DEPARTMENT OF MECHANICAL ENGINEERING

ACADEMIC REGULATIONS (R21)

FOR

B. Tech Four Year Degree Programme

(Applicable for the batches admitted from the A.Y. 2021-22)

PACE INSTITUTE OF TECHNOLOGY AND SCIENCES
(Autonomous)

Approved by AICTE and Govt. of Andhra Pradesh, Accredited by NAAC(A Grade)
Recognized under 2(f) & 12(B) of UGC, Permanently Affiliated to JNTUK, Kakinada
NH-16, Near Valluramma Temple, Ongole-523272
Andhra Pradesh, India.

ACADEMIC REGULATIONS (R21) FOR B. TECH. (REGULAR)
Applicable for students of B. Tech. (Regular) from Academic Year 2021-22 onwards

Pace Institute of Technology and Sciences,Ongole, 2021 Regulations (R21 Regulations) applicable for all the students admitted into first year of all B.Tech programmes from the academic year 2021-22 & B.Tech Lateral Entry Scheme from the Academic Year 2022-23 onwards

1. **Courses of study:**
   The following courses of study are offered at Pace Institute of Technology and Sciences,Ongole

Sl No	Branch	Short name	Code
1	Civil Engineering	CE	01
2	Electrical and Electronics Engineering	EEE	02
3	Mechanical Engineering	ME	03
4	Electronics & Communication Engineering	ECE	04
5	Computer Science and Engineering	CSE	05
6	Computer Science and Information Technology	CSIT	07
7	Information Technology	IT	12
8	Computer Science and Engineering (Internet of Things and Cyber Security Including Block Chain Technology)	CSE(IoT&CSBT)	47
9	Artificial Intelligence and Data Science	AIDS	54
10	Artificial Intelligence and Machine Learning	AIML	61
11	*Computer Science and Engineering (Indian Language)	CSE-R	63

   * Notified in A.Y: 2022-2023

2. **Medium of Instruction:**
   The medium of instruction of the entire B. Tech undergraduate programme in Engineering & Technology (including examinations and project reports) will be in English only. Similarly, the medium of instruction and examinations in AICTE approved Indian language B.Tech programme are in Telugu and English.

3. **Admissions:**
   Admission to the B. Tech Programme shall be made subject to the eligibility, qualifications and specialization prescribed by the A.P. State Government/University from time to time. Admissions shall be made either on the basis of the merit rank obtained by the student in the common entrance examination conducted by the A.P. Government/University or on the basis of any other order of merit approved by the A.P. Government/University, subject to reservations as prescribed by the Government/University from time to time.

4. **Programme Pattern:**

   (i) Total duration of the B. Tech (Regular) Programme is four academic years.

(ii) Each Academic year of study is divided in to two semesters.

(iii) Minimum number of instruction days in each semester is 90.

(iv) Grade points, based on percentage of marks awarded for each course will form the basis for calculation of SGPA (Semester Grade Point Average) and CGPA (Cumulative Grade Point Average).

(v) The total credits for the Programme are 160.

(vi) A three-week induction program is mandatory for all first year UG students and shall be conducted as per AICTE/UGC/APSCHE guidelines.

(vii) Student is introduced to "Choice Based Credit System (CBCS)".

(viii) A pool of interdisciplinary and job-oriented mandatory skill courses which are relevant to the industry are integrated into the curriculum of concerned branch of engineering (total five skill courses: two basic level skill courses, one on soft skills and other two on advanced level skill courses)

(ix) A student has to register for all courses in a semester.

(x) All the registered credits will be considered for the calculation of final CGPA.

(xi) Each semester has – "Continuous Internal Evaluation" (CIE) and "Semester End Examination" (SEE). Choice Based Credit System (CBCS) and Credit Based Semester System (CBSS) as indicated by UGC and course structure as suggested by AICTE are followed.

(xii) A 10 months industry/field mandatory internship, both industry and social, during the summer vacation and also in the final semester to acquire the skills required for job and prepare engineering graduates to connect with the needs of the industry and society at large.

(xiii) The charactor of students and make them aware of social needs, the extracurricular/co-curricular activities are included, which do not carry any credits. These activities include National Service Scheme (NSS), National Cadet Corps (NCC), Yoga & Meditation, Sports & Games and Professional Club Activities.

(xiv) Each department shall assign a faculty advisor/mentor after admission to each student or group of students from same department to provide guidance in courses registration/career growth/ placements/opportunities for higher studies/GATE/other competitive exams etc.

5. **Subject/Course Classification:**

All subjects/courses offered for the undergraduate programme in E & T (B. Tech degree programmes) are broadly classified as follows.

6. **Registration for Courses:**

(i) The Department shall invite registration forms from the students at the beginning of the semester for the registration for courses each semester. The registration process shall be closed within one week. If any student

Sl No	Category	Code	APSCHE breakup of Credits	AICTE Credits of breakup
1	Humanities and social science including Management courses	HSMC	10.5	12
2	Basic Science courses	BSC	21	25
3	Engineering courses science	ESC	24	24
4	Professional core Courses	PCC	51	48
5	Open Elective Courses	OEC	12	18
6	Professional Courses Elective	PEC	15	18
7	Internship, seminar, project work	PROJ	16.5	15
8	Skill Oriented Courses	SC	10	-
9	Laboratory Courses	LC	-	-
10	Mandatory courses	MC	Non-credit	Non-credit
			160	160

wishes to withdraw the registration, he/she shall submit a letter to the principal through the class teacher/instructor and HOD. The principal shall communicate the registration and withdraw details courses of each student in a consolidated form to the college examination section.

(ii) There are four open electives in each branch. All Open Electives are offered to students of all branches in general. A student shall choose an open elective, by consulting the HOD/advisor, from the list in such a manner that he/she has not studied the same course in any form during the Programme.

(iii) A student shall be mandated to pursue two elective courses under MOOCs during the programme. Students are advised to register for only for minimum 12 weeks in duration MOOCs courses. Student has to pursue and acquire a certificate for a MOOC course only from the SWAYAM/NPTEL through online with the approval of Head of the Department in order to earn the 3 credits. The Head of the department shall notify the list of such courses at the beginning of the semester. The details of the MOOCs courses registered by the students shall be submitted to the college examination center. The Head of the Department shall appoint a mentor for each of the MOOC subjects registered by the students to monitor the student's assignment submissions given by SWAYAM/NPTEL. The student needs to submit all the assignments given and needs to take final exam at the proctor center. The student needs to earn a certificate by passing the exam. The student will be awarded the credits given in curriculum only by submission of the certificate. In case if student does not pass subjects registered through SWAYAM/NPTEL, the same or alternative equivalent subject may be registered again through SWAYAM/NPTEL in the next semester with the recommendation of HOD and shall be passed. Even, if any student not cleared the courses through MOOCs up to the 7^{th} semester, he/she has to register for external examination through offline

mode in last semester of the programme (i.e., 8^{th} Semester) at college level.

(iv) Two summer internships or one internship and one Community Service Project (CSP), each with a minimum of six weeks duration shall be mandatorily done/completed respectively at the end of second and third years (during summer vacations). The internship can be done by the students at local industries, Govt. Organizations, Construction agencies, Industries, Hydel and thermal power projects and also in software MNCs. After completing the summer internship, the students shall register in the immediate respective odd semester and it will be evaluated at the end of the semester as per norms of the college. The student has to produce the summer internship satisfactory report and certificate taken from the organization to be considered for evaluation. The Department shall facilitate and monitor the student internship programs. Completion of internships is mandatory, if any student fails to complete internship, he/she will not be eligible for the award of degree. In such cases, the student shall repeat and complete the internship. The information pertaining to CSP is mentioned in Annexure-I.

(v) In the final semester, the student should mandatorily register and undergo internship and in parallel he/she should work on a project with well-defined objectives. At the end of the semester the candidate shall submit an internship completion certificate and a project report. A student shall also be permitted to submit project report on the work carried out during the internship. The project report shall be evaluated with an external examiner.

(vi) Curricular Framework for Skill oriented courses

(a) There are five (05) skill-oriented courses shall be offered during III to VII semesters and students must register and pass the courses successfully.

(b) For skill oriented/skill advanced course, one theory and two practical hours (1-0-2) or two theory hours (2-0-0) may be allotted as per the decision of concerned BOS.

(c) Out of the five skill courses; (i) two shall be skill-oriented courses from the same domain and shall be completed in second year (ii) Of the remaining three skill courses, one shall be necessarily be a soft skill course and the remaining 2 shall be skill-advanced courses either from the same domain or job-oriented skill courses, which can be of inter disciplinary nature.

(d) Students may register the interdisciplinary job-oriented skill courses based on the prerequisites and eligibility in consultation with HOD of the college.

(e) The student shall be given an option to choose either the skill courses being offered by the college or to choose a certificate course being

offered by Industries/Professional bodies/APSSDC or any other accredited bodies. However, the department has to assign mentors in the college to monitor the performance of the students.

(f) If a student chooses to take a Certificate Course offered by industries/Professional bodies/APSSDC or any other accredited bodies, in lieu of the skill advanced course offered by the Department, then the department shall mark overall attendance of the student for the remaining courses in that semester excluding the skill course in all the calculations of mandatory attendance requirements upon producing a valid certificate. However, the student is deemed to have fulfilled the attendance requirement of the course, if the external agency issues a certificate with satisfactory condition. If the certificate issued by external agency is marked with unsatisfactory condition, then the student shall repeat the course either in the college or at external agency. The credits will be awarded to the student upon producing the successful Course Completion Certificate from the agency/professional bodies and after passing in the viva-voce examination conducted at college as per college norms at the end of the semester.

7. **Award of B. Tech. Degree:**

(i) A student will be declared eligible for the award of B.Tech Degree if he fulfills the following academic regulations:

(a) A student shall be declared eligible for award of the B. Tech Degree, if he pursues a course of study in not less than four and not more than eight academic years.

(b) After eight academic years from the year of their admission, he/she shall forfeit their seat in B. Tech course and their admission stands cancelled.

(c) The student shall register for 160 credits and must secure all the 160 credits.

(d) All students shall register for NCC/NSS activities and will be required to participate in an activity specified by NSS officer during second and third semesters. Grade shall be awarded as Satisfactory or Unsatisfactory in the mark sheet on the basis of participation, attendance, performance and behavior. If a student gets an unsatisfactory Grade, he/she shall repeat the above activity in the subsequent years, in order to complete the degree requirements.

(e) Courses like Environmental Sciences, Universal Human Values, Ethics, Indian Constitution, Essence of Indian Traditional Knowledge etc., shall be included in the curriculum as non-credit mandatory courses. Environmental Sciences is to be offered compulsorily as mandatory course for all branches. A student has to secure 40% of the marks

allotted in the internal evaluation for passing the course. No marks or letter grade shall be allotted for all mandatory non-credit courses.

(f) Credit Definition:

1 Hour Lecture (L) per week	1 Credit
1 Hour Tutorial (T) per week	1 Credit
1 Hour Practical (P) per week	0.5 Credit
2 Hours Practical (Lab) per week	1 Credit

(ii) Award of B. Tech. (Honor)/B. Tech. (Minor):
B. Tech. with Honors or a B. Tech. with a Minor will be awarded if the student earns 20 additional credits are acquired as per the regulations/guidelines. The regulations/guidelines are separately provided. Registering for Honors/Minor is optional.

8. **Attendance Requirements:**

(i) A student is eligible to write the semester end examinations if he acquires a minimum of 40% in each course and 75% of attendance in aggregate of all the courses.

(ii) Condonation of shortage of attendance in aggregate up to 10% (65% and above and below 75%) may be granted by the College Academic Committee. However, this condonation concession is applicable only to any two semesters during the entire programme.

(iii) Shortage of Attendance below 65% in aggregate shall not be condoned.

(iv) A student who is short of attendance in a semester may seek re-admission into that semester when offered within 4 weeks from the date of commencement of class work.

(v) Students whose shortage of attendance is not condoned in any semester are not eligible to write their semester end examination of that class.

(vi) A stipulated fee of Rs. 500/- in the concerned semester shall be payable towards condonation of shortage of attendance. Students availing condonation on medical ground shall produce a medical certificate issued by the competitive authority.

(vii) A student will be promoted to the next semester if he satisfies the (i) attendance requirement of the present semester and (ii) minimum required credits.

(viii) If any candidate fulfills the attendance requirement in the present semester, he shall not be eligible for readmission into the same class.

(ix) For induction programme attendance shall be maintained as per AICTE norms.

(x) For non-credit mandatory courses the students shall maintain the attendance similar to credit courses.

9. **Evaluation-Distribution and Weightage of marks:**

(i) Paper setting and evaluation of the answer scripts shall be done as per the procedures laid down by the College Examination section from time to time.

(ii) For non-credit mandatory courses, like Environmental Sciences, Universal Human Values, Ethics, Indian Constitution, Essence of Indian Traditional Knowledge, the student has to secure 40% of the marks allotted in the internal evaluation for passing the course. No marks or letter grade shall be allotted for all mandatory non-credit courses.

(iii) A student is deemed to have satisfied the minimum academic requirements if he has earned the credits allotted to each theory/practical design/drawing subject/ project etc by securing not less than 35% of marks in the semester end exam and minimum 40% of marks in the sum total of the internal marks and semester end examination marks together.

(iv) Distribution and Weightage of marks:

The assessment of the student's performance in each course will be based on Continuous Internal Evaluation (CIE) and Semester-End Examination (SEE). The performance of a student in each semester shall be evaluated course–wise with a maximum of 100 marks for theory course and 50 marks for practical course. For theory courses the distribution shall be 30 marks for Internal Evaluation and 70 marks for the Semester End Examinations.

Sl.No	Components	Internal	External	Total
1	Theory	30	70	100
2	Engineering Graphics/Design/Drawing	30	70	100
3	Practical	15	35	50
4	Internship/Industrial Training/ Skill Development programme/Research Project	-	50	50
5	Mini Project	50	-	50
6	Project Work	60	140	200

(v) Continuous Internal Theory Evaluation:

(a) For theory subjects, during a semester, there shall be two mid-term examinations. Each mid-term examination consists of (i) one online objective examination (ii) one descriptive examination and (iii) one assignment. The online examination (objective) shall be 10 marks and descriptive examination shall be for 15 marks with a total duration of 1 hour 50 minutes (20 minutes for objective and 90 minutes for descriptive paper).

(b) The first online examination (objective) is set with 20 multiple choice questions for 10 marks (20 questions x $\frac{1}{2}$ marks) from first two and half units (50% of the syllabus). The descriptive examination is set with 3 full questions for 5 marks each from first two and half units (50% of the syllabus), the student has to answer all questions. In the similar lines, the second online and descriptive examinations shall be conducted on the rest of the syllabus.

(c) The assignment is given by the concerned class teacher for five marks from first two and half units (50% of the syllabus). The second assignment shall be given from rest of the syllabus. The first assignment should be submitted before the conduct of the first mid-term examination, and the second assignment should be submitted before the conduct of the second mid-term examination. However, There shall be no assignment with viva voce and class room tests for Applied/Engineering physics course. Finalized internal marks for Applied/Engineering physics course can be calculated with 80% weightage for the better of the two mid-term examinations and 20% for the other shall be considered for marks of 25 and is added to virtual lab - assignments 5 marks for awarding total 30 marks.

(d) The total marks secured by the student in each mid-term examination are evaluated for 30 marks. The first mid marks (Mid-1) consisting of marks of online objective examination, descriptive examination and assignment shall be submitted to the college examination section within one week after completion of first mid examination.

(e) The mid marks submitted to the college examination section shall be displayed in the concerned department notice boards for the benefit of the students.

(f) If any discrepancy found in the submitted Mid-1 marks, it shall be brought to the notice of college examination section within one week from the submission.

(g) Second mid marks (Mid-2) consisting of marks of online objective examination, descriptive examination and assignment shall also be submitted to College examination section within one week after completion of second mid examination and it shall be displayed in the notice boards. If any discrepancy found in the submitted mid-2 marks, it shall be brought to the notice of college examination section within one week from the submission.

(h) Internal marks can be calculated with 80% weightage for better of the two mids and 20% Weightage for another mid exam.

(i) Example:

Mid-1 marks =Marks secured in (online examination-1+descriptive examination-1 +one assignment-1)

Mid-2 marks=Marks secured in (online examination-2+ descriptive examination-2 +one assignment-2)

Final internal Marks = (Best of (Mid-1/Mid-2) marks x 0.8 + Least of (Mid-1/Mid-2) marks x 0.2)

(j) With the above criteria, college examination section will send mid marks of all courses in consolidated form to all the concerned departments and same shall be displayed in the concerned department notice boards. If any discrepancy found, it shall be brought to the notice of college examination section through proper channel within

one week with all proofs. Discrepancies brought after the given deadline will not be entertained under any circumstances.

(k) For practical subjects there shall be continuous evaluation during the semester for 15 internal marks .The internal 15 marks shall be awarded as follows: day to day work - 5 marks, Record-5 marks and the remaining 5 marks to be awarded by conducting an internal laboratory test.

(l) A student is required to undergo a mini project of his/her choice by applying theoretical concepts to develop a practical component /element/system that includes design/ testing/ analysis. The performance of a student in the mini project shall be internal evaluation by a three-member committee constituted by the HoD as per the following parameters: Innovation-10 Marks, Mini project report-15 Marks, Presentation-15 Marks and remaining 10 Marks to be awarded by conducting an internal Viva voce.

(vi) Semester End Theory Examinations Evaluation:

(a) The semester end examinations will be conducted college examination section for 70 marks consists of five questions carrying 14 marks each. Each of these questions is from one unit and may contain subquestions. For each question there will be an "either" "or" choice, which means that there will be two questions from each unit and the student should answer either of the two questions.

(b) For practical subjects the end examination shall be conducted by the teacher concerned and external examiner appointed by Chief Controller of Examinations for 35 marks.

Note: Laboratory marks and the internal marks awarded by the department are not final. The marks are subject to scrutiny and scaling by the Chief Controller of Examinations wherever felt desirable. The internal and laboratory marks awarded by the department will be referred to a Committee. The Committee shall arrive at a scaling factor and the marks will be scaled as per the scaling factor. The recommendations of the Committee are final and binding. All the laboratory records and internal test papers shall be preserved in respective departments as per college norms and shall be produced to the Committees of University as and when they ask for.

(c) For the course having design and / or drawing (such as Engineering Graphics, Engineering Drawing, Machine Drawing) and estimation, the distribution shall be 30 marks for internal evaluation (15 marks for continuous Assessment (day–to–day work) and 15 marks for internal tests) and 70 marks for end examination. There shall be two internal tests in a Semester for 15 marks each and final marks can be calculated with 80% weightage for better of the two tests and 20% weightage for other test and these are to be added to the marks obtained in day-to-day work.

(d) Evaluation of the summer internships: It shall be completed in collaboration with local industries, Govt. Organizations, construction agencies, Industries, Hydel and thermal power projects and also in software MNCs in the area of concerned specialization of the UG programme. Students shall pursue this internship during summer vacation just before its offering as per course structure. The minimum duration of this course shall be at least 6 weeks. The student shall register for the internship as per course structure after commencement of academic year. A supervisor/mentor/advisor has to be allotted to guide the students for taking up the summer internship. The supervisor shall monitor the attendance of the students while taking up the internship. Attendance requirements are as per the norms of the College. After successful completion, students shall submit a summer internship technical report to the concerned department and appear for an oral presentation before the departmental committee consists of an external examiner appointed by the Chief Controller of Examinations; Head of the Department, supervisor of the internship and a senior faculty member of the department. A certificate from industry/skill development center shall be included in the report. The report and the oral presentation shall carry 40% and 60% weightages respectively. It shall be evaluated for 50 external marks at the end of the semester. There shall be no internal marks for Summer Internship. A student shall secure minimum 40% of marks for successful completion. In case, if a student fails, he/she shall reappear as and when semester supplementary examinations are conducted by the College.

(e) The job-oriented skill courses may be registered at the department or at any accredited external agency. A student shall submit a record/ report on the on the list skills learned. If the student completes job-oriented skill course at external agency, a certificate from the agency shall be included in the report. The course will be evaluated at the end of the semester for 50 marks (record: 15 marks and viva-voce: 35 marks) along with laboratory end examinations in the presence of external (appointed by the Chief Controller of Examinations) and internal examiner (course instructor or mentor). There are no internal marks for the job-oriented skill courses.

(f) Mandatory Course (M.C): Environmental Sciences, Universal Human Values, Ethics, Indian Constitution, Essence of Indian Traditional Knowledge etc non-credit (zero credits) mandatory courses. Environmental Sciences shall be offered compulsorily as mandatory course for all branches. A minimum of 75% attendance is mandatory in these subjects. There shall be an external examination for 70 marks and it shall be conducted by the department internally. Two internal examinations shall be conducted for 30 marks and a student has to

secure at least 40% of the marks for passing the course. There is no online internal exam for mandatory courses. No marks or letter grade shall be printed in the transcripts for all mandatory non-credit courses, but only Completed (SA)/Not-completed (US) will be specified.

(g) Elective Course through Massive Open Online Course (MOOC) as Program Elective course. The student shall register for the course (Minimum of 12 weeks) offered by SWAYAM/NPTEL through online with the approval of Head of the Department. The Head of the Department shall appoint one mentor for each of the MOOC subjects offered. The student needs to register the course in the SWAYAM/NPTEL portal. During the course, the mentor monitors the student's assignment submissions given by SWAYAM/NPTEL. The student needs to submit all the assignments given and needs to take final exam at the proctor center. The student needs to earn a certificate by passing the exam. The student will be awarded the credits given in curriculum only by submission of the certificate. In case if student does not pass subjects registered through SWAYAM/NPTEL, the same or alternative equivalent subject may be registered again through SWAYAM/NPTEL in the next semester with the recommendation of HOD and shall be passed.

(h) Major Project (Project - Project work, seminar and internship in industry): In the final semester, the student should mandatorily register and undergo internship and in parallel he/she should work on a project with well-defined objectives. At the end of the semester the candidate shall submit an internship completion certificate and a project report. A student shall also be permitted to submit project report on the work carried out during the internship. The project report shall be evaluated with an external examiner. Evaluation: The total marks for project work 200 marks and distribution shall be 60 marks for internal and 140 marks for external evaluation. The supervisor assesses the student for 30 marks (Report: 15 marks, Seminar: 15 marks). At the end of the semester, all projects shall be showcased at the department for the benefit of all students and staff and the same is to be evaluated by the departmental Project Review Committee consisting of supervisor, a senior faculty and HOD for 30 marks. The external evaluation of Project Work is a Viva-Voce Examination conducted in the presence of internal examiner and external examiner appointed by the Chief Controller of Examinations and is evaluated for 140 marks.

10. **Recounting of Marks in the Semester End Examination:**
A student can request for recounting of his/her answer book on payment of a prescribed fee as per college norms.

11. **Re-evaluation of the End Semester Examination:**
A student can request for Revaluation of his/her answer book on payment of a prescribed fee as per college norms.

12. **Supplementary Examinations:**
A student who has failed to secure the required credits can appear for a supplementary examination, as per the schedule announced by the college.

13. **Malpractices in Examinations:**
Disciplinary action shall be taken in case of malpractices during Mid/End examinations as per the rules framed by the college.

14. **Promotion Rules:**
The following academic requirements have to be satisfied in addition to the attendance requirements mentioned in item no.8 for promotion to higher classes

    (a) A student shall be promoted from first year to second year if he fulfills the minimum attendance requirement as per College norms.
    (b) A student will be promoted from II to III year if he fulfills the academic requirement of 40% of credits up to either II year I-Semester or II year II-Semester from all the examinations, whether or not the candidate takes the examinations and secures prescribed minimum attendance in II year II semester.
    (c) A student shall be promoted from III year to IV year if he fulfills the academic requirements of 40% of the credits up to either III year I semester or III year II semester from all the examinations, whether or not the candidate takes the examinations and secures prescribed minimum attendance in III year II semester.

15. **Course Pattern:**
The entire course of study is for four academic years; all years are on semester pattern

    (a) A student eligible to appear for the semester end examination in a course, but absent from it or has failed in the semester end examination, may write the exam in that course when conducted next.
    (b) When a student is detained for lack of credits/shortage of attendance, he may be re-admitted into the same semester/year in which he has been detained. However, the academic regulations under which he was first admitted shall continue to be applicable to him.

16. **Earning of Credit:**
A student shall be considered to have completed a course successfully and earned the credits if he/she secures an acceptable letter grade in the range A+ to E as given below. Letter grade 'F' in any course implies failure of the student in that course and no credits earned. Absent is also treated as no credits earned. For project same % percentages will be followed for grading.

Marks Range Theory (Max – 100)	Marks Range Lab (Max – 50)	Level	Letter Grade	Grade Point
≥ 90	≥ 45	Outstanding	O	10
$\geq 80 \leq 89$	$\geq 40 \leq 44$	Excellent	S	9
$\geq 70 \leq 79$	$\geq 35 \leq 39$	Very Good	A	8
$\geq 60 \leq 69$	$\geq 30 \leq 34$	Good	B	7
$\geq 50 \leq 59$	$\geq 25 \leq 29$	Fair	C	6
$\geq 40 \leq 49$	$\geq 20 \leq 24$	Pass	P	5
<40	<20	Fail	F	0
-	-	Absent	AB	0

17. **Computation of SGPA and CGPA**

The UGC recommends the following procedure to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

(a) SGPA(S_k) of k^{th} semester (1 to 8) is ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the total number of credits of all the courses undergone/registered by a student, i.e.,

$$SGPA(S_k) = \frac{\sum_{i=1}^{n}(C_i \times G_i)}{\sum_{i-1}^{n} C_i}$$

(b) CGPA: The CGPA is calculated in the same manner taking into account all the 'm' courses/subjects registered by student over all the semesters of a Programme i.e., in all eight semesters

$$CGPA = \frac{\sum_{i=1}^{n}(C_i \times S_i)}{\sum_{i-1}^{n} C_i}$$

(c) SGPA and CGPA shall be rounded off to 2 decimal points and reported in transcripts.

(d) While computing the SGPA/CGPA, the subjects in which the student is awarded Zero grade points will also be included.

(e) Grade Point: It is a numerical weight allotted to each letter grade on a 10-point scale.

(f) Letter Grade: It is an index of the performance of students in a said course. Grades are denoted by letters O, S, A, B, C, P, F and AB.

(g) As per AICTE regulations, conversion of CGPA into equivalent percentage as follows:

$$EquivalentPercentage = (CGPA – 0.75) \times 10$$

(h) Illustration of Computation of SGPA and CGPA

(i) **Illustration for SGPA:**

Let us assume there are 6 subjects in a semester. The grades obtained as follows:

Course	Credit	Grade Obtained	Grade point	Si= Credit Point (Credit x Grade)
Subject 1	3	A	8	3 X 8 = 24
Subject 2	4	B	7	4 X 7 = 28
Subject 3	3	C	6	3 X 6 = 18
Subject 4	3	O	10	3 X 10 = 30
Subject 5	3	P	5	3 X 5 = 15
Subject 6	4	C	6	4 X 6 = 24
	20			139

Thus, SGPA =139/20 =6.95=6.9 (approx.)

Semester 1	Semester 2	Semester 3	Semester 4
Credits: 19.5 SGPA: 6.9	Credits: 19.5 SGPA: 7.8	Credits: 21.5 SGPA: 5.6	Credits: 21.5 SGPA: 6.0
Semester 5	Semester 6	Semester 7	Semester 8
Credits: 21.5 SGPA: 6.3	Credits: 21.5 SGPA: 8.0	Credits: 23 SGPA: 6.4	Credits: 12 SGPA: 7.5

(ii) **Illustration for CGPA:**

Thus,

$CGPA = \frac{19.5\times6.9+19.5\times7.8+21.5\times5.6+21.5\times6.0+21.5\times6.3+21.5\times8.0+23\times6.4+12\times7.5}{160} = 6.75$

18. **Award of Class**

After a student has satisfied the requirements prescribed for the completion of the program and is eligible for the award of B. Tech. Degree, he shall be placed in one of the following four classes:

Class Awarded	CGPA to be secured	Remarks
First Class with Distinction	$\geq$ 7.75 (without any supplementary appearance)	From the CGPA secured from 160 credits
First Class	$\geq$ 6.75	
Second Class	$\geq$ 5.75 <6.75	
Pass Class	$\geq$ 5.00 <5.75	

19. **Minimum Instruction Days**

The minimum instruction days for each semester shall be 90 working days. There shall be no branch transfers after the completion of the admission process. There shall be no transfer from one college/stream to another within the Constituent Colleges and Units of Jawaharlal Nehru Technological University Kakinada.

20. **Withholding of Results**

If the student is involved in indiscipline/malpractices/court cases, the result of the student will be withheld.

21. **Transitory Regulations**

(i) Discontinued or detained candidates are eligible for re-admission as and when next offered.

(ii) The re-admitted candidate will be governed by the rules & regulations under which the candidate has been admitted.

(a) In case of transferred students from other Universities, credits shall be transferred to PACE as per the academic regulations and course structure of College.

(b) The students seeking transfer to PACE from various other Universities / Institutions have to obtain the credits of any equivalent subjects as prescribed by PACE. In addition, the transferred candidates have to pass the failed subjects at the earlier Institute with already obtained internal/sessional marks to be conducted by PACE.

22. **Gap - Year**

Gap Year concept of Student Entrepreneur in Residence shall be introduced and outstanding students who wish to pursue entrepreneurship are allowed to take a break of one year at any time after I/II/III year to pursue entrepreneurship full time. This period shall be counted for the maximum time for graduation. An evaluation committee at college level shall be constituted to evaluate the proposal submitted by the student and the committee shall decide on permitting the student for availing the Gap Year.

23. **General**

(i) Wherever the words “he”, “him”, “his”, occur in the regulations, they include “she”, “her”, “hers”.

(ii) The academic regulation should be read as a whole for the purpose of any interpretation.

(iii) In case of any doubt or ambiguity in the interpretation of the above rules, the decision of the competent authority of the college is final.

(iv) The College may change or amend the academic regulations or syllabi at any time and the changes or amendments made shall be applicable to all the students with effect from the dates notified by the College.

