ACADEMIC REGULATIONS
COURSE STRUCTURE
AND
DETAILED SYLLABUS

(CHOICE BASED CREDIT SYSTEM)

R19

CAD/CAM

for

Master of Technology (M.Tech)
For the batches admitted 2019-20

M. Tech. - Regular Two Year Degree Program
(For batches admitted from the academic year 2019 - 20)

1. INTRODUCTION

Swarnandhra College of Engineering & Technology (Subsequently referred to as SCET) will be followed the norms of Jawaharlal Nehru Technological University Kakinada and Govt. of Andhra Pradesh.

Academic Programmes of the institute are governed by rules and regulations approved by the Academic Council, which is the highest Academic body of the Institute. These rules and regulations are applicable for the students of M. Tech (Regular) Course from the Academic Year 2019-20 onwards.

2. ADMISSIONS:

2.1. Admission into first year of M. Tech Programme: Admissions in each M.Tech program in the Institution are classified into **CATEGORY - A** through convener, PGECET and **GATE. CATEGORY- B** seats are filled by the college management.

2.2. Admissions with advance standing: These may arise in the following cases:

a) When a student seeks transfer from other colleges to SCET and desirous to pursue the study at SCET in an eligible branch of study.
b) When students of SCET get transferred from one regulation to another regulation or from previous syllabus to revised syllabus.
c) When a student after long discontinuity rejoins the college to complete his/her Program of study for the award of degree.

In all such cases for admission, when needed, permissions from the statutory bodies are to be obtained and the Programme of study at SCET will be governed by the transitory regulations.

3. DURATION OF THE PROGRAMME AND MEDIUM OF INSTRUCTION:

The duration of the M. Tech. Program is two academic years consisting of four semesters. The medium of instruction and examinations are in English. Students, who fail to fulfill all the academic requirements for the award of the degree within minimum of four academic years, will forfeit their admission in M. Tech course**.**

4. PROGRAMMES OF STUDY:

The following specializations are offered at present.

i) M. Tech – Power Electronics
ii) M. Tech – CAD/CAM
iii) M. Tech – VLSI System Design

iv) M. Tech – Computer Science & Engineering

v) M. Tech – Nanotechnology

vi) M. Tech – Structural Engineering

5. AWARD OF M. TECH DEGREE

- The candidate pursues a course of study in not less than two and not more than four academic years.
- The student shall register for all 68 credits and secure the same.

6. ATTENDANCE

The minimum instruction days in each semester are 90.

I. A student will be eligible to appear for end semester examinations, if he/she acquired a minimum of 75% of attendance in aggregate of all the courses.

II. Condonation of shortage of attendance in aggregate up to 10% on medical grounds (Above 65% and below 75%) in any semester may be granted by the College Academic Committee.

III. Shortage of Attendance below 65% in aggregate shall not be condoned

IV. Students with less than 65% of attendance in any semester are not eligible to take up their end examination of that particular semester and their registration for examination shall be allowed.

V. Attendance may also be condoned for those who participate in Intercollegiate/university sports, co- and extracurricular activities provided their attendance is in the minimum prescribed range for the purpose (>65%) and recommended by the concerned authority. He/ She shall pay the prescribed condonation fee.

VI. Prescribed Condonation fee shall be payable by the student to appear for the end examination.

VII. A Student will not be promoted to the next semester unless he/she satisfies the attendance requirement of the present semester as applicable. They may seek re-admission for that semester as and when offered consecutively by the Department.

7. EVALUATION

The performance of the candidate in each semester shall be evaluated course-wise, with a maximum of 100 marks for both theory and practical, on the basis of Internal Evaluation and End Semester Examination.

- For the theory subjects 70 marks shall be awarded based on the performance in the End Semester Examination and 30 marks shall be awarded based on the Internal Evaluation. Internal Evaluation shall be made based on the Weighted Average of the marks secured in the two Mid Examinations conducted, one in the middle of the Semester and the other immediately after the completion of instruction. The weightages are 80%

for the mid in which the student secured highest marks and 20% for the mid in which the student secured lowest marks.

