancing, Analysis of effect of unbalanced masses in single and multiple planes in rotating systems, Bearing reactions, Balancing of reciprocating masses: Primary and secondary balancing, Balancing of single and multi-cylinder engines (In-line, Radial and V engines), ISO standards.	08
3	**Free and Free-Damped Vibration of Single DoF Systems:** Periodic and Simple harmonic motion, Degree of freedom (DoF), Equation of motion, Natural frequency, Damped vibrations, Different damping models, Damped natural frequency, Torsional vibrations of the two and three rotor shaft systems, Critical speed of the shaft.	08
4	**Forced-Damped Vibration of Single Dof Systems:** Analytical solution of forced-damped vibrations with harmonic excitation and vector representation, Magnification factor, Phase difference, Transmissibility and Vibration isolation, Vibration measurements and ISO standards: Vibrometer, Accelerometer, Frequency measuring instruments, FFT analyzer.	07
5	**Introduction to Free Vibration of Multi-Dof Systems:** Equations of motion for linear, rectilinear and rotational systems of multi-DoF, Transverse vibration of beam, Torsional vibration of shaft, Different numerical methods (Dunkerley, Rayleigh, Stodola, Holzer).	08
6	**Mechanisms for Controls:** Governors: Types and Characteristics, Gyroscope and Gyroscopic couples: Gyroscopic effect in Automobiles, Ships and Airplanes.	04
	Total	**42**

List of References:

1. Rattan S. S., "*Theory of Machines"*, Tata McGraw-Hill, 4th edition, 2014.
2. Singh V. P., "*Mechanical Vibrations"*, Dhanpat Rai & Co., 4th edition, 2014.
3. Rao S. S., "*Mechanical Vibrations"*, Pearson Education, 4th edition, 2004.
4. Bansal R. K., Brar J. S., "*Theory of Machines"*, Laxmi Publication (P) Ltd., 4th edition, 2004.
5. Ambekar A. G., *"Mechanical Vibration and Noise Engineering"*, PHI Learning Pvt. Ltd., 2006.
6. Haideri F., "*Dynamics of Machinery"*, Nirali Publication, 10th edition, 2010.
7. Norton R. L., "*Kinematics and Dynamics of Machinery"*, McGraw-Hill, 2010.
8. Ghosh A., Mallik A. K., "*Theory of Mechanisms and Machines"*, East-West Press, 3rd edition, 2008.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Analyze static and dynamic forces on mechanisms.
2. Evaluate the balancing masses and their positions in rotary and reciprocating systems.
3. Analyze the free and free-damped vibrations of the single DoF systems.
4. Analyze the forced-damped vibrations of the single DoF systems.
5. Analyze the free vibrations of the multi DoF systems.
6. Examine the use of governors and estimate the effects of gyroscopic couples on the systems.

3PT02: OIL HYDRAULICS AND PNEUMATICS
CREDITS - 4 (LTP: 3,0,1)

Course Objective:

1. To develop a hydraulic/pneumatic circuit for a power transmission system.
2. To analyze operation and maintenance of a hydraulic/pneumatic circuit.

Teaching and Assessment Scheme:

Teaching Scheme ()Hours per week)			Credits	Assessment Scheme				
L	T	P	C	Theory Marks		Practical Marks		Total Marks
				ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction:** Functional requirements of a power transmission, how these requirements can be fulfilled by various power transmission systems like mechanical, oil hydraulic, pneumatic, electrical or their combinations; Fundamentals of oil hydraulics and pneumatics, Control functions of oil hydraulic systems; Comparison between Mechanical, Oil Hydraulic, Pneumatic and Electrical power transmission systems: Advantages, disadvantages and Applications of	10

Unit No.	Topics	Teaching Hours
	Oil Hydraulic and Pneumatic power transmissions. **Symbols and Properties of Oil:** Hydraulic & Pneumatic Symbols as per ISO/ANSI, Properties and selection of hydraulic fluids, Filtration, Hydraulic Reservoirs.	
2	**Oil Hydraulic Pumps and Actuators:** Construction, working principle and operation of rotary & reciprocating pumps like Gear, Vane, Generated-Rotor, Screw, Axial Piston, Radial Piston; Linear actuators like Ram type, Telescopic and Single acting/double acting, types of their constructions, types of mountings, cylinder materials, cushioning of hydraulic cylinders, Rotary actuators, specifications, sizing and selection of pumps and actuators.	9
3	**Control Valves and Accessories:** Construction, working principle and operation of Direction control valves, Flow control valves and Pressure control valves; including Non-return, Pressure relief, compound Pilot operated Pressure Relief, Safety, Sequence, Pressure Reducing, Unloading, Counterbalance valves. Different types of center positions of DCVs, Methods of actuation of DCVs. Hydraulic Intensifiers, Accumulators, Seals and Packing.	10
4	**Pneumatic Systems:** Pneumatic fundamentals, Construction, working principle and operation of pneumatic power transmission system components like Power source, FRL unit, Actuators and control valves like DCV, FCV, PCV, time delay, quick exhaust, twin pressure, shuttle valves and their applications. Selection, sizing and specifications of pneumatic components.	5
5	**Hydraulic Circuits:** Reciprocation, quick return, sequencing, speed control circuits, synchronizing circuits, accumulator circuits, industrial circuits like press circuits, machine tool circuits, forklift, earth mover circuits- design and selection of components. **Pneumatic Circuits:** Pneumatic circuits like reciprocating circuits, switching circuits, sequential circuits, hydro pneumatic circuits, solenoid operated circuits, simple logic circuits, Selection, sizing and specifications of pneumatic components.	4
6	**Hydraulic and Pneumatic Controllers used in Feedback Control systems:** Construction, working principle and operation of Proportional and Servo control valves including Servo-type DCV like nozzle valve, flapper type valve, mechanical servo valve, single and double stage servo valves; Applications of servomotor systems in feedback control systems.	4
	Total	**42**

List of References:

1. Pippenger, John J., Hicks, Tyler G, "*Industrial Hydraulics"*, *3rd Edition*, McGraw-Hill International, 1987.

2. Majumdar, S. R., "*Oil Hydraulic Systems, Principle and Maintenance"*, Tata McGraw-Hill New Delhi, 2001.
3. Majumdar, S. R., *Basic Pneumatic Systems, Principle and Maintenance*, McGraw-Hill.
4. Anderson, B. W., "*The Analysis & Design of Pneumatic Systems"*, John Wiley.
5. Esposito, Anthony. *"Fluid Power with Application"*, Pearson.
6. Jagadeesha T., Thammaiah Gowda, "*Fluid Power: Generation, Transmission and Control"*, Wiley.
7. Mc Clay Donaldson, "*Control of Fluid Power Analysis and Design"*, Ellis Horwood Ltd.
8. Pease, A., Pippenger, John J., *Basic Fluid Power* Dudley, Prentice Hall, 1987
9. Cundiff, John S., "*Fluid Power Circuits and Controls: Fundamentals and Applications"*, CRC Press, 2002
10. Sullivan, James A., "*Fluid Power: Theory and Applications*," 3rd Edition, Prentice Hall, 1989
11. Jagadeesha T., Thammaiah Gowda, "*Fluid Power: Generation, Transmission and Control*", Wiley.
12. Shanmuga K, Sundaram, "*Hydraulic and Pneumatic Controls: Understanding made Easy*", S. Chand & Co Book publishers, New Delhi, 2006 (Reprint 2009)

Course Outcomes (COs):

At the end of this course students will be able to …

1. Identify and analyse the functional requirements of a power transmission system for a given application. (Application involving fluid power transmission)
2. Illustrate construction and working principle of oil hydraulic pumps and actuators.
3. Illustrate construction and working principle of hydraulic control valves and accessories.
4. Understand fundamentals of pneumatic power transmission, components of pneumatic system and their applications.
5. Illustrate working of basic hydraulic and pneumatic circuits and design a hydraulic and/or pneumatic circuit to accomplish the specified task of power transmission.
6. Illustrate construction and working principle of hydraulic and pneumatic valves used in feedback control systems.