ACADEMIC REGULATIONS (R21) FOR B. TECH. (LATERAL ENTRY SCHEME)
Applicable for students admitted into II B. Tech. from the Academic Year 2022-23 onwards

1. **Award of B. Tech. Degree**
   A student will be declared eligible for the award of B. Tech. Degree if he fulfills the following academic regulations:

   (a) A student shall be declared eligible for the award of the B. Tech Degree, if he pursues a course of study in not less than three academic years and not more than six academic years. After six academic years from the year of their admission, he/she shall forfeit their seat in B. Tech course and their admission stands cancelled.

   (b) The candidate shall register for 121 credits and secure all the 121 credits.

2. **The attendance regulations of B. Tech. (Regular) shall be applicable to B.Tech (lateral entry).**

3. **Promotion Rule**
   A student shall be promoted from second year to third year if he fulfills the minimum attendance requirement.
   A student shall be promoted from III year to IV year if he fulfills the academic requirements of 40% of the credits up to either III year I semester or III year II semester from all the examinations, whether or not the candidate takes the examinations and secures prescribed minimum attendance in III year II semester.

4. **Award of Class**
   After a student has satisfied the requirement prescribed for the completion of the program and is eligible for the award of B. Tech. Degree, he shall be placed in one of the following four classes:

Class Awarded	CGPA to be secured	Remarks
First Class with Distinction	$\geq$ 7.75 (without any supplementary appearance)	From the CGPA secured from 121 credits
First Class	$\geq$ 6.75	
Second Class	$\geq$ 5.75 <6.75	
Pass Class	$\geq$ 5.00 <5.75	

   The Grades secured, Grade points and Credits obtained will be shown separately in the memorandum of marks.

5. **All the other regulations as applicable to B. Tech. 4-year degree course (Regular) will hold good for B.Tech. (Lateral Entry Scheme).**

Annexure-I

COMMUNITY SERVICE PROJECT

I. Introduction

(1) Community Service Project is an experiential learning strategy that integrates meaningful community service with instruction, participation, learning and community development

(2) Community Service Project involves students in community development and service activities and applies the experience to personal and academic development.

(3) Community Service Project is meant to link the community with the college for mutual benefit. The community will be benefited with the focused contribution of the college students for the village/ local development. The college finds an opportunity to develop social sensibility and responsibility among students and also emerge as a socially responsible institution.

II. Objective

Community Service Project should be an integral part of the curriculum, as an alternative to the 2 months of Summer Internships / Apprenticeships / On the Job Training, whenever there is an exigency when students cannot pursue their summer internships. The specific objectives are;

(i) To sensitize the students to the living conditions of the people who are around them

(ii) To help students to realize the stark realities of the society.

(iii) To bring about an attitudinal change in the students and help them to develop societal consciousness, sensibility, responsibility and accountability

(iv) To make students aware of their inner strength and help them to find new /out of box solutions to the social problems.

(v) To make students socially responsible citizens who are sensitive to the needs of the disadvantaged sections.

(vi) To help students to initiate developmental activities in the community in coordination with public and government authorities.

(vii) To develop a holistic life perspective among the students by making them study culture, traditions, habits, lifestyles, resource utilization, wastages and its management, social problems, public administration system and the roles and responsibilities of different persons across different social systems.

III. Implementation of Community Service Project

(i) Every student should put in a minimum of 180 hours for the Community Service Project during the summer vacation.

(ii) Each class/section should be assigned with a mentor.

(iii) Specific Departments could concentrate on their major areas of concern. For example, Dept. of Computer Science can take up activities related to Computer Literacy to different sections of people like - youth, women, house-wives, etc

(iv) A log book has to be maintained by each of the student, where the activities undertaken/involved to be recorded.

(v) The log book has to be countersigned by the concerned mentor/faculty in charge.

(vi) Evaluation to be done based on the active participation of the student and grade could be awarded by the mentor/faculty member.

(vii) The final evaluation to be reflected in the grade memo of the student.

(viii) The Community Service Project should be different from the regular programmes of NSS/NCC/Green Corps/Red Ribbon Club, etc.

(ix) Minor project report should be submitted by each student. An internal Viva shall also be conducted by a committee constituted by the principal of the college.

(x) Award of marks shall be made as per the guidelines of Internship/apprentice/ on the job training

IV. **Procedure**

(1) A group of students or even a single student could be assigned for a particular habitation or village or municipal ward, as far as possible, in the near vicinity of their place of stay, so as to enable them to commute from their residence and return back by evening or so.

(2) The Community Service Project is a twofold one –

(a) First, the student/s could conduct a survey of the habitation, if necessary, in terms of their own domain or subject area. Or it can even be a general survey, incorporating all the different areas. A common survey format could be designed. This should not be viewed as a duplication of work by the Village or Ward volunteers, rather, it could be another primary source of data.

(b) Secondly, the student/s could take up a social activity, concerning their domain or subject area. The different areas, could be like –

- Agriculture
- Health
- Marketing and Cooperation
- Animal Husbandry

- Horticulture
- Fisheries
- Sericulture
- Revenue and Survey
- Natural Disaster Management
- Irrigation
- Law & Order
- Excise and Prohibition
- Mines and Geology
- Energy
- Internet
- Free Electricity
- Drinking Water

(V) **Expected Outcomes**

(1) Benefits of Community Service Project to Students

Learning Outcomes

(a) Positive impact on students' academic learning

(b) Improves students' ability to apply what they have learned in "the real world"

(c) Positive impact on academic outcomes such as demonstrated complexity of understanding, problem analysis, problem-solving, critical thinking, and cognitive development

(d) Improved ability to understand complexity and ambiguity

Personal Outcomes

(a) Greater sense of personal efficacy, personal identity, spiritual growth, and moral development

(b) Greater interpersonal development, particularly the ability to work well with others, and build leadership and communication skills

Social Outcomes

(a) Reduced stereotypes and greater inter-cultural understanding

(b) Improved social responsibility and citizenship skills

(c) Greater involvement in community service after graduation

Career Development

(a) Connections with professionals and community members for learning and career opportunities

(b) Greater academic learning, leadership skills, and personal efficacy can lead to greater opportunity

Relationship with the Institution

(a) Stronger relationships with faculty

(b) Greater satisfaction with college

(c) Improved graduation rates

(2) Benefits of Community Service Project to Faculty Members

(a) Satisfaction with the quality of student learning

(b) New avenues for research and publication via new relationships between faculty and community

(c) Providing networking opportunities with engaged faculty in other disciplines or institutions

(d) A stronger commitment to one's research

(3) Benefits of Community Service Project to Colleges and Universities

(a) Improved institutional commitment

(b) Improved student retention

(c) Enhanced community relations

(4) Benefits of Community Service Project to Community

(a) Satisfaction with student participation

(b) Valuable human resources needed to achieve community goals

(c) New energy, enthusiasm and perspectives applied to community work

(d) Enhanced community-university relations.

VI. **Suggestive List of Programmes Under Community Service Project**

(a) The following the recommended list of projects for Engineering students. The lists are not exhaustive and open for additions, deletions and modifications. Colleges are expected to focus on specific local issues for this kind of projects. The students are expected to carry out these projects with involvement, commitment, responsibility and accountability. The mentors of a group of students should take the responsibility of motivating, facilitating, and guiding the students. They have to interact with local leadership and people and appraise the objectives and benefits of this kind of projects. The project reports shall be placed in the college website for reference. Systematic, Factual, methodical and honest reporting shall be ensured.

(b) For Engineering Students

- Water facilities and drinking water availability
- Health and hygiene
- Stress levels and coping mechanisms
- Health intervention programmes
- Horticulture
- Herbal plants
- Botanical survey
- Zoological survey
- Marine products

- Aqua culture
- Inland fisheries
- Animals and species
- Nutrition
- Traditional health care methods
- Food habits
- Air pollution
- Water pollution
- Plantation
- Soil protection
- Renewable energy
- Plant diseases
- Yoga awareness and practice
- Health care awareness programmes and their impact
- Use of chemicals on fruits and vegetables
- Organic farming
- Crop rotation
- Floury culture
- Access to safe drinking water
- Geographical survey
- Geological survey
- Sericulture
- Study of species
- Food adulteration
- Incidence of Diabetes and other chronic diseases
- Human genetics
- Blood groups and blood levels
- Internet Usage in Villages
- Android Phone usage by different people
- Utilization of free electricity to farmers and related issues
- Gender ration in schooling level- observation.

Complimenting the community service project, the students may be involved to take up some awareness campaigns on social issues/special groups. The suggested list of programmes are;

(c) Programmes for School Children

- Reading Skill Programme (Reading Competition)
- Preparation of Study Materials for the next class.
- Personality / Leadership Development
- Career Guidance for X class students
- Screening Documentary and other educational films

- Awareness Programme on Good Touch and Bad Touch (Sexual abuse)
- Awareness Programme on Socially relevant themes.

(d) Programmes for Women Empowerment

- Government Guidelines and Policy Guidelines
- Womens' Rights
- Domestic Violence
- Prevention and Control of Cancer
- Promotion of Social Entrepreneurship

(e) General Camps

- General Medical camps
- Eye Camps
- Dental Camps
- Importance of protected drinking water
- ODF awareness camp
- Swatch Bharat
- AIDS awareness camp
- Anti Plastic Awareness
- Programmes on Environment
- Health and Hygiene
- Hand wash programmes
- Commemoration and Celebration of important days

(f) Programmes for Youth Empowerment

- Leadership
- Anti-alcoholism and Drug addiction
- Anti-tobacco
- Awareness on Competitive Examinations
- Personality Development

(g) Common Programmes

- Awareness on RTI
- Health intervention programmes
- Yoga
- Tree plantation
- Programmes in consonance with the Govt. Departments like –
  - Agriculture
  - Health
  - Marketing and Cooperation
  - Animal Husbandry
  - Horticulture
  - Fisheries

- Sericulture
- Revenue and Survey
- Natural Disaster Management
- Irrigation
- Law & Order
- Excise and Prohibition
- Mines and Geology
- Energy

VII. **Role of Students:**

(a) Students may not have the expertise to conduct all the programmes on their own. The students then can play a facilitator role.

(b) For conducting special camps like Health related, they will be coordinating with the Governmental agencies.

(c) As and when required the College faculty themselves act as Resource Persons.

(d) Students can work in close association with Non-Governmental Organizations like Lions Club, Rotary Club, etc or with any NGO actively working in that habitation.

(e) And also, with the Governmental Departments. If the programme is rolled out, the District Administration could be roped in for the successful deployment of the programme.

(f) An in-house training and induction programme could be arranged for the faculty and participating students, to expose them to the methodology of Service Learning.

Timeline for the Community Service Project Activity

1. **Duration: 8 weeks**

(a) Preliminary Survey (One Week)

(i) A preliminary survey including the socio-economic conditions of the allotted habitation to be conducted.

(ii) A survey form based on the type of habitation to be prepared before visiting the habitation with the help of social sciences faculty. (However, a template could be designed for different habitations, rural/urban.

(iii) The Governmental agencies, like revenue administration, corporation and municipal authorities and village secretariats could be aligned for the survey.

(b) Community Awareness Campaigns (Two Weeks)
Based on the survey and the specific requirements of the habitation, different awareness campaigns and programmes to be conducted, spread

over two weeks of time. The list of activities suggested could be taken into consideration.

(c) Community Immersion Programme (Four Weeks)

Along with the Community Awareness Programmes, the student batch can also work with any one of the below listed governmental agencies and work in tandem with them. This community involvement programme will involve the students in exposing themselves to the experiential learning about the community and its dynamics. Programmes could be in consonance with the Govt. Departments.

(d) Community Exit Report (One Week)

During the last week of the Community Service Project, a detailed report of the outcome of the 8 weeks works to be drafted and a copy shall be submitted to the local administration. This report will be a basis for the next batch of students visiting that particular habitation. The same report submitted to the teacher-mentor will be evaluated by the mentor and suitable marks are awarded for onward submission to the College Examination section.

Throughout the Community Service Project, a daily log-book need to be maintained by the students batch, which should be countersigned by the governmental agency representative and the teacher-mentor, who is required to periodically visit the students and guide them.

Annexure-II

MALPRACTICES RULES
DISCIPLINARY ACTION FOR / IMPROPER CONDUCT IN EXAMINATIONS

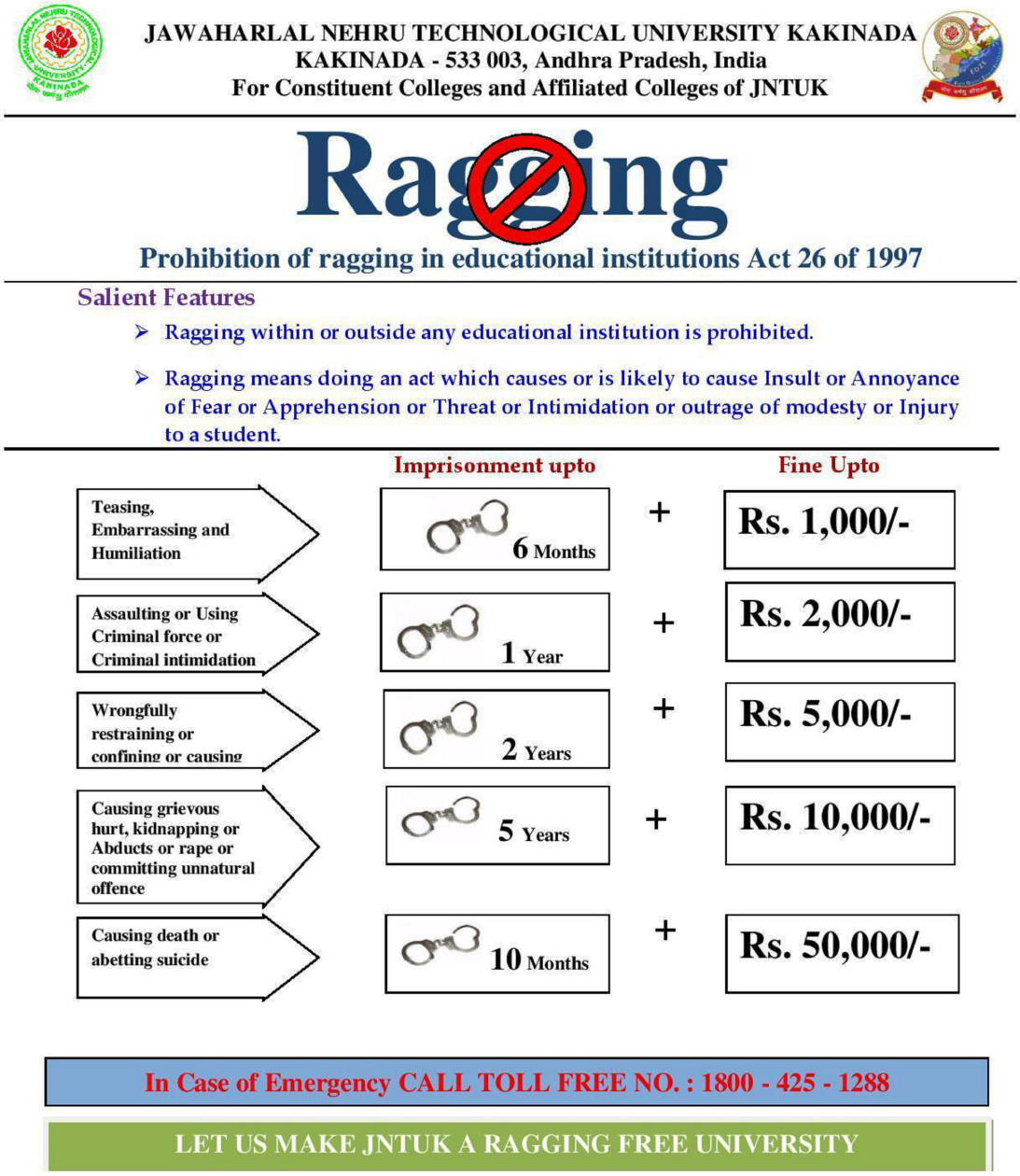
Sl. No.	Nature of Malpractices/Improper conduct	Punishment
	If the candidate:	
1. a.	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination)	Expulsion from the examination hall and cancellation of the performance in that subject only.
1. b.	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination (theory or practical) in which the candidate is appearing.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that Semester/year. The Hall Ticket of the candidate is to be cancelled.
3	Impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate, who has been impersonated, shall be cancelled in all the subjects of the examination (including practicals and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all semester end examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him.

4	Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all semester end examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
5	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks.	Cancellation of the performance in that subject.
6	Refuses to obey the orders of the Chief Superintendent/Assistant – Superintendent / any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer-in-charge, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the College campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is registered against them.

7	Leaves the exam hall taking away answer script or intentionally tears the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all Semester End Examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
8	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat.
9	If student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Student of the colleges expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the College will be handed over to police and, a police case will be registered against them.
10	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year.
11	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester/year examinations.

12	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the Chief Controller of Examinations for further action and impose suitable punishment.	

Annexure-III



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA - 533 003, Andhra Pradesh, India
For Constituent Colleges and Affiliated Colleges of JNTUK

Ragging

ABSOLUTELY NO TO RAGGING

1. **Ragging is prohibited as per Act 26 of A.P. Legislative Assembly, 1997.**
2. **Ragging entails heavy fines and/or imprisonment.**
3. **Ragging invokes suspension and dismissal from the College.**
4. **Outsiders are prohibited from entering the College and Hostel without permission.**
5. **Girl students must be in their hostel rooms by 7.00 p.m.**
6. **All the students must carry their Identity Cards and show them when demanded**
7. **The Principal and the Wardens may visit the Hostels and inspect the rooms any time.**

Jawaharlal Nehru Technological University Kakinada
For Constituent Colleges and Affiliated Colleges of JNTUK

In Case of Emergency CALL TOLL FREE NO. : 1800 - 425 - 1288

LET US MAKE JNTUK A RAGGING FREE UNIVERSITY

DEPARTMENT OF MECHANICAL ENGINEERING

PACE R-21 UNDER GRADUATE (B.Tech) COURSE STRUCTURE

I Year - I Semester						
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	P21HST01	Communicative English	3	0	0	3
2	P21BST01	Linear Algebra & Differential Equations	3	0	0	3
3	P21BST05	Engineering Chemistry	3	0	0	3
4	P21EST01	Engineering Graphics	3	0	0	3
5	P21EST03	C-Programming for Problem Solving	3	0	0	3
6	P21HSL01	English Language Communication Skills Lab	0	0	3	1.5
7	P21BSL04	Engineering Chemistry Lab	0	0	3	1.5
8	P21ESL02	C-Programming for Problem Solving Lab	0	0	3	1.5
9	P21MCT01	Induction Program	2	0	0	0
Total Credits						19.5

I Year - II Semester						
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	P21BST03	Engineering Physics	3	0	0	3
2	P21BST06	Numerical Methods & Vector calculus	3	0	0	3
3	P21EST07	Basic Electrical & Electronics Engineering	3	0	0	3
4	P21EST10	Engineering Mechanics	3	0	0	3
5	P21EST14	Python Programming	3	0	0	3
6	P21BSL02	Engineering Physics Lab	0	0	3	1.5
7	P21ESL04	Engineering Workshop	0	0	3	1.5
8	P21ESL07	Python Programming Lab	0	0	3	1.5
9	P21MCT02	Biology for Engineering	2	0	0	0
Total Credits						19.5

DEPARTMENT OF MECHANICAL ENGINEERING

PACE R-21 UNDER GRADUATE (B.Tech) COURSE STRUCTURE

II Year - I Semester						
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	P21BST08	Transformation Techniques & Differential Equations	3	0	0	3
2	P21MET01	Metallurgy & Material Science	3	0	0	3
3	P21MET02	Mechanics of Solids	3	0	0	3
4	P21MET03	Fluid Mechanics & Hydraulic Machines	3	0	0	3
5	P21MET04	Thermodynamics	3	0	0	3
6	P21MEL01	Fluid Mechanics & Hydraulic Machines Lab	0	0	3	1.5
7	P21MEL02	Metallurgy Lab	0	0	3	1.5
8	P21MEL03	Mechanics of Solids Lab	0	0	3	1.5
9	P21MES01	Computer Aided Engineering Drawing Practice	1	0	2	2
10	P21MCT03	Environmental Science	2	0	0	0
Total Credits						21.5

II Year - II Semester						
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	P21BST07	Probability and Statistics	3	0	0	3
2	P21MET05	Theory of Machines	3	0	0	3
3	P21MET06	Thermal Engineering	3	0	0	3
4	P21MET07	Manufacturing Technology	3	0	0	3
5	P21MBT02	Industrial Engineering and Management	3	0	0	3
6	P21MEL04	Computer Aided Machine Drawing Lab	0	0	3	1.5
7	P21MEL05	Thermal Engineering Lab	0	0	3	1.5
8	P21MEL06	Manufacturing Technology Lab	0	0	3	1.5
9	P21MES02	Drafting and Modeling	1	0	2	2
Total Credits						21.5
Internship 2 Months (Mandatory) during summer vacation						

DEPARTMENT OF MECHANICAL ENGINEERING

PACE R-21 UNDER GRADUATE (B.Tech) COURSE STRUCTURE

III Year - I Semester						
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	P21MET08	Design of Machine Elements-I	3	0	0	3
2	P21MET09	Metal Cutting & Machine Tools	3	0	0	3
3	P21MET10	Refrigeration & Air Conditioning	3	0	0	3
4	P21MEXXX	Professional Elective-I	3	0	0	3
5	P21MEXX	Open Elective-I	3	0	0	3
6	P21MEL07	Theory of Machines Lab	0	0	3	1.5
7	P21MEL08	Refrigeration & Air Conditioning Lab	0	0	3	1.5
8	P21MES03	Simulation	1	0	2	2
9	P21XXXXX	Design Thinking for Innovation	2	0	0	0
10	P21MEI01	Summer Internship 2 Months (Mandatory) after II Year (to be evaluated during III Year I Semester)	0	0	0	1.5
Total Credits						21.5

Professional Elective - I		
S.No	**Course Code**	**Course Title**
1	P21MEE01	Maintenance Engineering
2	P21MEE02	Automotive Electrical Systems
3	P21MEE03	Automation in Manufacturing
4	P21MEE04	Robotics

Open Elective - I		
S.No	**Course Code**	**Course Title**
NPTEL COURSE		

DEPARTMENT OF MECHANICAL ENGINEERING

PACE R-21 UNDER GRADUATE (B.Tech) COURSE STRUCTURE

III Year - II Semester						
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	P21MET11	Metrology & Measurements	3	0	0	3
2	P21MET12	Heat & Mass Transfer	3	0	0	3
3	P21MET13	Design of Machine Elements-II	3	0	0	3
4	P21MEEXX	Professional Elective-II	3	0	0	3
5	P21XXXXX	Open Elective-II	3	0	0	3
6	P21MEL09	Machine Tools Lab	0	0	3	1.5
7	P21MEL10	Heat Transfer Lab	0	0	3	1.5
8	P21MEL11	Metrology & ICS Lab	0	0	3	1.5
9	P21MES04	Advanced Communication Skills	1	0	2	2
10	P21XXXXX	Constitution of India	2	0	0	0
Total Credits						21.5
Industrial/Research Internship (Mandatory) 2 Months during summer vacation						

Professional Elective - II		
S.No	**Course Code**	**Course Title**
1	P21MEE05	Powder Metallurgy
2	P21MEE06	Electric and Hybrid Vehicle Technology
3	P21MEE07	Production Planning and Control
4	P21MEE08	Renewable Sources of Energy

Open Elective - II		
S.No	**Course Code**	**Course Title**
NPTEL COURSE		

DEPARTMENT OF MECHANICAL ENGINEERING

PACE R-21 UNDER GRADUATE (B.Tech) COURSE STRUCTURE

IV Year - I Semester						
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	P21MEXX	Professional Elective-III	3	0	0	3
2	P21MEXX	Professional Elective-IV	3	0	0	3
3	P21MEXX	Professional Elective-V	3	0	0	3
4	P21XXXX	Open Elective-III	3	0	0	3
5	P21XXXX	Open Elective-IV	3	0	0	3
6	P21XXXXX	Universal Human Values-II	3	0	0	3
7	P21MES05	Non-destructive Testing	1	0	2	2
8	P21MEI02	Industrial/Research Internship 2 Months (Mandatory) after III Year (to be evaluated during IV Year I Semester)	0	0	0	3
Total Credits						23

Professional Elective - III		
S.No	**Course Code**	**Course Title**
1	P21MEE09	Applications of AI in Mechanical Engineering
2	P21MEE10	Electric and Hybrid Vehicle Design
3	P21MEE11	Intelligent Manufacturing Systems

Professional Elective - IV		
S.No	**Course Code**	**Course Title**
1	P21MEE12	AI in Autonomous Vehicles
2	P21MEE13	Fuel Cell Technology and Hydrogen Storage System
3	P21MEE14	Lean Manufacturing

Professional Elective - V		
S.No	**Course Code**	**Course Title**
1	P21MEE15	AI in Inspection & Quality Control
2	P21MEE16	Autotronics
3	P21MEE17	Smart Factory

DEPARTMENT OF MECHANICAL ENGINEERING

PACE R-21 UNDER GRADUATE (B.Tech) COURSE STRUCTURE

IV Year - II Semester						
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	P21MEP01	Project Work, Seminar and Internship in Industry	0	0	0	12
Internship (6 Months)						
Total Credits						12

Course Code	Course Name	Course Structure			
		L	T	P	C
P21HST01	Communicative English	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite: The students should have basic knowledge of English grammar and LSRW skills.

Course Objectives: The student will be able

1. To enable the engineering students to develop their basic communication skills in English for academic and social purposes.
2. To equip the students with appropriate oral and written communication skills.
3. To inculcate the skills of listening, reading and critical thinking.
4. To integrate English Language learning with employability skills and training.
5. To enhance the students' proficiency in reading skills enabling them to meet the academic demands of their course.

Course Outcomes: After going through this course the student will be able to

1. Use English Language effectively in spoken and written forms
2. Interpret the contextual meaning of words
3. Comprehend the given texts and respond appropriately
4. Recall and reproduce the theme in a given context
5. Communicate confidently in formal and informal contexts

UNIT–I **(9 Lectures)**

a. Reading Skills: Leela's Friend – R.K. Narayan
b. Vocabulary: Synonyms, Antonyms and Word formation, Root Words
c. Grammar: Parts of Speech, Sentence structure and Types of sentences
d. Writing: Letter Writing, Note Making and Note Taking

UNIT–II **(10 Lectures)**

a. Reading Skills: Dr. A.P.J. Abdul Kalam's Biography
b. Vocabulary: Prefixes, Suffixes and Affixes
c. Grammar: Prepositions and Articles
d. Writing: Paragraph Writing and Precis Writing

UNIT–III **(9 Lectures)**

a. Reading Skills: Three Days to See – Helen Keller
b. Vocabulary: Collocations, One word substitutes & Idioms
c. Grammar: Tenses, Active voice & Passive voice
d. Writing: Technical Report Writing

UNIT–IV **(9 Lectures)**

a. Reading Skills: Satya Nadella's Email to His Employees on His First Day as CEO of Microsoft
b. Vocabulary: Phrasal verbs and Commonly confused words
c. Grammar: Subject–Verb Agreement (Concord) and Question tags
d. Writing: Curriculum vitae, Cover Letter and Resume Writing. (Functional, Chronological and standard Resumes)

UNIT–V **(8 Lectures)**

a. Reading Skills: Mokshagundam Visveswaraya
b. Vocabulary: Homonyms, Homophones and Homographs
c. Grammar: Modal Auxiliaries, Degrees of Comparison and Direct speech & Indirect Speech
d. Writing: E- mail Writing and Essay Writing

Text Books:

1. New Horizons – Pearson Publishers
2. Fluency in English", A Course Book for Engg. Students, Published by Orient Black Swan, Hyderabad, 2016 print.
3. "Technical Communication- Principles and Practice", Third Edition. New Delhi: Oxford University press.
4. Epitome of Wisdom – Maruthi Publications

Reference Books:

1. Meenakshi raman, Sangeetha, Sharma Fundamentals of technical communication, Pg: 119-153 Oxford University press, 2015
2. Rutherford, Andhrea. J, Communication skills for technology. Pearson, New Delhi.2001
3. Raymond Murphy, Murphy's English Grammar, Cambridge University Press 2004
4. Meenakshi raman, Sangeetha, Sharma,Technical communication: English Skills for Engineers, Oxford University press, 2009
5. Michael Swan, Practical English Usage, Oxford University press, 1996

Web Resources:

1. www.englishhints.com
2. www.enchantedlearning.com
3. www.learnenglish.de/grammar/prefixtext.html

4. http://www.magickeys.com/books/riddles/words.html
5. http://www.pinnacle.edu.in/campusfiles/1826_campusFile_1.pdf
6. http://www.yourdictionary.com
7. http://www.learnenglish.com
8. http://www.cambridge.org
9. http://www.eslcafe.com
10. http://www.eslgames.com
11. http://www.penguin.co.uk
12. http://www.edufind.com/english/practice
13. www.englishhints.com,www.enchantedlearning.com,
14. www.learnenglish.de/grammar/prefixtext.html
15. http://www.magickeys.com/books/riddles/words.html

Course Code	Course Name	Course Structure			
		L	T	P	C
P21BST01	Linear Algebra & Differential Equations	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite: Basics of Matrix Algebra, Differentiation, Integration

Course Objectives: The student will be able to

1. The concept of rank of a matrix which is used to know the consistency of system of linear equations and find the solution by using various analytical and numerical methods.
2. Eigen values and eigenvectors of a given matrix. Cayley-Hamilton theorem to find the inverse and power of a matrix and determine the nature of the quadratic form,
3. Recognize and model differential equations, apply analytical techniques to compute solutions for engineering problems.
4. The general solution to the higher order linear differential equations and applies to calculate the current in electrical circuits.
5. Explore the use of Laplace transform method to solve with initial value problems of ordinary differential equations.

Course Outcomes: After going through this course the student will be able to

1. Demonstrate the understanding of rank of a matrix. Analyze the solution of the system of linear equations.
2. Find the Eigen values and Eigenvectors of a matrix, apply Cayley-Hamilton theorem to determine inverse and power of a matrix and identify the nature of the quadratic form.
3. Solve the differential equations of first order and first degree related to various engineering fields.
4. Find the complete solution to the higher order linear differential equations and apply these methods to find the current in complex electrical circuits.
5. Apply the technique of Laplace transform and solve differential equations for analytical solutions with the initial conditions.