- Each mid examination shall be conducted for a total duration of 90 minutes with 3 questions from two and half units (without choice) and each question for 10 marks.
- End semester examination is conducted for 70 marks. Question paper consists of five questions from five units with internal choice. Duration of exam is 180 minutes.
- For practical courses, 30 marks for Internal Evaluation and 70 marks for external examination. Out of 30 Internal marks 15 marks shall be awarded for day-to-day work including Record work and the remaining 15 marks to be awarded by conducting internal laboratory test.
- For MOOCs Course, the student shall register for the course (Minimum of 12 weeks) offered by SWAYAM/NPTEL/JNTUK MOOCs through online with the approval of committee comprises of Head of the Department and two senior faculty. The Head of the Department shall appoint one mentor for each of the MOOC courses offered. 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.

- A candidate shall be deemed to have secured the minimum academic requirement in a course if he secures a minimum of 40% of marks in the End semester Examination and a minimum aggregate of 50% of the total marks in the end semester Examination and Internal.

- A candidate shall be given one chance to re-register for each course provided the internal marks secured by a candidate are less than 50% and has failed in the end examination after completion of the third semester.

- The candidate's attendance in the re- registered course(s) shall be calculated separately to decide upon his/her eligibility for writing the end examination in those courses(s). In the event of the student taking another chance, his internal marks and end examination marks obtained in the previous attempt stand cancelled. For re-registration the candidates have to apply to the Institute by paying the requisite fees and get approval from the concern authorities before the start of the semester in which re-registration is required.
- In case the candidate secures less than the required attendance in any re-registered course(s), he/she shall not be permitted to write the End Examination in that course. He shall again re- register the subject when next offered.

- Laboratory examination must be conducted with internal and external examiner. External examiner will be appointed by the COE from the approved panel of examiners.
- The candidate has to register for the audit course mandatorily and he has to pass the audit courses for successful completion of the degree. However the credits earned in the audit courses are not included in the computation of CGPA
- **Mini Project:** Mini Project in the 3rd semester will be evaluated for 100 marks.

  The project work is evaluated for internal assessment for 30 and external examination for 70.

  i) Internal Assessment: Internal Assessment will be monitored by Project Review Committee consisting of 1) Head of the Department 2) Supervisor and 3) Senior faculty member on the basis of two seminars. The internal marks will be awarded by Project Supervisor.

  ii) External Examination: External Examination will be conducted through presentation / viva – voice and evaluated by Project external examination committee consisting of 1) Head of the Department 2) Supervisor and 3) External examiner appointed by COE.

8. EVALUATION OF PROJECT/DISSERTATION WORK

Every candidate shall be required to submit a thesis or dissertation on a topic approved by the Project Review Committee.

- A Project Review Committee (PRC) shall be constituted with Head of the Department, Supervisor and two senior faculty members or one Industrial Expert duly appointed by the COE.
- Registration of Project Work: A candidate is permitted to register for the project work after satisfying the attendance requirement of all the courses.
- If a candidate wishes to change their supervisor or topic of the project, he/she can do with the recommendation of the Project Review Committee (PRC).
- The project work shall be initiated at the beginning of the III Semester and the duration of the project is two semesters. The candidate has to pass all the theory and practical subjects before submission of the Thesis.
- For submission of the thesis, the candidate to fulfill the following requirements

  1) Plagiarism report of the thesis

  2) Publication in UGC listed journals, is desirable.
- The thesis shall be adjudicated by one examiner from the approved panel of examiners, by the COE.

- If the report of the examiner is favorable, Viva-Voce examination shall be conducted by a board consisting of the Supervisor, Head of the Department and external examiner who adjudicated the Thesis.
- The Board shall jointly report the candidate's work as one of the following:

  A. Excellent

  B. Good

  C. Satisfactory

  D. Unsatisfactory

The Head of the Department shall coordinate and make arrangements for the conduct of Viva-Voce examination.