3PT03: METAL FORMING, JOINING AND FOUNDARY PRACTICES
CREDITS - 4 (LTP: 3,0,1)

Course Objective:

To illustrate technology of welding, casting and forming processes

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction:** Objectives of a manufacturing process, Classifications of Manufacturing Processes for metals and alloys.	2
2	**Theory of Welding and Welding Processes:** Definition of a weld, a joint, Types & Parameters of weld, Types of joints, Weldment, Welding positions, Mechanisms of formation of weld, Metallurgical aspects of fusion and pressure welding Basic requirements of welding and how these requirements are fulfilled by welding processes, Classifications of welding processes. Comparison between welding, soldering, brazing and riveting. Arc Welding Processes: The welding arc, Nature and Behavior of welding arc and its relevance to the practice, Arc initiation and arc maintenance methods, Arc welding power sources and their characteristics. Principle of operation, characteristics, consumables, equipment, process variables and capabilities of arc welding processes like SMAW, SAW, GMAW, GTAW, Designing arc welding procedures. Principle of operation, characteristics, consumables, equipment, process variables and capabilities of processes like Resistance, LASER, Electron Beam, Friction, Oxy-Acetylene Gas welding. Other Joining Processes like Brazing, Soldering and Adhesive Bonding; Thermal Cutting processes: Oxy-Acetylene gas cutting - mechanism of cutting, effect of process variables, applications; Plasma arc cutting, LASER Beam cutting processes.	16
3	**Fundamentals of Metal casting and Metal casting Processes:** Applications of metal casting, Classification of casting processes. Mechanism and Rate of Solidification of Metals and Alloys: Solidification of pure metals and alloys, Factors influencing solidification of castings, Feeding Resistance, Gas Porosity in castings, Factors causing gas dissolution in liquid metal, Degassing techniques. Gating Design, gating ratios, Aspiration effects and its prevention, Gating methods, Slag-Trap systems, Metal Fluidity, Factors governing metal fluidity, Measurement of fluidity. Feeder Design and Placement, Directional solidification in castings Expendable Mould Production: Pattern Construction: Types of patterns, Pattern Allowances, Design of pattern, Moulding Material: Types of Sand, Properties, Preparation and Testing, Moulding processes like Green sand, dry sand, CO_2 moulding, Shell Moulding, Investment casting. Permanent Mould processes like Centrifugal casting, Pressure Die casting Defects in castings	12

Unit No.	Topics	Teaching Hours
4	**Theory of Metal Forming and Forming Processes:** Application of metal forming, Theory of Plastic deformation, Strain hardening, Recovery, Recrystallization and Grain Growth, Effect of Temperature, Composition and Strain rates on metal forming, Characteristics and applications of Hot working and Cold working, Classification of metal forming processes according to stresses. Working principle, characteristic features, capabilities and application of Bulk Metal Forming Processes like Rolling, Forging, Extrusion, Wire Drawing and Thread Rolling. Working principle, characteristic features, process variables, capabilities and application of Sheet Metal Working like Shearing, Bending, Deep Drawing, Spinning, Coining, Embossing,	12
	Total	**42**

List of References:

1. Parmar, R. S., "*Welding Processes and Technology*", 3rd edition, Khanna Publishers, 1996
2. Kaushish, J. P., *"Manufacturing Processes"*, 2nd Edition, PHI Learning Pvt. Ltd, 2010
3. Rao, P. N., *"Manufacturing Technology: Volume 1 Foundry, Forming and Welding"*, 5th edition, Tata McGrawHill, 2018
4. Ghosh, Amitabh & Mullick, "*Manufacturing Science*", 2nd edition, EWP, 1986.
5. Ravi, B., "*Metal Casting: Computer-Aided Design and Analysis*" PHI,2005
6. Flinn, R. A., "*Fundamentals of Metal Casting*", Addison-Wesley
7. Houldcroft, Peter, "*Welding Process Technology*", Cambridge University Press,1977
8. Cary, Howard B.,Helzer, Scott, "*Modern Welding Technology",* 6th edition, Pearson, 2005
9. Kalpkjian, S, Schmid Stevens, "*Manufacturing Engineering & Technology*" 7th Edition, Pearson, 2013
10. Black, J.. T., & Kohser, Ronald A.; "*DeGarmo's Materials and Processes in Manufacturing*", 10th edition, John Wiley & Sons, Inc., 2007
11. Juneja, B. L., "*Fundamentals of Metal Forming*", 1st Edition, New Age International (P) Ltd.,2007

Course Outcomes (COs):

At the end of this course students will be able to …

1. Identify how the given process achieves the required shape and size along with required properties.
2. Illustrate capabilities of welding processes and select an appropriate welding process for a given application and hence develop a welding procedure for a given job.
3. Illustrate casting problem (melting, refining & pouring and production of a mould) and explain process capabilities and application of casting processes. Design a "mould ready to pour" solution for a given casting.
4. Illustrate capabilities and hence application of bulk metal forming processes and sheet metal work.

3PT04: AUTOMOBILE ENGINEERING
CREDITS - 3 (LTP: 3,0,0)

Course Objective:
To understand the basic structure of an Automobile, its systems and to develop methodologies which facilitate the application of the subject to practical problems for safety and stability.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				
L	T	P	C	Theory Marks		Practical Marks		Total Marks
				ESE	CE	ESE	CE	100
3	0	0	3	60	40	00	00	

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction to Automobile & Automobile Performance:** Development of automobile, classification of automobiles, main parts of automobiles, vehicle assemblies, specifying an automobile, resistance to the motion of the vehicle, power required for propulsion of the vehicle, power required for acceleration, effect of different drives like front wheel/rear wheel/for wheel drive, stability of a vehicle on a slope, dynamics of a vehicle running on banked track, stability of a vehicle taking a turn. **Modern Vehicles:** Construction and operational features of four wheelers available in Indian market, introduction to electric vehicles & hybrid vehicles. Future Vehicles**.** **Chassis, Frame & Body:** Types of frames, engine location, Comparison of front and rear mounting of engine. Rear, front and four wheel drives, their relative merits, types of chassis, types of bodies & their construction.	6
2	**Transmission System:** **Clutch:** Necessity and requirements of clutch, constructional features and working of different types of clutch, calculation of surface area and number of driving and driven plates, fluid coupling. **Gear Box:** Functions and need of gear box, gears & gear ratios, types manual of gear boxes, automatic transmission, epicyclic gearing, torque converter, free wheel clutch, semi/fully automatic transmission, continuously variable transmission(CVT). **Propeller Shaft, Differential and Rear axle:** Propeller shafts and their types, hotchkiss drive, torque tube drive, whirling of propeller shaft. Principle of the differential, limited slip differential, rear	11

Unit No.	Topics	Teaching Hours
	axle **Wheels & Tyres :** Types of wheels, wheel dimensions, type of tyres, tread design, tyre section, designations, wear	
3	**Steering System:** Steering layout, types of steering gears, steering linkages, steering mechanism, definitions and significance of camber, caster, king pin inclination, toe in and toe out on turn, measurement and adjustment of various steering system layouts, steering ratio, under steering and over steering, power assisted steering, steering geometry, checking wheel alignment and steering geometry, computerized wheel alignment equipment.	7
4	**Suspension System:** Principle, type of suspension system, conventional and independent front and rear axle, spring, rubber and air suspensions, automatic/hydro suspension system, shock absorbers.	5
5	**Brakes:** Principle, braking distance, braking efficiency ,weight transfer, wheel skidding, principle and working of various types of brakes, power assisted brakes, power operated brakes, anti-lock brake systems (ABS), diagnosis of faults , adjustment and maintenance of brakes.	7
6	**Battery, Lighting System , Accessories and Safety System :** **Battery:** Construction, working, methods of rating, faults, charging methods, test, generator and cranking motor with drive purpose, construction, faults and diagnosis, voltage and current regulator, purpose, typical circuit, layout, working principle, voltage setting. **Lighting system:** Wiring system, head lights, aiming of head lights, indicating lights. **Accessories** like direction indicators, hazard flashes, horn, speedometer, tachometer, wind screen wiper, wind screen washer, central locking system, power windows, and vehicle tracking system. **Safety provisions** in an Automobile	6
	Total	**42**

List of References:

1. Dr. Kirpal Singh "*Automobile Engineering Vol- I & II",* Standard Pub.& Dist.
2. Dr. K.M.Gupta "*Automobile Engineering Vol- I & II"*, Umesh Pub.
3. R.B.Gupta, "*Automobile Engineering"*, Satya Prakashan
4. Dr. N.K.Giri, "*Automobile Technology"*, Khanna Pub.
5. W.Crouse *"Automotive Mechanics*", Tata Mc Graw Hill
6. G.B.S.Narang "*Automobile Engineering*", Khanna Pub

Course Outcomes (COs):

After learning the course the students should be able to:

1. Understand the construction details of different types of vehicle and functions of various systems. Modern Vehicles
2. Understand the construction of transmission systems.
3. Analyze basic calculation of Steering.
4. Understand the construction of Suspension systems.
5. Analyze weight transfer by Braking and reaction coming on each wheel.
6. Understand Battery, Lighting, Accessories and Safety System.