UNIT–I: Solving System of Linear Equations (8 Lectures)

Rank of a matrix by Echelon form-Normal form- Normal form through PAQ method – Solving system of homogeneous and non-homogeneous linear equations – Gauss elimination – Gauss Jordon methods.

UNIT–II: Eigen values – Eigenvectors, Cayley-Hamilton Theorem and Quadratic forms (10 Lectures)

Eigen values - Eigenvectors– Properties – Cayley-Hamilton theorem (without proof)- Finding inverse and power of a matrix by Cayley-Hamilton theorem–Reduction to Diagonal form. Quadratic forms: Rank, index, signature and nature of the

quadratic forms–Reduction of quadratic form to canonical forms by orthogonal transformation.

UNIT–III: Differential Equations of First Order and First Degree (10 Lectures)

Linear differential equation - Bernoulli's differential equation–Exact equations and equations reducible to exact form.

Applications: Newton's Law of cooling-Law of natural growth and decay-Orthogonal trajectories-Electrical circuits.

UNIT–IV: Linear Differential Equations of Higher order (8 Lectures)

Non-homogeneous equations of higher order with constant coefficients-with RHS term of the type e^{ax}, $sinax$, $cosax$, polynomials in x, $e^{ax}V(x)$, $x^nV(x)$ and general method - Method of Variation of parameters.

Applications: LCR circuit

UNIT–V: Laplace Transforms (9 Lectures)

Laplace transforms of standard functions– First shifting Theorem-Change of scale property multiplication by t^n–division by t, transforms of derivatives and integrals – Second shifting theorem– Laplace transform of Periodic functions.

Inverse Laplace transforms – Convolution theorem (without proof)

Applications: Evaluation of integrals using Laplace transforms - Solving ordinary differential equations (Initial value problems) using Laplace transforms.

Text Books:

1. B. S. Grewal, Higher Engineering Mathematics, 44^{th} Edition, Khanna Publishers
2. B.V. Ramana, Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.

Reference Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10^{th} Edition, Wiley-India.
2. H. K. Das, Advanced Engineering Mathematics, 22^{nd} Edition, S. Chand & Company Ltd.
3. David Poole, Linear Algebra- A modern introduction, 4^{th} edition, Cengage.
4. Peter O' Neil, Advanced Engineering Mathematics, Cengage
5. Srimantha Pal, S C Bhunia, Engineering Mathematics, Oxford University Press.

Web Resources:

1. `http://tutorial.math.lamar.edu/Classes/DE/DE.aspx`
2. `http://mathworld.wolfram.com/topics`
3. `http://www.nptel.ac.in/course.php`

Course Code	Course Name	Course Structure			
		L	T	P	C
P21BST05	Engineering Chemistry	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite: Basic Chemistry at Intermediate or equivalent level.

Course Objectives: The student will be able

1. To analyze the different types of composite plastic materials and interpret the mechanism of conduction in conducting polymers.
2. To utilize the theory of construction of electrodes, batteries and fuel cells in redesigning new engineering products and categorize the reasons for corrosion and study methods to control corrosion.
3. To understand various synthetic methods of nanomaterials for modern advances of engineering technology. Summarize the techniques that detect and measure changes of state of reaction. Illustrate the commonly used industrial materials.
4. Differentiate petroleum, petrol, synthetic petrol and have knowledge how they are produced Study alternate fuels and analyze flue gases.
5. To analyze the suitable methods for purification and treatment of hard water and brackish water.

Course Outcomes: At the end of this unit, the students will be able to

1. Analyze the different types of composite plastic materials and interpret the mechanism of conduction in conducting polymers.
2. Utilize the theory of construction of electrodes, batteries and fuel cells in redesigning new engineering products and categorize the reasons for corrosion and study methods to control corrosion.
3. To understand various synthetic methods of nanomaterials for modern advances of engineering technology. Summarize the techniques that detect and measure changes of state of reaction. Illustrate the commonly used industrial materials.
4. Differentiate petroleum, petrol, synthetic petrol and have knowledge how they are produced Study alternate fuels and analyze flue gases.
5. To analyze the suitable methods for purification and treatment of hard water and brackish water.

UNIT–I: Polymer Technology (9 Lectures)

Polymerization: Introduction, classification, methods of polymerization (Emulsion and Suspension), mechanical properties.

Plastics: Compounding, fabrication (compression, injection, blown film and extrusion), preparation, properties and applications (Poly ethylene, PVC, Polycarbonates and Bakelite).

Elastomers: Introduction, preparation, properties and applications (Buna S, Thiokol and Polyurethanes).

Composite materials: Fiber reinforced plastics, conducting polymers, biodegradable polymers,

UNIT–II: Electrochemical Cells and Corrosion (10 Lectures)

Galvanic Cells, Single electrode potential, electrochemical series and uses of series, standard hydrogen electrode, calomel electrode, construction of glass electrode, batteries (Dry cell, Li ion battery, Lead Acid battery and Ni-Cd cells).

Corrosion: Definition, theories of corrosion (Chemical and Electrochemical), galvanic corrosion, differential aeration corrosion, stress corrosion, galvanic series, corrosion control (Proper designing and cathodic protection), protective coatings (Surface preparation, Cathodic coatings, Anodic coatings, Electroplating and Electroless plating).

UNIT–III: Chemistry of Materials (10 Lectures)

Nano materials: Introduction, sol-gel method, characterization by (Brunauer Emmet Teller (BET), and transmission electron microscopy (TEM) with example (TiO2), applications of fullerenes, carbon nanotubes (types, preparation and applications).

Refractories: Definition, classification, properties (refractoriness, refractoriness under load, porosity and thermal spalling), failure of refractories.

Lubricants: Definition, mechanism of lubricants, properties (definition and importance).

Cement: - Constituents, manufacturing, parameters to characterize the clinker formation: lime saturation factor (LSF), silica ratio (SR) and alumina ratio (AR), chemistry of setting and hardening, deterioration of cement.

UNIT–IV: Fuel Technology (8 Lectures)

Introduction, calorific value, higher calorific value, lower calorific values, problems using Dulong's formula, proximate and ultimate analysis of coal sample and their significance, numerical problems, petroleum (refining-cracking), synthetic petrol (Bergius), petrol knocking, diesel knocking, octane and cetane ratings, anti-knocking agents, Introduction to alternative fuels (Natural gas, liquefied petroleum gas, compressed natural gas), Flue gas analysis by Orsat apparatus.

UNIT–V: Water Technology (8 Lectures)

Hardness of water, determination of hardness by complexometric method, boiler troubles (priming and foaming, scale formation, boiler corrosion, caustic embrittlement), internal treatments, softening of hard water (zeolite process and related sums, ion exchange process), treatment of industrial waste water, potable water and its specifications, steps involved in purification of water, chlorination, break point chlorination-desalination (reverse osmosis and electro dialysis).

Text Books:

1. P.C. Jain and M. Jain "Engineering Chemistry", 15/e, Dhanpat Rai & Sons, Delhi, (Latest edition).

2. Shikha Agarwal, “Engineering Chemistry”, Cambridge University Press, New Delhi, (2019).

3. S.S. Dara, “A Textbook of Engineering Chemistry”, S.Chand & Co, (2010).

4. Shashi Chawla, “Engineering Chemistry”, Dhanpat Rai Publicating Co. (Latest edition).

Reference Books:

1. K. SeshaMaheshwaramma and MridulaChugh, “Engineering Chemistry”, Pearson India Edition.

2. O.G. Palana, “Engineering Chemistry”, Tata McGraw Hill Education Private Limited, (2009).

3. CNR Rao and JM Honig (Eds) “Preparation and characterization of materials” Academic press, New York (latest edition).

4. B. S. Murthy, P. Shankar, “Textbook of Nanoscience and Nanotechnology”, University press (latest edition).

Web Resources:

1. http://jntuk-coeerd.in/
2. http://en.wikipedia.org/wiki/title
3. http://nptel.ac.in/coures/105106/.com
4. https://en.wikipedia.org/wiki/Electrochemistry
5. https://www.youtube.com/watch?v=WLyaZbT97EI&list=PLzW3l18TEXrpqo3jRarGr9ao-61tB2184
6. https://encyclopedia.che.engin.umich.edu/
7. http://encyclopedia.che.engin.umich.edu/Pages/ProcessParameters/Spectrometers/Spectrometers.html

Course Code	Course Name	Course Structure			
		L	T	P	C
P21EST01	Engineering Graphics	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite: Nill

Course Objectives: The student will be able

1. To introduce the students to use drawing instruments and to draw polygons, Engineering Curves and Scales, orthographic projections, projections of points.
2. To introduce the students to use projections of lines.
3. To make the students draw the projections of the planes and the various types of solids.
4. To enable the students to gain the ability to convert the Isometric views in to Orthographic views vice versa and development of surfaces of regular solids.
5. To introduce the students to use the Fusion 360 for creating basic geometric figures.

Course Outcomes: After going through this course the student will be able to

1. Construct polygons, scales and engineering curves and Identify the position of points with use of orthographic projections.
2. Identify the position of points and lines with use of orthographic projections.
3. Analyze the location and position of plane figures and solids through orthographic projections.
4. Develop 2D and 3D objects by converting their view.
5. Construct basic geometric figures using Fusion 360.

UNIT–I **(9 Lectures)**

Introduction To Engineering Graphics: Introduction to Drawing instruments and their uses, construction of regular polygons, Conic sections- ellipse, parabola, hyperbola using general method, Scales- Diagonal scale, Vernier scale.

Projections of Points: Principle of orthographic projection-Method of Projection – First and third angle projection methods- Projections of Points.

UNIT–II **(9 Lectures)**

Projections Of Lines: projection of straight lines- parallel to one plane and inclined to the other plane, projections of straight lines inclined to both the planes, determination of true lengths, angle of inclinations and traces.

UNIT–III **(9 Lectures)**

Projections Of Planes: projections of plane figures- triangle, square, rectangle, pentagon and hexagon, circle with surfaces inclined to both the reference planes.

Projections Of Solids: projections of solids: projections of regular solids with the axis inclined to only one reference plane.

UNIT–IV **(9 Lectures)**

Surface Development: development of surfaces for basic solids- prisms, pyramids, cylinder and cone.

Projections of Pictorial Views: Conversion of isometric views into orthographic views and conversion of orthographic views in to isometric views.

UNIT–V **(9 Lectures)**

Introduction To Autodesk Fusion 360: fusion 360 fundamentals-Getting Started -The Fusion 360 Interface Design Navigation & Display-Design Units and Origin -Quick Shape Creation.

Creating Sketched Geometry: Introduction to the sketching workflow - sketch entities -dimensioning sketch constraint.

Text Books:

1. Engineering Drawing by N.D. Bhatt & V.M. Panchal, Charotar Publications, 2014.
2. Engineering Drawing by Basant Agrawal and C.M. Agrawal, McGraw Hill Education Pvt. Limited, 2013.
3. Engineering Drawing by Prof. K.L. Narayana & Prof. R.K.Kannaiah, Scitech Publications, 2010.
4. Parametric Modeling with Autodesk Fusion 360 By Randy H. Shih SDC publications April 23, 2021

Reference Books:

1. Engineering Graphics with AutoCAD 2002 by James D. Bethune, PHI, 2011.
2. Engineering Graphics. P I Varghese Tata McGraw Hill Education Pvt. Ltd, 2010.
3. Engineering drawing – P.J. Shah .S.Chand Publishers,2010.
4. Engineering Drawing- Johle/Tata Macgraw Hill Book Publishers, 2010.
5. Autodesk Fusion 360: A Tutorial Approach Kindle Edition by Prof. Sham Tickoo Purdue Univ. and CADCIM Technologies.

Web Resources:

1. https://lecturenotes.in/subject/436/engineering-drawing-ed.
2. web.iitd.ac.in/~achawla/public_html/201/lectures/sp46.pdf.
3. https://www.smartzworld.com/notes/engineering-drawing-pdf-1st-year-notes-ppts
4. https://www.researchgate.net/305754529_A_Textbook_of_Engineering_Drawing
5. www.academia.edu/32510080/N_d_bhatt_engineering_drawing_pdf

Course Code	Course Name	Course Structure			
		L	T	P	C
P21EST03	C - Programming for Problem Solving	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite: Nill

Course Objectives: The student will be able

1. To impart adequate knowledge on the need of programming languages and problem solving techniques.
2. To impart problem solving skills.
3. To enable student to write programs in C and to solve the problems.

Course Outcomes: After going through this course the student will be able to

1. Design algorithms and flowchart / Pseudo code for a given problem.
2. Design programs involving decision structures and loops.
3. Implement different operations on arrays and solve problems using functions.
4. Understand pointers and strings.
5. Implement structures, unions and file operations in C programming for a given application problem.

UNIT–I (8 Lectures)

Introduction to Programming: Computer hardware, Bits and Bytes, programming languages, application and system software, the software development process.

Idea of algorithm: steps to solve logical and numerical problems. Representation of algorithm: flowchart/pseudo code with examples, from algorithms to programs.

UNIT–II (9 Lectures)

Introduction to C: Overview of C, Constants, Variables and Data Types, Operators and Expressions, Managing Input and Output. Decision Making - Branching and Looping. Enumerated Data type, Renaming Data type with type def, Type Casting.

UNIT–III (10 Lectures)

Arrays: Definition, Declaration, Initialization, Assignment, Processing array, Passing array to a function, Two and multi dimensional array. **Functions:** Defining a function, Accessing a function, Passing argument to functions, Function prototypes, Nested function call, Storage classes.

UNIT–IV (9 Lectures)

Pointers: Definition, initialization, operations on pointers, functions and pointers, arrays and pointers, pointers to pointers, dynamic memory allocation.

Strings: C Strings, String Input / Output functions, arrays of strings, string manipulation functions.

UNIT–V (9 Lectures)

Structures: Definition, declaration, initialization, accessing members, array of structures, arrays within structure, functions and structures, pointers to structures, nested structures, unions.
File Handling: Types, operations on files, modes, file I/O functions, Random Access Functions.

Text Books:

1. Byron S Gottfried, —Programming with C, Schaums Outlines, Second Edition, Tata McGraw-Hill, 2006.
2. Problem Solving and Program Design in C, 4^{th} edition, by jeri R. Hanly and Elli B.Koffman.
3. Balagurusamy. 2011. C Programming. Tata Mc Graw Hills, New Delhi, India.

Reference Books:

1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India.
2. Yashavant P. Kanetkar. —Let Us C, BPB Publications, 2011.

Web Resources:

1. `https://www.studytonight.com/c/`
2. `https://www.cprogramming.com/tutorial/c-tutorial.html`
3. `https://www.javatpoint.com/c-programming-language-tutorial`
4. `https://www.tutorialspoint.com/cprogramming/`

Course Code	Course Name	Course Structure			
		L	T	P	C
P21HSL01	English Language Communication Skills Lab	0	0	3	1.5

Internal Marks: 15 External Marks: 35

Course Prerequisite: Basic knowledge of English grammar, Basic understanding of English vocabulary, Ability to speak simple sentences, Have interest to learn the language.

Course Objectives: The student will be able

1. To facilitate computer assisted multimedia instructions enabling individualized and independent language learning.
2. To sensitize the students to the nuances of English speech sounds, word accent, intonation and rhythm.
3. To bring about a consistence accent and intelligibility in students' pronunciation of English by providing an opportunity for practice in speaking.
4. To improve the fluency of students in spoken English and neutralize their mother tongue influence.
5. To train students to use language appropriately for public speaking, group discussion and interviews.

Course Outcomes: After going through this course the student will be able to

1. Better understanding of nuances of English language through audio visual experience and group activities.
2. Neutralization of accent for intelligibility.
3. Speaking skills with clarity and confidence which in turn enhances their employability skills.
4. Better understanding of the production of sounds of language.
5. Suitable body language for employability.

EXERCISE–I **(3 Sessions)**

A. Introduction to Phonetics
   Consonant sounds
   Vowel sounds – Pure Vowels & Diphthongs

B. Greeting, Introducing & taking leave and Ice – Breaking Activity

EXERCISE–II **(2 Sessions)**

A. Structure of Syllables - Plural markers & Past tense Markers

B. JAM Session & Situational Dialogues

EXERCISE–III **(2 Sessions)**

A. Word Stress & Rules of 'r' pronunciation

B. Role play, Giving Directions & Story Narration

EXERCISE–IV **(2 Sessions)**

A. Consonant Cluster, Neutralization of Mother Tongue Influence and Listening Comprehension – Listening for General Details

B. Describing objects, events, places etc. & Presentation Skills – Extempore, Public Speaking.

EXERCISE–V **(3 Sessions)**

A. Intonation & Listening Comprehension – Listening for Specific Details

B. Interview Skills & Group Discussion

Text Books:

1. Strengthen your Communication Skills - Maruthi Publication, Hyderabad 2013
2. A textbook of English Phonetics for Indian Students by T. Balasubramanian (Macmillan)

Reference Books:

1. INFOTECH English (Maruthi Publications).
2. Personality Development and Soft Skills (Oxford University Press, New Delhi)
3. Suresh Kumar, E. & Sreehari, P. 2009. A Handbook for English Language Laboratories. New Delhi: Foundation
4. Speaking English Effectively 2^{nd} Edition by Krishna Mohan and N. P. Singh, 2011. Macmillan Publishers India Ltd. Delhi.
5. Sasi Kumar, V & Dhamija, P.V. How to Prepare for Group Discussion and Interviews. Tata McGraw Hill
6. Hancock, M. 2009. English Pronunciation in Use. Intermediate. Cambridge: CUP
7. Spoken English: A Manual of Speech and Phonetics by R. K. Bansal & J. B. Harrison. 2013. Orient Blackswan. Hyderabad
8. Hewings, M. 2009. English Pronunciation in Use. Advanced. Cambridge: CUP
9. Marks, J. 2009. English Pronunciation in Use. Elementary. Cambridge: CUP
10. Nambiar, K.C. 2011. Speaking Accurately. A Course in International Communication. New Delhi : Foundation

11. Soundararaj, Francis. 2012. Basics of Communication in English. New Delhi: Macmillan

12. Spoken English (CIEFL) in 3 volumes with 6 cassettes, OUP.

13. English Pronouncing Dictionary Daniel Jones Current Edition with CD.

Web Resources:

1. http://www.cambridge.org
2. http://www.edufind.com/english/practice
3. http://www.learnenglish.com
4. http://www.penguin.co.uk

Course Code	Course Name	Course Structure			
		L	T	P	C
P21BSL04	Applied Chemistry Lab	0	0	3	1.5

Internal Marks: 15 External Marks: 35

Course Prerequisite: Basic Chemistry at Intermediate or equivalent level.
Course Objectives: The purpose of this course to provide students with practical knowledge of quantitative analysis of materials by classical and instrumental methods for developing experimental skills in building technical competence.
Course Outcomes: After going through this course the student will be able to

1. Carrying out different types of titrations for estimation of concerned in materials using comparatively more quantities of materials involved for good results.
2. Handling different types of instruments for analysis of materials using small quantities of materials involved for quick and accurate results.

LIST OF EXPERIMENTS: Introduction to Chemistry laboratory – Molarity, normality, primary, secondary standard solutions, volumetric titrations, quantitative analysis.

1. Determination of HCl using standard Na_2CO_3 solution.
2. Determination of alkalinity of water sample containing Na_2CO_3 and NaOH.
3. Determination of Mn^{+2} using standard oxalic acid solution.
4. Determination of ferrous iron using standard $K_2Cr_2O_7$ solution.
5. Determination of Cu^{+2} using standard hypo solution.
6. Determination of temporary and permanent hardness of water using standard EDTA solution.
7. Determination of Fe^{+3} by a colorimetric method.
8. Determination of the concentration of acetic acid using sodium hydroxide (p^Hmetry method).
9. Determination of isoelectric point of amino acids using p^Hmetry method (or) conductometric method.
10. Determination of the concentration of strong acid vs strong base (by conductometric method).
11. Determination of strong acid vs strong base (by potentiometric method).
12. Estimation of Vitamin C.
13. Preparation of Nylon-6, 6 and Bakelite (demonstration only).

Reference Books:

1. Dr. Jyotsna Cherukuris (2012) Laboratory Manual of engineering chemistry-II,
2. VGS Techno Series

3. Chemistry Practical Manual, Lorven Publications

Web Resources:

1. https://vlab.amrita.edu/index.php?sub=2&brch=193.

Course Code	Course Name	Course Structure			
		L	T	P	C
P21ESL02	C - Programming for Problem Solving Lab	0	0	3	1.5

Internal Marks: 15 External Marks: 35

Course Prerequisite: Nil

Course Objectives: The student will be able

1. To understand the various steps in program development.
2. To understand the basic concepts in C Programming Language.
3. To understand different modules that includes conditional and looping expressions.
4. To understand how to write modular and readable C Programs.
5. To write programs in C to solve problems using arrays, structures and files.

Course Outcomes: At the end of this course, the students will be able to

1. Apply and practice logical ability to solve the problems.
2. Understand C programming development environment, compiling, debugging, and linking and executing a program using the development environment.
3. Analyzing the complexity of problems, modularize the problems into small modules and then convert them into programs.
4. Understand and apply the in-built functions and customized functions for solving the problems.
5. Understand and apply the pointers, memory allocation techniques and use of files for dealing with variety of problems.
6. Document and present the algorithms, flowcharts and programs in form of user-manuals

Experiment Wise Programs

EXERCISE–I

a. Write a simple C program to Print “Hello World”

b. Write a simple C Program to Calculate Area and Circumference of Circle

c. Write a simple C program to implement basic arithmetic operations - sum, difference, product, quotient and remainder of given numbers.

EXERCISE–II: Write C programs to demonstrate the following operators

a. Assignment Operator.

b. Relational and Logical Operator.

c. Increment and decrement operator.

d. Bitwise operators.

e. Ternary operator.

EXERCISE–III

a. Write a C programs - to find the largest and smallest of 2 numbers(if – else), to find the largest and smallest of 3 numbers(Nested if – else), roots of quadratic equation(else – if ladder).

b. The total distance travelled by vehicle in't' seconds is given by distance=ut+1/2 at 2 where 'u' and 'a' are the initial velocity and acceleration.

   Write a c program to find the distance travelled at regular intervals of time given the Values of 'u' and 'a'. The program should provide the flexibility to the user to select his own time intervals and repeat the calculations for different values of 'u' and 'a'.

c. Write a c program, which takes two integer operands and one operator from the user, performs the operation and the prints the result. (consider the operators $+, -, *, /, \%$ and use switch statement).

EXERCISE–IV

a. Write a C program to find the sum of individual digits of a positive integer

b. A Fibonacci Sequence is defined as follows: the first and second terms in the sequence are 0 and 1.Subsequent terms are found by adding the preceding two terms in the sequence .Write a c program to generate the first n terms of the sequence.

c. Write a c program to generate all the prime numbers between 1 and n, where n is a value supplied by the user.

EXERCISE–V

a. Write a C program to read in two numbers, x and n, and then compute the sum of this geometric progression: $1 + x + x^2 + x^3 + ... + x^n$

b. Write a C program to generate Pascal's triangle.

c. Write a C program to construct a pyramid of numbers

EXERCISE–VI

a. Write a c program to find both the largest and smallest number in a list of integers.

b. Write a c program that uses functions to perform the following:

   i. Addition of Two Matrices.

   ii. Multiplication of Two Matrices.

EXERCISE–VII

a. Write a programs that use both recursive and non-recursive functions

b. To find the factorial of a given integer.

c. To find the GCD of two given integers.

EXERCISE–VIII

a. Write a c program that uses functions to perform the following operations:

   i. To insert a sub-string in given main string from a given position.

   ii. To delete n Characters from a given position in a given string.

b. Write a C program to determine if the given string is a palindrome or not.

EXERCISE–IX

a. Write a C program that displays the position or index in the string S Where the string T begins, or - 1 if S doesn't contain T.

b. Write a C program to count the lines, words and characters in a given text .

EXERCISE–X

a. Write a program to print the details of a student like(Name, Rollno, marks) using nested structures.

b. Write a C Program to Calculate Difference Between Two Time Period.

EXERCISE–XI

a. Write a C program that uses functions to perform the following operations:

   i. Reading a complex number

   ii. Writing a complex number

   iii. Addition of two complex numbers

   iv. Multiplication of two complex numbers
   (Note: represent complex number using a structure.)

EXERCISE–XII

a. Write a C program which copies one file to another and display the contents of a file

b. Write a C program to reverse the first n characters in a file.

c. Write a C program to merge two files into a third file (i.e., the contents of the first file followed by those of the second are put in the third file)

Course Code	Course Name	Course Structure			
P21BST03	Engineering Physics	L	T	P	C
		3	0	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite: The basics of analytical and conceptual understanding of physics.

Course Objectives: After going through this course the student will be able

1. To impart the concepts of wave optics.
2. Learn the concepts of Polarization and Lasers.
3. To study the solid state physics through Crystallography and X-ray diffraction.
4. To explore the knowledge of Oscillations and vibrations in engineering fields.
5. To learn the basic concepts in Acoustics, Magnetism and Dielectrics.

Course Outcomes: At the end of this course, the students will be able to

1. Understand the basic concepts in optics and apply for engineering applications.
2. Gain knowledge of Lasers and enable the students to develop Laser devices to apply the knowledge various systems like Industries and medicine.
3. Enable to apply the concept of crystal structure and x-ray diffraction for new materials.
4. Understand the basic concepts oscillations and vibrations to apply in Engineering fields
5. Acquire the knowledge of Acoustics, Magnetism and Dielectrics.

UNIT–I:WAVE OPTICS (9 Lectures)

Interference: Introduction, Principle of Superposition of waves, colors in thin films, interference in thin films, Newton's rings: Determination of wavelength and refractive index.

Diffraction: Introduction, differences between interference and diffraction, difference between Fraunhoffer and Fresnel diffraction, Fraunhoffer diffraction at single slit, Fraunhoffer diffraction due to double slit, Diffraction grating (N-slits qualitative), resolving power of grating

UNIT–II: POLARIZATION AND LASERS (9 Lectures)

Polarization: Introduction, types of polarization, Double refraction, methods of production, Half wave plate and quarter wave plate

Lasers: Introduction, Characteristics of laser, absorption, spontaneous emission, stimulated emission, Einstein's coefficients, population inversion, pumping, pumping mechanisms, types of lasers: Ruby laser, He-Ne laser, diode laser, applications of lasers.

UNIT–III: CRYSTALLOGRAPHY AND X-RAY DIFFRACTION (8 Lectures)

Crystallography: Introduction, Space lattice, Basis, Crystal structure, Lattice parameters, Unit cell, crystal systems and Bravais lattices, structures and packing fraction of SC, BCC, and FCC, Lattice constant.

X-ray diffraction: Introduction, Miller Indices, Important features of Miller indices, separation between successive crystal planes, Bragg's law..

UNIT–IV: OSCILLATIONS AND VIBRATIONS (9 Lectures)

Harmonic oscillations: Introduction, simple harmonic motion, the simple oscillator, equation of motion of a simple oscillator, characteristics, energy of simple harmonic oscillator, damped harmonic oscillator, heavy, critical and light damping, waves (longitudinal, transverse and standing waves)

Transverse vibrations of stretched strings: Velocity of transverse wave along stretched string, Frequency of vibrating string, Harmonics and overtones.

UNIT–V: ACOUSTICS MAGNETISM AND DIELECTRICS (10 Lectures)

Acoustics: Introduction, sound absorption coefficient, reverberation, reverberation time, Sabine's formula for reverberation time, conditions for good auditorium.

Magnetism and Dielectrics: Classification of magnetic materials: dia, para, and ferromagnetic materilas, Ferromagnetism, Hysterisis, Types of polarization: Electronic polarization, ionic polarization, orientation polarization, Internal field, Clausius Mossoti equation.

Text Books:

1. Engineering physics by M. N. Avadhanulu and P.G.Kshirsagar, S.Chand, NewDelhi.
2. Optics by Ajoy Ghatak, McGraw Hill Education.
3. Principle of Lasers by O. Svelto
4. Solid state physics by AJ Dekker.
5. Vibrations and waves in physics by Ian G. Main, 3rd Edn, Cambridge University Press
6. Engineering physics by D. K. Bhattacharya and Poonam Tandon, Oxford Press

Reference Books:

1. Optics by E.Hecht.
2. The physics of vibrations and waves by H.J. Pain, John Wiley & Sons, Ltd
3. Engineering physics by Palanisamy (scitech publications).
4. Engineering physics by Palanisamy (scitech publications).
5. EngineeringPhysics by RKGAUR&SLGUPTA,DhanpatRaiPublication
6. Physics by Halliday and Resnick.

7. Physics for Engineers by M. R. Srinasan, New age International publishers

Web Resources:

1. https://ocw.mit.edu/courses/physics/8-03sc-physics-iii-vibrations-and-waves-fall-2016/part-iii-optics/
2. https://ncert.nic.in/textbook/pdf/leph202.pdf
3. https://ncert.nic.in/textbook/pdf/keph206.pdf

Course Code	Course Name	Course Structure			
		L	T	P	C
P21BST06	Numerical Methods & Vector Calculus	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite: Differentiation, Partial differentiation, Integration, Differential Equations

Course Objectives: The student will be able to

1. The different numerical techniques to solve algebraic and transcendental equations and evaluate the polynomials from the numerical data.
2. The approximate solutions using numerical methods in the absence of analytical solutions of various systems of ordinary differential equations and integrations.
3. Enhance the knowledge level to visualize integrals in higher dimensional coordinate systems, possible representation and evaluation of geometrical and physical quantities in terms of multiple integrals.
4. Interpret concepts of vector functions, vector fields, differential calculus of vector functions in Cartesian coordinates and apply them for various engineering problems.
5. Evaluate line, surface and volume integrals and construct relation between line, surface and volume integrals using vector integral theorems.

Course Outcomes: After going through this course the student will be able to

1. Evaluate approximate roots of the polynomial and transcendental equations by different algorithms and apply Newton's forward, backward interpolation and Lagrange's formulae for equal and unequal intervals.
2. Apply different algorithms for approximating the integrals of numerical data and solutions of ordinary differential equations to its analytical computations.
3. S Evaluate the multiple integrals by using change of variables and change of order of integration. Also apply double and triple integration techniques in evaluating areas and volumes bounded by regions and solids.
4. nterpret the physical meaning of different operators such as gradient, curl and divergence.
5. Determine line, surface and volume integrals. Apply Green's, Stoke's and Gauss divergence theorems to calculate line, surface and volume integrals.