- If the report of the Viva-Voce is unsatisfactory, the candidate shall retake the Viva-Voce examination only after three months. If he fails to get a satisfactory report at the second Viva-Voce examination, the candidate has to re-register for the project and complete the project within the stipulated time after taking the approval from the concerned authorities.

9. GRADING SYSTEM:

9.1 Award of Grade:

(i) Grade Point Average (GPA):

a) The Grade Point Average (GPA) will be calculated according to the formula.

$$GPA = \frac{\sum C_i G_i}{\sum C_i}$$

Where C_i = number of credits for the subject i

G_i = grade points obtained by the student in the subject.

b) Semester Grade Point Average (SGPA) is awarded to candidates considering all the subjects of the semester. Zero grade points are also included in this computation.

c) To arrive at Cumulative Grade Point Average (CGPA), the formula is used considering the student's performance in all the courses taken in all the semesters completed up to the particular point of time.

$$CGPA = \frac{\sum C_i G_i}{\sum C_i}$$

Where C_i = number of credits for the subject i

G_i = grade points obtained by the student in the subject.

(ii) After a student satisfies the requirements prescribed for the award of M. Tech Program he/she shall be placed in one of the following four grades. The award of the degree is based on CGPA on a grade point scale of 10.

CGPA	Award of Division
≥7.75	First Class with Distinction
≥6.75	First Division
≥5.75	Second Division
<5.75	Unsatisfactory

9.2 Award of Grade in Each Semester:

a. Based on the performance during a given semester, a final letter grade will be awarded at the end of the semester for each subject. The letter grades and the corresponding grade points are as given in the Table.

Percentage of Marks Scored	Letter Grade	Level	Grade points
>=90	O	Outstanding	10
80– 89	S	Excellent	9
70-79	A	Very Good	8
60-69	B	Good	7
50-59	C	Fair	6
< 50	F	Fail	0
		Absent	0

b. Grade Sheet: A grade sheet (memorandum) will be issued to each student indicating his performance in all courses taken in that semester and also indicating the Grades.

c. Transcripts: After successful completion of the total program of study, a Transcript containing performance of all academic years will be issued as a final record. Duplicate transcripts will also be issued up to any point of study to any student on request and by paying the stipulated fee in force.

d. Candidates shall be permitted to apply for revaluation within the stipulated period with payment of prescribed fee.

10. CONDUCT AND DISCIPLINE:

Students admitted in SCET are to be followed the conduct and discipline of the college and which will be updated from time to time.

11. MALPRACTICES:

If any malpractices held in internal assessment tests or Semester-End Examinations, Principal constitute a Malpractice Enquiry Committee to enquire the case. The principal shall take necessary action based on the recommendations of the committee as per stipulated norms.

12. WITHHOLDING OF RESULTS

If the student has not paid the dues, if any, to the university or if any case of indiscipline is pending against him, the result of the student will be withheld. His degree will be withheld in such cases.

13. GENERAL

- Wherever the words ‒he‖, ‒him‖, ‒his‖, occur in the regulations, they include ‒she‖, ‒her‖, ‒hers‖.
- The academic regulation should be read as a whole for the purpose of any interpretation.
- In the case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Chairman, Academic Council is final.
- 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.

SWARNANDHRA COLLEGE OF ENGINEERING AND TECHNOLOGY

(AUTONOMOUS)