3PT05: DESIGN OF MACHINE ELEMENTS
CREDITS - 4 (LTP: 3,0,1)

Course Objective:
To design mechanical components and systems.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				
L	T	P	C	Theory Marks		Practical Marks		Total Marks
				ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction:** Selection of preferred sizes, Standardization, Materials Selection in Machine Design, IS coding of steels and Cast Irons, Aesthetic and Ergonomic considerations in Design, Manufacturing and Assembly considerations in Design.	04
2	**Design For Fluctuating Loads:** Stress Concentration, Endurance limit and Fatigue failure, Factors affecting endurance limit, S-N Diagram Fluctuating stresses: Soderberg, Gerber, Goodman and Modified-Goodman criteria, Combined stresses, Cumulative damage in fatigue.	08
3	**Design Of Couplings :** Concept of rigid and flexible couplings, Design of Rigid flange couplings, Marine type couplings, Bush Pin type Flexible couplings.	05
4	**Design Of Springs:** Classification of springs, Materials standard for springs. Helical Spring, Style of ends, Stresses, Correction Factors, Deflection, Design against static and fluctuating loads, Concentric springs, Surge phenomenon. Helical Torsional and Spiral Springs. Design of multi-leaf springs.	07

Unit No.	Topics	Teaching Hours
5	**Belt And Chain Drives:** **Flat Belt Drive:** Belt Construction, Methods for tensioning, Design of flat belt drive with pulley and Selection of Belts from catalogues. **V-Belt Drive:** Design of V belt drive, Selection of V-Belts from catalogues, Timing belt drives selection procedure. **Chain Drive:** Nomenclature of roller chains, Length and power rating of chains, Design of chain drives.	10
6	**Pressure Vessels:** Thin cylinders and spherical vessels, Thickness of cylindrical and spherical shells, Cylindrical pipes. Thick cylinders, Principal stresses in cylinder subjected to internal/external pressure, Lame's equation, Clavarino's and Birnie's equations, Auto-frettage, Wire wound cylinders, Compounding of cylinders. Gasketed Joints, Design of End closures. Introduction to pressure vessel design codes.	08
	Total	**42**

List of References:

1. Bhandari V, "*Design of Machine Elements*", 4th Edition, Tata McGraw-Hill Book Co, 2016.
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett "*Mechanical Engineering Design*", 9th Edition, Tata McGraw-Hill, 2011.
3. Robert C. Juvinall and Kurt M. Marshek, "*Fundamentals of Machine Design*", 4th Edition, Wiley, 2005.
4. R L Norton, "*Machine Design an Integrated Approach*", Prentice Hall, 1998.
5. Spottes, M.F., "*Design of Machine Elements*", Prentice Hall 1994.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Apply various considerations for design of mechanical components.
2. Design mechanical components for variable loads.
3. Design rigid and flexible couplings.
4. Design various type of springs.
5. Design belt and chain drives.
6. Design pressure vessels.

3PT06: COMPUTER AIDED DESIGN
CREDITS - 4 (LTP: 3,0,1)

Course Objective:

1. To apply geometric modeling techniques for mechanical design and analysis.
2. To outline the techniques of finite element analysis.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction:** A typical product cycle, CAD and CAE tools for the design process of product cycle, CAD / CAM integration. Graphics exchange standards and Database management systems.	04
2	**Geometric Transformations:** Representation of points, Homogeneous representation; Translation, Scaling, Reflection, Rotation, Shearing, transformations about an arbitrary point/axis/plane in space, and concatenations in 2D and 3D; Orthographic and perspective projections. Window to View-port transformation.	05
3	**Geometric Modelling of Curves and Surfaces:** Non-parametric and parametric representation of curves, parametric representation and generation of line:Locating a point on a line, parallel lines, perpendicular lines, distance of a point, Intersection of lines; circle, ellipse, parabola, hyperbola, Synthetic curves: concept of continuity, Hermite cubic spline: equation, properties and blending. Bezier curves: blending function, properties, generation, B-spline curves, properties, open uniform basis functions, non-uniform basis functions, periodic b-spline curve and NURBS. Implicit and explicit function of surfaces, types of surfaces, Surface Representation, Plane Surface, Ruled Surface, Surfaces of Revolution, Tabulated Surfaces, Hermite Bi-cubic surface, Bézier Surface, Coons Surface	09
4	**Mathematical representation of solids:** Geometry and Topology, Comparison of wireframe, surface and solid models, Properties of solid model, properties of representation schemes, Concept of Half-spaces, Boolean operations. Schemes: B-rep, CSG, Sweep representation, ASM, Primitive instancing, Cell Decomposition and Octree encoding.	04
5	**Applications of Surface and Solid Model:** Solid Modeling for Part, Assembly: Bottom-up and Top-down assembly approaches, Interference Detection, Finite Element Analysis, Computer Aided Part Programming, Computer Aided Process Planning, Automated Layout and Drafting, Computer Aided Manufacturing. Product Lifecycle Management.	04
6	**Introduction to FEA:** Review of stress-strain relation and generalized Hooke's Law, Plane stress and Plane strain conditions; Concept of Total Potential Energy; Basic procedure for	16

Unit No.	Topics	Teaching Hours
	solving a problem using Finite Element Analysis. 1-D Analysis: Concept of Shape function and natural coordinates, strain - displacement matrix, derivation of stiffness matrix for static structural problems, properties of stiffness matrix. 1-D structural problems with elimination and penalty approaches. Trusses: Formulation of stiffness matrix, simple truss problems to find displacement, reaction and stresses in truss members. Case Studies on static structural problem.	
	Total	**42**

List of References:

1. Ibrahim Zied, "*CAD / CAM: Theory and Practice*", McGraw-Hill
2. Hearn E J and Baker M P, Computer Graphics, Pearson.
3. Chandrupatla T A and Belegundu A D, "*Introduction to Finite Elements in Engineering*", PHI.
4. Logan D, A First Course in the Finite Element Method, Cengage.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Develop awareness of computer skills for product development cycle.
2. Compute transformations of geometric entities.
3. Employ parametric representations of curves and surfaces.
4. Illustrate representations of solid modeling techniques.
5. Apply surface and solid models to real life engineering problems.
6. Illustrate basics of finite element analysis.

3PT07: INTERNAL COMBUSTION ENGINES AND TURBINES
CREDITS - 4 (LTP: 3,0,1)

Course Objective:

To analyze internal combustion engines and turbines for energy transfer applications.

Teaching and Assessment Scheme:

Teaching Scheme (Hours Per Week)			Credits	Assessment Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Content:

Unit No.	Topics	Teaching Hours
1	**Introduction:** Recapitulation and applications of IC engines, P-V and valve timing diagrams. Modern engines **Testing of I C Engine:** Aims of engine testing, measurement of indicated power, brake power, friction power, speed, air consumption, fuel consumption. IC engine efficiencies, specific output, specific fuel consumption, heat balance sheet.	08
2	**I C engine fuels:** Desirable properties of I. C. engine fuels, required qualities of S.I and C I engine fuels, rating of S I and C I engine fuels, dopes/additives for S I & C I engines, alternate fuels like CNG, LNG, LPG, vegetable oils, biodiesel, alcohol, biogas and hydrogen for IC engines. **Fuel supply systems for S.I engines:** Fuel supply system for SI engines, properties of air-petrol mixture, mixture requirement for different loads and speeds, simple carburetors and its working, calculation of air-fuel ratio, types of carburetors, limitations of a single jet carburetor, modern carburetors, problems in carburetors, altitude compensation, gasoline injection in SI engines, MPFI system for modern automobile engines **Fuel supply systems for C.I. engines:** Requirement of ideal injection system, types of injection systems, CRDI injection system, fuel pumps and injectors, types of nozzles, spray formation, quantity of fuel and size of nozzle orifice.	10
3	**Systems for I C Engine:** **Ignition system**: battery, magneto, and electronic, spark plug, firing order. **Governing system :** quality, quantity & hit and miss governing, **Scavenging systems**: scavenging processes & systems **Cooling system**: Air and Water Cooling system, Types of cooling systems **Lubricating System**: Properties, additives added to lubricating oil, types of lubrication **Supercharging:** Objects, Supercharging of SI and CI engines, effects of supercharging, supercharging limits, methods of supercharging, turbo charging	6
4	**Combustion in S.I. Engines:** Stages of combustion, ignition lag and the factors affecting the ignition lag, flame propagation and factors affecting flame propagation, abnormal combustion and knocking in SI engines, factors affecting knocking, effects of knocking, control of knocking. **Combustion in C.I. engines:** Stages of combustion, delay period and the factors affecting it, detonation in C.I. engines, factors affecting detonation, controlling detonation.	6

Unit No.	Topics	Teaching Hours
5	**Steam nozzles and turbines:** Types of nozzles, velocity of steam, discharge through nozzle, critical pressure ratio and condition for maximum discharge. Principle of operation, types of steam turbines, compounding of steam turbines, impulse and Reaction turbine – velocity diagram, calculation of work, power and efficiency, condition for maximum efficiency, governing of steam turbines. **Gas turbine:** Brayton cycle, Applications and types of gas turbines, optimum pressure ratio for maximum specific work and efficiency, Methods to improve performance of gas turbine plant. Steam and gas turbine combined cycle.	12
	Total	**42**

List of References:

1. V.Ganeshan," *Internal combustion engines*", 4th Edition, Mc Grawhill Compnies.
2. Mathur & Sharma, "*Internal combustion engines",* 2014 Edition, Dhanpatrai & sons, New Delhi.
3. Heywood, Internal combustion engine, Mc Grawhill Compnies
4. R Yadav," *Steam and gas turbine*" 7th Edition, Central Publishing House, Ahmedabad
5. Rogowaski," *Elements of I C Engines*" (Mc Grawhill)
6. Taylor," *The I. C. Engine Theory and Practice Vol. I*" (John Wiley)
7. B S Patel, J P Hadiya, and H G Katariya, "*Internal combustion engines*" fourth Edition, Books India Publication, Ahmedabad, 2018
8. P.K. Nag," *Power Plant Engineering* ", 3rd edition, Tata McGraw-Hill, 2017
9. El Wakil M. M., *"Power Plant Technology",* 2017 Edition, Tata McGraw-Hill.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Discriminate types and working of I C Engines and to analyze the performance of I C Engine.
2. Illustrate fuel used in IC engine and its supply system
3. Explain various systems used in IC engine.
4. Illustrate the basic combustion process and categorize combustion chambers used in IC engine.
5. Apply the basic thermodynamics and fluid flow principles to different power generation methods. Analyze thermodynamic cycles of gas turbine power plant and combined cycle power plant.