UNIT–I: Iterative Methods, Finite differences and Interpolation (10 Lectures)

Introduction-Solution of algebraic and transcendental equations-Bisection method -Method of false position-Newton-Raphson method (Single variable only)

Interpolation: Introduction-Errors in polynomial interpolation-Finite differences – Forward differences-Backward differences-Relations between operators-Newton's forward and backward formulae for interpolation -Interpolation with unequal intervals -Lagrange's interpolation formula.

UNIT–II: Numerical integration, Solution of ordinary differential equations with initial **(9 Lectures)**

Trapezoidal rule – Simpson's 1/3rd and 3/8th rule– Solution of ordinary differential equations by Taylor's series – Picard's method of successive approximations – Euler's method – Modified Euler's method-Runge-Kutta method (second and fourth order).

UNIT–III:Multiple Integrals: **(9 Lectures)**

Double integrals (Cartesian and Polar) – Change of order of integration – Change of variables (Cartesian to Polar coordinates) –Triple integrals- Change of variables (Cartesian to Cylindrical and Spherical coordinates).

Applications: Areas by double integrals and Volumes by triple integrals.

UNIT–IV: Vector Differentiation: **(8 Lectures)**

Scalar and Vector point functions-Vector Differential operator- Gradient – Directional derivatives – Divergence – Curl – Laplacian second order operator- Vector identities- Applications: Scalar Potential function.

UNIT–V: Vector Integration: **(9 Lectures)**

Line integral – Work done – Circulation- Surface integral- Volume integral

Vector Integral Theorems (without proof): Application of Green's theorem in a plane- Stoke's theorem- Gauss Divergence theorem.

Text Books:

1. B.S. Grewal, Higher Engineering Mathematics, 44^{th} Edition, Khanna Publishers.
2. B.V. Ramana, Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.

Reference Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10^{th} Edition, Wiley-India.
2. H. K. Das, Advanced Engineering Mathematics, 22^{nd} Edition,S. Chand & Company Ltd.
3. David Poole, Linear Algebra- A modern introduction, 4^{th} edition, Cengage.
4. Peter O' Neil, Advanced Engineering Mathematics, Cengage
5. Srimantha Pal, S C Bhunia, Engineering Mathematics, Oxford University Press.

Web Resources:

1. `http://tutorial.math.lamar.edu/Classes/DE/DE.aspx`
2. `http://mathworld.wolfram.com/topics`
3. `http://www.nptel.ac.in/course.php`

Course Code	Course Name	Course Structure			
		L	T	P	C
P21EST07	Basic Electrical and Electronics Engineering	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite: Physics

Course Objectives: The student will be able

1. To Explain the concept of passive elements, and understand the applications of network theorems for analysis of electrical networks.
2. To understand the faraday's laws and basic Principle of transformer.
3. To understand the working principle of DC machines.
4. To understand the working principle of AC machines.
5. To analyze the operation of PN junction diode, half wave, full wave rectifiers and Transistors.

Course Outcomes: After completion of this course, the student is able to:

1. Explain the concept of passive elements, and understand the applications of network theorems for analysis of electrical networks.
2. Understand the faraday's laws and basic Principle of transformer.
3. Understand the working principle of DC machines.
4. Understand the working principle of AC machines.
5. Analyze the operation of PN junction diode, half wave, full wave rectifiers and Transistors.

UNIT–I: Electrical Circuits (9 Lectures)

Basic definitions – Types of network elements- Types of sources - Ohm's Law - Kirchhoff's Laws –Resistive networks - Inductive networks - Capacitive networks – Series - Parallel circuits- Star-delta and delta-star transformations - Source transformation - nodal analysis and mesh analysis.

UNIT–II: Magnetic Circuits and Transformers (9 Lectures)

Basic definition of Magnetic quantities - Faraday's laws of electromagnetic induction- Analogy between electrical and magnetic circuits. Concept of self and mutual inductance.

Principle of operation and construction of single phase transformer–EMF equation – Applications..

UNIT–III: DC Machines (9 Lectures)

Construction and Principle of operation of DC Machines–Types of Generators and Motors-EMF equation – Torque equation –Speed control of DC Shunt Motor- power losses and efficiency-Working Principle of Brushless DC Motor-Applications.

UNIT–IV: AC Machines (9 Lectures)

Principle of operation and construction of 3-phase Induction motor -Principle of operation and construction of alternators-Construction and Principle of operation of Switched Reluctance Motor-Applications.

UNIT–V: Introduction to Semiconductor Devices (9 Lectures)

PN junction diode-Diode applications-Half wave -Full wave rectifiers -Types of Transistors: PNP and NPN junction transistors, transistor as an amplifier.

Text Books:

1. Engineering Circuit Analysis by William Hayt and Jack E.Kemmerley, Mc-Graw Hill Company, 6^{th} Edition
2. Electrical Technology by Surinder Pal Bali, Pearson Publications.
3. Electronic Devices and Circuits, R.L. Boylestad and Louis Nashelsky, 9^{th} Edition, PEI/PHI 2006.
4. Electronic Devices and Circuits – J. Millman, C.C. Halkias, Tata Mc-Graw Hill

Reference Books:

1. Electrical Circuit Theory and Technology by John Bird, Routledge Taylor &Francis Group
2. Electrical Machines by D. P.Kothari, I .J .Nagarth, Mc Graw Hill Publications, 4^{th} Edition
3. Electrical Machines by R.K.Rajput, Lakshmi publications, 5^{th} Edition.
4. R.Srinivasan-Special electrical machines-Lakshmi Publications,2013
5. Basic Electrical Engineering by M.S.Naidu and S.Kamakshiah, TMH Publications
6. Electronic Devices and Circuits by David A. Bell, Oxford University Press
7. Electronic Devices and Circuits – Salivahanan, Kumar, Vallavaraj, TATA MC Graw Hill, Second Edition.

Web Resources:

1. https://embeddedengineers.files.wordpress.com/2015/09/electronic-devices-and-circuits-by-salivahanan.pdf
2. https://electricalanswers.files.wordpress.com/2014/09/a-textbook-of-electrical-technology-volume-i-basic-electrical-engineering-b-l-theraja.pdf

Course Code	Course Name	Course Structure			
		L	T	P	C
P21EST10	Engineering Mechanics	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Objectives:

1. The students are to be exposed to the concepts of force, direction and its application and concept of equilibrium conditions.
2. the students are to be exposed to concepts of analysis of frames and friction.
3. The students are to be exposed to concepts of centre of gravity
4. The students are to be exposed to concepts of moment of inertia and polar moment of inertia including transfer methods and their applications.
5. The students are to be exposed to motion in straight line and in curvilinear paths, its velocity and acceleration computation and methods of representing plane motion.

Course Outcomes: At the end of this course, the students will be able to

1. Determine the resultant force and moment for a given system of forces
2. Analyse planar determine the forces in members of trusses, frames and problems related to friction
3. Determine the centroid and centre of gravity of composite figures second moment of area
4. Determine the second moment of area and mass moment of composite bodies
5. Calculate the motion characteristics of a body subjected to a given force system

UNIT–I: (10 Lectures)

Introduction, system of units, laws of mechanics, force characterises of a force, system of forces, co-planar concurrent forces: composition of forces, resolution of forces. Coplanar parallel forces, varignon's principles, couple, resolution of a force into a force and a couple.

Conditions of equilibrium, free body diagram, equilibrium of coplanar concurrent forces, lamis theorem, types of supports, types of loadings, simply supported beams.

UNIT–II: (9 Lectures)

Analysis of trusses: method of joints, method of sections.

Friction: types of frictions, laws of friction, angle of friction, angle of repose and cone of friction, block, wedges & ladder problems.

UNIT–III: (8 Lectures)

Centroid: Centroids of simple figures (from basic principles) – Centroids of Composite Figures

Centre of Gravity: Centre of gravity of simple body (from basic principles), center of gravity of composite bodies, pappus theorem.

UNIT–IV: **(9 Lectures)**

Area moments of Inertia: Definition – Polar Moment of Inertia, Transfer Theorem, Moments of Inertia of Composite Figures, Products of Inertia, Transfer Formula for Product of Inertia.

Mass Moment of Inertia: Moment of Inertia of Masses, Transfer Formula for Mass Moments of Inertia, mass moment of inertia of composite bodies.

UNIT–V: **(9 Lectures)**

Kinematics: Rectilinear and Curvelinear motions – Velocity and Acceleration – Motion of Rigid Body – Types and their Analysis in Planar Motion. Introduction – Rectilinear motion – Motion with uniform and variable acceleration–Curvilinear motion–Components of motion– Circular motion – Projectiles

Kinetics: Kinetics of a particle – D'Alembert's principle – Motion in a curved path – work, energy and power. Principle of conservation of energy – Kinetics of a rigid body in translation, rotation – work done – Principle of work-energy – Impulse-momentum

Text Books:

1. Engineering Mechanics - S.Timoshenko&D.H.Young., 5^{th} Edn , Mc Graw Hill publications.2017
2. Engineering Mechanics statics and dynamics – R.C.Hibbeler, 14^{th} Edn – Pearson Publ.2019.

Reference Books:

1. Engineering Mechanics: Statics and Dynamics by Anil Kumar Dhiman and Poonam Dhiman and Durgesh Kulshreshtha, McGraw Hill,2015.
2. Engineering Mechanics: Statics Si Version by MERIAM KRAIGE BOLTON, WILEY INDIA, 2017.
3. A Textbook of Engineering Mechanics (As Per the Latest Syllabus OfJntu, Kakinada) by Dr. S SBhavikatti, New Age International (P) Ltd., Publishers,2020
4. Basic Civil Engineering And Engineering Mechanics (Rgpv) by Dr. S SBhavikatti , New Age International (P) Ltd., Publishers,2012.

Web Resources:

1. https://nptel.ac.in/courses/105/106/105106116/
2. https://lecturenotes.in/download/note/27822-note-for-engineering-mechanics-em-by-amit-das
3. https://gita.edu.in/lectnote/mechanics.pdf
4. https://www.sanfoundry.com/1000-engineering-mechanics-questions-answers/

Course Code	Course Name	Course Structure			
		L	T	P	C
P21EST14	Python Programming	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite: NILL

Course Objectives: The student will be able

1. To read and write simple Python programs.
2. To develop Python programs with conditionals and loops.
3. To define Python functions and apply OOP concept.
4. To use Python data structures — lists, tuples, dictionaries.
5. To develop GUI applications in Python.

Course Outcomes: At the end of this course, the students will be able to

1. Understand the basics of python programming.
2. Understand control flow and implement various data structures provided by python.
3. Implement packages, methods and functions.
4. Develop real-world applications using oops and exception handling.
5. Build GUI Applications in Python.

UNIT–I: (8 Lectures)

Introduction: History of Python, Need of Python Programming, Applications Basics of Python Programming Using the REPL(Shell), Running Python Scripts, Variables, Assignment, Keywords, Input-Output, Indentation.

UNIT–II: (9 Lectures)

Types, Operators and Expressions: Types - Integers, Strings, Booleans, Expressions and order of evaluations, Control Flow- if, if-elif-else, for, while, break, continue, pass.

Data Structures Lists - Operations, Slicing, Methods; Tuples, Sets, Dictionaries, Sequences, Comprehensions..

UNIT–III: (10 Lectures)

Functions - Defining Functions, Calling Functions, Passing Arguments, Keyword Arguments, Default Arguments, Variable-length arguments, Anonymous Functions, Fruitful Functions (Function Returning Values), Scope of the Variables in a Function - Global and Local Variables.

Modules: Creating modules, import statement, from. Import statement, name spacing,

Python packages: Introduction to PIP, Installing Packages via PIP, Using Python Packages

UNIT–IV: (9 Lectures)

Object Oriented Programming OOP in Python: Classes, 'self variable', Methods, Constructor Method, Inheritance, Overriding Methods, Data hiding.

Error and Exceptions: Difference between an error and Exception, Handling Exception, try except block, Raising Exceptions, User Defined Exceptions.

UNIT–V: (9 Lectures)

Brief Tour of the Standard Library & Files - Operating System Interface - String Pattern Matching, Mathematics, Internet Access, Dates and Times, Data Compression, Multithreading, GUI Programming, Turtle Graphics, file operations.

Text Books:

1. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2^{nd} edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/thinkpython/).
2. Guido van Rossum and Fred L. Drake Jr, "An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2011.

Reference Books:

1. John V Guttag, "Introduction to Computation and Programming Using Python", Revised and expanded Edition, MIT Press , 2013
2. Kenneth A. Lambert, "Fundamentals of Python: First Programs", CENGAGE Learning, 2012.
3. Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.
4. Charles Dierbach, "Introduction to Computer Science using Python: A Computational Problem Solving Focus, Wiley India Edition, 2013.

Web Resources:

1. `https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/`
2. `https://www.codecademy.com/learn/learn-python`
3. `https://www.codementor.io/collections/learn-python-bwbc63ulz`
4. `http://www.diveintopython3.net/`
5. `https://www.python.org/3/`
6. `https://www.learnpython.org`

Course Code	Course Name	Course Structure			
		L	T	P	C
P21BSL02	Engineering Physics Lab	0	0	3	1.5

Internal Marks: 15 External Marks: 35

Course Prerequisite: The basics of analytical and conceptual understanding of physics.

Course Objectives: The student will be able to

1. Deploy scientific method of experiments in the laboratory.
2. Develop the procedures and observational skills for appropriate use of simple and complex apparatus.
3. Enable analytical techniques, statistical analysis and graphical analysis.
4. Reinforce ideas and concepts covered in lecture host of experiments.
5. Train to find the radius of curvature of a Plano-convex lens forming Newton's rings.

Course Outcomes: After going through this course the student will be able to

1. Apply the phenomenon of interference and diffraction of light waves.
2. HImplement the concept of resonance in LCR circuit and sonometer.
3. HM toAnalyze the S determine its dependent properties.
4. Evaluate the behavior of electronic components and its characteristics.

LIST OF EXPERIMENTS: (any eight of the following to be done)

1. Determination of Radius of Curvature of Plano-Convex lens by forming Newton's Rings.
2. Determination of Wavelengths of various spectral lines using diffraction grating with the normal incidence method.
3. Study of magnetic field along the axis of a current carrying coil and to verify Stewart-Gee's method.
4. Determination of energy gap of PN junction Diode.
5. Determination of hall coefficient and carrier concentration using Hall effect
6. Study of V-I characteristics of Zener diode.
7. Determination of frequency of a vibrating bar or electrical tuning fork using Melde's apparatus.
8. Determination of acceleration due to gravity using compound pendulum
9. Verification of laws of transverse waves by Sonometer.
10. Determination of Velocity of sound by volume resonator.
11. Determination of rigidity modulus by Torsional Pendulum.

Course Code	Course Name	Course Structure			
		L	T	P	C
P21ESL04	Engineering Workshop	0	0	3	1.5

Internal Marks: 15 External Marks: 35

Course Prerequisite: NIL

Course Objectives: The student will be able

1. To provide hands on experience about use of different engineering materials, tools, equipment and processes those are common in the engineering field.
2. To provide the students hands on experience to make different joints in carpentry with hand tools like jack plane, various chisels & hand saws.
3. To provide the students hands on experience to make different joints in Sheet metal work with hand tools like snips, stacks, nylon mallets etc.
4. To provide the students hands on experience to make different connections in house wiring with hand tools like cutting pliers ,tester ,lamps& lamp holders etc.
5. To develop a right attitude, team working, precision and safety at work place.

Course Outcomes: At the end of the course, the student will be able to

1. Identify and use marking out tools, hand tools, measuring equipment and to work to prescribed tolerances.
2. Familiarize with the basics of tools and equipment used in Carpentry.
3. Fabricate various basic components using Sheet metal.
4. Apply basic electrical engineering knowledge for house wiring practice.
5. Gain the hands on experience to form different models in Black smithy.

LIST OF EXPERIMENTS:

Minimum ONE experiment among the four, should be conducted from each trade. The Exercise in each trade should be conducted.

1. **Carpentry** **(6 Lectures)**

   (a) Cross-Lap joint

   (b) Dove tail joint

   (c) T - Lap joint

   (d) Mortise & Tenon joint

   Exercise: To make a wood product – Roof trusses/ King Post/Queen post/Modified queen post etc.,

2. **Fitting** **(6 Lectures)**

   (a) Square fit

   (b) V - Fit

(c) Half round fit

(d) Dovetail fit

Exercise: To make a product by fitting – Rollers support with different profiles per given diagram.

3. **TinSmithy** **(6 Lectures)**

(a) Rectangular Tray

(b) Cylinder

(c) Square box without lid

(d) Funnel

Exercise: To make a small product by tin smithy operations – Tray/ Cone/ Funnels/Motor Covers etc.,

4. **Black Smithy** **(6 Lectures)**

(a) Round rod to Square

(b) S-Hook

(c) Round Rod to Flat Ring

(d) Round Rod to Square headed bolt

Exercise: To make a product by using above methods as per specified dimensions.

5. **House wiring** **(6 Lectures)**

(a) One lamp controlled by one switch

(b) Parallel and Series connections

(c) Fluorescent lamp fitting

(d) Stair case wiring

REFERENCE BOOKS:

1. Work shop Manual / P.Kannaiah/ K.L.Narayana/ SciTech Publishers, 2015.
2. Engineering Practices Lab Manual, Jeyapoovan, SaravanaPandian, Vikas publishers, 2009.
3. Dictionary of Mechanical Engineering, GHF Nayler, Jaico Publishing House, 2003.

Course Code	Course Name	Course Structure			
P21ESL07	Python Programming Lab	L	T	P	C
		0	0	3	1.5

Internal Marks: 15 External Marks: 35

Course Outcomes: At the end of the course, the student can able to

1. Describe the Numbers, Math functions, Strings, List, Tuples and Dictionaries in Python.
2. Express different Decision Making statements and Functions.
3. Interpret object oriented programming in Python.
4. Understand File handling operations.
5. Design GUI Applications.

Exercise1 - Basics

a. Running instructions in Interactive interpreter and a Python Script
b. Write a program to purpose fully raise Indentation Error and Correct it

Exercise 2 - Operations

a. Write a program to compute distance between two points taking input from the user (Pythagorean Theorem).
b. Write a program add.py that takes 2 numbers as command line arguments and prints its sum.

Exercise 3 – Control Flow

a. Write a Program for checking whether the given number is a even number or not.
b. Using a for loop, write a program that prints out the decimal equivalents of 1/2,1/3,1/4,...,1/10.
c. Write a program using a for loop that loops over a sequence. What is sequence?
d. Write a program using a while loop that asks the user for a number, and prints a count down from that number to zero.

Exercise 4 – Control Flow-Continued

a. Find the sum of all the primes below two million. Each new term in the Fibonacci sequence is generated by adding the previous two terms. By starting with 1 and 2, the first 10 terms will be:1, 2, 3, 5, 8, 13, 21, 34, 55, 89, ...
b. By considering the terms in the Fibonacci sequence whose values do not exceed four million, find the sum of the even-valued terms.

Exercise 5 - DS

a. Write a program to count the numbers of characters in the string and store them in a dictionary data structure.

b. Write a program to use split and join methods in the string and trace a birth day with a dictionary data structure.

Exercise 6- DS-Continued

a. Write a program combine lists that combines these lists into a dictionary.
b. Write a program to count frequency of characters in a given file. Can you use character frequency to tell whether the given file is a Python program file, C program file or a text file?

Exercise 7 - Files

a. Write a program to print each line of a file in reverse order.
b. Write a program to compute the number of characters, words and lines in a file.

Exercise 8 - Functions

a. Write a function dups to find all duplicates in the list.
b. b) Write a function unique to find all the unique elements of a list.

Exercise 9 - Functions –Problem Solving

a. Write a function cumulative product to compute cumulative product of a list of numbers.
b. Write a function reverse to reverse a list. Without using the reverse function.
c. Write function to compute gcd, lcm of two numbers. Each function shouldn't exceed one line.

Exercise 10 – Multi - D Lists

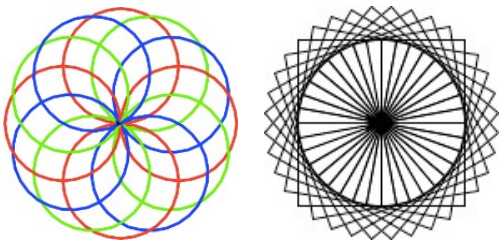
a. Write a program to perform addition of two square matrices.
b. Write a program to perform multiplication of two square matrices.

Exercise 11 - OOP

Class variables and instance variable and illustration of the self variable
i)Robot.
ii)ATM Machine.

Exercise - 12 GUI, Graphics

a. Write a GUI for an Expression Calculator using tk.
b. Write a program to implement the following figures using turtle



Course Code	Course Name	Course Structure			
		L	T	P	C
P21MCT02	Biology for Engineering	2	0	0	0

Internal Marks: 30 External Marks: 70

Course Prerequisite: Nill

Course Objectives: The student will be able to

1. Overall understanding of living organisms and their characteristics
2. Basic understating of the biological principles of cell biology
3. Awareness on basic organization of organisms
4. Understanding about the machinery of the cell functions
5. Basic knowledge on biological problems that requires engineering expertise

Course Outcomes: After going through this course, the student will be able to

1. The overview ofbiological observations that lead to major discoveries.
2. The concept of the cell,various stages of cell cycle, ultrastructure of Eukaryotic cell, Glycolysis and Krebs cycle
3. Analysis of biomolecules, identification of DNA in the molecular basis
4. The concepts of recessiveness and dominance during the passage of genetic-material from parent to offspring
5. Chromosomal disorders, the concept of origin of life with detailed description of Darwinian evolution and Lamarckism

UNIT–I: History of Biology (6 Lectures)

Science and Engineering; Definition of Biology, Characteristics of living organisms, Diversity in the living world, Applications of biology; **Biological classification of organisms:**Nomenclature, History of biological classification, Systematic Hierarchy, **Classification of the five kingdoms:** Monera, Protista, Fungi, Plantae and animalia.

Major contributions of prominent scientists: Aristotle,Antonie van Leeuwenhoek, Linnaeus, William Harvey, Louis Pasteur,Watson & Crick,Charles Darwin, Salim-Moizuddin Abdul Ali and YellapragadaSubbarao.

UNIT–II: Cell Biologyand Immunology (6 Lectures)

Ultra structure of animal cell: Plasma membrane, Golgi complex, Endoplasmic reticulum, Mitochondria,Glycolysis, Kreb's cycle, Lysosomes, Ribosomes, chromosomes, and Nucleus.Cell divisions: Cell cycle stages, Mitotic phase, meiosis.

Immunity: Innate immunity, Acquired immunity.Immunoglobulins: structure and biological properties of immunoglobulin classes, Immune disorder: AIDS.

UNIT–III: Biomolecules (6 Lectures)

Introduction, properties of biomolecules,Carbohydrates:structure, classifications andfunctions of carbohydrates.Proteins:structure, classification and functions of proteins. Lipids:characteristic features of lipids, important functions in biological systems, classification of lipids and vitamins.

Nucleic acids: structure and properties of DNA & RNA.Enzymes: Mode of action of enzymes, properties of enzymes, classification and nomenclature of enzymes, importance of enzymes.

UNIT–IV: Genetics and Evolution (6 Lectures)

Introduction, reasons for Mendel's success, characters selected by Mendel, Mandel's laws:1. Law of dominance 2.Law of segregation or Law of purity of gametes 3.Law of independent assortment. Monohybrid cross,Dihybrid cross, Test cross, back cross. Multiple alleles and Blood grouping, Sex determination in human.Chromosomal disorders in human- Klinefelter's syndrome, Turner's syndrome and Down's syndrome.Protein synthesis: Transcription and Translation.

Evolution: Evolutionary concepts: Theory of special creation, Cosmozoic theory, Theory of spontaneous generation or abiogenesis, Biogenesis theory, Theory of catastrophism, Theory of organic evolution. Origin of life: Primitive atmosphere and molecules, Biological evolution, Experimental chemical origin of life.Theories of evolution: Lamarckism and Darwinism.

UNIT–V: Human Health & Diseases And Applied Biology (6 Lectures)

Common diseases in humans: Health, Disease, Pathogens, Transmission, Bacterial diseases: Typhoid, Pneumonia, Diphtheria, Tetanus, Plague, Cholera, Tuberculosis, Syphilis, Gonorrhoea,Leprosy, Peptic ulcers;Viral diseases:Common cold, Measles, Rubella, Rabies, Chickenpox, Flu,Smallpox, Chikungunya, Poliomyelitis, AIDS;Fungal diseases: Ringworm;Protozoan diseases:Malaria, Amoebic dysentery and Helminth diseases: Filariasis, Ascariasis.

Applied Biology:rDNA technology; Industrial use of microorganisms- alcohols, acids and vitamins; enzymes, pollution control, vaccines, hormones.Monoclonal antibodies and stem cells.

Reference Books:

1. Biology: A global approach: Campbell, N.A.; Reece, J.B.; Urry, Lisa; Cain, M, L.; Wasserman, S. A.; Minorsky, P.V.; Jackson, R. B. Pearson Education Ltd
2. Outlines of Biochemistry, Conn, E.E; Stumpf, P.K; Bruening, G; Doi, R.H., John Wiley and Sons
3. Principles of Biochemistry (V Edition), By Nelson, D. L.; and Cox, M. M.W.H. Freeman and Company
4. Molecular Genetics (Second edition), Stent, G. S.; and Calender, R.W.H. Freeman and company, Distributed by Satish Kumar Jain for CBS Publisher
5. Microbiology, Prescott, L.M J.P. Harley and C.A. Klein 1995. 2nd edition Wm, C. Brown Publishers

Web Resources:

1. Human health and diseases:`https://www.emedicalprep.com/study-material/biology/biology-in-human-lefare/human-health-and-disease`

2. Aristotle's biology: https://en.wikipedia.org/wiki/Aristotle%27s_biology.
3. Sir Ronald Ross:https://en.wikipedia.org/wiki/Ronald_Ross.
4. Recombinant DNA Technology:https://microbenotes.com/recombinant-dna-/technology-steps-applications-and-limitations/
5. Nucleic acids:https://www.khanacademy.org/science/ap-biology/gene-/expression-and-regulation/dna-and-rna-structure/a/nucleic-acids.

Course Code	Course Name	Course Structure			
P21BST08	Transformation Techniques and Differential Equations	L	T	P	C
		3	0	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite:

1) Differentiation
2) Integration

Course Objectives: The student will be able

1. To understand Fourier series representation of Periodic signals.
2. To The Fourier transform can be used to interpolate functions and to smooth signals.
3. To solve finite difference equations using Z-transforms.
4. To enlighten the learners in the concept of differential equations and multivariable calculus.
5. To equip the students with standard concepts and tools at an intermediate to advanced level mathematics to develop the confidence and ability among the students to handle various real-world problems and their applications.

Course Outcomes: At the end of the course, student will be able to

1. Find or compute the Fourier series of periodic signals.
2. Know and be able to apply integral expressions for the forwards and inverse Fourier transform to range of non-periodic waveforms.
3. Solving methods for finite difference equations using Z-transforms.
4. Familiarize with functions of several variables which is useful in optimization.
5. Identify the solution methods for partial differential equation related to various engineering fields.

UNIT–I: Fourier series (9 Lectures)

Fourier series: Introduction – Periodic functions – Fourier series of periodic function –Dirichlet's conditions – Even and odd functions – Change of interval – Half-range sine and cosine series.

UNIT–II: Fourier Transforms (10 Lectures)

Fourier Transforms: Fourier integral theorem (without proof) –Fourier sine and cosine integrals– Sine and cosine transforms –Properties–inverse transforms –Finite Fourier transforms.

UNIT–III: Z-TRANSFORMS (8 Lectures)

Introduction-properties-Damping rule-Shifting rule-Initial and Final value theorems – Inverse Z transform-Convolution theorem-Solution of difference equation by Z-transform

UNIT–IV: Partial differentiation (10 Lectures)

Introduction – Homogeneous function – Euler's theorem – Total derivative – Chain

rule – Jacobian – Functional dependence – Taylor's and Mc Laurent's series expansion of functions of two variables.
Applications: Maxima and Minima of functions of two variables without constraints and Lagrange's method (with constraints).

UNIT–V: PDE of first order & Second order and Applications (10 Lectures)

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Solutions of first order linear (Lagrange) equation and nonlinear (standard types) equations.
Second order PDE: Solutions of linear partial differential equations with constant coefficient – RHS term of the type e^{ax+by} , sin(ax+ by) , cos(ax+ by), $x^m\ y^n$
Applications of PDE: Method of separation of Variables

Text Books:

1. B. S. Grewal, Higher Engineering Mathematics, 44^{th} Edition, Khanna Publishers.
2. B.V. Ramana, Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.

Reference Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10^{th} Edition, Wiley-India.
2. H. K. Das, Advanced Engineering Mathematics, 22^{nd} Edition, S. Chand & Company Ltd.
3. David Poole, Linear Algebra- A modern introduction, 4^{th} edition, Cengage.
4. Peter O' Neil, Advanced Engineering Mathematics, Cengage
5. Srimantha Pal, S C Bhunia, Engineering Mathematics, Oxford University Press.

text Web Resources:

1. `http://tutorial.math.lamar.edu/Classes/DE/DE.aspx`
2. `http://mathworld.wolfram.com/topics`
3. `http://www.nptel.ac.in/course.php`

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MET01	Metallurgy & Material Science	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite: Engineering Chemistry and Engineering Physics

Course Objectives: The student will be able

1. To acquire the fundamentals of Material science, Physical metallurgy Crystallization of metals.
2. To gain the knowledge different binary phase diagrams various alloys.
3. To study the properties and practical applications of cast irons and steels.
4. To study the affect of various alloying elements on iron-iron carbide system and heat treatment processes used in practical applications.
5. To study the properties and applications of ceramic, composite and other advanced materials.