MECHANICAL ENGINEERING DEPARTMENT

M.TECH COURSE STRUCTURE

I SEMESTER

S.No	Course Code	Course Title	L	T	P	C	IM	EM	TM
1	19CC1T01	Research Methodology and IPR	2	0	0	2	30	70	100
2	19CC1T02	Advanced CAD	3	0	0	3	30	70	100
3	19CC1T03	Computer Aided Manufacturing	3	0	0	3	30	70	100
	Elective - I								
4	19CC1E01 19CC1E02 19CC1E03	1. Fracture Mechanics 2. Advanced Stress Analysis 3. Additive Manufacturing Technologies	3	0	0	3	30	70	100
	Elective - II								
5	19CC1E04 19CC1E05 19CC1E06	1. Automation in Manufacturing 2. Industrial Robotics 3. Design for Manufacturing	3	0	0	3	30	70	100
6	19CC1L01	Advanced Computer Aided Design Lab	0	0	4	2	30	70	100
7	19CC1L02	Computer Aided Manufacturing Lab	0	0	4	2	30	70	100
8		Audit Course- I	2	0	0	0			
		Total Credits	**16**	**0**	**8**	**18**	**210**	**490**	**700**

II SEMESTER

S.No	Course Code	Course Title	L	T	P	C	IM	EM	TM
1	19CC2T01	Advanced Finite Element Methods	3	0	0	3	30	70	100
2	19CC2T02	Simulation and Modeling Of Manufacturing Systems	3	0	0	3	30	70	100
3	**Elective - III**								
	19CC2E07 19CC2E08 19CC2E09	1. Intelligent Manufacturing Systems 2. Optimization and Reliability 3. Quality Engineering in Manufacturing	3	0	0	3	30	70	100
4	**Elective - IV**								
	19CC2E10 19CC2E11 19CC2E12	1. Advanced Mechatronics 2. Design and Manufacturing of MEMS and Micro Systems 3. Advances in Nano Technology	3	0	0	3	30	70	100
5	19CC2P01	Mini Project with Seminar	0	0	4	2	50	-	50
6	19CC2L01	Simulation of Manufacturing Systems Lab	0	0	4	2	30	70	100
7	19CC2L02	Material Characterization Lab	0	0	4	2	30	70	100
8		Audit Course- II	2	0	0	0	-	-	-
		Total Credits	**14**	**0**	**12**	**18**	**230**	**420**	**650**

III **SEMISTER**

S.No	Course Code	Course Title	L	T	P	C	IM	EM	TM
1	**Elective - V**								
	19CC3E13 19CC3E14 19CC3E15	1. Non destructive Evaluation 2. Computer Graphics 3. Product Design and Developement	3	-	-	3	30	70	100
2	**Open Elective**								
	19CM3O01 19CC3O02 19CC3O03 19MB3O04 19CC3O05 19PE3O06	1. Business Analytics 2. Industrial Safety 3. Operations Research 4. Cost Management of Engineering Projects 5. Composite Materials 5. Waste to Energy	3	-	-	3	30	70	100
3		Project Phase-I	-	-	20	10	-	-	-
		Total Credits	6	-	20	**16**	**60**	**140**	**200**

IV **SEMISTER**

S.No	Course Code	Course Title	L	T	P	C	IM	EM	TM
1	19CC4P01	Project Phase-II	-	-	32	16	-	-	-
		Total Credits	-	-	**32**	**16**	-	-	-

LIST OF AUDIT COURSES I & II

S.No.	Course Code	Name of the Course
1	19ACXM01	English for Research Paper Writing
2	19ACXM02	Disaster Management
3	19ACXM03	Sanskrit for Technical Knowledge
4	19ACXM04	Value Education
5	19ACXM05	Constitution of India
6	19ACXM06	Pedagogy Studies
7	19ACXM07	Stress Management by yoga
8	19ACXM08	Personality Development Through Life Enlightenment Skills

ADVANCED CAD

COURSE OUTCOMES: Students are able to

CO1: Explain the CAD tools including CAD software and geometric modelling.[K2]
CO2: Interpret the parametric representation of analytic curves and synthetic curves in geometric modelling.[K3]
CO3: Explain the surface representation methods, parametric representation of analytic curves and synthetic curves in surface modelling.[K2]
CO4: Illustrate the geometry and topology of solid modelling and constructive solid geometry.[K3]
CO5: Explain the 2D and 3D transformation methods and describe about the data exchange formats.[K2]

UNIT- I:
CAD Tools: Definition of CAD Tools, Graphics standards, Graphics software: requirements of graphics software, Functional areas of CAD, Efficient use of CAD software. Basics of Geometric Modelling: Requirement of geometric 3D Modeling, Geometric models, Geometric construction methods, Modelling facilities desired.