3PT08: ENERGY CONSERVATION AND MANAGEMENT
CREDITS – 3 (LTP: 3,0,0)

Course Objective:

To apply energy conservation principles and management techniques to different energy conversion systems

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	00	00	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Energy Scenario:** Introduction to energy & power scenario of world, National Energy consumption data and environmental aspects associated with energy utilization; Energy Auditing- need, types, methodology and barriers, role of energy managers, instruments of energy auditing.	8
2	**Energy Conservation Act 2001 and related policies:** Energy conservation Act 2001 and its features, notifications under the Act, Schemes of Bureau of Energy Efficiency (BEE) including Designated consumers, State Designated Agencies, ECBC code for Building Construction.	3
3	**Financial Management:** Energy Economics- discount period, payback period, internal rate of return, net present value; Life Cycle costing- ESCO concept.	5
4	**Energy Monitoring and Targeting:** Defining monitoring & targeting, elements of monitoring & targeting, data and information-analysis, techniques – energy consumption, production, cumulative sum of differences (CUSUM).	5
5	**Energy Conservation in Electrical Utilities :** Components of EB billing, HT and LT supply, transformers, cable sizing; Concept of capacitors, power factor improvement, harmonics; Electric motors- motor efficiency computation, energy efficient motors; Illumination- Lux, Lumens, types of lighting, efficacy, LED lighting and scope of energy conservation in lighting, Case Study.	8
6	**Energy Efficiency in Thermal Utilities and systems:** Thermal systems, Boilers, Furnaces, Heat exchangers and Thermic Fluid heaters- efficiency computation and energy conservation measures; Steam distribution and usage, steam traps, condensate recovery, flash steam utilization; Insulation & Refractories. Energy conservation in major utilities; pumps, fans, blowers, compressed air systems, Refrigeration& Air Conditioning systems, Cooling Towers, DG sets, Case Study.	13
	Total	**42**

List of References:

1. Witte L.C., Schmidt P.S. and Brown D.R., "*Industrial Energy Management and Utilization*", Hemisphere Publ., Washington, 1988..
2. Callaghan P.W., "*Design and Management for Energy Conservation*", Pergamum Press, Oxford
3. Murphy W.R. and McKay G., "*Energy Management*", Butterworth's, London, 1987.
4. Bureau of Energy Efficiency, "*Energy Manager Training Manual*", Reference book No:1 to 4.
5. Dale R Patrick, Stephen W Fardo, "*Energy Conservation Guidebook*", 2nd Edition, CRC Press
6. Shobh Nath Singh, "*Non-Conventional Energy Resources*", Pearson Education India; First edition (2015).

Course Outcomes (COs):

After learning the course the students should be able to:

1. Outline energy scenario, audit and management.
2. Apply energy conservation policy, regulations in industrial practices.
3. Evaluate energy economics.
4. Identify opportunities for rational use of energy.
5. Analyze electrical systems for energy conservation.
6. Analyze the thermal systems for energy efficiency.

4PT01: MACHINE DESIGN
CREDITS - 4 (LTP: 3,0,1)

Course Objective:

To design mechanical power transmission and material handling systems using standard procedure.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				
L	T	P	C	Theory Marks		Practical Marks		Total Marks
				ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Design of Spur and Helical Gears:** Classification of gears, Selection of type of gears, Law of Gearing, Gear terminology, Standard system of gear tooth, force analysis, Interference and undercutting, number of teeth, gear tooth failures, selection of material. Spur and Helical Gears: Stress in gear tooth: Lewis formula, AGMA bending stress equation and AGMA pitting resistance formula, Gear quality and	14

Unit No.	Topics	Teaching Hours
	selection aspects. Design of Bevel and Worm Gears: Specifications and design of bevel gears, Specification and design of worm gears.	
2	**Concept of Speed Reducer and Gear Box:** Comparison and Choice of progression, General design procedure, Determination and fixation of spindle speeds, Selection of the best structure diagram, Selection of gear layout and ray diagram, Determination of number of teeth on gears. Harmonic drives: Design Principle and applications.	06
3	**Journal Bearings:** Classification of bearings. Journal bearing Types, Types of lubrication, Lubricants, Effect of pressure and temperature on viscosity, Stable lubrication, Thin and thick film lubrication. Hydrostatic Bearing: Viscous flow through rectangular slot, Step bearing, Energy losses. Hydrodynamic Bearing: Lubrication theory, Petroff's Equation, Reynolds' Equation, Design of bearings with Raimondi and Boyd method, power loss and heat generation, Bearing materials.	05
4	**Rolling Contact Bearings:** Classification, Static load carrying capacity, Stribeck's equation, Dynamic load carrying capacity, Equivalent bearing load, Load-Life relation, Selection of bearing life, Load factor, Selection of bearing from catalogue, Design for cyclic loads and speeds, Bearing with probability of survival other than 90%, Selection of ball bearings and taper roller bearing, Bearing failure, Lubrication of rolling contact bearing.	04
5	**Design of Brakes:** Friction materials and their properties, Design of single and double shoe brakes, Design of simple and compound band brakes, Design of disc brakes.	06
6	**Design of Material Handling Systems:** Design of lifting equipment: Wire rope, Crane hook, Hoisting tackle, Drums and Buckets. Design of conveying equipment: Belt conveyers, Screw conveyers and Vibratory conveyers.	07
	Total Hours	**42**

List of References:

1. Bhandari V, *"Design of Machine Elements",* 4th Edition, Tata McGraw-Hill Book Co, 2016.
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett *"Mechanical Engineering Design"*, 9th Edition, Tata McGraw-Hill, 2011.
3. Robert C. Juvinall and Kurt M. Marshek, *"Fundamentals of Machine Design",* 4th Edition, Wiley, 2005.
4. R L Norton, *"Machine Design an Integrated Approach",* Prentice Hall, 1998.
5. Spottes, M.F*., "Design of Machine Elements*", Prentice Hall 1994.
6. N. K. Mehta, *"Machine Tool Design",* Tata McGraw Hill
7. Kalaikathir Achchagam "*Design Data*", PSG College of Technology, 2012

Course Outcomes (COs):

1. At the end of this course students will be able to …
2. Design various types of gears.
3. Design speed reducers.
4. Design journal bearings.
5. Select rolling contact bearings.
6. Design various types of brakes.
7. Design material handling systems.

4PT02: PRODUCTION TECHNOLOGY
CREDITS - 4 (LTP: 3, 0, 1)

Course Objective:

To expose principles of conventional and modern machining processes along with fundamentals of jigs and fixtures for quality production.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	150
3	0	2	4	60	40	20	30	

Course Contents:

Unit No	Topic	Teaching Hours
1	**Theory of Machining:** Principles of metal cutting, Classification of machining processes, Geometry of single point cutting tools, Different cutting tool materials and their applications, Coatings used for Cutting tool. **Mechanics of Metal Cutting**: Classification of chips, Mechanism of chip formation, Effect of process parameters and tool geometry on mechanism of chip formation, Chip breakers, Orthogonal and oblique cutting, Forces acting in the cutting zone, Merchant's circle diagram, Force and velocity relationship, Effect of tool geometry on cutting forces and power consumption, Machine tool dynamometers. Thermal aspects in Metal Cutting: Heat sources in metal cutting, Heat flow and distribution in the cutting zone, Measurement of cutting temperature and its control, Functions of cutting fluid, Types of cutting fluids, Application of cutting fluids, Maintenance and disposal of cutting fluids. Tool wear and Tool life: Types of tool wear, Physical mechanism of tool wear, Tool life, Formulation of Taylor's tool life equation, Factors affecting tool life. Economics of Metal Cutting: Factors influencing economics of cutting, Economical cutting speed for minimum cost and maximum production rate. Machinability of metals: Definition and machinability criteria, Factors affecting machinability, Survey of machinability of engineering materials.	12

Unit No	Topic	Teaching Hours
2	**Gear Manufacturing:** Forming and generation methods in gear cutting, Gear finishing operations.	4
3	**Unconventional machining methods:** Introduction, Working principle, equipment, process parameters and applications of EDM, Wire cut EDM, ECM, USM, EBM, LBM, AJM, WJM, and AWJM.	8
4	**Jigs, Fixtures and Gauges:** Necessity, Elements of jigs and fixtures, Principle of 3-2-1 location and its application, Types of locators, Concept of work piece control, geometric control, dimensional control and mechanical control, Clamping, Clamping devices, Design of drill jigs, Fixtures for milling and turning, Modular fixtures, Taylor's principle of gauge design.	10
5	**Statistical Quality Control**: Variability in manufacture, Normal distribution curve, and Variable control charts, Process capability indexes, Attribute control charts, Tolerance analysis in assemblies using additive relationship and probabilistic relationship.	8
	Total	**42**