Course Outcomes: After completion of the course the student will be able to

1. Acquire the knowledge related to the structure and properties of materials and crystal systems
2. Understand the phase diagrams of various alloys.
3. Understand the properties of ferrous materials and their engineering applications.
4. Understand the basic concepts of Heat treatment processes and their applications.
5. Gain knowledge on nonferrous materials, composite materials and basic steps involved in the Powder Metallurgy process.

UNIT–I: Structure of Metals and Constitution of Alloys (10 Lectures)

Bonds in Solids– Ionic, Covalent and Metallic bonds; Classification of solids – Amorphous and Crystalline solid, Crystal structure-BCC, FCC, HCP.

Crystallization of metals– Nuclei formation and Crystal growth, grain and grain boundaries, effect of grain boundaries on the properties of metal / alloys, Grain size and methods of grain size measurements; Necessity of alloying, types of solid solutions- substitutional solid solutions and Hume-Rothery rules of solid solubility, interstitial solid solutions,

UNIT–II: (9 Lectures)

Equilibrium Diagrams: Introduction to Phase and Phase diagrams with its Importance and types-Unary, Binary and Ternary phase diagrams; Experimental methods of construction of equilibrium diagrams, Lever rule , Study of important binary phase diagrams of Fe-Fe3C and Cu -Ni.Micro constituents in steels- Austenite, Isomorphous alloy systems Ferrite, Cementite, Pearlite, Bainite, Martenite; eutectic, peritectic, eutectoid and peritectoid reactions. Cooling curve of pure iron, Lever Rule, Gibbs Phase Rule.

UNIT–III: **(8 Lectures)**

Steels: Introduction, Classification and Influence of constituents on steel; Structure, properties and applications of plain carbon steels; Alloy steels-Purpose and effect of alloying elements; Properties of - manganese steels, Stainless steels, tool and die steels.

Cast Irons: Introduction, comparison with steels and Classification; Structure and properties of White Cast iron, Malleable Cast iron, grey cast iron, S.G. cast iron.

UNIT–IV: **(9 Lectures)**

Heat Treatment of Alloys: Introduction to furnaces and purpose of heat treatment; Process and applications of Annealing, normalizing, Hardening and tempering; Effect of cooling on austenite transformation, TTT diagrams, Hardenability and factors affect hardening; Surface Hardening of Steels- Carburizing, Nitriding, Cyaniding ,

Non-Ferrous Metals and Alloys: Structure and properties of Copper and its alloys, Aluminium and its alloys, Titanium and its alloys, Magnesium and its alloys, Super alloys.

UNIT–V: **(9 Lectures)**

Ceramics: Introduction; Crystalline ceramics, glasses, ceramets, abrasive materials.

Composite Materials: Composites- Introduction, types-particle reinforced, fiber reinforced and structural composites, applications and reinforcing materials.

Text Books:

1. Introduction to Physical Metallurgy - Sidney H. Avener - McGrawHill, 2007
2. Essential of Materials science and engineering - Donald R.Askeland - Cengage, 2019.
3. KennethG.Budinski and Michael K.Budinski “Engineering Materials” Prentice-Hall of India Private Limited, 4 th Indian Reprint 2002

Reference Books:

1. Material Science and Metallurgy – Dr. V.D.Kodgire, Everest Publishing House, 2018.
2. Materials Science and engineering - Callister & Balasubrahmanyam, Wiley India Pvt. Limited, 2009.
3. Material Science for Engineering students – Fischer – Elsevier Publishers, 2009.
4. Material science and Engineering - V. Rahghavan, PHI publishers, 2015
5. Introduction to Material Science & Engineering byYipWah Chung CRC Press, 2010.

6. Material Science and Metallurgy – A V K Suryanarayana – B S Publications, 2014.
7. Material Science and Metallurgy – U. C. Jindal – Pearson Publication, 2012.
8. Material Science and Engineering by William D Callsber John Wiley and Sons 1997.

Web Resources:

1. www.nature.com
2. www.synl.ac.cn
3. www.web.archive.org
4. www.nptel.ac.in

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MET02	Mechanics of Solids	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite: Engineering Mechanics.

Course Objectives: The student will be able

1. To extend knowledge of various stresses-strains poisons ratio and strain energy in members under different loadings.
2. To describe and analyze the shear force and bending moment diagrams of various beams subjected to different loads.
3. To come across the flexural stresses, section modulus and the distribution of shear stress in the beams of various sections.
4. To find slope and deflection for different support arrangements by Double integration method, Macaulay's method and Moment-Area and also problem solving techniques.
5. To analyze stresses induced and the failure criterion in Thin and Thick cylinders.

Course Outcomes: After completion of the course the student will be able to

1. Apply the fundamental concepts of stress, strain and analyze the stresses on inclined planes for solids.
2. Analyze and design the shear force and bending moment diagrams for various types of beams under different loads.
3. Compute the bending stress and shear stress induced in the beams for various cross sections.
4. Interpret the slope and deflection of beams by Double Integration method and Macaulay's method.
5. Evaluate the stresses and deformation in thin, thick cylinders and spherical shells

UNIT–I: (9 Lectures)

SIMPLE STRESSES AND STRAINS: Elasticity and plasticity – Types of stresses and strains – Hooke's law – stress – strain diagram for mild steel – Working stress – Factor of safety – Lateral strain, Poisson's ratio and volumetric strain – Elastic modulus and the relationship between them – Bars of varying section – composite bars –Temperature stresses. Strain energy – Resilience – Gradual, sudden, impact and shock loadings.

UNIT–II: (9 Lectures)

SHEAR FORCE AND BENDING MOMENT: Definition of beam – Types of beams – Concept of shear force and bending moment – S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, U.D.L,

uniformly varying loads and combination of these loads – Point of contra flexure – Relation between S.F, B.M and rate of loading at a section of a beam.

UNIT–III: (9 Lectures)

FLEXURAL STRESSES AND SHEAR STRESSES: Theory of simple bending – Assumptions – Derivation of bending equation: M/ I = f/y = E/R Neutral axis – Determination bending stresses – section modulus of rectangular and circular sections(Solid and Hollow), I,T, Angle and Channel sections Derivation of formula – Shear stress distribution across various beams sections like rectangular, circular, triangular, I, T angle sections.

UNIT–IV: (9 Lectures)

DEFLECTION OF BEAMS: Bending into a circular arc – slope, deflection and radius of curvature – Differential equation for the elastic line of a beam – Double integration and Macaulay's methods – Determination of slope and deflection for cantilever and simply supported beams subjected to point loads, - U.D.L. uniformly varying load. Mohr's theorems – Moment area method – application to simple cases including overhanging beams.

UNIT–V: (9 Lectures)

THIN CYLINDERS AND THICK CYLINDERS: Thin seamless cylindrical shells – Derivation of formula for longitudinal and circumferential stresses – hoop, longitudinal and volumetric strains – changes in dia, and volume of thin cylinders – Riveted boiler shells – Thin spherical shells- lame's equation – cylinders subjected to inside & outside pressures –compound cylinders.

Text Books:

1. Strength of Materials, S.S.Rattan., Tata McGraw-Hill Education, 2011.
2. A Textbook of Strength of Materials, R. K. Bansal., Laxmi Publications, 2010.
3. Strength of Materials, Geoffrey Harwood Ryder., Macmillan, 1961.

Reference Books:

1. Mechanics of Materials, SI Edition, James M. Gere, Barry J. Goodno., 8^{th} Edition, Cengage Learning, 2012.
2. Hibbeler, R.C., Mechanics of Materials, Hibbeler, R.C., Pearson Education, Low Price Edition, 2007.
3. Strength of Materials by R.S. Khurmi; S. Chand & Co. 2005

Web Resources:

1. `www.tutorialspoint.comp`
2. `www.nist.gov`
3. `www.swayam.gov.in`

4. www.mechanicalc.com

5. www.web.mst.edu

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MET03	Fluid Mechanics & Hydraulic Machines	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite: Engineering Mechanics, Mathematics.

Course Objectives: The student will be able

1. To know the properties of fluids and concept of control volume.
2. To analyse the applications of the laws of conservation for closed conduit flow.
3. To understand the importance of dimensional analysis.
4. To understand the impact force acting on different positioned and angled vanes.
5. To understand the importance of various types of flow in turbines and pumps.

Course Outcomes: After completion of the course the student will be able to

1. Understand the properties like viscosity, surface tension and vapor pressure.
2. Calculate the flow rates using pilot tube, venturimeter, and orifice meter, Flow nozzle and Turbine flow meter.
3. Understand the Bernoulli's equations, Darcy Weisbach equation, Minor losses.
4. Understand the impact of jets and operation of hydraulic machineries.
5. Evaluate the performance characteristics of hydraulic turbines & pumps . Also a little knowledge on hydraulic systems and fluidics is imparted to the student.

UNIT–I: (9 Lectures)

FLUID STATICS: Dimensions and units: physical properties of fluids - specific gravity, viscosity and its Significance, surface tension, capillarity, and vapor pressure. Atmospheric, gauge and vacuum pressure, Measurement of pressure – Manometers - Piezometer, U-tube, inverted and differential manometers. Pascal's & hydrostatic laws.

UNIT–II: (9 Lectures)

FLUID KINEMATICS: Introduction, flow types. Equation of continuity for one dimensional flow, Circulation and vorticity, Stream line, path line and streak lines and stream tube. Stream function and Velocity potential function, differences and relation between them. Condition for irrotational flow, flownet, source and sink, doublet and vortex flow.

FLUID DYNAMICS: surface and body forces –Euler's and Bernoulli's equations for flow along a stream Line, momentum equation and its applications, force on pipe bend.

UNIT–III: (9 Lectures)

CLOSED CONDUIT FLOW: Reynolds's experiment- Darcy Weisbach equation- Minor losses in pipes- pipes in series and pipes in parallel- total energy line-hydraulic gradient line

BASICS OF TURBO MACHINERY: hydrodynamic force of jets on stationary and moving flat, inclined, and curved vanes, jet striking centrally and at tip, velocity diagrams, work done and efficiency, flow Over radial vanes.

UNIT–IV: (9 Lectures)

HYDRAULIC TURBINES: classification of turbines, impulse and reaction turbines, Pelton wheel, Francis turbine and Kaplan turbine-working proportions, work done, efficiencies, hydraulic design – Draft tube- theory- functions and efficiency.

PERFORMANCE OF HYDRAULIC TURBINES: Geometric similarity, Unit and specific quantities, characteristic Curves, governing of turbines, selection of type of turbine, cavitation, surge tank, water hammer. Hydraulic systems- hydraulic ram, hydraulic lift, hydraulic coupling. Fluidics – amplifiers, sensors and Oscillators. Advantages, limitations and applications.

UNIT–V: (9 Lectures)

CENTRIFUGAL PUMPS: classification, working, work done – manometric head-losses and efficiencies specific Speed- pumps in series and parallel-performance characteristic curves, cavitations & NPSH.

RECIPROCATING PUMPS: Working, Discharge, slip, indicator diagrams.

Text Books:

1. Hydraulics, fluid mechanics and Hydraulic machinery MODI and SETH, Rajsons Publications Pvt. Limited, 2017
2. Fluid Mechanics and Hydraulic Machines by Rajput, SCHAND publications, 2016.
3. Fluid Mechanics and Hydraulic Machines by RK Bansal, Laxmi Publications (P) Ltd, 2018.

Reference Books:

1. Fluid Mechanics and Hydraulic Machines by RK Bansal, Laxmi Publications (P) Ltd, 2018.
2. Fluid Mechanics and Machinery by D. Rama Durgaiah, New Age International, 2007.
3. Instrumentation for Engineering Measurements by James W. Dally, William E. Riley ,John Wiley & Sons Inc. 2004 (Chapter 12 – Fluid Flow Measurements)
4. Fluid Mechanics and Hydraulic Machines by Domkundwar & Domkundwar, Dhanpatrai & Co, 2016.

Web Resources:

1. www.mechengg.net
2. www.efluids.com
3. www.hydraulic-machines.com

Course Code	Course Name	Course Structure			
P21MET04	Thermodynamics	L	T	P	C
		3	0	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite: Engineering Physics, Mathematics-I & II.

Course Objectives: The student will be able

1. To understand the concepts of heat, work, energy, and different laws of thermodynamics.
2. To familiarize the basic understanding of entropy, availability, and its application to open and closed systems &concepts of Thermodynamic relations,.
3. To impart the concepts of Properties of pure substance and steam calculations.
4. To introduce the concepts of gas power cycles.
5. To familiarize refrigeration and air conditions concepts and understand the working principles.

Course Outcomes: After completion of the course the student will be able to

1. The student will demonstrate basic understanding and knowledge of thermodynamic properties and different laws of thermodynamics.
2. The student will describe basic knowledge of entropy, availability, and its application to open and closed systems.
3. The student will explain basic understanding of Thermodynamic relation and steam based analysis.
4. The student will demonstrate the knowledge of gas power cycles and their analysis.
5. The student will explain the basic understanding of Refrigeration and Air conditioning principles.

UNIT–I: (9 Lectures)

BASIC CONCEPTS AND FIRST LAW: System, boundary, Surrounding, control volume, Universe, Types of Systems, Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic Equilibrium, State, Property, Process, Cycle – Reversibility – Quasi – static Process, Irreversible Process, Causes of Irreversibility – Energy in State and in Transition, Types, Work and Heat, Point and Path function. Zeroth Law of Thermodynamics – Concept of Temperature – Principles of Thermometry –Reference Points – Constant Volume gas Thermometer – Scales of Temperature, Ideal Gas Scale, Joule's Experiments – First law of Thermodynamics – Corollaries – First law applied to a Process – applied to a flow system – Steady Flow Energy Equation. PMM-I, throttling and free expansion processes.

UNIT–II: (9 Lectures)

SECOND LAW, AVAILABILITY AND IRREVERSIBILITY: Limitations of the First

Law – Thermal Reservoir, Heat Engine, Heat pump, Refrigerator, Coefficient of performance, Second Law of Thermodynamics, Kelvin-Planck and Clausius Statements and their Equivalence / Corollaries, PMM of Second kind, Carnot's principle, Carnot cycle and its specialties, Thermodynamic scale of Temperature, Clausius Inequality, Concept of Entropy, Principle of Entropy Increase – Energy Equation, Availability and Irreversibility – Thermodynamic Potentials, Gibbs and Helmholtz Functions, Maxwell Relations, Tds relations – Elementary Treatment of Third Law of Thermodynamics.

UNIT–III: (9 Lectures)

PROPERTIES OF PURE SUBSTANCE: Pure Substances, P-V-T surfaces, T-s and h-s diagram, Mollier chart, dryness fraction, property tables, analysis of steam undergoing various thermodynamic processes using Mollier chart– steam calorimetry. Vapour Power Cycles: simple Rankine cycle, concepts of regeneration and reheat, analysis of Rankine Cycle.

UNIT–IV: (9 Lectures)

GAS POWER CYCLES: Otto, Diesel and dual cycles, Brayton cycle, Sterling Cycle, Atkinson Cycle, Ericsson Cycle, Lenoir Cycle, representation on P-V and T -S diagrams - description and efficiencies, mean effective pressures. Comparison of Otto, Diesel, and dual cycle.

UNIT–V: (9 Lectures)

REFRIGERATION: Bell-Coleman cycle - vapour compression cycle, effect of vapour condition on COP of VCR, vapour absorption cycle, properties of common refrigerants.

PSYCHOMETRY AND AIR CONDITIONING: Psychometric terms, psychometric processes and air conditioning systems.

Text Books:

1. Engineering Thermodynamics, PK Nag 4^{th} Edn , TMH, 2013.
2. Thermodynamics – An Engineering Approach with student resources DVD – Y.A.Cengel&M.A.Boles , 7^{th} Edn – McGrawHill
3. R.K.Rajput, "A Text Book of Engineering Thermodynamics ", Fifth Edition, 2017.

Reference Books:

1. FEngineering Thermodynamics – Jones & Dugan PHI, 2007.
2. Thermodynamics – J.P.Holman, McGrawHill, 2008.
3. Basic Engineering Thermodynamics – A.Venkatesh – Universities press, 2016.
4. An Introduction to Thermodynamics - Y.V.C.Rao – Universities press, 2005.
5. Thermodynamics – W.Z.Black&J.G.Hartley, 3^{rd} Edn Pearson Publ.
6. Engineering Thermodynamics – D.P.Misra, Cengage Publ.

7. Engineering Thermodynamics – P.Chattopadhyay – Oxford Higher Edn Publ.

Web Resources:

1. www.nptel.ac.in
2. www.ihed.ras.ru/thermo/thermo_inet.htm
3. www.hyperphysics.phy-astr.gsu.edu
4. www.onlinelibrary.wiley.com

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MEL01	Fluid Mechanics & Hydraulic Machines Lab	0	0	3	1.5

Internal Marks: 15 External Marks: 35

Course Prerequisite: Engineering mechanics, Mathematics.

Course Objectives:

To impart practical exposure on the performance evaluation methods of various flow measuring equipment and hydraulic turbines and pumps.

Course Outcomes: At the end of the course, the student will be able to

1. Calculate the pressure using various manometers.
2. Calculate the discharge of various equipment's.
3. Calculate the friction factor of different pipes
4. Conduct performance tests on various pumps and turbines.
5. Identify the force on different vanes.

LIST OF EXPERIMENTS:

Conduct any 12 of the 15 experiments.

1. Impact of jets on Vanes.
2. Performance Test on Pelton Wheel.
3. Performance Test on Francis Turbine.
4. Performance Test on Kaplan Turbine.
5. Performance Test on Single Stage Centrifugal Pump.
6. Performance Test on Multi Stage Centrifugal Pump.
7. Performance Test on Reciprocating Pump.
8. Calibration of Venturi meter.
9. Calibration of Orifice meter.
10. Determination of friction factor for a given pipe line.
11. Determination of loss of head due to sudden contraction in a pipeline.
12. Turbine flow meter.
13. Bernoulli's Theorem Apparatus
14. Reynolds's Apparatus
15. Determination of Co-efficient of Discharge for an Mouth Piece and Orifice

Course Code	Course Name	Course Structure			
P21MEL02	Metallurgy Lab	L	T	P	C
		0	0	3	1.5

Internal Marks: 15 External Marks: 35

Course Prerequisite: Metallurgy & Material Science

Course Objectives: The students will be able

To impart practical exposure on the microstructures of various materials and practical knowledge on the evaluation of material properties through various destructive testing procedures.

Course Outcomes: At the end of the course, the student will be able to

1. Acquire the knowledge related to the structure and properties of materials and crystal systems.
2. Experiment with different materials for the evaluation of material properties through various destructive testing procedures.
3. Examine the microstructures of different materials and also identify the hardness values.
4. Characterize microstructures of engineering alloys using optical microscopy and image analyzer.

LIST OF EXPERIMENTS:

1. Study of crystal models for simple cubic, body centered cubic, and face centered cubic and hexagonal close packed structures.
2. Study of the Micro Structure of pure metals like Iron, Cu and Al.
3. Grain size measurement by different methods.
4. Study of the Microstructure of Mild steels, low carbon & high carbon steels.
5. Study of the Micro Structures of Cast Irons.
6. Study of the Micro Structures of Non-Ferrous alloys.
7. Study of the Micro structures of Heat treated steels.
8. Study of Microstructures of different alloy steels.
9. To find the hardenability of steels by Jominy End Quench Test.
10. To find out the hardness of various treated and untreated steels.

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MEL03	Mechanics of Solids Lab	0	0	3	1.5

Internal Marks: 15 External Marks: 35

Course Prerequisite: Chemistry & Physics.

Course Objectives: The students will be to

1. Impart practical knowledge on the evaluation of material properties through various destructive testing procedures.
2. The student will perform tests on materials in tension, compression, torsion, bending, and impact.
3. These conditions and/or constraints are designed to reinforce classroom theory by having the student perform required tests, analyze subsequent data, and present the results in a professionally prepared report.

Course Outcomes: At the end of the course, the student will be able to

1. Conduct tension test on steel, aluminum, copper and brass.
2. Perform compression tests on spring and wood.
3. Determine elastic constants using flexural and torsion tests.
4. Determine hardness of metals.

LIST OF EXPERIMENTS:

1. Direct tension test
2. Bending test on simple supported
3. Bending test on cantilever beam
4. Torsion test
5. Brinells hardness test
6. Rockwell hardness test
7. Test on springs
8. Compression test on cube
9. Impact test
10. Punch shear test.

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MES01	Computer Aided Engineering Drawing Practice	1	0	2	2

Internal Marks: 0 External Marks: 50

Course Prerequisite: Engineering Graphics

Course Objectives: The student will be able

1. To import the knowledge on sections of solids and its importance
2. To import the knowledge on development of surfaces and its importance
3. To import the knowledge on intersection of solids in designing and manufacturing
4. To introduce various commands in AutoCAD to draw the geometric entities and to create 2D models.
5. To make the students create geometrical model of simple solids

Course Outcomes: At the end of the course, the student will be able to

1. Student understands how to know the hidden details of machine components with the help of sections.
2. Students get exposed on working of sheet metal with help of development of surfaces.
3. Student understands how to know the hidden details of Interpret three dimensional models
4. Student shall exposed to modeling commands for generating 2D computer aided drafting tools
5. Student shall exposed to modeling commands for generating 3D drafting tools which are useful to create machine elements for computer aided analysis.

PART-A

UNIT-I:

SECTIONS OF SOLIDS: Sections and Sectional views of Right Regular Solids – Prism, Cylinder, Pyramid & Cone.

UNIT-II:

DEVELOPMENT OF SURFACES: Development of Surfaces of Right Regular Solids – Prism, Cylinder, Pyramid, Cone

UNIT-III:

INTERPENETRATION OF RIGHT REGULAR SOLIDS: Intersection of Cylinder Vs Cylinder, Cylinder Vs Prism, Cylinder Vs Cone, Prism Vs Cone

PART-B

UNIT-IV:

INTRODUCTION TO COMPUTER AIDED DRAFTING: Generation of points, lines, curves, polygons, dimensioning. Types of modeling, object selection commands – edit, zoom, cross hatching, pattern filling, 2D wire frame modeling.e

UNIT-V:

COMPUTER AIDED SOLID MODELING: Isometric projections, modeling of 3D simple solids & Modeling of Machine Parts

TEXT BOOKS:

1. Engineering drawing by N.D Bhatt ,Charotarpublications.
2. Engineering Graphics, K.C. john, PHIPublications.
3. Engineering Drawing by K. L. Narayana, Scitech Publications.

REFERENCES:

1. Mastering Auto CAD 2013 and Auto CAD LT 2013 – George Omura,Sybex
2. Auto CAD 2013 fundamentals- Elisemoss, SDCPubl.
3. Engineering Drawing and Graphics using Auto Cad – T Jeyapoovan,vikas
4. Engineering Drawing + AutoCAD – K Venugopal, V. Prabhu Raja, NewAge
5. Engineering Drawing – Agarwal and Agarwal, Mc GrawHil
6. Text book of Engineering Drawing with auto-CAD ,K.venkatareddy/B.S publications.

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MCT03	Environmental Science	2	0	0	0

Internal Marks: 30 External Marks: 70

Course Prerequisite: Basic knowledge about sciences up to intermediate or equivalent level.

Course Objectives: The student will be able to

1. Overall understanding of the natural resources
2. Basic understanding of the ecosystem and its diversity
3. Acquaintance on various environmental challenges induced due to unplanned anthropogenic activities
4. An understanding of the environmental impact of developmental activities
5. Awareness on the social issues, environmental legislation and global treaties

Course Outcomes: After going through this course the student will be able to acquire

1. The concepts of the ecosystem and its function in the environment. The need for protecting the producers and consumers in various ecosystems and their role in the food web
2. The natural resources and their importance for the sustenance of the life and recognize the need to conserve the natural resources
3. Various attributes of the pollution and their impacts and measures to reduce or control the pollution along with waste management practices
4. The biodiversity of India and the threats to biodiversity, and conservation practices to protect the biodiversity
5. Social issues both rural and urban environment and the possible means to combat the challenges and environmental assessment stages involved in EIA and the environmental audit.

UNIT–I: (6 Lectures)

MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES: Definition, Scope and Importance– Need for Public Awareness. Renewable energy Resources, Solar energy-solar cells, solar batteries, wind energy, wind mills, ocean energy, tidal energy and nonrenewable energy resources: LPG, water gas, producer gas. World food problems, degradation and Soil erosion - overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging and salinity.

UNIT–II: (6 Lectures)

ECOSYSTEMS: Concept of an ecosystem. – Structure, Components and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Ecological pyramids - Food chains, food webs and Introduction, types, characteristic features, structure and function of

the following ecosystem: a. Forest ecosystem. b. Grassland ecosystem c. Desert ecosystem d. Aquatic – River and Lake Ecosystems.

UNIT–III: (6 Lectures)

BIODIVERSITY AND ITS CONSERVATION: Introduction, Definition: genetic, species and ecosystem diversity – Bio-geographical classification of India –Value of biodiversity: consumptive use, Productive use, social, ethical and aesthetic values – Biodiversity at global, National and local levels – India as a mega-diversity nation – Hot-spots of biodiversity – Threats to biodiversity: habitat loss, poaching of wildlife, Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

UNIT–IV: (6 Lectures)

ENVIRONMENTAL POLLUTION: Definition, Cause, Effects and Control measures of : a. Air Pollution, b. Water pollution, c. Soil pollution, d. Marine pollution, e. Noise pollution, f. Nuclear hazards.

SOLID WASTE MANAGEMENT: Causes, effects and control measures of urban and industrial wastes

DISASTER MANAGEMENT: Floods, earthquake, cyclone and landslides.

UNIT–V: (6 Lectures)

SOCIAL ISSUES AND THE ENVIRONMENT: From unsustainable to sustainable development – Urban problems related to energy – Water conservation, rain water harvesting and watershed management –Environmental ethics: Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies Population growth – Impacts on society, variation among nations. Environmental Impact Assessment (EIA) and Environmental Protection Acts.

Text Books:

1. Text book of Environmental Studies for Undergraduate Courses by ErachBharucha for University Grants Commission, Universities Press, 2005.
2. Environmental Studies by Benny Joseph, Tata McGraw Hill Co, New Delhi, 2008.

Reference Books:

1. Environmental Science & Engineering by Dr. A. Ravikrishnan, Hitech Publishing Company Pvt. Ltd. 2013.
2. Perspectives in Environmental Studies, Second edition, AnubhaKoushik and C.P. Koushik, New Age International (P) Limited, Publishers, 2004.

Online References:

1. Environmental Science - Oxford Research Encyclopedia
2. Environmental Science - Museum of Science and Industry
3. Collegesat.du.ac.in/UG/Envinromental%20Studies_ebook.pdf

Course Code	Course Name	Course Structure			
		L	T	P	C
P21BST07	Probability & Statistics	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite: Principle of counting, Permutations and Combinations.

Course Objectives: The student will be able

1. To familiarize the students with the foundations of probability and statistical methods.
2. To impart probability concepts and statistical methods in various applications of engineering.

Course Outcomes: At the end of this course, the students will be able to

1. Explain the basic terms of Statistical Inference.
2. Interpret the association of characteristics and through correlation and regression tools.
3. Make the use of the concepts of probability and their applications. Also apply discrete and continuous probability distributions to solve various engineering problems.
4. Understand the various distribution and sampling and identify the estimation errors in sampling distributions.
5. Apply the proper test statistics to test the hypothetical data by Tests of Hypothesis.

UNIT–I: Descriptive Statistics (9 Lectures)

Introduction - Measures of Central tendency - Measures of Variability (Spread or variance) - Moments – Skewness - Kurtosis.

UNIT–II: Curve Fitting and Correlation and Regression (9 Lectures)

Method of least squares - Straight line - Parabola-Exponential curve - Power curve – Correlation - Correlation coefficient - Rank correlation - Regression and Regression lines.

UNIT–III: Probability Theory and Random Variable: (9 Lectures)

Probability Theory: Probability - Axioms of Probability - Elementary theorems - Conditional probability - Baye's theorem (Without Proofs).

Random Variables: Discrete random variable - Distribution function of a discrete random variable - Probability mass function: Properties - Mean and Variance - Continuous random variable - Distribution function - Density function: Properties- Mean and variance.

Probability Distributions: Binomial distribution - Poisson distribution and their fitting to data - Normal distribution - Mean and Variance (Without proof).

UNIT–IV: Sampling theory and Theory of estimation (9 Lectures)

Sampling Theory: Introduction - Population and Samples - Sampling distribution of means (σ known)-Central limit theorem (without proof).

Theory of estimation: Point estimation- Interval estimation - Estimation of one mean and two means - Estimation of one proportion and two proportions.

UNIT–V: Tests of Hypothesis: (9 Lectures)

Introduction – Hypothesis - Null and Alternative Hypothesis - Type I and Type II errors - Level of significance - One tail and two-tail tests -Tests concerning one mean and two means (Large and Small samples) -Tests on proportions.

Text Books:

1. S. C. Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics, 11/e (Reprint) 2019, Sultan Chand & Sons Publications.
2. Miller and Freund's,Probability and Statistics for Engineers, 7/e, Pearson, 2008.

Reference Books:

1. T. K. V. Iyenger, Probability and Statistics, S. Chand & Company Ltd, 2015
2. Jay I. Devore, Probability and Statistics for Engineering and the Sciences, 8^{th} Edition, Cengage.
3. Sheldon M. Ross, Introduction to probability and statistics Engineers and the Scientists, 4^{th} Edition, Academic Foundation, 2011.

Web References:

1. https://leanpub.com/LittleInferenceBook
2. https://www.coursera.org/learn/statistical-inference
3. https://www.datacamp.com/community/open-courses/statistical-inference-and-data-analysis

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MET05	Theory of Machines	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite: Engineering Mechanics.

Course Objectives: The student will be able

1. To understand the kinematics and rigid- body dynamics of kinematically driven machine components
2. To understand the motion of linked mechanisms in terms of the displacement, velocity and acceleration at any point in a rigid link
3. To be able to design cam systems to generate specified output motion.
4. To understand the stability of sea vehicles, aircrafts and automobile vehicles and know the design of flywheel.
5. To identify the suitable governors for the particular application and to determine the unbalanced forces of reciprocating and rotating masses.