UNIT- II:
Geometric Modeling: Classification of wireframe entities, Curve representation methods, Parametric representation of analytic curves: line, circle, arc, conics, Parametric representation of synthetic curves: Hermite cubic curve, Bezier curve, B-Spline curvewire, NURBS, Curve manipulations.

UNIT- III:
Surface Modeling: Classification of surface entities, Surface representation methods, Parametric representation of analytic surfaces: plane surface, ruled surface, surface of revolution, tabulated cylinder, Parametric representation of synthetic curves: Hermite cubic surface, Bezier surface, B-Sp line surface, Blending surface, Surface manipulations.

UNIT- IV:
Solid Modelling: Geometry and topology, Boundary representation, The Euler-Poincare formula, Euler operators, Constructive solid geometry: CSG primitives, Boolean operators, CSG expressions, Interior, Exterior, closure, Sweeping: linear and non-linear, Solid manipulations, feature modeling.

UNIT- V:
Transformations: 2-D and 3-D transformations: translation, scaling, rotation, reflection, concatenation,homogeneous coordinates, Perspective projection, orthotropic projection, isometric projection, Hidden surface removal, shading, rendering.
Evaluation Criteria: Evaluation criteria of CAD software, Data exchange formats: GKS, IGES, PHIGS,CGM, STEP Dimensioning and tolerances: Linear, angular, angular dimensions, maximum material condition (MMC), Least material condition (LMC), Regardless of feature size (RFS).

TEXT BOOKS:
1. CAD/CAM Concepts and Applications/ Alavala/ PHI.
2. Mastering CAD/CAM / Ibr

him Zeid / McGraw Hill International.
3. CAD/CAM Principles and Applications/ P.N. Rao/TMH/3rd Edition
REFERENCES BOOKS:
1. CAD/CAM /Groover M.P./ Pearson education

2. CAD / CAM / CIM, Radhakrishnan and Subramanian/ New Age
3. Principles of Computer Aided Design and Manufacturing/ Farid Amirouche/ Pearson

COMPUTER AIDED MANUFACTURING

COURSE OUTCOMES: Students are able to

CO1. Write APT programming for various machining processes. [K3]
CO2. Explain Interchangeable tooling system and Adaptive control of machining processes. [K2]
CO3. Explain the Post Processors and its necessity. [K2]
CO4. Explain Applications and Programming of Micro Controllers. [K3]
CO5. Explain Computer aided process planning and Computer Aided Inspection processes. [K2]

UNIT - I

COMPUTER AIDED PROGRAMMING: General information, APT programming, Examples APT programming problems (2D machining only). NC programming on CAD/CAM systems, the design and implementation of post processors .Introduction to CAD/CAM software, Automatic Tool Path generation

UNIT - II

TOOLING FOR CNC MACHINES: Interchangeable tooling system, preset and qualified tools, coolant fed tooling system, modular fixturing, quick change tooling system, automatic head changers. DNC Systems and Adaptive Control: Introduction, type of DNC systems, advantages and disadvantages of DNC, adaptive control with optimization, Adaptive control with constraints, Adaptive control of machining processes like turning, grinding.

UNIT - III

POST PROCESSORS FOR CNC: Introduction to Post Processors: The necessity of a Post Processor, the general structure of a Post Processor, the functions of a Post Processor, DAPP — based- Post Processor: Communication channels and major variables in the DAPP — based Post Processor, th creation of a DAPP — Based Post Processor.