List of References:

1. Boothroyd G, "*Fundamentals of Machining and Machine Tools*", 3rd edition, CRC publication.
2. Lissaman A. J., Martin S. J., *"Principles of Engineering Production*", ELBS.
3. Rao P. N., *"Manufacturing Technology Vol. - 2",* 3rd ed, Tata McGraw Hill.
4. Raghuvanshi B. S., *"Workshop Technology Vol. II",* Dhanpat Rai & Co.
5. P. C. Sharma, *"Textbook of Production Engg."* S. Chand.
6. Joshi P. H., *"Jigs and Fixtures (Design Manual)",* 3rd edition, McGraw Hill.
7. Jain V. K., *"Advanced Machining Processes",* Allied Publishers.
8. Amitabha Ghosh and Asok Kumar Mallik *"Manufacturing Science",* John Wiley and Sons.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Apply the fundamental principles of metal cutting processes to improve the performance of manufacturing processes.
2. Decide Gear manufacturing method based on industrial applications.
3. Select unconventional machining method for industrial applications.
4. Design of jigs, fixtures and gauges for components.
5. Apply statistical method to monitor and maintain the quality of product.

4PT03: REFRIGERATION, AIR CONDITIONING AND COMPRESSORS
CREDITS - 4 (LTP: 3,0,1)

Course Objective:

1. To analyze various refrigeration cycles and psychrometric processes.
2. To analyze compressors for efficient energy transfer.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Air cycle Refrigeration:** Bell-coleman cycle and its analysis, Reversed Brayton cycle, need for air-conditioning air-crafts, working and analysis of simple, Bootstrap and regenerative air refrigeration systems, advantages of using air cycle for air-craft applications. **Vapour compression Refrigeration:** Modifications in reversed Carnot cycle, analysis of simple cycle, effects of load variation, temperature of condenser, liquid under cooling and suction superheating on performance, actual cycle, limitations of single stage system and need for multi-staging ,compound compression with intercooler, flash gas removal and flash intercooling ,multi-evaporator systems. **Vapour absorption Refrigeration:** Desirable characteristics of refrigerant and refrigerant-absorbent pair, working principle of Aqua-NH_3 system, actual cycle, Aqua-LiBr system, comparison with vapour compression system, Electrolux refrigerator.	15
2	**Refrigerants**: Nomenclature, desirable thermal, chemical and physical properties, primary and secondary refrigerants, Future industrial refrigerants. **Refrigeration system components**: Refrigeration system components, and selection of compressors, scroll compressor, condensers, expansion devices, and evaporators, refrigeration piping accessories, evacuation and charging of refrigerant.	5
3	**Psychrometry:** Dalton's law of partial pressure, Properties of moist air, temperature and humidity measuring instruments, psychrometric chart, and psychrometric processes such as sensible heating and cooling, heating and humidification cooling and dehumidification, chemical dehumidification, adiabatic saturation, desert cooler, introduction to applied psychrometry.	8
4	**Reciprocating compressors:** Construction and working, Multistage conditions for minimum work, Intercooling, Heat rejected in compressors and intercoolers, Efficiency and control of air compressors. **Centrifugal compressors:** Construction and Operation, Ideal energy transfer (Euler's work) velocity diagram, Isentropic efficiency, Static and total temperatures, Power input factor, Slip and slip factor, Pressure coefficient, Pre-whirl, Effect of blade shape on performance, Surging and choking. **Axial Flow Compressors :**	14

Unit No.	Topics	Teaching Hours
	Introduction, Construction and operation, Velocity diagram and work done factor, Pressure ratio and static pressure rise, Characteristics of curves of centrifugal and axial flow compressors.	
	Total	**42**

List of References:

1. C P Arora, "*Refrigeration and Air Conditioning*", Third Edition, McGraw-Hill India Publishing Ltd.
2. Ramesh Arora, "*Refrigeration and Air-conditioning*", First Edition, Prentice Hall of India.
3. Manohar Prasad, "*Refrigeration and Air Conditioning*", Third Edition, New Age International Publisher.
4. Roy. J Dossat, "*Principles of Refrigeration*", Fourth Edition, Pearson Education.
5. Jordon and Prister, "*Refrigeration and Air Conditioning*", First Edition, Prentice Hall of India Pvt. Ltd.
6. W.F. Stocker and J. W. Jones, "*Refrigeration and Air Conditioning*", Second Edition, McGraw-Hill.
7. R. Yadav, "*Applied Thermodynamics*", First Edition, Central Publishing House.
8. B.K.Venkanna, "*Fundamentals of Turbo machinery*", First Edition, Prentice Hall of India.
9. Valan Arasu, "*Turbo Machines*", First Edition, Vikas Publishing House Pvt Ltd.
10. S.M. Yahya, "*Turbines, Compressors and Fans*", Fourth Edition, McGraw-Hill India Publishing Ltd.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Analyze various refrigeration cycles.
2. Explain refrigerants and refrigeration system components.
3. Analyze psychometric processes.
4. Analyze compressors and their processes.

4PT41: DESIGN OF PRESSURE VESSELS
CREDITS – 3 (LTP: 3,0,0)

Course Objective:

To design components of pressure vessel using codes and standards.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	0	0	**100**

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Stresses in Pressure Vessels:** General theory of membrane stresses in vessel under internal pressure and its application to shells (Cylindrical, Conical and Spherical) and end closures. Bending of circular plates and determination of stresses in simply supported and clamped circular plate. Thermal stresses, Stress concentration in plate having circular hole due to bi-axial loading, Excessive elastic deformation, Plastic instability, Brittle rupture and creep. Theory of reinforced opening and reinforcement limits, design of composite analysis, wind and seismic load consideration in the design of pressure vessel.	10
2	**Design of Vessels Using Codes:** Introduction to ASME codes for pressure vessel design, Pressure vessel and related components' design using ASME codes; Supports for short vertical vessels, Stress concentration at a variable thickness transition section in a cylindrical vessel; Design of nozzles.	12
3	**Supports for Vertical & Horizontal Vessels:** Design of base plate and support lugs. Types of anchor bolt, its material and allowable stresses. Design of saddle supports.	04
4	**Other Design Considerations:** Buckling phenomenon, Elastic Buckling of circular ring and cylinders under external pressure, Collapse of thick walled cylinders or tubes under external pressure, Effect of supports on Elastic Buckling of Cylinders, Design of circumferential stiffeners, and Buckling under combined External pressure and Axial loading. Fatigue, shock, high pressure, high temperature, irradiation, corrosion, and other hostile environments; High strength, light weight pressure vessels, Vessels resistant to external high pressures found in undersea exploration, offshore drilling, and mineral mining.	08
5	**Piping Design:** Flow diagram, Piping layout and piping stress analysis; Flexibility factor and stress intensification factor; Design of piping system as per B31.1 piping code. Piping components - bends, tees, bellows and valves. Types of piping supports and their behavior; Introduction to piping Codes and Standards.	08
	Total Hours	**42**

List of References:

1. Harvey J F, "*Pressure vessel design"*, CBS, publication.
2. Brownell L. E & Young. E. D, "*Process equipment design"*, Wiley Eastern Ltd., India.
3. Henry H Bednar, "*Pressure vessel Design Hand book"*, CBS publishers and distributors.
4. Stanley M Wales, "*Chemical Process Equipment*, Selection and Design", Butterworths,
5. Series in Chemical Engineering, 1988.
6. J. Phillip Ellenberger "*Pressure Vessels*: ASME Code Simplified".
7. "*ASME Pressure Vessel and Boiler Code"*, Section VIII Div. 1, 2, and 3.
8. "*American standard code for pressure piping"*, B 31.1.
9. Smith P, "*Fundamentals of Piping Design"*, Elsevier.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Determine stresses in pressure vessels
2. Design pressure vessels using ASME codes
3. Design support members of pressure vessels
4. Apply other design considerations for pressure vessels
5. Design of pressurized fluid piping.