Course Outcomes: At the end of this course, the students will be able to

1. Design various types of linkage mechanisms for Obtaining specific motion and analyse them for optimal functioning.
2. Analyze the rigid link and compute the velocity and acceleration at any point in a rigid link.
3. Design the cam and follower arrangements for various applications.
4. Analyze stabilization of sea vehicles, aircrafts and automobile vehicles and design the flywheel.
5. Analyze the various governors and compute unbalanced forces of reciprocating and rotating masses.

UNIT–I: (9 Lectures)

MECHANISMS: Classification of mechanisms-Basic kinematic concepts and definitions-Degree of freedom, mobility- Grashof's law, Kinematic inversions of four bar chain and slider crank chains-Limit positions- Mechanical advantage-Transmission angle-Description of some common mechanisms-Quick return mechanism, straight line generators-Universal Joint-Rocker mechanisms - Toggle Mechanisms.

UNIT–II: (9 Lectures)

VELOCITY AND ACCELERATION DIAGRAMS: Displacement, velocity and acceleration analysis of simple mechanisms - four bar and slider crank mechanisms by graphical and analytical methods - instantaneous centers - velocity and acceleration analysis using loop closure equations - dynamics-Coincident points- Coriolis component of acceleration- introduction to linkage synthesis- three position graphical synthesis for motion and path generation Introduction, force calculations using method of joints and method of sections.

UNIT–III: **(9 Lectures)**

CAMS: Classification of cams and followers-Terminology and definitions-Displacement diagrams- Uniform velocity, parabolic, simple harmonic and cycloidal motions-derivatives of follower motions- specified contour cams- circular and tangent cams-pressure angle and undercutting, sizing of cams, graphical and analytical disc cam profile synthesis for roller and flat face followers

UNIT–IV: **(9 Lectures)**

PRECESSION: Gyroscopes, effect of precession motion on the stability of moving vehicles such as two wheeler and four wheeler - aero planes and ships, static and dynamic force analysis of planar mechanisms.

TURNING MOMENT DIAGRAMS: Dynamic force analysis of slider crank mechanism, inertia torque, angular velocity and acceleration of connecting rod, crank effort and turning moment diagrams- fluctuation of energy – flywheel and their design.

UNIT–V: **(9 Lectures)**

GOVERNORS: Watt, porter and proell governors, spring loaded governors – Hartnell and Hartung with auxiliary springs. Sensitiveness, isochronism and hunting.

BALANCING: Balancing of rotating masses single and multiple – single and different planes, use analytical and graphical methods. Primary, secondary and higher balancing of reciprocating masses, analytical and graphical methods, unbalanced forces and couples.

Text Books:

1. Theory of Machines by Thomas Bevan, 3^{rd} edition, CBS Publishers & Distributors, 2005.
2. Mechanisms of Machines by Cleghorn W.L. , Oxford University Press, 2005.

Reference Books:

1. Kinematics and Dynamics of Machinery by Robert L. Norton, Tata McGrawHill, 2009.
2. Theory of Mechanisms and Machines by Ghosh A. and Mallick A.K., Affiliated East-West Pvt.
3. Mechanism and Machine Theory by JS Rao and RV Dukkipati, New Age publications.

Web References:

1. `https://swayam.gov.in`
2. `https://www.codecogs.com`
3. `https://learnmechanical.com`
4. `https://nptel.ac.in`

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MET06	Thermal Engineering	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite: Thermodynamics

Course Objectives: The course is intended

1. To familiarize the student with the various engine systems along with their function and necessity.
2. To make the students learn about the performance of IC engines,fuel ratings.
3. To study the functions and components of steam nozzles and impulse steam turbines.
4. To make students learn mechanical details, and to calculate power and efficiency of reciprocating compressors and rotary compressors.
5. To study the principles of gas turbines, jet propulsion and rockets.

Course Outcomes: At the end of this course, the students will be able to

1. Understand how internal-combustion engines working principles and the different systems are used in automobile engines.
2. Conduct engine test to determine performance characteristics during combustion processes.
3. Analyse the functions of various steam nozzles and steam flow in steam turbines with velocity triangles.
4. Understand the methods of improving the efficiencies of air compressors.
5. Apply the principles of gas turbines, jet propulsions and rockets for different applications.

UNIT–I: (9 Lectures)

IC Engines: Components, classification and working of IC engines, comparison of two stroke and four stroke engines, comparison of SI and CI Engines, Valve and Port Timing Diagrams, Fuel systems simple carburettor, Multi point fuel injection, Common rail Direct Injection system, Cooling systems and lubricating systems. Ignition system - Battery, Magneto and Electronic systems.

UNIT–II: (9 Lectures)

Performance of IC Engines: Performance test - Measurement of Brake power, Indicated power, Fuel consumption, Air consumption; Heat balance test, Morse test and Retardation test on IC engine. Combustion process -pre ignition, Knocking and detonation, Fuel requirements, Cetane number and Octane number.

UNIT–III: (9 Lectures)

Nozzles and steam turbines: Nozzles: Type of nozzles, Compressible flow through nozzle- condition for maximum discharge -nozzle efficiency. Steam Turbines: Impulse and reaction principles, compounding of steam turbines, velocity diagrams Work done and efficiency.

UNIT–IV: **(9 Lectures)**

Air compressors: Reciprocating Air Compressors: Classification, Operation, Effect of clearance volume, compression ratio, volumetric efficiency, power input, Single-stage and Multi-stage compressors, Effect of inter-cooling, optimum intermediate pressure in a two-stage compressor.

Rotary Compressors: Introduction, Types and their applications, principles of working, Centrifugal compressor working principles-Axial flow compressor working principles - Surging, Choking and Stalling, Centrifugal compressor, axial flow compressor and comparison..

UNIT–V: **(9 Lectures)**

Gas turbines: Brayton cycle, Simple gas turbine plant, closed cycle and open cycle for gas turbines,Regeneration, Intercooling and Reheating, condition for maximum pressure ratio and optimum pressure ratio, actual cycle.

Jet Propulsion: classification of jet propulsive engines – working principles with schematic diagrams and representation on T-S diagram - Ramjet engines, pulsejet engines, turbojet engine, turbofan engine, turboprop engine.

Rocket Propulsion: Rocket engines - rocket engine performance, solid and liquid propellant rockets, comparison of various propulsion systems.

Text Books:

1. Ganesan V, Internal Combustion Engines, Tata McGraw Hill, 2017
2. M.L.Mathur and F.S.Mehta, Thermal Engineering, Jain brothers,2014
3. R K Rajput, Thermal Engineering, lakshmi publications
4. P.L.Ballaney, Thermal Engineering, 2/e, Khanna, 2005.
5. Thermal Engineering-I, Thermal Engineering-II ByPakirappaDurga Publishing House Hyderabad 2017-18

Reference Books:

1. Cengal Y.A and Boles M.A, Thermodynamics: An Engineering Approach, 5/e,
2. Yahya, S. M., Turbines, Compressors and Fans, 4/e, Tata McGraw Hill, 2010
3. Nag P.K, Engineering Thermodynamics, 4/e, Tata McGraw-Hill, 2008
4. Onkar Singh, Thermal Turbomachines, 3/e, Wiley India, 2014

Web References:

1. www.smartzworld.com
2. www.lecturenotes.in
3. www.learnengineering.in
4. www.mechanical.in
5. https://nptel.ac.in

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MET07	Manufacturing Technology	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite: Metallurgy & Material Science

Course Objectives: The course is intended to

1. Understand fundamentals of casting.
2. Provide insight into sand casting and introduce other advanced casting processes.
3. Impart fundamentals of gas welding, arc welding and principles of advanced welding processes and their applications.
4. Impart knowledge on bulk forming processes and powder metallurgy.
5. Understand the various sheet metal forming processes like blanking, piercing, deep drawing and processing of plastics.

Course Outcomes: At the end of this course, the students will be able to

1. Expose and understand the fundamentals of casting
2. Understand the sand casting and other advanced casting processes
3. Understand the various welding processes and their applications
4. Gain knowledge on forging, rolling and extrusion processes.
5. Understand the various sheet metal forming and processing of plastics.

UNIT–I: (9 Lectures)

Casting: Steps involved in making a casting – Advantage of casting and its applications. – Patterns and Pattern making – Types of patterns – Materials used for patterns, pattern allowances and their construction, Principles of Gating, Gating ratio and design of Gating systems

UNIT–II: (8 Lectures)

Methods of melting and types of furnaces, Solidification of castings, Solidification of pure metals and alloys, short & long freezing range alloys. Risers – Types, function and design, casting design considerations, Basic principles and applications of Centrifugal casting, Die casting and Investment casting.

UNIT–III: (10 Lectures)

Welding: Classification of welding processes, types of welded joints and their characteristics, Gas welding, Different types of flames and uses, Oxy – Acetylene Gas cutting. Basic principles of Arc welding, Manual metal arc welding, Sub merged arc welding, Inert Gas welding- TIG & MIG welding. Resistance welding, Solid state welding processes- Friction welding, Friction stir welding, Forge welding, Explosive welding; Thermit welding, Plasma welding, Laser welding, electron beam welding, Soldering & Brazing. Heat affected zones in welding; pre & post heating, weldability of metals, welding defects – causes and remedies – destructive and nondestructive testing of welds, design of welded joints.

UNIT–IV: **(9 Lectures)**

Plastic deformation in metals and alloys: Hot working and Cold working, Strain hardening and annealing. Bulk forming processes: Forging - Types Forging, Smith forging, Drop Forging, Roll forging, Forging hammers, Rotary forging, forging defects; Rolling – fundamentals, types of rolling mills and products, Forces in rolling and power requirements. Extrusion and its characteristics. Types of extrusion, Impact extrusion, Hydrostatic extrusion; Wire drawing and Tube drawing. Introduction to powder metallurgy – compaction and sintering, advantages and applications

UNIT–V: **(9 Lectures)**

Sheet metal forming: Blanking and piercing, Forces and power requirement in these operations, Deep drawing, Stretch forming, Bending, Springback and its remedies, Coining, Spinning, Types of presses and press tools. Processing of Plastics: Types of Plastics, Properties, Applications and their processing methods, Blow and Injection molding.

Text Books:

1. Manufacturing Processes for Engineering Materials - Kalpakjian S and Steven R Schmid- Pearson Publ , 5th Edn, 2007.
2. Fundamentals of Modern Manufacturing - Mikell P Groover- Wiley publ – 3rd Edition, 2009.
3. Manufacturing Technology by P.N. Rao, TMH, 5th Edition, 2013.

Reference Books:

1. Production Technology by R.K. Jain, Khanna Publishers,17th Edition, 2011.
2. Metals Handbook Vol. 5 published by ASM, Ohio, 1994.
3. Foundry Technology – Dharmendra kumar & S.K.Jain, CBS Publisher, 2007.
4. Production Technology- R.K. Jain- Khanna, 2004.
5. Production Technology-P C Sharma-S. Chand, 2006.
6. Manufacturing Processes- H.S. Shaun- Pearson, 2012.
7. Manufacturing Processes- J.P. Kaushish- PHI, 2010.

Web References:

1. www.elsevier.com/books/foundry-technology/beeley
2. www.lecturenotes.in
3. www.zollern.com
4. www.slideshare.net
5. www.sciencedirect.com

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MBT02	Industrial Engineering & Management	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite: Nil

Course Objectives: The course is intended to

1. To impart fundamental knowledge and skill sets required in the Industrial Management and Engineering profession.
2. The ability to apply basic knowledge of mathematics, probability and statistics, and the domain knowledge of Industrial Management and Engineering.
3. IToproduce graduates with the ability to adopt a system approach to design, develop, implement and innovate integrated systems that include people, materials, information, equipment and energy.
4. To enable students to understand the interactions between engineering, business, technological and environmental spheres in the modern society.
5. To enable students to understand their role as engineers and their impact to society at the national and global context.

Course Outcomes: At the end of this course, the students will be able to

1. Understand the concepts of management importance and the principle of management.
2. Understand the concepts related to plant layout like governing factors and optimizing the design of layouts.
3. Understand the importance & types of production and concepts of work study method and time study to increase the productivity.
4. Understand the concepts of human resource management, personal management and industrial relations.
5. Understand the concepts of project management techniques.

UNIT–I: (9 Lectures)

INTRODUCTION: Definition of industrial engineering (I.E), development, applications, role of an industrial engineer, differences between production management and industrial engineering, quantitative tools of IE and productivity measurement. concepts of management, importance, functions of management, scientific management, Taylor's principles, theory X and theory Y, Fayol's principles of management.

UNIT–II: (9 Lectures)

PLANT LAYOUT: Factors governing plant location, types of production layouts, advantages and disadvantages of process layout and product layout, applications, quantitative techniques for optimal design of layouts, plant maintenance, preventive and breakdown maintenance.

UNIT–III: **(9 Lectures)**

OPERATIONS MANAGEMENT& STATISTICAL QUALITY CONTROL: Importance, types of production, applications, work study, method study and time study, work sampling, PMTS, micro-motion study, rating techniques, MTM, work factor system, flow process charts. Quality control, its importance, SQC, attribute sampling inspection with single and double sampling, Control charts – X and R – charts X AND S charts and their applications, numerical examples, total quality management

UNIT–IV: **(9 Lectures)**

HUMAN RESOURCE MANAGEMENT: Concept of human resource management, personnel management and industrial relations, functions of personnel management, Job evaluation, its importance and types, merit rating, quantitative methods, wage incentive plans, types.

UNIT–V: **(9 Lectures)**

VALUE ANALYSIS: Value engineering, implementation procedure, enterprise resource planning and supply chain management.

PROJECT MANAGEMENT: PERT, CPM – differences & applications, critical path, determination of floats, importance, project crashing, smoothing and numerical examples.

Text Books:

1. Industrial Engineering and management by O.P Khanna, Khanna Publishers.
2. Industrial Engineering and Production Management, MartandTelsang, S.Chand& Company Ltd. NewDelhi.

Reference Books:

1. Industrial Management by Bhattacharya DK, Vikaspublishers.
2. Operations Management by J.G Monks, McGrawHillPublishers.
3. Industrial Engineering by Banga&Sharma.
4. Principles of Management by Koontz O' Donnel, McGraw Hill Publishers.
5. Statistical Quality Control byGupta.
6. Industrial Engineering and Management by Raju, Cengage Publishers.

Web References:

1. http://iso14000.com
2. http://www.epa.gov/p2
3. http://quality.nist.gov

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MEL04	Computer Aided Machine Drawing Lab	0	0	3	1.5

Internal Marks: 15 External Marks: 35

Course Prerequisite: Engineering Graphics

Course Objectives: The student will be able

1. To involve the students in modeling of various mechanical components and their parts in Machine drawing.
2. To enable the students to acquire requisite knowledge, techniques how to connect the various assembly components.
3. To enable the students to gain the knowledge in making 2D,3D modeling of simple machine parts and assembly drawings through modeling software's.

Course Outcomes: At the end of the course, the student will be able to

1. Draw the basic proportionate drawings for bearings, fasteners, various joints etc.
2. Combine parts to form an assembly of mechanical components such as stuffing box, screw jack and connecting rod etc., using modeling soft wares.
3. Draft the sectional views of assembled components.

PART-A

MODULE 1

Review of graphic interface of the software. Review of basic sketching commands and navigational commands. Starting a new drawing sheet. Sheet sizes. Naming a drawing, Drawing units, grid and snap.

Thread Forms: Thread terminology, sectional views of threads. ISO Metric (Internal & External) BSW (Internal & External) square and Acme. Sellers thread, American Standard thread.

Fasteners: Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grub screw, Allen screw.

PART-B

MODULE 2

Keys: Parallel key, Taper key, Feather key, Gibhead key and Woodruff key

Riveted Joints: Single and double riveted lap joints, butt joints with single/double coverstraps(Chain and Zigzag, using snap head rivets).

MODULE 3

Cotter joint (socket and spigot), knuckle joint (pin joint) for two rods

Couplings: Split Muff coupling, protected type flanged coupling and universal coupling (Hooks' Joint).

PART-C

MODULE 4

(Part drawings should be given)

1. Plummer block (Pedestal Bearing)
2. Screw jack (Bottle type)
3. Machine vice

TEXT BOOKS:

1. A Primer on Computer Aided Machine Drawing-2007', Published by VTU, Belgaum.
2. Machine Drawing', N.D.Bhat&V.M.Panchal

REFERENCES:

1. A Text Book of Computer Aided Machine Drawing', S. Trymbaka Murthy, CBS Publishers, New Delhi, 2007.
2. Machine Drawing', K.R. Gopala Krishna, Subhash Publication.

NOTE: Sketching of the component drawing should be done in A3/A4 sheet in the instruction class. The drawing should be reproduced using suitable software tool.

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MEL05	Thermal Engineering Lab	0	0	3	1.5

Internal Marks: 15 External Marks: 35

Course Objectives: The student will be able
To understand the basic principles in the areas of internal combustion engines, reciprocating air compressors, boilers.

Course Outcomes: At the end of the course, the student will be able to

1. Identify the various fuel characterizations through experimental testing.
2. Analyze the performance characteristics of an internal combustion engines
3. Evaluate the fuel characteristics.
4. Study working principles of water tube and fire tube boilers.

LIST OF EXPERIMENTS:

1. Valve timing diagrams of SI and CI engines.
2. Port timing diagram on two stroke petrol engine.
3. Testing of Fuels – Viscosity, flash point and fire point
4. I.C. Engines performance test on 4 -stroke single cylinder diesel engine.
5. I.C. Engines performance test on 2-stroke single cylinder petrol engine.
6. Evaluation of engine friction by conducting Morse test on 4-stroke multi cylinder petrol engine.
7. Determination of FP by retardation on IC engine on 4 -stroke single cylinder diesel engine.
8. Heat balance sheet on 4 stroke single cylinder diesel engine.
9. Disassembly and assembly of different parts of two wheelers and 4 wheeler vehicles.
10. Study of boilers, mountings and accessories.

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MEL06	Manufacturing Technology Lab	0	0	3	1.5

Internal Marks: 15 External Marks: 35

Course Prerequisites: Metallurgy & Material Science

Course Objectives: The student will be able

To impart hands-on practical exposure on manufacturing processes and equipment.

Course Outcomes: At the end of the course, the student will be able to

1. Operate different welding machines.
2. Perform moldings on injection and blow molding equipment.
3. Prepare mould cavities of various shapes.
4. Prepare different patterns.
5. Perform metal forming operations.

Minimum of 12 Exercises need to be performed

I. METAL CASTING:

1. Pattern Design and making - for one casting drawing.
2. Sand properties testing - for strength and permeability.
3. Mould preparation, Melting and Casting

II WELDING:

1. Gas welding
2. Gas cutting
3. Manual metal arc welding - Lap & Butt Joints
4. Resistance Spot Welding
5. Brazing and soldering

III METAL FORMING AND POWDER METALLURGY:

1. Blanking & Piercing operations and study of simple, compound and progressive dies.
2. Deep drawing and extrusion operations.
3. Bending and other operations

IV PROCESSING OF PLASTICS

1. Injection Moulding
2. Blow Moulding

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MES02	Drafting and Modeling	1	0	2	2

Internal Marks: 0 External Marks: 50

Course Prerequisite:

1. **DRAFTING:** Development of part drawings for various components in the form of orthographic and isometric. Representation of dimensioning and tolerances, study of DXE, IGES files..
2. **SURFACE MODELING -** Generation of various surfaces using surface modeling.

The following contents to be done by any 3D software package:

1. **PART MODELING:** Generation of various 3D models through Pad, revolve, shell, sweep, parent child relation, Boolean operations and various standard translators.
2. **ASSEMBLY DRAWINGS**: (Any four of the following using solid model software) Generation of various Parts/assemblies: like Screw Jack, Oldham's Coupling, Foot step bearing, Couplings, knuckle and cotter joints, Crankshaft, Connecting Rod, Piston and Cylinder.

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MET08	Design of Machine Elements-I	3	1	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite: Strength of Materials

Course Objectives: The course is intended

1. To analyze the basic design concepts, material selection and Apply failure theories in evaluating strength of machine elements.
2. To analyze the strength of machine components subjected to static and variable loads.
3. To analyze the design concepts and failures of riveted joints and welded joints.
4. To evaluate design of keys, joints and shafts subjected to combination of loads.
5. To analyze the design considerations of couplings and springs subjected to various load conditions.

Course Outcomes: At the end of this course, the students will be able to

1. Apply the design procedure and selection of material for a specific application and standards.
2. Design a component when it is subjected to variable loads.
3. Design riveted and welded joints under various loading conditions.
4. Apply design concepts and material selection to keys, joints and shafts.
5. Design couplings and evaluate deformations of various springs at different loading conditions.

UNIT–I: (9 Lectures)

INTRODUCTION: General considerations in the design of Engineering Materials and their properties – selection –Manufacturing consideration in design, tolerances and fits –BIS codes of steels.

STRESSES IN MACHINE MEMBERS: Simple stresses – combined stresses – Torsional and bending stresses – impact stresses- Various theories of failure under static load – factor of safety – design for strength and rigidity – preferred numbers. The concept of stiffness in tension, bending, torsion and combined situations – static strength design based on fracture toughness

UNIT–II: (9 Lectures)

STRENGTH OF MACHINE ELEMENTS: Stress concentration – theoretical stress concentration factor – fatigue stress concentration factor notch sensitivity – design for fluctuating stresses – Endurance limit – Estimation of endurance strength –Factor of safety for fatigue loading- Goodman's line – Soderberg's line – Modified Goodman's line.

UNIT–III: (9 Lectures)

RIVETED JOINTS: Types of riveted heads and riveted joints - Lap Joint – Butt joint – Failure of riveted joints - Design of joints with initial stresses and efficiency - eccentric loading

WELDED JOINTS: Types of welded joints - Failure of welded joints - Design consideration of welded joints for static, varying load and eccentric loading -. Caulking and Fullering.

UNIT–IV: (9 Lectures)

KEYS, COTTERS AND KNUCKLE JOINTS: Classification of Keys-Design of keys-stresses in keys-cotter joints- spigot and socket, sleeve and cotter, jib and cotter joints-knuckle joints.

SHAFTS: Causes of failures, shaft material, Design of solid and hollow shafts for stiffness and rigidity – design of shafts for axial, torsion, combined loading and bending stress - Flexible shaft.

UNIT–V: (9 Lectures)

SHAFT COUPLINGS: Types of shaft couplings-Rigid couplings – muff, split muff and flange couplings, flexible couplings – flange coupling (modified).

MECHANICAL SPRINGS: Materials for springs, Stresses and deflections of helical springs – extension -compression springs – springs for fatigue loading, energy storage capacity – helical torsion springs – co-axial springs, leaf springs.

Text Books:

1. Design of Machine Elements by V.Bandari, TMH Publishers
2. A Text Book of Machine Design by R.S Khurmi & J.K Gupta
3. A Text Book of Machine Design by R.S Khurmi & J.K Gupta

Reference Books:

1. CDesign of Machine Elements / V.M.
2. Machine design / Schaum Series.
3. Data books
   (1) PSG College of technology
   (2) Mahadevan

Web References:

1. `http://nptel.ac.in`

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MET09	Metal Cutting & Machine Tools	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite: Engineering workshop, Engineering drawing, Production Technology.

Course Objectives: The student will be able to

1. The course provides students with fundamental knowledge and principles in
2. Material removal processes
3. In this course, the students apply the fundamentals and principles of metal cutting to practical applications through multiple labs using lathes, milling machines, grinding machines, and drill presses, Computer Numerical Control etc.
4. Establish the relation between shear angle and chip thickness ratio, stress and strain in the chip and cutting forces.
5. To provide information regarding the cutting tool materials and their application to different metals in metal cutting.
6. To develop fundamental knowledge on cutting fluids and tool wear mechanisms.

Course Outcomes: At the end of this course, the students will be able to

1. Analyze the concepts of metal cutting, tool life, and cutting force and chip characteristics.
2. Demonstrate the operations performed on lathe and also classify different types of Automatic Lathes.
3. Illustrate the working of milling, Shaping, slotting, planning, drilling machines Gain the knowledge of operating the mechanisms and apply machining economics.
4. Assess different levels of surface finishing operations performed on grindig process
5. Explain the working principles of jigs and fixtures & CNC machines

UNIT–I: (9 Lectures)

Introduction – Classification of Machining process, Machine tools, Cutting tools, Cutting conditions– geometry of single point cutting tool, tool angles, chip formation and types of chips – built up edge and its effects, chip breakers, mechanics of orthogonal cutting –Merchant's force diagram, cutting forces, cutting speeds, feed, depth of cut, tool life, tool wear, machinability, economics of machining, coolants, tool materials and properties.

UNIT–II: (9 Lectures)

Engine Lathe – Principle of working, specification of lathe – types of lathe – work holders, tool holders – box tools taper turning, thread turning – for lathes and

attachments, constructional features of speed gear box and feed gear box. Turret and capstan lathes – cullet chucks – special work holders – tool geometry. Working principle and features of automatic lathes – classification – single spindle and multi-spindle automatic lathes – tool layout and cam design for automats.

UNIT–III: (9 Lectures)

MILLING MACHINES: Working principles, specifications – classification of Milling Machines – horizontal, vertical and universal Milling Machines, machining operations.Types of cutters, geometry of milling cutters – methods of indexing.

SHAPING, SLOTTING AND PLANNING MACHINES: Principles of working – principal parts – specifications, operations performed, machining time calculations.

DRILLING, BORING MACHINES Principles of working, specifications, types, operations performed – tool holding devices – twist drill – Boring Machines – fine Boring Machines – jig boring machine, deep hole Drilling Machine.

UNIT–IV:FINISHING PROCESSES: (9 Lectures)

Theory of grinding – classification of grinding machines, cylindrical and surface grinding machines, tool and cutter grinding machines, different types of abrasives, bonds, specification and selection of a grinding wheel. Lapping, Honing & Broaching operations, comparison to grinding

UNIT–V: (9 Lectures)

JIGS & FIXTURES: Principles of design of jigs and fixtures and uses, classification of jigs & fixtures, principles of location and clamping, types of clamping & work holding devices, typical examples of jigs and fixtures.

CNC MACHINE TOOLS: CNC Machines, working principle, classification, constructional features of CNC machines, CNC controller, types of motion controls in CNC machines, applications of CNC machines

Text Books:

1. Production Technology by R.K. Jain and S.C. Gupta
2. Workshop Technology – B.S.Raghu Vamshi – Vol II
3. Metal cutting and machine tool engineering by Pakirappa ,Durga publishing house Hyderabad
4. Workshop Technology Vol-II by HazraChowdary,Media promoters & Publishers
5. Production Engineering by P.C. Sharma, S.Chand&Co , 2007.

Reference Books:

1. Gosh and Malik , Manufacturing Science, East west press Pv.t Ltd., 2nd EDITION, 2011.
2. J.P.Kaushish, Manufacturing Processes, PHI, Second Edition, 2010.

3. H.M.T. (Hindustan Machine Tools), Production Technology, Tata MeGraw Hill, 2009.

4. Kalpakjain S, Manufacturing Engineering & Technology, Pearson Education, 4TH edition 2001.

Web References:

1. www.metalwebnews.com
2. www.mini-lathe.com
3. www.britannica.com
4. www.americanmachinist.com

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MET10	Refrigeration & Air Conditioning	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite: Thermodynamics

Course Objectives: The student will be able

1. To introduce the students with a simplistic approach to the fundamental concepts of air refrigeration cycles.
2. To create an interest and intuitive understanding of the nuances of this core subject which deals with vapour compression refrigeration system and refrigeration components.
3. To create an interest and intuitive understanding of the nuances of this core subject which deals with vapour absorption and non-conventional refrigeration system.
4. To impart knowledge in air-conditioning processes, air conditioning systems and can evaluate cooling loads for air conditioning systems.
5. To impart knowledge on various air-conditioning equipment and clean room air conditioning.

Course Outcomes: At the end of this course, the students will be able to

1. Explain air refrigeration cycle and different aircraft refrigeration systems
2. Explain refrigeration components and working of vapor compression refrigeration system
3. Describe vapor absorption, steam jet and nonconventional refrigeration systems
4. Explain psychrometric processes, different air conditioning systems and determine cooling and heating loads for air conditioning systems
5. Describe working of various air-conditioning equipment and clean room air conditioning.

UNIT–I: (10 Lectures)

FUNDAMENTALS OF REFRIGERATION: Introduction – Definition and meaning of refrigeration-Necessity and applications of refrigeration–unit of refrigeration and Coefficient of Performance (COP)–methods of refrigeration- Bell- Coleman cycle–open and closed air refrigeration systems, actual air refrigeration system- Necessity of cooling in aircraft, Types of aircraft refrigeration systems– simple bootstrap, regenerative and reduced ambient systems, Simple problems

UNIT–II: (9 Lectures)

REFRIGERANTS AND REFRIGERATION COMPONENTS: Refrigerants–desirable properties, types, nomenclature and selection, modern refrigerants Compressors–general classification and principles, condensers and cooling towers–classification and

working principles, evaporators–classification and working principles, expansion devices–types and working principles.

VAPOR COMPRESSION REFRIGERATION SYSTEMS: Working principle and essential components of the system, simple vapor compression refrigeration cycle–COP, representation of cycle on T-s and P-h charts, effect of sub cooling and superheating, cycle analysis, methods to improve the COP, use of P-h charts, Simple problems.

UNIT–III: (8 Lectures)

VAPOR ABSORPTION REFRIGERATION SYSTEM: Calculation of maximum COP, description and working of ammonia–water refrigeration system, lithium bromide-water refrigeration system - two shell and four shell, and Domestic Electrolux refrigerator.

NON-CONVENTIONAL REFRIGERATION SYSTEMS: Steam jet refrigeration system-working principle, basic components, advantages and disadvantages (no mathematical treatment), Thermo electric refrigerator, Vortex tube.

UNIT–IV:FINISHING PROCESSES: (10 Lectures)

AIR CONDITIONING SYSTEMS: Psychrometric processes, Summer and winter air conditioning systems, need for ventilation, consideration of infiltration, requirements of human comfort and concept of effective temperature, comfort chart, comfort air conditioning, requirements of industrial air conditioning.

DESIGN OF AIR CONDITIONING SYSTEMS: Bypass Factor (BF) – concept of SHF, ESHF and ADP - load concepts of RSHF, GSHF - Cooling load calculations and simple problems based on Psychrometric charts.