UNIT - IV

MICRO CONTROLLERS: Introduction, Hardware components, I/O pins, ports, external memory:counters, timers and serial data I/O interrupts. Selection of Micro Controllers, Embedded Controllers, Applications and Programming of Micro Controllers. Programming Logic Controllers (PLC' s): Introduction, Hardware components of PLC, System, basic structure, principle of operations, Programming mnemonics timers, Internal relays and counters, Applications of PLC's in CNC Machines.

UNIT - V

COMPUTER AIDED PROCESS PLANNING: Hybrid CAAP System, Computer Aided Inspection and quality control, Coordinate Measuring Machine, Limitations of CMM, Computer Aided Testing, Optical Inspection Methods, Artificial Intelligence and expert system: Artificial Neural Networks, Artificial Intelligence in CAD, Experts systems and its structures.

TEXT BOOKS:

1. Computer Control of Manufacturing Systems / Yoram Koren / Mc Graw Hill. 1983.
2. CAD/CAM Principles and Applications, P.N.Rao, TMH

REFERENCES:

1. Computer Aided Design Manufacturing – K. Lalit Narayan, K. Mallikarjuna Rao and M.M.M. Sarcar, PHI, 2008.
2. CAD / CAM Theory and Practice,/ Ibrahim Zeid,TMH
3. CAD / CAM / CIM, Radhakrishnan and Subramanian, New Age
4. Principles of Computer Aided Design and Manufacturing, Farid Amirouche, Pearson
5. Computer Numerical Control Concepts and programming, Warren S Seames, Thomson

FRACTURE MECHANICS
(Professional Elective - I)

COURSE OUTCOMES: Students can able to
CO1: Illustrate various types of Fracture in Metals and Single Crystals.[K2]
CO2: Calculate stresses and strains in structural members subjected to various types of loadings. [K3]
CO3: Explain the Cyclic Stress strain curve. [K2]
CO4: Explain about various types of Effects on fatigue. [K2]
CO5: Evaluate creep damage in Creep deformation. [K4]

UNIT-I:
Fracture: Introduction, Types of Fracture in Metals, Griffith Theory of Brittle Fracture, Fracture of Single Crystals, Ductile Fracture, Concept of the Fracture Curve. Fracture Mechanics: Strain Energy Release rate, Fracture Toughness and Design, Cra **METHODS OF COMPOSITES** ck Opening Displacement, J-Integral, R Curve

UNIT-II:
Theory of Elasticity and Plasticity: Elasticity Theory: The State of Stress and strain, elastic stress-strain relation, anisotropy, elastic behavior of metals, ceramics and polymers. Plasticity: Hydrostatic and Deviatoric stress, Octahedral stress, yield criteria and yield surface, texture and distortion of yield surface, true stress and true strain, flow rules, strain hardening, Ramberg Osgood equation, stress - strain relation in plasticity, plastic deformation of metals and polymers

UNIT-III:
Fatigue-I: Introduction, Stress Cycles, S-N Curve, Effect of Mean Stress on Fatigue, Cyclic Stress strain curve, Low Cycle Fatigue, Strain Life Equation, Structural Features of Fatigue, Fatigue Crack Propagation, Effect of Metallurgical Variables on Fatigue.

UNIT-IV:
Fatigue-II: Effect of stress concentration on Fatigue, Size Effect, Surface effects on Fatigue, Fatigue under Combined stresses, Design for Fatigue, Machine Design approach-Infinite life design, Local strain approach, Corrosion Fatigue, Effect of Temperature on fatigue.

UNIT-V:
Creep deformation: The evolution of creep damage, primary, secondary and tertiary creep, Micro mechanisms of creep in materials and the role of diffusion, Ashby creep deformation maps. Stress dependence of creep – power law dependence. Comparison of creep performance under different conditions – extrapolation and the use of Larson-Miller parameters, Creep-fatigue interactions, Examples.

TEXT BOOKS:
1. Mechanical Metallurgy by G. E. Dieter, McGraw Hill, (1988)
2. Thin Film Materials L.B. Freund and S. Suresh, Cambridge University Press (2003).