4PT42: GAS DYNAMICS AND PROPULSIVE SYSTEMS
CREDITS - 3 (LTP: 3, 0, 0)

Course Objective:

To analyze compressible flow through constant and variable area duct and propulsive system by applying principles of Fluid mechanics.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	100
3	0	0	3	60	40	0	0	

Course Contents:

Unit No.	Topics	Teaching Hours
1.	**Fundamentals of Compressible Flow:** Basic equations of compressible flow: Continuity equation, Energy equation and Momentum equation; stagnation states, Mach wave and Mach cones, effect of Mach number on compressibility.	6
2.	**Flow through variable area duct:** One dimensional isentropic flow in duct of varying cross sectional area; flow through convergent and convergent- divergent nozzles, analysis of flow through nozzle by using property tables, analysis of flow through diffuser; critical properties and choking of nozzle	10
3.	**Normal shock waves:** Development of shock wave, thickness of shock wave, strength of shockwave, Prandtl relation, Rankine- Hugoniot relation, variation of flow parameter across the normal shock.	6
4.	**Flow in constant area duct with friction (Fanno flow):** Fanno flow equation and its solution, relation of flow properties with length, graphical presentation of flow properties, experimental coefficient of friction, preliminery design of the duct.	6
5.	**Flow in constant area duct with heat transfer (Rayleigh flow):** Rayleigh flow equations and its solution, variation of flow properties with length of duct, analysis for maximum heat transfer, preliminery design of	6

Unit No.	Topics	Teaching Hours
	the duct.	
6.	**Theory of jet propulsion:** Operating principle of Propulsive systems; Propulsive, Thermal and Overall efficiency, specific fuel consumption, thrust equation and cycle analysis; performance and salient features of ram jet, turbojet, turbofan and turboprop engines, practical application of engines.	8
	Total	**42**

List of References:

1. S. M. Yahya, "*Fundamentals of Compressible flow with Aircraft and Rocket Propulsion*" *Third Edition*, New age international Publication.
2. P. Balachandran, *"Fundamentals of Compressible fluid dynamics*", PHI Learning, New Delhi.
3. E. Rathakrishnan, *" Gas Dynamics*", *Second Edition*, PHI Learning Pvt Ltd,
4. P. Murugaperumal, "Gas *Dynamics and Jet Propulsion*" *Third Edition*, SciTech Publication, Chennai.
5. The Ascher H. Shapiro, "*Dynamics and thermodynamics of Compressible fluid flow Volume-I"*, The Ronald Press Company, New York.
6. J. D. Anderson, "*Modern Compressible Flow*", *Third Edition*, McGraw Hill,2003.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Apply governing equations to practical problems involving compressible fluid flow.
2. Analyze compressible flow through variable area duct critically.
3. Analyze compressible flow having Normal shock by using different relations.
4. Apply governing equations to compressible flow through constant area duct with friction and flow through constant area duct with heat transfer.
5. Interpret propulsive systems for their working and application.

4PT43: DESIGN OF HEAT EXCHANGERS
CREDITS - 3 (LTP: 3,0,0)

Course Objective:

To design heat exchangers for engineering applications.

Teaching and Assessment Scheme:

Teaching Scheme			Credits	Assessment Scheme				
L	T	P	C	Theory Marks		Practical marks		Total Marks
				ESE	CE	ESE	CE	
3	0	0	3	60	40	0	0	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction to heat exchangers:** Classification, selection, overall heat transfer coefficient, LMTD method for heat exchanger analysis for parallel, counter, multi-pass and cross flow heat exchanger, e-NTU method for heat exchanger analysis,	10
2	**Fouling and Design methodology:** Fouling, cleanliness factor, percent over surface, techniques to control fouling, additives, rating and sizing problems, heat exchanger design methodology	6
3	**Design of double pipe heat exchangers:** Thermal and hydraulic design of inner tube and annulus, hairpin heat exchanger with bare and finned inner tube, total pressure drop	6
4	**Design of Shell & tube heat exchangers:** Basic components, basic design procedure of heat exchanger, TEMA code, J-factors, conventional design methods, Bell-Delaware method.	8
5	**Design of compact heat exchangers:** Heat transfer enhancement, plate fin heat exchanger, tube fin heat exchanger, heat transfer and pressure drop	6
6	**Heat Transfer Enhancement and Performance Evaluation:** Enhancement of heat transfer, Performance evaluation of Heat Transfer Enhancement technique. Introduction to pinch analysis.	6
	Total	**42**

List of References:

1. Sadik, Kakac, "*Heat Exchanger Selection, Rating and Thermal Design"* CRC Press, Second edition
2. Ramesh K Shah, "*Fundamentals of Heat Exchanger Design",* Wiley Publication, August 2003
3. *Kays*, V.A. and London, A.L., "*Compact Heat Exchangers",* McGraw Hill,1998.
4. *Kuppan*, T, Macel Dekker, "*Heat Exchanger Design Handbook"* CRC Press ,June 2013
5. Schunder E.U., "*Heat Exchanger Design Hand Book"*,Hemisphere Pub,May 2015
6. Donald Q Kern, "*Process Heat transfer"*,McGraw Hill,1983

Course Outcomes (COs):

After learning the course the students should be able to:

1. Outline common types of heat exchangers.
2. Analyze heat exchangers.
3. Design double pipe heat exchangers.
4. Design Shell & tube heat exchangers.
5. Design of compact heat exchangers.
6. Evaluate the performance of heat exchangers.

4PT44: PROJECT MANAGEMENT
CREDITS - 3 (LTP: 3,0,0)

Course Objective:

To illustrate Project management practices

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	0	0	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction to project management:** Project management vs general management, life cycle of projects, selection of projects to meet organizational goals. Types of Projects, Government Regulatory Framework, Market Analysis, Technical Analysis. **Management of the organization & the team**: the project manager's role, responsibilities; selection of a project manager, projects & organization.	08
2	**Planning the project:** The planning process, work break down structure, multidisciplinary teams. **Budgeting the project**: methods of budgeting, cost estimating & its improvement, budget uncertainty & risk management. Brief idea on Project Financing. Project cash flow, Financial estimates and Projections, cost of capital.	08
3	**Scheduling the project:** CPM & PERT networks, project uncertainty & risk management, Gantt chart, Use of computer aided tools for the analysis.	08
4	**Allocating resources to the project:** Expediting a project, resource loading & levelling, allocating resources to projects, Goldratt's critical chain.	08
5	**Monitoring & controlling the project:** The plan-monitor-control cycle, data collecting and reporting, earned value, project control, designing the control system, scope creep & change control.	05
6	**Project Execution**. Various phases of project execution, Timely execution of project, various statutory approvals, OH & S (Occupational Health and Safety) aspects during project execution, Case Study **Evaluating & terminating the project:** Evaluation, project auditing, and project termination. Project quality assurance. Microsoft Project	05
	Total	**42**

List of References:

1. Samuel J Mantel Jr., Jack R Meredith, Scott M Shafer, Margaret M Sutton, M R Gopalan, "*Project Management*", Wiley India Pvt. Ltd.
2. Eliyahu M. Goldratt, "*Critical Chain: A Business Novel*", North River Press 1997.
3. Dr. B. C. Punmia, K. K. Khandelwal "*Project Planning and Control with PERT and CPM*", Laxmi Publication (P) Ltd.
4. Chandra Prasanaa – Projects-Planning analysis, Selection,Implementation and Review –Tata Mcgrow-Hill-

Course Outcomes (COs):

At the end of this course students will be able to …

1. Appraise project manager's role
2. Apply the concepts of project planning and budgeting
3. Apply the concepts of scheduling of projects
4. Apply the concepts of allocation of resources to projects
5. Apply methods of monitoring of projects
6. Appraise how to evaluate and terminate projects

4PT04: COMPUTER AIDED MANUFACTURING
CREDITS - 4 (LTP: 3,0,1)

Course Objective:

1. To impart the knowledge of CNC technology.
2. To illustrate the computer aided techniques used in manufacturing.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				
L	T	P	C	Theory Marks		Practical Marks		Total Marks
				ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction:** CAM Concepts, objectives and scope, nature and type of manufacturing system, evolution, benefits of CAM, role of management in CAM	02
2	**NC/CNC Machine Tools:** Types, classification, specification and components, construction details, controllers, CNC hardware: re-circulating ball screw, linear motion guide ways, stepper and servo motors, sensors and actuators, axis designation, NC/CNC tooling, fundamentals of part programming, part programming for turning center and machining center, canned cycles, advanced part programming, CAD/CAM integration.	17
3	**Robot Technology:** Introduction: robot anatomy, specifications of robot, power sources, actuators and transducers, sensors, grippers, robot safety, programming, applications, forward and inverse kinematics, concepts of computer vision and machine intelligence.	06

Unit No.	Topics	Teaching Hours
4	**Group Technology and Computer Aided Process Planning (CAPP):** Introduction, part families, part coding systems, cell design, composite part concepts, benefits of group technology. Approaches to process planning, variant and generative CAPP, application and benefits.	07
5	**Flexible Manufacturing System:** Concept of FMS, types of flexibility, FMS lay out and advantages. Automated material handling systems, ASRS, AGVs, Cellular manufacturing, tool management, flexible assembly systems.	06
6	**Integrated Production Management System:** Introduction, PPC fundamentals, problems with PPC, MRP-I, MRP-II, concept of JIT, concepts of Expert System in Manufacturing and Management Information System.	04
	Total	**42**

List of References:

1. Mikell P. Groover, "*Automation, Production System and CIM*", 3rd edition, Prentice Hall.
2. Tien Chien Chang, *Computer Aided Manufacturing*, Pearson Education
3. N. K. Tiwari, P. N. Rao, T. K. Kundra, "*Computer Aided Manufacturing",* McGraw-Hill Education
4. P. M. Agrawal, V. J. Patel, "*CNC fundamentals and programming"*, Charotar Publishing House Pvt, Ltd.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Outline Computer Aided Manufacturing
2. Identify the working of the CNC machine tool elements
3. Prepare part program for CNC machines to manufacture geometrical features.
4. Apply the fundamentals of robotics for manufacturing
5. Design manufacturing process plan in the context of CAPP.
6. Apply part and/or product variation for manufacturing.
7. Identify application of PPC, JIT, MRP I , MRP II and expert system to CAM