UNIT–V: (8 Lectures)

EQUIPMENT FOR AIR CONDITIONING SYSTEMS: Classification, heaters, humidifiers and dehumidifiers, filters, grills, registers, fans and blowers.

CLEAN ROOM AIR CONDITIONING: Clean Room – Definition and classification, sources of contamination, key elements of clean room design, difference between clean room A/C to conventional A/C, Filtration.

Text Books:

1. Refrigeration and Air-conditioning, Arora C.P., Tata Mc Graw –Hill, New Delhi, 2017
2. A Course in Refrigeration and Air conditioning / SC Arora & Domkundwar / Dhanpatrai, 2018.
3. Handbook of ASHRAE, Robert Persons, 2019.

Reference Books:

1. Refrigeration and Air Conditioning, Manohar Prasad, New Age International, 2009.
2. Basic Refrigeration and Air-Conditioning / Ananthanarayanan / TMH, 2013

3. Principle of Refrigeration, Dossat R.D., 4th ed.
4. Principles of Refrigeration, Roy J. Dossat, Wiley Limited, 2002
5. Refrigeration and Air-conditioning, Stoecker W.F., and Jones J.W., Mc Graw – Hill, New Delhi, 1983

Web References:

1. https://easyengineering.net
2. www.dl.kashti.ir
3. www.nptel.ac.in
4. https://lecturenotes.in
5. https://www.sciencedirect.com
6. http://home.iitk.ac.in
7. https://www.smartzworld.com

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MEL07	Theory of Machines Lab	0	0	3	1.5

Internal Marks: 15 External Marks: 35

Course Objectives: The student will be able to

1. Study various types of force systems, basic principles of mechanics of rigid bodies and Calculation the unknown forces through the use of equilibrium equations for a rigid body.
2. Analyze simple trusses using method of joints and method of sections.
3. Study and determine centroids and centre of gravity of various composite shapes.
4. Study the concept of moment of inertia and the mathematical calculations involved in finding moment of inertia of two dimensional areas.
5. Learn principle of dynamics and apply it to impulse and momentum, work and energy which is useful to analyze turbo machineries.

Course Outcomes: At the end of the course, the student will be able to

1. Apply the principle of rigid body equilibrium and to determine unknown forces.
2. Analyze the force of friction and trusses using method of Joints and method of sections.
3. Find the centroids and center of gravity of composite areas.
4. Calculate the moment of inertia of various shapes by integration and moment of inertia of composite areas.
5. Understand kinematics, kinetics and rotation of a rigid body.

LIST OF EXPERIMENTS:

1. Determine whirling speed of shaft theoretically and experimentally.
2. Determine the position of sleeve against controlling force and speed of a Hartnell governor and to plot the characteristic curve of radius of rotation.
3. Determine the gyroscopic effect with respect to various loads and speeds.
4. Determine the frequency of undamped free vibration of an equivalent spring mass system.
5. Determine the frequency and damping coefficient of damped force vibration of a spring mass system.
6. Study the static and dynamic balancing using rigid blocks.
7. Find the moment of inertia of a flywheel axle system.
8. Draw the cam profile of various cam and follower.
9. Draw the displacement, velocity and acceleration diagram against crank rotation for single slider crank mechanism.

10. Find coefficient of friction between belt and pulley.
11. Study simple and compound screw jack and determine the mechanical advantage , velocity ratio and efficiency.

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MEL08	Refrigeration & Air Conditioning Lab	0	0	3	1.5

Internal Marks: 15 External Marks: 35

Course Objectives: The student will be able to

1. Familiarisation with R & AC tools and perform the basic operations on soft copper tube
2. Conduct performance test on Vapour Compression Refrigeration test rig, Domestic Refrigerator, Water Cooler, Ice Plant and Air condition Test Rig
3. Detect the Leakage of Refrigerant and vacuumization and refrigerant charging for a given vapour compression system.

Course Outcomes: At the end of the course, the student will be able to

1. Explain various tools used in Refrigeration & Air Conditioning
2. Conduct the performance test and evaluate the COP of Vapour Compression Refrigeration test rig, Domestic Refrigerator, Water Cooler, Ice Plant.
3. Calculate the COP of a given Air condition Test Rig
4. Conduct the vacuumization and refrigerant charging for a given vapour compression system
5. Describe Window Air Conditioning System

LIST OF EXPERIMENTS:

1. Perform basic fabrication operations viz., flaring, swaging, bending and brazing on soft copper tubes
2. Evaluate the C.O.P of a given Vapour Compression cycle test rig
3. Evaluate the C.O.P of a Domestic Refrigerator
4. Evaluate the C.O.P of a water cooler
5. Evaluate the C.O.P of Ice Plant
6. Perform various types of leak detection methods of a refrigeration system
7. Evaluate the C.O.P. of given air-conditioning system
8. Apply the method of vacuumization and refrigerant charging for a given vapour compression system.
9. Study of Window Air Conditioning System & Summer Air Conditioning system

Course Code	Course Name	Course Structure			
P21MES03	Simulation	L	T	P	C
		1	0	2	2

Internal Marks: 0 External Marks: 50

Course Objectives: The student will be able

1. To impart the fundamental knowledge on using various analytical tools like ANSYS, FLUENT, etc., for Engineering Simulation.
2. To know various fields of engineering where these tools can be effectively used to improve the output of a product.
3. To impart knowledge on how these tools are ued in Industries by solving some real time problems using these tools

Course Outcomes: At the end of the course, the student will be able to

1. The student will be able to appreciate the utility of the tools like ANSYS or FLUENT in solving real time problems and day to day problems.
2. Use of these tools for any engineering and real time applications.
3. Acquire knowledge on utilizing these tools for a better project in their curriculum as well as they will be prepared to handle industry problems with confidence when it matters to use these tools in their employment.

1. **DRAFTING :** Development of part drawings for various components in the form of orthographic andisometric. representation of dimensioning and tolerances scanning and plotting. study of script, DXE and IGES files.
2. **PART MODELING :** Generation of various 3D models through protrusion, revolve, shell sweep. creation of various features. study of parent child relation. feature based and boolean based modeling surface and assembly modeling. study of various standard translators. design simple components.
3. (a) Determination of deflection and stresses in 2D and 3D trusses and beams .
   (b) Determination of deflections component and principal and Von-mises stresses in plane stress, plane strain and Axisymmetric components.
   (c) Determination of stresses in 3D and shell structures (at least one example in each case)
   (d) Estimation of natural frequencies and mode shapes, Harmonic response of 2D beam.
   (e) Steady state heat transfer Analysis of plane and Axisymmetric components.
4. (a) Development of process sheets for various components based on tooling Machines.

(b) Development of manufacturing and tool management systems.

(c) Study of various post processors used in NC Machines.

(d) Development of NC code for free form and sculptured surfaces using CAM packages.

(e) Machining of simple components on NC lathe and Mill by transferring NC Code / from a CAM package. Through RS 232.

(f) Quality Control and inspection.

Packages to be provided to cater to drafting, modeling & analysis from the following:

Auto CAD, Micro Station, CATIA, Pro-E, I-DEAS, ANSYS, NISA, CAEFEM, Gibbs CAM, Master CAM etc.

Course Code	Course Name	Course Structure			
		L	T	P	C
P21XXXXX	Design Thinking for Innovation	2	0	0	0

Internal Marks: 30 External Marks: 70

UNIT–I: Design thinking Evolution

Definitions and stories. Design thinking Importance, and Impact-History and Evolution of Design Thinking, - Three Space of Innovation in Design Thinking- knowledge funnel - Design Thinking Process, -Design thinking mindset for innovation

UNIT–II: Building confidence, Mindset and Building Team

Myths of Innovation- Myths of Creativity-Creative Confidence-Innovators DNA - 5 forces of growth (SEPIA),- 5 frictional forces (DCAFE),- 3 capacity levers (VAL)-Building Design Teams.

UNIT–III: Empathy-Define

Initial Problem Description - beginner's mindset-5whys,- persona development-Empathy mapping-interview with empathy and stories collection-Question the critical assumptions -Reframe Problem Definition – (PoV) point of view- how might we

UNIT–IV: Ideation

Ideation and Visualization- Brainstorming-SCAMPER-Mind mapping-sketch –structure idea-Storyboard-Customer Co-Creation-Provocation-Role-play

UNIT–V: Prototyping -Testing

Step-by-step prototyping & low fidelity prototyping -Testing Prototyping -feedback capturing grid, conduct A/B Testing-Experiment grid, user retrospective board-Create a Pitch of the prototype

Text Books:

1. An AVA Book, "Design Thinking", AVA Publishing, 2010
2. Dr.BalaRamaduri, "Karmic Design Thinking", 2020, ISBN:978-9354190100

Reference Books:

1. proach", 3rd edition, Springer, 2007
2. Tom Kelley, Jonathan Littman, "Ten Faces in Innovation", Currency Books, 2006
3. Liedtka, Jeanne and Ogilvie, Timothy, Ten Tools for Design Thinking
4. The Design Thinking Playbook: Mindful Digital Transformation of Teams, Products, Services, Businesses, and Ecosystems by Michael Lewrick
5. The Myths of Innovation by Scott Berkun, Publisher(s): O'Reilly Media, IncISBN: 9781449389628

6. The Myths of Creativity: The Truth About How Innovative Companies and People Generate Great Ideas, D BurkusJossey-Bass, San Francisco, CA (2014), 214 pp, ISBN: 978-1-118-61114-2
7. Creative Confidence: Unleashing the Creative Potential within Us All by (Author), David Kelley(Author)
8. The innovator's DNA: mastering the five skills of disruptive innovators Author: Dyer, JeffGregersen, Hal B, 1958-Christensen, Clayton MPublished: Boston, Mass: Harvard Business Press, [2011]
9. Collective Genius: The Art and Practice of Leading Innovation, Authors: Linda A Hill, Greg Brandeau, Emily Truelove, Kent Lineback
10. Change by Design, by Tim Brown
11. Unmukt-Science and Art of Design Thinking Authors Arun Jain School of Design Thinking 2019
12. The Design Thinking Play Book by Michael Lewrick, Patrick Link& Larry Leifer, Wiley Press,2018
13. The Design of Business: Why Design Thinking Is the Next Competitive Advantage. Martin, R. (2009). Boston, MA: Harvard Business Press.

Online Resources:

1. https://www.interaction-design.org/literature/topics/design-thinking
2. https://www.interaction-design.org/literature/article/how-to-develop-an-empathic-approach-in-design-thinking
3. https://medium.com/dc-design/what-is-human-centered-design-6711c09e2779
4. https://think.design/user-design-research/user-testing/
5. Mentor-DesignThinking.pdf (aim.gov.in)
6. Mentor-DesignThinking.pdf (aim.gov.in)

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MEE01	Maintenance Engineering	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite: NIL

Course Objectives: The student will be able

1. To illustrate the techniques used for maintenance management and practices adapted in industry.
2. To develop ability in failure analysis techniques and preventive measures for maintenance.
3. To execute the knowledge in machinery and vehicle maintenance system and condition monitoring.
4. To equip the students in audit system, planning and scheduling for maintenance.
5. To understand the techniques and implementing for productive maintenance.

Course Outcomes: At the end of this course, the students will be able to

1. Apply the knowledge in key concepts in maintenance policies and reliability tool.
2. Analyze the technical skill in failure analysis and preventive measures.
3. The students will able to machinery and vehicle maintenance and condition monitoring.
4. Acquire knowledge about Maintenance Audit system and methodology.
5. Apply the system of productive maintenance, losses and Master plan.

UNIT–I: MAINTENANCE ENGINEERINGAND MANGAEMENT (9 Lectures)

Maintenance – Basic concepts, Need of Maintenance, Maintenance Policies, Strategies and Effects of maintenance-Maintenance forms/actions and their inter relationships, descriptions of various Maintenance actions. Maintenance organization, objectives of organization design, types of organization

Reliability – Basic concepts, Bathtub curve, Failure rate, Mean time before failure. System reliability – Reliability of series and parallel systems-Markov models optimization of system Reliability

UNIT–II: FAILURE ANALYSIS & PREVENTION MEASURES (9 Lectures)

Failure Analysis (FA) - Basic Failure Mechanisms, Distortion Failures, Overload Failures -Failure Analysis Techniques-Consequence, FMEA, FMECA and FTA

Preventive Measures (PM) - Process flow, Frequency in PM. Types of PM -Time based, usage based. PM planning, advantage & disadvantage of PM, elements of PM for machinery and Check list

UNIT–III: MACHINERY AND VEHICLE MAINTENANCE (9 Lectures)

Machinery Maintenance (MM)- Practices on production machines- lathe, Drilling, Milling, Shaper, Planner and CNC machine. Computerized machine monitoring system- Vibration, Speed, Temperature, pressure

Vehicle Maintenance (VM) – Need, importance, primary and secondary functions, classification of maintenance work - vehicle insurance - basic problem diagnosis. Automotive service procedures– service intervals - Towing and recovering.

UNIT–IV: MAINTENANCE SYSTEM AUDIT (9 Lectures)

Maintenance Audit Methodology- ISO 19011:2018 , Maintenance Audit Objective , strategies - Organization Culture, Employee Empowerment, Materials Management, Maintenance Process Improvement, Budgeting and Cost Control, Planning and Scheduling, Maintenance Tactical Delivery. Information Technology-Computer-aided maintenance management system (CMMS), functions, applications and advantages of CMMS

UNIT–V: TOTAL PRODUCTIVE MAINTENANCE (9 Lectures)

EQUIPMENT FOR AIR CONDITIONING SYSTEMS: Classification, heaters, humidifiers and dehumidifiers, filters, grills, registers, fans and blowers.

CLEAN ROOM AIR CONDITIONING: Clean Room – Definition and classification, sources of contamination, key elements of clean room design, difference between clean room A/C to conventional A/C, Filtration.

Text Books:

1. Gupta A. K., Reliability, Maintenance and Safety Engineering, University Science Press, New Delhi, 2009
2. Venkataraman, Maintenance Engineering and Management, Prentic-Hall of India Pvt. Ltd., New Delhi, 2007
3. Bhattacharya S.N., “Installation, Servicing and Maintenance”, S. Chand and Co., 1995

Reference Books:

1. Mishra.R.C. Pathak. K, ”Maintenance Engineering and Management”, Second Edition, PHI Learning, 2012
2. Tanmoy Deb, ”Maintenance Management and Engineering”, Ane Books Pvt. Ltd. 2011
3. CAD/CAM/CIM/ P. Radha Krishnan & S. Subrahamanyarn and Raju/New Age International Publishers/2003.
4. Svstem Approach to Computer Integrated Design and Manufacturing/ Singh/John Wiley /96.
5. Rao S. S., Reliability-Based Design, McGraw-Hill, Inc, New York, 1992.

WEB LINKS

1. https://easyengineering.net
2. www.onlinelibrary.wiley.com
3. www.learnengineering.in
4. www.ktunotes.in
5. www.coursehero.com

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MEE02	Automotive Electrical Systems	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite: NIL

Course Objectives: The student will be able to

1. The student should have a thorough grasp of basic electrical laws.
2. The student should understand and be able to diagnose problems with basic electrical systems and components.
3. The student should understand and be able to diagnose problems with batteries.
4. The student should understand and be able to diagnose problems with starting systems, charging systems & ignition systems.
5. The student should understand and be able to diagnose problems with lighting, instrumentation, warning systems and accessory systems.

Course Outcomes: At the end of this course, the students will be able to

1. Know the working principle of battery
2. Identify the components of starting system & different starter drive units
3. Analyze the structure and function of charging system.
4. Understand the working of ignition system
5. Understand the working of different dash board equipments

UNIT–I: (9 Lectures)

BATTERIES: Principle and construction of lead-acid battery. Principle and construction of Lithium – ion battery. Characteristics of battery, rating, capacity and efficiency of batteries. Various tests on battery condition, charging methods.

UNIT–II: (9 Lectures)

STARTING SYSTEMS: Basic of starting – conventional starting, Modern starting system. Principle & construction of starter motor. Working of starter drive units – Bendix drive, Axial drive & over running clutch drive mechanisms.

UNIT–III: (9 Lectures)

CHARGING SYSTEM: Function, Components of DC and AC Charging System for Automobile, construction, operating principle, characteristics, charging circuit controls – cut out, relays, and voltage and current regulators

UNIT–IV: (9 Lectures)

IGNITION SYSTEM: Types, construction & working of battery coil and magneto ignition systems. Relative merits, centrifugal and vacuum advance mechanisms. Types and construction of spark plugs, Electronic Ignition system. Digital ignition system. Control Strategy of Electronic Ignition System. Recent advancement in automotive electrical systems

UNIT–V: (9 Lectures)

LIGHTING SYSTEM & ACCESSORIES: Details of head light, side light and Braking circuits. Head light dazzling & preventive methods. Electrical fuel-pump, Speedometer, Fuel, oil & temperature gauges, Horn, Wiper system, wiring system. Recent Advancements in Automotive Electrical system

Text Books:

1. Automotive Electrical Equipment, Kholi,P.L., Tata McGraw-Hill Co. Ltd., New Delhi, (1975)
2. Judge,A.W., Modern Electrical Equipment of Automobiles, Chapman & Hall, London, (1992)

Reference Books:

1. Automobile Electrical Equipment, Young,A.P.& Griffiths,L., English Language Book Society & New Press, (1990)
2. Storage Batteries, Vinal,G.W., John Wiley & Sons Inc., New York, (1985)
3. Automobile Electrical Equipment, Crouse, W.H., McGraw Hill Book Co. Inc., New York, (1980).
4. Electrical Ignition Equipment, Spreadbury,F.G., Constable & Co. Ltd., London, (1962)
5. Automotive Hand Book, fifth edition, Robert Bosch, Bentley Publishers, (2003)

WEB LINKS

1. www.googlebooks.com
2. www.nptel.ac.in
3. www.synl.ac.cn
4. www.ktunotes.in
5. www.web.archive.org

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MEE03	Automation in Manufacturing	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite: Industrial Engineering and Management, Manufacturing Technology

Course Objectives: The student will be able to

1. Understand the basic principles of automation and tool transfer, implementation of automated flow line.
2. Understand design aspects and analysis of material handling system.
3. Understand ways of improving line balance and solving line balancing problems.

Course Outcomes: At the end of this course, the students will be able to

1. Implement concepts of a productive system in automation.
2. Apply the concepts of high volume production system
3. Analysis of the automated flow lines for controlling and designing.
4. Apply it in material handling systems for balancing assembly lines.
5. Apply the concepts of automated flow lines and design technologies.

UNIT–I: (9 Lectures)

Fundamentals of Manufacturing Automation: Basic Principles of automation, Types of automated systems, Degrees of automation, Automation - reasons, Production operations and automation strategies, Plant Layout, Production concepts and mathematical models, Design the parts for automation, Automatic loading Systems.

UNIT–II: (9 Lectures)

High Volume Production Systems: Automated flow lines, Methods of work flow, Transport transfer mechanisms, buffer storage, Control functions, Automation for machining operations, Design and fabrication considerations.

UNIT–III: (9 Lectures)

Analysis of Automated Flow Lines: Analysis of transfer lines without storage, Partial automation, Automated flow lines with storage buffers, Implementation of automatic flow lines, Line balancing problems, Considerations in assemble line design.

UNIT–IV FINISHING PROCESSES: (9 Lectures)

Assembly Systems and Line Balance: Manual assembly lines, Line balancing problem, Methods of line balancing, Ways to improve line balancing, Flexible manual assembly lines, automated assembly systems, Analysis of multi station assembly. Manufacturing Cells, Automated Cells, Analysis of Single Station Cells

UNIT–V: (9 Lectures)

Automated Material Handling: Types of equipment and functions, Design and analysis of material handling system, Conveyor system, Automated guided vehicle system, Components operation, Types, Design of automated guided vehicles and applications, Automated storage and Retrieval systems - Types, Basic components and Applications, Design for Automated Assembly, Communication Systems in Manufacturing

Text Books:

1. Mikell P. Groover, —Automation, Production Systems and CIM||, PHI Pvt., Ltd., 1998 2. P. Radha Krishnan & S.Subrahamanyarn and Raju, —CAD/CAM/CIM||, New Age International Publishers, 2003. 3. Singh, —System Approach to Computer Integrated Design and Manufacturing||, John Wiley 1996.
2. T.O. Boucher, Computer automation in manufacturing - an Introduction, Chappman and Hall, 1996.

Reference Books:

1. Automation, production systems and computer integrated manufacturing/ Mikell.P Groover/PHI/3rd edition/2012
2. Automation, Production Systems and CIM/ MikeJ P.
3. CAD/CAM/CIM/ P. Radha Krishnan & S. Subrahamanyarn and Raju/New Age International Publishers/2003.
4. Svstem Approach to Computer Integrated Design and Manufacturing/ Singh/John Wiley /96.
5. Computer Aided Manufacturing/Tien-Chien Chang, Richard A. Wysk and Hsu-Pin Wang/ Pearson/ 2009

WEB LINKS

1. www.smartzworld.com
2. www.nptel.ac.in
3. www.lecturenotes.in
4. www.myclgnotes.com
5. www.me-mechanicalengineering.com

Course Code	Course Name	Course Structure			
P21MEE04	Robotics	L	T	P	C
		3	0	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite: Kinematics of Machinery

Course Objectives: The student will be able

1. To give students practice in applying their knowledge of mathematics, science and Engineering and to expand this knowledge into the vast area of robotics.
2. To understand the basic components of robotics.
3. To understand the motion analysis and kinematic of robotics.
4. To mathematical approach to explain how the robotic arm motion can be described.
5. To The students will understand functioning of sensors and actuators.

Course Outcomes: At the end of this course, the students will be able to

1. Identify various robot configurations.
2. Identify the various components of robots.
3. Carryout kinematic and dynamic analysis for simple serial kinematic chains.
4. Perform the mathematical approach for motion of robots.
5. Perform trajectory planning for a manipulator by avoiding obstacles and Select appropriate actuators and sensors for a robot based on specific application

UNIT–I: (9 Lectures)

INTRODUCTION: Robotics in Automation, CAD/CAM and Robotics- An over view of Robotics – Applications of Robotics – Classification by coordinate system and control system.

UNIT–II: (9 Lectures)

COMPONENTS OF THE INDUSTRIAL ROBOTICS: Function line diagram representation of robot arms, common types of arms. Components, Architecture, number of degrees of freedom – Requirements and challenges of end effectors, determination of the end effectors, comparison of Electric, Hydraulic and Pneumatic types of locomotion devices.

UNIT–III: (9 Lectures)

MOTION ANALYSIS: Homogeneous transformations as applicable to rotation and translation- problems.

MANIPULATOR KINEMATICS: Specifications of matrices, D-H notation joint coordinates and world coordinates Forward and inverse kinematics – problems.

DYNAMICS: Differential transformation and manipulators, jacobians- problems Dynamics- Lagrange- Euler and Newton – Euler formulations – Problems.

UNIT–IV: **(9 Lectures)**

FINISHING PROCESSES: General considerations in path description and generation-Trajectory planning and Avoidance of obstacles, path planning, Skew motion, joint integrated motion – straight line motion – robot programming, languages and software packages – description of paths with a robot programming language.

UNIT–V: **(9 Lectures)**

ROBOT ACTUATORS AND FEEDBACK COMPONENTS: Actuators: Pneumatics, Hydraulic actuators, Electric and stepper motors. Feedback components: Position sensors – potentiometers, resolvers, encoders – velocity sensors.

Text Books:

1. Industrial Robotics by Groover, M P/Pearson edu.
2. Robotics and Control by Mittal R K & Nagrath I J, TMH Publishers

Reference Books:

1. Robotics by Fu K S, McGraw Hill Publishers.
2. Klafter, Prantice Hall publishers.
3. Robot Analysis and Control by H.Asada and J.J.E. Slotine, BSP Books pvt. Ltd.
4. Introduction to Robotics by John J. Craig, Pearson Edu.

WEB LINKS

1. https://www.iare.ac.in
2. https://www.millibar.com
3. https://www.coursehero.com
4. https://link.springer.com
5. https://www.ulektzbooks.com

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MET11	Metrology & Measurements	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite: Engineering Mathematics, Physics

Course Objectives: The student will be able

1. To build the knowledge in limits, fits and tolerances measurement.
2. To develop knowledge on different standards of length, calibration of End Bars, linear and angular measurements.
3. To make use of optical measuring instruments, interferometer and Coordinate measuring machines.
4. To measure the Screw thread, gear profile using various measuring instruments.
5. To Learn principle of Machine tool testing to evaluate machine tool quality.

Course Outcomes: At the end of this course, the students will be able to

1. Examine the tolerances, limits of size, fits of geometrical components.
2. Measure the linear and angular measurements of components by using various types of gauges and calibration of instruments.
3. Measure specified dimensions of components by using optical measuring instruments, interferometer and Coordinate measuring machines.
4. Apply the knowledge to choose appropriate method and instruments for inspection of various gear, thread elements and also using optical instruments.
5. Examine the machine tools by alignment test and can do flatness measurement.

UNIT–I: (9 Lectures)

SYSTEMS OF LIMITS AND FITS: Introduction, nominal size, tolerance, limits, deviations, fits –Unilateral and bilateral tolerance system, hole and shaft basis systems- interchangeability, determistic & statistical tolerances, selective assembly. International standard system of tolerances, selection of limits and tolerances for correct functioning, precision, accuracy and error measurements

UNIT–II: (9 Lectures)

LINEAR MEASUREMENT: Length standards, end standards, slip gauges calibration of the slip gauges, dial indicators, micrometer, steel rule, calipers.

MEASUREMENT OF ANGLES AND TAPERS: Different methods – bevel protractor, angle slip gauges- angle dekkor- spirit levels- sine bar- sine table, rollers and spheres used to measure angles and tapers, angle plate.

LIMIT GAUGES: feeler gauge, Taylor's principle – design of goes and no go gauges; plug, ring, snap, gap, taper, profile and position gauges.

UNIT–III: **(9 Lectures)**

OPTICAL MEASURING INSTRUMENTS: Tools maker's microscope and uses - autocollimators, optical projector, optical flats and their uses.

INTERFEROMETRY: Interference of light, interference bands, Michelson's interferometer, NPL flatness interferometer, and NPL gauge interferometer.

ADVANCE MEASUREMENTS: Basic concept of CMM - types of CMM - software and applications - telescope gauge.

UNIT–IV: **(9 Lectures)**

GEAR MEASUREMENT: Types of gears, measurements of gear tooth profile - gear tooth vernier & flange micro meter - total composite error and tooth to tooth composite errors, rolling gear tester, involute profile checking by profile projector.

SCREW THREAD MEASUREMENT: Elements of measurement – errors in screw threads- concept of virtual effective diameter, measurement of effective diameter, angle of thread and thread pitch, and profile thread gauges, screw pitch gauge.

COMPARATORS: Types - mechanical, optical, electrical and electronic, pneumatic comparators and their uses thread & beam comparators and their uses.

UNIT–V: **(9 Lectures)**

FLATNESS MEASUREMENT: Measurement of flatness of surfaces - straight edges-surface plates – auto collimator - roughness measurement

MACHINE TOOL ALIGNMENT TESTS: Principles of machine tool alignment testing on lathe, drilling, milling and planar machines.

Text Books:

1. Gupta. I.C., "Engineering Metrology", Dhanpatrai Publications, 2005.
2. Jain R.K. "Engineering Metrology", Khanna Publishers, 2005.
3. Instrumentation, Measurement and Analysis B C Nakra, K K Chaudhry McGraw–Hill 4th Edition

Reference Books:

1. Charles Reginald Shotbolt, "Metrology for Engineers", 5th edition, Cengage Learning EMEA,1990.
2. Backwith, Marangoni, Lienhard, "Mechanical Measurements", Pearson Education , 2006.
3. Engineering Metrology Gupta I.C Dhanpat Rai Publications.
4. Raghavendra, Krishnamurthy "Engineering Metrology & Measurements", Oxford Univ. Press, 2013.
5. Donald Packman, "Industrial Instrumentation", Wiley Eastern, 2004.

Web References:

1. www.nptel.ac.in

2. www.smartzworld.com
3. www.lecturenotes.in
4. www.me-mechanicalengineering.com
5. www.myclgnotes.com

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MET12	Heat & Mass Transfer	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite: Thermodynamics

Course Objectives: The student will be able

1. To apply the concept of steady state heat conduction encounter.
2. To apply the concept of heat transfer rate in extended surfaces and transient heat conduction with respect to time.
3. To apply the heat transfer in condensation, boiling systems and analyze the performance of heat exchangers.
4. To solve the free, forced convection heat transfer problems.
5. To illustrate the concept of radiation heat transfer between two bodies and mass transfer.

Course Outcomes: At the end of this course, the students will be able to

1. Evaluate the amount of heat transfer in 1-Dimensional steady state heat conduction.
2. Compute the concept of Temperature distribution through fins and Analyze the 1-Dimesional steady state transient heat conduction equations.
3. Estimate the heat exchanger performance; analyze the various regimes in boiling and condensation.
4. Analyze free and forced convection of heat transfer problems using different empirical correlations.
5. Examine the concept of radiation heat transfer and mass transfer.

UNIT–I: (9 Lectures)

INTRODUCTION TO HEAT TRANSFER: Modes and mechanisms of heat transfer-General Differential equation of Heat Conduction– Cartesian and Polar Coordinates.

ONE DIMENSIONAL STEADY STATE HEAT CONDUCTION– plane and Composite Systems– overall heat transfer coefficient– critical radius of insulation – Conduction with Internal Heat Generation.

UNIT–II: (9 Lectures)

ONE DIMENSIONAL TRANSIENT CONDUCTION HEAT TRANSFER: Fins– Extended Surfaces – Unsteady state Heat Conduction– Lumped system Analysis-Semi Infinite and Infinite Solids – Use of Heisler's charts.

UNIT–III: (9 Lectures)

PHASE CHANGE HEAT TRANSFER: Regimes of Boiling Curve–Nucleate Boiling and Film Boiling – Film wise and drop wise condensation –Nusselt's theory of condensation on vertical and horizontal plates using empirical correlations.

HEAT EXCHANGERS: Classification of heat exchangers – Concepts of LMTD and Effectiveness - NTU methods - Compact Heat Exchangers - types - problems.

UNIT–IV: (9 Lectures)

CONVECTIVE HEAT TRANSFER: Dimensional analysis– Buckingham Pi theorem for forced and free convection, application for developing semi – empirical non-dimensional correlation for convective heat transfer.

FREE AND FORCED CONVECTION: Concepts about Hydrodynamic and Thermal Boundary Layer – Free and Forced Convection during external flow over Plates and Cylinders and Internal flow through tubes.

UNIT–V: (9 Lectures)

RADIATION: Heat exchange between two black bodies – concepts of shape factor – heat exchange between grey bodies – radiation shields–Electrical Analogy.

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

Text Books:

1. Heat Transfer/JPHOLMAN/TMH
2. Heat and Mass Transfer/Aroraand Domkundwar/Dhanpatrai&sons
3. Heat Transfer/P.K.Nag/TMH
4. Principles of Heat Transfer/ Frank Kreith, RM Manglik & MS Bohn/Cengage learning publishers

Reference Books:

1. Fundamentals ofEngg.Heat and Mass Transfer/R.C.Sachdeva/ New Age International.
2. Heat and Mass Transfer/Cengel/McGraw Hill.Heat and Mass Transfer/D.S.Kumar/ S.K.Kataria&Sons
3. A Text book on Heat Transfer-4thEdition/ S.PSukhatme/Universities Press

Web References:

1. www.nptel.ac.in
2. www.smartzworld.com
3. www.lecturenotes.in
4. www.me-mechanicalengineering.com
5. www.myclgnotes.com

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MET12	Design of Machine Elements-II	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite: Strength of Materials

Course Objectives: The student will be able

1. To analyze the design of Various bearings with respect to loads and selection of suitable bearings.
2. To design IC engine main components.
3. To evaluate the design of screws and various power transmission systems.
4. To design curved beams of various cross sections.
5. To design various types of gears and failures.

Course Outcomes: At the end of this course, the students will be able to

1. Design the suitable bearing based on the application of the loads and predict the life of the bearing.
2. Design the engine parts like piston, connecting rod and crankshaft.
3. Apply the design concepts to screws and mechanical transmission system.
4. Evaluate stresses in the curved beams with different cross section.
5. Apply the Design concepts for the spur and helical gear.

UNIT–I: (9 Lectures)

BEARINGS: Classification and selection of bearings- applications, types of journal bearings – lubrication – Petroff's Equation– bearing modulus – full and partial bearings – clearance ratio – heat dissipation of bearings, bearing materials – journal bearing design – ball and roller bearings – static loading of ball & roller bearings, bearing life.

UNIT–II: (9 Lectures)

ENGINE PARTS: Connecting Rod: Materials for connecting rod and design of connecting rod – Crank shafts: Types of crank shafts, design of crank shafts – crank pins. Pistons - Design of pistons - structural and thermal.

UNIT–III: (9 Lectures)

DESIGN OF POWER SCREWS: Design of screw, square ACME, buttress screws, design of nut, compound screw, differential screw, Screw Jack.

POWER TRANSMISSIONS SYSTEMS: Transmission of power by belt and rope drives, transmission efficiencies, belts – flat and v types – ropes - pulleys for belt and rope drives, materials, chain drives. Wire Ropes: Construction, Designation, Stresses in wire ropes, rope sheaves and drums.

UNIT–IV: (9 Lectures)

DESIGN OF CURVED BEAMS: introduction, stresses in curved beams, expression for radius of neutral axis for rectangular, circular, trapezoidal and T-section, design of crane hooks, C –clamps.

UNIT–V: **(9 Lectures)**

DESIGN OF GEARS: Types of gears - selection of material - Design of Spur gears and helical gears – load concentration factor – dynamic load factor, surface compressive, bending strength - Tooth wear and failure analysis.

Text Books:

1. Machine Design/V.Bandari/TMH Publishers 2015.
2. Machine Design/T.V. Sundararajamoorthy/N. Shanmugam
3. Design Data Book/PSG College of Technology 2012
4. Machine Design Data Book by S.Md.Jalaludeen.

Reference Books:

1. Machine Design: An integrated Approach / R.L. Norton / Pearson Education
2. Mech. Engg. Design / JE Shigley/Tata McGraw Hill education
3. Machine Design, Volume-1 & 2 by S.Md.Jalaludeen.

Web References:

1. www.nptel.ac.in

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MEL10	Heat Transfer Lab	0	0	3	1.5

Internal Marks: 15 External Marks: 35

Course Objectives: The student will be able to
To apply the theoretical concept in practical, including application in heat transfer through solids, fluids in conduction, convection, radiation heat transfer
Course Outcomes: At the end of the course, the student will be able to

1. Perform steady state conduction experiments to determine the thermal conductivity of different materials.
2. Evaluate heat transfer coefficients for Forced convection over exterior surfaces, Natural Convection, Film wise and drop wise condensation and Compare with theoretical values.
3. Analyze the heat exchanger performance by using the method of logarithmic mean temperature difference and effectiveness.
4. Calculate radiation heat transfer of an emissivity of plate, Stefan Boltzmann's constant and Compare theoretical values.
5. Analyze the heat flux value by using boiling curve.

LIST OF EXPERIMENTS:

1. Determination of overall heat transfer co-efficient of a composite slab.
2. Determination of heat transfer rate through a lagged pipe.
3. Determination of heat transfer rate through a concentric sphere.
4. Determination of thermal conductivity of a metal rod.
5. Determination of heat transfer rate in drop and film wise condensation.
6. Determination of efficiency of a pin-fin.
7. Demonstration of heat pipe
8. Determination of effectiveness of parallel and counter flow heat exchangers.
9. Determination of heat transfer coefficient in forced convection.
10. Determination of heat transfer coefficient in natural convection
11. Determination of emissivity of a given surface.
12. Determination of Stefan Boltzman constant.
13. Determination of critical heat flux.
14. Study of two – phase flow.

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MEL09	Machine Tools Lab	0	0	3	1.5

Internal Marks: 15 External Marks: 35

Course Prerequisite: Engineering workshop

Course Objectives: The student will be able

To understand the parts of various machine tools, operations and make the different shapes of components that can be produced on these machine tools.

Course Outcomes: At the end of the course, the student will be able to

1. Analyze and select the suitable machine to perform the machining operation.
2. Apply the practical skill in making a component using different operations of lathe.
3. Develop the grooved components using milling, shaper and slotter machines.
4. Develop the smooth machined surfaces and cutting tools using grinding machines.
5. Build the various drilled and tapped components

LIST OF EXPERIMENTS:

1. Study of general purpose machines -lathe, drilling machine, milling machine, shaper, planning machine, slotting machine, cylindrical grinder, surface grinder and tool and cutter grinder.
2. Perform Step turning and taper turning on lathe machine.
3. Perform Thread cutting and knurling on lathe machine.
4. Perform Drilling and boring on lathe.
5. Perform Drilling and tapping in different dimensions.
6. Perform Shaping and planning on the work piece.
7. Perform internal Slotting on the work piece.
8. Perform grooving operation using Milling machine on the work piece.
9. Perform Cylindrical surface grinding on the work piece.
10. Perform grinding of tool angles using tool and cutter grinder

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MEL11	Metrology & ICS Lab	0	0	3	1.5

Internal Marks: 15 External Marks: 35

Course Prerequisite: Engineering Physics

Course Objectives: The student will be able to

To make use of suitable measuring instruments for the measurement of dimensions of the various components

Course Outcomes: At the end of the course, the student will be able to

1. Measure the linear and angular dimensions of the components.
2. Measure the internal and external dimensions with suitable instruments.
3. Conduct the alignment and surface tests on the machine tools.
4. Test and calibrate the different temperature, pressure measurement instruments.
5. Measure and calibrate the rotameters and transducers.

LIST OF EXPERIMENTS:

Note: The students have to conduct at least 7 experiments from each lab

METROLOGY LAB

1. Measurement of lengths, heights, diameters by vernier calipers, micrometers etc.
2. Measurement of bores by internal micrometers and dial bore indicators.
3. Use of gear tooth vernier caliper for tooth thickness inspection and flange micro meter for checking the chordal thickness of spur gear.
4. Machine tool alignment test on the lathe.
5. Machine tool alignment test on drilling machine.
6. Machine tool alignment test on milling machine.
7. Angle and taper measurements with bevel protractor, Sine bar, rollers and balls.
8. Use of spirit level in finding the straightness of a bed and flatness of a surface.
9. Surface roughness measurement with roughness measuring instrument.

INSTRUMENTATION LAB

1. Calibration of pressure gauge.
2. Calibration of transducer for temperature measurement.
3. Study and calibration of LVDT transducer for displacement measurement.
4. Calibration of strain gauge.
5. Calibration of thermocouple.
6. Calibration of capacitive transducer.

7. Study and calibration of photo and magnetic speed pickups.
8. Calibration of resistance temperature detector.
9. Study and calibration of a rotameter.
10. Study and calibration of Mcleod gauge for low pressure.

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MES04	Advanced Communication Skills	1	0	2	2

Internal Marks: 0 External Marks: 50

Introduction:

A course on Advanced English Communication Skills (AECS) Lab is considered essential at the third year level of B.Tech. At this stage, the students need to prepare themselves for their career which requires them to listen to, read, speak and write in English both for their professional and interpersonal communication. The main purpose of this course is to prepare the students of Engineering for their placements.

Course Objectives: This Lab focuses on using multi-media instruction for language development to meet the following targets:

1. To improve students' fluency in spoken EnglishLearn the fundamental concepts about solar energy systems and devices.
2. To enable them to listen to English spoken at normal conversational speed
3. To help students develop their vocabulary
4. To read and comprehend texts in different contexts
5. To communicate their ideas relevantly and coherently in writing
6. To make students industry-ready
7. To help students acquire behavioural skills for their personal and professional life
8. To respond appropriately in different socio-cultural and professional contexts

Course Outcomes: At the end of the course, the student will be able to

1. Acquire vocabulary and use it contextually
2. Listen and speak effectively
3. Develop proficiency in academic reading and writing
4. Increase possibilities of job prospects
5. Communicate confidently in formal and informal contexts

Syllabus

The following course activities will be conducted as part of the Advanced English Communication Skills (AECS) Lab:

1. **Inter-personal Communication and Vocabulary Building** - Starting a Conversation – Responding Appropriately and Relevantly – Role Play in Different Situations - Synonyms and Antonyms, One- word Substitutes, Prefixes and Suffixes, Idioms and Phrases and Collocations.

2. **Reading Comprehension and Listening Skills** –General Vs Local Comprehension, Techniques- Reading for Facts, Guessing Meanings from Context, Skimming, Scanning, Inferring Meaning-Listening Comprehension(Video/Audio talks)
3. **Technical Writing Skills –** Structure and Presentation of Different Types of Writing – Letter Writing/Resume Writing/ e-correspondence/ Technical Report Writing- Circular writing/ Meeting agenda/ Minutes of Meeting.
4. **Presentation Skills** – Public speaking-Oral Presentations (individual or group) through JAM Sessions/Seminars/PPTs and Written Presentations through Posters/Projects/Reports/ e-mails / Assignments. . . etc.,- Stage dynamics-BodyLanguage- Para Language.
5. **Getting Ready for the Job:**
   (a) **Group Discussion and Interview Skills** – Dynamics of Group Discussion, Intervention, Summarizing, Modulation of Voice, Body Language, Relevance, Fluency and Organization of Ideas and Rubrics of Evaluation-Concept and Process, Pre-interview Planning, Opening Strategies, Answering Strategies, Interview through Tele-conference & Video-conference and Mock Interviews.
   (b) **Soft Skills:** Inter and Intra Personal Skills.

Minimum Hardware Requirement:

Advanced English Communication Skills (AECS) Laboratory shall have the following Infrastructural facilities to accommodate at least 30 students in the lab

1. Spacious room with appropriate acoustic s
2. Eight round tables with five movable chairs for each table.
3. Audio-visual aids
4. LCD Projector
5. Public Address system
6. Computer with suitable configuration

Suggested Software: The software consisting of the prescribed topics elaborated above should be procured and used

1. Oxford Advanced Learner's Compass, 10th Edition.
2. DELTA's key to the Next Generation TOEFL Test: Advanced Skill Practice.
3. TOEFL & GRE(KAPLAN, AARCO & BARRONS, USA, CRACKING GRE by CLIFFS)
4. TRAIN2SUCCESS.COM

Suggested Reading:

1. Technical Communication by Meenakshi Raman & Sangeeta Sharma, Oxford University Press2009.
2. Technical Communication by Paul V.Anderson.2007. Cengage Learning pvt. Ltd. NewDelhi.
3. Business and Professional Communication: Keys for Workplace Excellence .Kelly M. Quintanilla & ShawnT.Wahl. SageSouth AsiaEdition. SagePublications.2011
4. The Basics of Communication: A Relational Perspective. Steve Duck & David T.McMahan. Sage South AsiaEdition.SagePublications.2012
5. English Vocabulary in Use series, CambridgeUniversityPress2008.
6. Management Shapers Series by Universities Press (lndia) Pvt Ltd., Himayatnagar, Hyderabad2008.
7. Handbook for Technical Communication by David A.McMurrey & Joanne Buckley.2012.
8. Handbook for Technical Writing by David A McMurrey & JoanneBuckely CENGAGE Learning 2008.
9. Job Hunting by Colm Downes, Cambridge University Press2008.
10. Master Public Speaking by Anne Nicholls, JAICOPublishingHouse,2006.
11. English for Technical Communication for Engineering Students, Aysha Vishwamohan, Tata Mc Graw-Hil 2009.
12. Books on TOEFL/GRE/GMAT/CAT/IELTS/SAT by Barron's/DELTA/Cambridge University Press.
13. The Definitive Book of body Language – by Allan Pease, Barbara Pease.

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MCT05	Constitution of India	2	0	0	0

Internal Marks: 30 External Marks: 70

Course Prerequisite: None

Course Objectives: The student will be able

1. To know about Indian constitution.
2. To know about central government functionalities in India.
3. To know about state government functionalities in India.
4. To know about functions of Indian Constitution.
5. To know about Indian society.

Course Outcomes : At the end of the course, student will be able to

1. Understand the background and structure of Indian Constitution.
2. Understand the functions of the Indian government.
3. Understand the functions of the State government.
4. Understand and abide the rules of the Indian constitution.
5. Understand and appreciate different culture among the people.

UNIT–I: (6 Lectures)

INTRODUCTION: Historical Background – Constituent Assembly of India – Philosophical foundations of the Indian Constitution – Preamble – Fundamental Rights – Directive Principles of State Policy – Fundamental Duties – Citizenship – Constitutional Remedies for citizens.

UNIT–II: (6 Lectures)

STRUCTURE AND FUNCTION OF CENTRAL GOVERNMENT: Union Government — Structures of the Union Government and Functions – President – Vice President – Prime Minister – Cabinet – Parliament – Supreme Court of India – Judicial Review.

UNIT–III: (6 Lectures)

STRUCTURE AND FUNCTION OF STATE GOVERNMENT: State Government– Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts.

UNIT–IV: (6 Lectures)

CONSTITUTION FUNCTIONS: Indian Federal System– Center – State Relations – President's Rule – Constitutional Amendments – Constitutional Functionaries – Assessment of working of the Parliamentary System in India.

UNIT–V: (6 Lectures)

INDIAN SOCIETY: Society, Nature, Meaning and definition; Indian Social Structure; Caste, Religion, Language in India; Constitutional Remedies for citizens – Political Parties and Pressure Groups; Right of Women, Children and Scheduled Castes and Scheduled Tribes and other Weaker Sections.

Text Books:

1. Introduction to the Constitution of India, Durga Das Basu, 24th Edition, Prentice Hall of India, New Delhi, 2019.
2. Indian Political System, R.C.Agarwal, S.Chand Company, New Delhi, 1997.
3. Society: An Introduction Analysis, Maciver, Mac Milan India Ltd., New Delhi.
4. Social Stratification in India: Issues and Themes, K.L.Sharma, 1st Edition, SAGE Publications Pvt. Ltd, 1997.

Reference Books:

1. Introduction to the Constitution of India, Sharma, Brij Kishore, 7th Edition, Prentice Hall of India, New Delhi, 2015.
2. Indian Political System, U.R.Gahai, New Academic Publishing House, Jalaendhar, 1992.
3. Indian Social Problems, R.N. Sharma, Media Promoters and Publishers Pvt. Ltd.

text Web Resources:

1. https://www.india.gov.in/sites/upload_files/npi/files/coi_part_full.pdf
2. https://www.india.gov.in/my-government/constitution-india
3. www.legislative.gov.in/constitution-of-india
4. https://www.constitution.org/cons/india/const.html

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MEE05	Powder Metallurgy	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite: Metallurgy & Materials Science

Course Objectives: The student will be able to

1. To introduce the concepts of powder metallurgy with special reference to recent development of powder metallurgy products.
2. This course teaches powder preparation, characterization, compaction and sintering.
3. Acquire the knowledge of Powder Characterization: Powder conditioning.
4. Student able to Basic aspects, types of compaction presses.
5. Acquire the knowledge of Sintering techniques and Sintered Products.

Course Outcomes: At the end of this course, the students will be able to

1. Acquire the knowledge of Powder Metallurgy History, Applications and its importance.
2. Acquainted the knowledge of metal powder production methods.
3. Aware about the powder characterization techniques
4. Familiar about basic methods of Powder compaction for green compact.
5. Explain various powder forming techniques other than the compaction, mechanism of sintering and types sintering for development of mechanical properties.

UNIT–I: (9 Lectures)

Introduction and modern developments in Powder Metallurgy-Advantages, limitations and applications of Powder Metallurgy- Basic Steps for Powder Metallurgy

Characteristics of metal powder: Chemical composition, Particle size, shape and size distribution, Characteristics of powder mass such as apparent density, tap density

UNIT–II: (9 Lectures)

Metal powder production methods: Atomization, Reduction from oxide, Electrolysis, Crushing, Milling, Condensation of metal vapour, Hydride and carbonyl processes, Mechanical Alloying, New developments.

UNIT–III: (9 Lectures)

Powder Characterization: Powder conditioning, fundamentals of powder compaction, density distribution in green compacts, compressibility, green Strength, pyrophorocity and toxicity

UNIT–IV: (9 Lectures)

Powder Compaction Methods: Basic aspects, types of compaction presses, compaction tooling and role of lubricants, Single and double die compaction, isostatic pressing, hot pressing.

UNIT–V: **(9 Lectures)**

Sintering: Definition, stages, effect of variables, sintering atmospheres and furnaces, Mechanism, liquid-phase sintering, Secondary operations.

Sintered Products: Study of sintered bearings, cutting tools, metallic filters, friction and antifriction parts and electrical contact materials. Defects in Powder metallurgy processed materials and their processing.

Text Books:

1. Introduction to Powder Metallurgy, A. K. Sinha, Dhanpatrai Publication
2. Powder Metallurgy: Science, Technology, and Materials, Anish Upadhyaya, Gopal Shankar Upadhyaya, CRC Press
3. Powder Metallurgy: Science, Technology and Applications, P. C. Angelo, R. Subramanian
4. Powder Metallurgy, W.D.Jones
5. Principles of Powder Metallurgy, T.Shukerman
6. Handbook of Powder Metallurgy :- H.H.Hausner
7. Powder Metallurgy, ASM Handbook, Vol-VII.
8. German R.M., Powder Metallurgy and Particulate Materials Processing, MPIF. 2005
9. Masuda H., Powder Technology Handbook, Taylor & Francis 2006
10. Sands R.L. and Shakespeare C.R., Powder Metallurgy Practice and Applications, Newness Publication 1970
11. Powder Metal Technologies and Applications, Metals Handbook, Vol.7, 9th edition, ASM 1989
12. Upadhyaya G.S., Powder Metallurgy Technology, Cambridge Press 1996

Reference Books:

1. Sinha A. K., “Powder Metallurgy”, Dhanpat Rai & Sons. New Delhi, 1982.
2. R.M. German, “Powder Metallurgy and Particulate Materials Processing”, Metal Powder Industries Federation, Princeton, NJ, 2005.

Web References:

1. www.nptel.ac.in
2. www.smartzworld.com
3. www.lecturenotes.in
4. www.myclgnotes.com
5. www.me-mechanicalengineering.com

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MEE06	Electric and Hybrid Vehicle Technology	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite: Basic Electrical & Electronics Engineering

Course Objectives: The student will be able

1. To impart basic fundamentals of automotive electronics for automotive applications.
2. To understand the functions of microprocessor and microcomputer controlled devices and components.
3. To known about actuators and drives used in automobile.
4. To lean concepts and functions of measurements and for the automotive system.
5. To demonstrate the functions of electronics equipments and sensors

Course Outcomes: At the end of this course, the students will be able to

1. Demonstrate the functions of automotive electronics for automotive applications.
2. Discuss the working and applications ofmicroprocessor and microcomputer controlled devices and their components.
3. Develops the knowledge in functions of actuators, solenoids and relays.
4. Illustrate concepts of measurements system and instrumentation used in automobile. Examine knowledge in cooling of electronics Equipment, sensors and application

UNIT–I: INTRODUCTION (9 Lectures)

Need of electric and hybrid vehicles, Layout of electric vehicle and components, performance of electric vehicles – traction motor characteristics, tractive effort, transmission requirements, energy consumption, advantage and Limitations of electric and hybrid vehicles, electronic control system.flexible fuel vehicles (FFV), solar powered vehicles

UNIT–II: DRIVES AND CONTROL (9 Lectures)

DC and AC motors, permanent magnet motors, brushless DC and reluctance motors, characteristics, regenerative braking. DC and AC generators, voltage and frequency regulations- Principle of Control systems- speed and torque control

UNIT–III: HYBRID VEHICLES (9 Lectures)

Hybrid vehicle- benefits, types of HEVs. Architecture layout of series and parallel hybrid vehicles and, Concepts of hybrid electric drive. Types of drive system, merits and demerits for series and parallel hybrid electric vehicle. Design requirements

UNIT–IV: ENERGY DEVICES (9 Lectures)

Electromechanical batteries- types of batteries –lead acid batteries, nickel based batteries, lithium based batteries, electrochemical reactions, thermodynamic voltage, specific energy, High energy and power density batteries, fuel cells, flexible fuel systems ultra capacitors.

UNIT–V: NEW GENERATION VEHICLES (9 Lectures)

Stratified charge engines- learn burn engines, low heat rejection engines, hydrogen engines, HCCI engine, VCR engine, surface ignition engines, VVTI engines. Merits and de-merits

Text Books:

1. Ronald K Jurgen, "Electric and Hybrid – Electric Vehicles", SAE, 2002.
2. Ron Hodkinson and John Fenton, "Light Weight Electric/Hybrid Vehicle Design", Butterworth-Heinemann, 2001.

Reference Books:

1. Mehrdad Ehsani, Yimin Gao, sebastien E. Gay and Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRS Press, 2004.
2. James Larminie and John Loury, "Electric Vehicle Technology-Explained", John Wiley & Sons Ltd., 2003. 3 Sandeep Dhameja, "Electric Vehicle Battery Systems", Butterworth –Heinemann, 2002.

Web References:

1. www.nptel.ac.in
2. https://www.sae.org
3. https://onlinelibrary.wiley.com

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MEE07	Production Planning and Control	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite: Industrial Engineering and Management

Course Objectives: The student will be able to

1. Demonstrate the concepts of production and service systems
2. The ability to apply principles and techniques in the design, planning and control of these systems to optimize/make best use of resources in achieving their objectives.
3. Identify different strategies employed in manufacturing and service industries to plan production and control inventory.
4. Measure the effectiveness, identify likely areas for improvement,
5. Develop and implement improved planning and control methods for production systems.

Course Outcomes: At the end of this course, the students will be able to

1. Apply the systems concept for the design of production and service systems.
2. Describe forecasts in the manufacturing and service sectors using selected quantitative and qualitative techniques.
3. Evaluate the principles and techniques for planning and control of the production and service systems
4. To Analyze/correlate the best use of resources.
5. Justify the importance and function of inventory. Demonstrate the selected techniques for its control and management under dependent and independent demand circumstances.

UNIT–I: (9 Lectures)

INTRODUCTION: Definition – Objectives of production Planning and Control – Functions of production planning and control – Elements of production control – Types of production – Organization of production planning and control department – Internal organization of department – Product design factors – Process Planning sheet.

UNIT–II: (9 Lectures)

FORECASTING – Importance of forecasting – Types of forecasting, their uses – General principles of forecasting – Forecasting techniques– qualitative methods and quantitative methods.

UNIT–III: (9 Lectures)

INVENTORY MANAGEMENT: Functions of inventories – relevant inventory costs – ABC analysis – VED analysis – EOQ model – Inventory control systems – P–Systems and Q-Systems. Introduction to MRP & ERP, LOB (Line of Balance), JIT inventory, and Japanese concepts, Introduction to supply chain management

UNIT–IV FINISHING PROCESSES:: (9 Lectures)

ROUTING: Definition – Routing procedure – Route sheets – Bill of material – Factors affecting routing procedure. Scheduling – definition –Difference with loading

SCHEDULING POLICIES: Techniques, Standard scheduling methods - Line Balancing, Aggregate planning, Chase planning, Expediting, controlling aspects

UNIT–V: (9 Lectures)

DISPATCHING: Activities of dispatcher – Dispatching procedure –follow up – definition – Reason for existence of functions – types of follow-up, applications of computer in production planning and control

Text Books:

1. Elements of Production Planning and Control / Samuel Eilon / Macmillan Publishers
2. Modern Production and operation managements / Baffa & Rakesh Sarin / John Wiley Publishers
3. Operations Management / Joseph Monks / McGraw-Hill Ryerson Publishers

Reference Books:

1. Operations Management / S.N. Chary/ TMH Publishers
2. Reliability Engineering & Quality Engineering / Dr. C. Nadha Muni Reddy and Dr. K.Vijaya Kumar Reddy / Galgotia Publications, Pvt., Limited.
3. Production Control A Quantitative Approach / John E. Biegel/ Prentice-Hall

WEB LINKS

1. www.kthstudies.com
2. www.emaraldinsight.com
3. www.tandfonline.com
4. www.sartrex.ca

Course Code	Course Name	Course Structure			
		L	T	P	C
P21MEE08	Renewable Sources of Energy	3	0	0	3

Internal Marks: 30 External Marks: 70

Course Prerequisite: Engineering Physics, Engineering Chemistry

Course Objectives: The student will be able to

1. Create awareness about sources of energy and able to estimate how long the available conventional fuel reserves will last.
2. Learn the fundamental concepts about solar energy systems and devices.
3. Design wind turbine blades and know about applications of wind energy for water pumping and electricity generation.
4. Assimilate the working of OTEC system and different possible ways of extracting energy from ocean
5. Learn the fundamental concepts about Magneto-hydrodynamics and fuel cells.

Course Outcomes: At the end of this course, the students will be able to

1. Assimilate of renewable and non-renewable sources of energy
2. Gain knowledge about working principle of various solar energy systems
3. Understand the application of wind energy and wind energy and Bio-mass conversion system.
4. Develop capability to do basic design of Ocean Thermal Energy Conversion
5. Assimilate the applications of different renewable energy sources like hydro, fuel cells etc.

UNIT–I: (9 Lectures)

ENERGY RESOURCES: Introduction to Conventional Energy Resources - Availability and their limitations; Energy Non-Conventional Energy Resources – Classification, Advantages, Limitations, Comparison of Conventional and Non-Conventional Energy Resources, World Energy Scenario, Indian Energy Scenario. Energy Storage: Sizing and Necessity of Energy Storage.

UNIT–II: (9 Lectures)

SOLAR THERMAL SYSTEMS: Introduction, Solar Constant, Basic Sun-Earth Angles, Measurement of Solar Radiation Data – Pyranometer and Pyrheliometer, Principle of Conversion of Solar Radiation into Heat, – Solar thermal collectors and characteristics –Flat plate collectors – Heat transfer processes – Solar concentrators' parabolic trough, parabolic dish, Central Tower Collector –performance and evaluation

UNIT–III: (9 Lectures)

WIND ENERGY: Introduction, Sources and potentials, horizontal and vertical axis windmills, performance characteristics, betz criteria, types of winds, wind data measurement.

BIO-MASS ENERGY: Introduction, Principles of bio-conversion, anaerobic/aerobic digestion, types of bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, bio fuels, I.C. engine operation and economic aspects.

UNIT–IV : (9 Lectures)

GEOTHERMAL ENERGY & OCEAN THERMAL ENERGY CONVERSION (OTEC): Introduction, Resources, types of wells, methods of harnessing the energy, potential in India. Introduction, Resources, Ocean thermal energy conversion (OTEC) Availability, theory and working principle, performance and limitations

UNIT–V: (9 Lectures)

MAGNETO-HYDRO DYNAMICS (MHD): Introduction, Principle of working of MHD Power plant, performance and limitations.

FUEL CELLS: Principle of working of various types of fuel cells and their working, performance and limitations.

Text Books:

1. Solar Energy, Sukhatme. S.P., Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.
2. "Renewal Energy Resources", John Twideu and Tony Weir, BSP Publications, 2006.
3. "Energy Resources: Conventional & Non-Conventional", M.V.R. Koteswara Rao, BSP Publications, 2006.
4. Non-Conventional Energy Resources, Khan B.H., Tata McGraw Hill, New Delhi, 2006.
5. Renewable Energy Sources, Twidell, J.W. & Weir, A. EFN Spon Ltd., UK, 2006.
6. Solar Energy: Fundamentals and Applications, Garg, Prakash, Tata McGraw Hil, 1997.

Reference Books:

1. Non-Conventional Energy Sources, Khanna Publications, G.D. Rai, New Delhi, 2011.
2. "Renewable Energy, Power for a Sustainable Future", Godfrey Boyle, , Oxford University Press, U.K., 1996.
3. Biogas Technology – A Practical Handbook, Khandelwal, K.C., Mahdi, S.S., Tata McGraw-Hill, 1986.
4. "Fundamentals Design, Modeling & Applications", Tiwari. G.N., Solar Energy – Narosa Publishing House, New Delhi, 2002.
5. "Wind Energy Conversion Systems", Freris. L.L., Prentice Hall, UK, 1990.

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1. https://www.sciencedirect.com
2. https://www.nrel.gov
3. https://www.energy.gov
4. https://www.eia.gov
5. https://biomassenergytechniques.com
6. https://new.ingwb.com