4PT05: POWER PLANT ENGINEERING
CREDITS - 3 (LTP: 3,0,0)

Course Objective:

Outline various types of thermal power plants

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	CE	ESE	CE	
3	0	0	3	60	40	00	00	100

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Thermal Power Plant:** General layout of modern thermal power plant, Site selection, Presents status of power generation in India. Rankine Cycle: Basic Rankine cycle and modifications, External and internal irreversibility, **High Pressure Boilers and Boiler draught**: Unique features, Types, advantages of high pressure boilers, Methods of superheat control, sizing and selection of boilers. **Boiler Draught**: Natural draught – estimation of height of chimney, Maximum discharge condition, Forced, Induced and balanced draught, Power requirement by fans.	12
2	**Steam Nozzles:** Types of nozzles, velocity of steam, discharge through nozzle, critical pressure ratio and condition for maximum discharge, physical significance of critical pressure ratio, nozzle efficiency, Effect of back pressure, supersaturated flow. **Steam Turbine**: Principle of operation, types of steam turbines-Impulse and Reaction, compounding of steam turbines, impulse turbine – velocity diagram, calculation of work, power and efficiency, condition for maximum efficiency, Reaction turbines – velocity diagram, degree of reaction, reheat factor, governing of steam turbine – throttle, nozzle and bypass governing, Methods of attachment of blades to turbine rotor, Labyrinth packing, Losses in steam turbines, sizing and selection of turbines.	10
3	**Condensers and Cooling Towers:** Types of condensers, sources of air in condenser, Effects of air leakage, Methods of obtaining maximum vacuum in condenser, vacuum & condenser efficiency, Mass of cooling water required, Edward air pump, Necessity of cooling ponds and cooling towers, Condenser water cooling systems, Types of cooling towers and cooling ponds. **Feed Water Treatment:** Necessity of feed water treatment, Different impurities found in feed water, Effect of impurities, pH & its role in corrosion and scale formation, Internal & external water treatment systems – Hot lime soda process, Zeolite ion exchange process, Demineralization plants, Reverse osmosis process, Sea water treatment using reverse osmosis, De-aeration.	10
4	**Nuclear Power Plant:** Basics of nuclear energy conversion, Layout and subsystems of nuclear power plants, Boiling, Water Reactor (BWR), Pressurized Water Reactor (PWR), CANDU Reactor, Pressurized Heavy Water Reactor (PHWR), Fast Breeder Reactors (FBR), gas cooled and liquid metal cooled reactors, safety measures for nuclear power plants, Nuclear waste and its disposal, Nuclear power plants in India.	6

Unit No.	Topics	Teaching Hours
5	**Economics of Power Generation:** Energy, economic and environmental issues, power tariffs, load distribution parameters, load curve, capital and operating cost of different power plants, pollution control technologies including waste disposal options for coal and nuclear plants.	4
	Total	**42**

List of References:

1. P.K. Nag, "*Power Plant Engineering*", 3rd edition, Tata McGraw-Hill, 2017
2. El Wakil M. M., "*Power Plant Technology*", Tata McGraw-Hill. 2017 Edition
3. R. K. Rajput, "*A Text book of Power Plant Engineering*", Fifth Edition, Laxmi Publication. Fifth Edition, 2016
4. V Ganeshan, "*Gas Turbines*", Fifth Edition, McGraw Hill Education, 2017
5. Elliot T. C., Chen K and Swanekamp R. C., "*Power Plant Engineering",* McGraw Hill.
6. R Yadav, *"Steam and gas turbine*" 7th Edition, Central Publishing House, Amdavad.

Course Outcomes (COs):

After learning the course the students should be able to:

1. Outline national energy scenario and analyze Rankine cycle.
2. Analyze Steam nozzles and Steam turbines.
3. Outline Steam condensers, cooling towers and feed water treatments.
4. Outline various nuclear reactors.
5. Analyze Economics of Power Generation.

4PT06: PRODUCT ENGINEERING
CREDITS - 4 (LTP: 3,0,1)

Course Objective:

To explain the process of manufacturing components as per the design

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction:** General Manufacturing Processes, Organization Chart, Product engineering and Process engineering. Classifying Operations: Basic Process Operations, Principal Process Operations, Major Operations, Auxiliary Process Operations, Supporting Operations. Preliminary Part Print	09

Unit No.	Topics	Teaching Hours
	Analysis: Problems Encountered in Reading and Interpreting Part Prints, Establishing the General Characteristics of the Workpiece, Auxiliary Methods for Visualizing the Part from the Print, Determining the Principal Process, Alternate Processes, Functional Surfaces of the Workpiece, Determining Areas Used for Processing, Specifications, Nature of the Work to be Performed, Finishing and Identifying Operations, Relating the Part to Assembly.	
2	**Dimensional & Tolerance Analysis**: types of dimensions, measuring the geometry of form, surface quality and its measurement, baselines, direction of specific dimensions Tolerance Charts: Causes of Workpiece Variation, Terms Used in Determining Workpiece Dimensions, How Limits are Expressed, How Tolerances are Expressed, The Problem of Selective Assembly, Tolerance Stacks, Cost of Arbitrary Tolerance Selection . Computer aided tolerance analysis.	10
3	**Workpiece Control:** Equilibrium Theories, Concept of Location, Geometric Control, Dimensional Control, Mechanical Control, Alternate Location Theory.	06
4	**Planning and Selection of manufacturing processes:** functions, economy and appearance, fundamental rules of Manufacturing process, Basic design of the product, influence of process engineering on product design, rechecking specifications, how materials selected affect process cost, using materials more economically, the material cost balance sheet, eliminating operations, selection the proper tooling, availability of equipment, make or buy decisions. Process picture.	05
5	Determining the manufacturing sequence; Selection of Equipment; Standard Equipment. Classification of Tooling: Sources of tooling, tooling, tools, tool holders, workpiece holders, moulds, patterns, core boxes, dies, templates, gauges.	06
6	**Value Engineering:** definition and objectives of value engineering, evaluation of function, worth, cost and value. Value engineering job plan. FAST diagram	06
	Total	42

List of References:

1. Donald F Eary and George E Johnson, “Process Engineering for Manufacturing” , Prentice Hall Inc
2. V Kovan, “Fundamentals of Process Engineering”, Mir Publication
3. George Dieter, “Engineering Design”, McGraw Hill Inc
4. Harold G Tuffty, “A Compendium on Value Engineering”, The Indo-American Society
5. Arthur E Mudge, “Value Engineering – A Systematic Approach”, McGraw Hill
6. CMTI, “Machine Tool Design Hand Book”, Tata McGraw Hill Inc

Course Outcomes (COs):

At the end of this course students will be able to …

1. Analyze the part print for selection of processes in the context of manufacturing
2. Analyze tolerances before manufacturing the actual components as per the process sequence
3. Apply the 3-2-1 location concepts
4. Selection of process sequence to create quality components
5. Explain the need for tooling in machining processes
6. Explain the value engineering concepts.

4PT45: TURBOMACHINERY
CREDITS - 4 (LTP: 3,0,1)

Course Objective:

To analyze and design turbomachines of different designs/types for efficient energy transfer.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction:** Definition of Turbomachine, Dimensional analysis and performance laws, incompressible fluid analysis, variable geometry turbomachines, compressible fluid analysis. API standards in turbomachinery.	5
2	**Energy Transfer in Turbomachinery:** The continuity equation, Euler's turbine equation in terms of velocity and its application to different turbomachine, degree of reaction, efficiencies of turbomachine, small stage efficiency or polytropic efficiency.	6
3	**Two dimensional Cascade**: Nomenclature of blade and cascade, blade arrangement in compressor cascade and turbine cascade, analysis of cascade forces, efficiency of compressor cascade, cascade performance and working range of cascade.	6
4	**Centrifugal compressor:** Stage velocity triangle, enthalpy- entropy diagram, stage analysis, slip factor, diffuser, volute casing, stage losses and performance characteristics.	6
5	**Three Dimensional Flow in Axial Turbomachine**: Theory of radial equilibrium, The indirect problem and the direct problem, Design with free vortex flow, forced vortex flow and general whirl distribution.	12

Unit No.	Topics	Teaching Hours
	Centrifugal and Axial fan stage: Fan applications, Types of centrifugal fan, design parameters, losses, fan bearings, fan noise; types of axial fan stages	
6	**Radial flow Turbines**: Velocity triangle and h-s diagram of radial turbine stage, Spouting velocity, stage efficiency and degree of reaction. Wind Turbine: Wind turbine aerodynamics, Analysis of Horizontal axis wind turbine and Vertical axis wind turbine.	7
	Total	**42**

List of References:

1. S. L. Dixon, *"Fluid Mechanics and Thermodynamics of Turbomachinery", Fourth Edition,* Butterworth Heinemann, 1998.
2. B. K. Venkanna, "*Fundamentals of Turbomachinery", First Edition,* PHI Learning Pvt. Ltd.
3. S M Yahya, "*Turbines, Compressors and Fans*", *Fourth Edition*, Tata McGraw Hill Education Pvt. Ltd.
4. V. Kadambi & Manohar Prasad, "*An Introduction to Energy Conversion Vol. III, Turbomachinery". First Edition*, Wiley Eastern Limited.
5. H. Cohen, C. F. G. Rogers, HIH Saravanamuttoo, "*Gas Turbine Theory", Fifth Edition* Pearson Education Ltd.

Course Outcomes (COs):

At the end of this course students will be able to …

1. Interpret and apply performance laws to turbomachines of different types.
2. Determine energy transfer in turbomachines of different designs
3. Analyze flow through two dimensional turbine and compressor cascade.
4. Analyze flow through centrifugal compressor and its performance.
5. Design axial flow turbomachine with radial equilibrium and resolve practical cases of fan.
6. Analyze flow through radial flow turbine and wind turbine.

4PT46: FINITE ELEMENT METHODS
CREDITS - 4 (LTP: 3, 0, 1)

Course Objective:

To formulate and solve structural, thermal and fluid flow problems using numerical methods.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				
L	T	P	C	Theory Marks		Practical Marks		Total Marks
				ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Fundamentals Of Continuum Mechanics:** Equilibrium of continuum-Differential formulation, Energy Approach-Integral formulation. Overview of approximate methods for the solution of the mathematical models: Rayleigh-Ritz methods, Methods of Weighted Residuals (Galerkin, Least-squares & Collocation methods), Piecewise Interpolation.	08
2	**FE Modelling And Discretization:** Concepts of Modelling and discretization, Shape functions, elements and Degrees-of-Freedom, Strain – displacement relation, Local and Global equations.	06
3	**1D Elements:** 1D Linear and Quadratic elements, Elimination and Penalty Approach, Properties of global stiffness matrix, Formulation of Truss element, Plane truss: Stiffness and Force matrix. Beam element - Euler – Bernoulli Element formulation, plane frames.	08
4	**2D Elements:** Plane stress, plane strain, Triangular (CST, LST): Shape function, Jacobian matrix, strain-displacement matrix, stress-strain relationship matrix, force vector. Quadrilateral Elements (Q4, Q8): Shape function, Jacobian matrix, strain-displacement matrix, stress-strain relationship matrix, force vector. Axisymmetric problems and applications. Case studies	08
5	**Dynamic Problems:** Formulation of dynamic problems, selection of appropriate element, consistent and lumped mass matrices for 1-D and 2-D element, Solution of eigenvalue 1-D problems: Transformation methods, Jacobi method, Vector Iteration methods, subspace iteration method.	07
6	**Scalar Problems:** Steady state heat transfer: Element formulations, treatment to boundary conditions with application to 1-D heat conduction, heat transfer through thin fins; Potential flow problems.	05
	Total	**42**

List of References:

1. Chandrupatla T. R., Belegunda A. D., "*Introduction to Finite Element in Engineering*", PHI.
2. Logan D., "*A first Course in the Finite Element Methods*", Thompson Learning
3. Reddy J. N., "*An Introduction to Finite Element Methods*", McGraw-Hill.
4. Cook R. D., "*Concepts and Applications of Finite Element Analysis*", Wiley India

Course Outcomes (COs):

At the end of this course students will be able to …

1. Formulate and solve continuum mechanics problems
2. Outline the concept of Finite Element Method for solving problems
3. Formulate and solve 1D problems

4. Formulate and solve 2D finite element problems
5. Formulate and solve dynamic finite element problems
6. Formulate and solve heat transfer and fluid flow problems

4PT47: MACHINE TOOL DESIGN
CREDITS - 4 (LTP: 3,0,1)

Course Objective:
To select and design drives of various components of machine tools

Teaching and Assessment Scheme:

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**General Principle of machine tool design:** Introduction to machine tool, General requirements of machine tool design, Specifications and layout of machine tools, Machining range diagram, Interference diagram, Parameter defining working motions of a machine tool. Working and auxiliary motion in machine, Machine tool drives, Hydraulic transmission, Mechanical transmission, mechanical, hydraulic and electric drives. Ergonomics and aesthetic aspects of machine tool design.	07
2	**Regulation of Speed and Feed:** Speed regulation using step cone pulley, Design of speed and feed boxes, step less speed and feed regulations.	06
3	**Design of Machine Tool Structures:** Fundamentals of machine tool structures and their requirements, Design criteria of machine tool structure, Materials for machine tool structure, Structure profiles, Design of beds and columns, Design of housing models, bases and tables, Design of saddle, carriages and rams.	07
4	**Design of Guideways and Power Screws:** Function and type of guide-ways, design of slide-ways, Protecting devices for slide-ways, Selection of power screws.	07
5	**Design of Spindles and Selection of Spindle Supports:** Materials for spindles, Design principles of spindles, Antifriction bearings, Sliding bearings.	08

Unit No.	Topics	Teaching Hours
6	**Recent developments in machine tools:** Hexapod mechanism, Design features: Hexapods of Telescopic Struts and Hexapods of Ball Screw Struts, hexapods constructional features, characteristics and application, CNC machine tool controls.	07
	Total fTotal	**42**

List of References:

1. N.K. Mehta, "*Machine Tool Design"*, Tata McGraw Hill.
2. F. Koenigsberger, "*Design Principles of Metal Cutting Machine tool"*, Pergamon press
3. *"Machine Tool design Handbook"*, CMTI Bangalore, McGraw-Hill
4. Sen and Bhattacharya, "*Machine Tool Design"*, CBS Publications.
5. Boothroyd, G., "*Fundamentals of Metal Machining and Machine Tools"*, McGraw hill.
6. Acherkan, "*Machine Tool Design, Vol 2 & 3"*, MIR Pub, Russia. 7. Machine Tool Design
7. Helmi A Youssef, "*Machining Technology: Machine tools and operations"*, CRC Press

Course Outcomes (COs):

At the end of this course students will be able to …

1. Identify appropriate drives for generating a given motion in machine tools
2. Design speed and feed drives.
3. Design machine tool structure.
4. Design guide ways and select power screws.
5. Design spindle and select its supports.
6. Outline recent developments in machine tools.

4PT48: GEOMETRIC DIMENSIONING AND TOLERANCING
CREDITS – 4 (LTP: 3, 0, 1)

Course Objective:

To apply the concepts of GD & T for design, manufacturing and inspection.

Teaching and Assessment Scheme:

Teaching Scheme (Hours per week)			Credits	Assessment Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	CE	ESE	CE	
3	0	2	4	60	40	20	30	150

Course Contents:

Unit No.	Topics	Teaching Hours
1	**Introduction:** Geometric product definition principles; verification of position with open setup; geometric characteristic symbols Geometric Dimensioning and	10

Unit No.	Topics	Teaching Hours
	Tolerancing: an explanation of tolerance zone conversion; surfaces, features, features of size, datum features, datum features of size, and datum's; tolerances; components common to geometrically dimensioned & toleranced drawing; fits & allowances, advantages of GD&T	
2	**MMC, LMC & RFS:** Maximum Material Condition (meaning & use); Least Material Condition (meaning & use); Regardless of Feature Size How to read a Feature Control Frame	06
3	**Size Control Form:** The Taylors principle; Gauging size limits. Rules, concepts, Characteristics, and Untoleranced Dimensions: individual or related Datum's, Material Conditions; untoleranced dimensions	06
4	**Datums:** Datum features; oddly configured & curved surfaces as datum features; equalizing datum's; datum feature symbols; flexible parts; direct vs indirect tolerancing. MMC and its ramifications. Relations between individual features. Virtual Condition and Resultant condition Boundaries: Virtual condition (MMC concept & a functional boundary). Effect of LMC; wall thickness calculation.	05
5	**Datum Feature of Size Representation:** Modes of datum feature representation; angular orientation. Form Controls: flatness; straightness: circularity; free state variation; circularity Orientation Controls: orientation characteristics; angularity; perpendicularity Profile; line element controls Run out: circular & total Location: concentricity; the return of symmetry; position	05
6	A Logical Approach to part Tolerancing Dimensioning and Tolerancing Schemes Steps for the Development of a Dimensional Inspection Plan Paper Gauging and Functional Gauging	10
	Total	**42**

List of References:

1. James D Meadows, *"Geometric Dimensioning and Tolerancing*", Marcel Dekker, Inc
2. James D Meadows, "*Measurement of Geometric Tolerances in Manufacturing*" Marcel Dekker, Inc
3. P S Gill, "*Geometric Dimensioning and Tolerancing*", S K Kataria & sons, 2005-6

Course Outcomes (COs):

At the end of this course students will be able to

1. Contrast between conventional and GD&T tolerance zones
2. Explain MMC, LMC and RFS concepts
3. Explain Taylor's principle of gauging
4. Assess the significance of selection of datum & datum features
5. Point out form, orientation, profile, runout and orientation controls
6. Explain the use of paper and functional gauging