REFERENCE BOOKS:
1. Fracture Mechanics Fundamentals and Applications by T.L. Anderson, 2nd Ed. CRC press,(1995)
2. Fracture of Brittle Solids by B. Lawn, Cambridge Solid State Science Series 2nd ed 1993.
3. Fundamentals of Fracture Mechanics by J.F. Knott, Butter worths (1973)
4. Worked examples in Fracture Mechanics by J.F. Knott, P Withey, Institute of Materials.
5. Fracture Mechanics by H.L. Ewald and R.J. H. Wanhill, Edward Arnold, (1984).

ADVANCED STRESS ANALYSIS
(Professional Elective - I)

COURSE OUTCOMES: Students can able to

CO1. Explain the concepts of theory of elasticity and plasticity. [K2]

CO 2. Analyse stresses in components subjected to various loading using different methods.[K4]

CO 3. Analyse different cross section, shaft and bar subjected to torsion.[K4]

CO 4. Analyse Unsymmetrical Bending and Shear Centre.[K4]

CO 5. Evaluate Pressurized Cylinders and Rotating Disks using Governing equations.[K5]

UNIT -I:

Theory of Elasticity Analysis of stress, Analysis of stain, Elasticity problems in two dimension and three dimensions, Mohr's circle for three dimensional stresses. Stress tensor, Air's stress function in rectangular and polar coordinates.

UNIT -II:

Energy Methods Energy method for analysis of stress, strain and deflection The three theorem's - theorem of virtual work, theorem of least work, Castiglio ni's theorem, Rayleigh Ritz method, Galekin's method, Elastic behavior of anisotropic materials like fiber reinforced composites.

UNIT -III:

Theory of TorsionTorsion of prismatic bars of solid section and thin walled section. Analogies for torsion, membrane analogy, fluid flow analogy and electrical analogy. Torsion of conical shaft, bar of variable diameter, thin walled members of open cross section in which some sections are prevented from warping, Torsion of noncircular shaft.

UNIT -IV:

Unsymmetrical Bending and Shear CentreConcept of shear center in symmetrical and unsymmetrical bending, stress and deflections in beams subjected to unsymmetrical bending, shear center for thin wall beam cross section, open section with one axis of symmetry, general open section, and closed section.

UNIT -V:

Pressurized Cylinders and Rotating DisksGoverning equations, stress in thick walled cylinder under internal and external pressure, shrink fit compound cylinders, stresses in rotating flat solid disk, flat disk with central hole, disk with variable thickness, disk of uniform strength, Plastic action in thick walled cylinders and rotating disc.

TEXT BOOKS:

1. Theory of Elasticity/Timoshenko S.P. and Goodier J. N./ Koakusha Publishers
2. Advanced strength of materials / Den Hortog J.P./Torrent
3. Mechanical Vibrations/ Den Ilartog J.P./ Dover Publications
4. Theory of Vibrations with Applications/ Thomson W.T./ CBS Publishing
5. Mechanical Vibrations/ Rao S.S./ Addison Wesley Longman

ADDITIVE MANUFACTURING TECHNOLOGIES
(Professional Elective -I)

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UNIT–I:

Introduction: Prototyping fundamentals: Need for time compression in product development, Need for Additive Manufacturing, Historical development, Fundamentals of Additive Manufacturing, AM Process Chain, Advantages and Limitations of AM, Commonly used Terms, Classification of AM process, Fundamental Automated Processes: Distinction between AM and CNC, other related technologies.

UNIT–II:

Liquid-based AM Systems: Stereo lithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. Solid ground curing (SGC): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Poly jet: Process, Principle, working principle, Applications, Advantages and Disadvantages, Casestudies. Micro fabrication.

Solid-based AM Systems: Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Multi-Jet Modelling (MJM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

UNIT–III:

Powder Based AM Systems: Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Three-dimensional Printing (3DP): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

Laser Engineered Net Shaping (LENS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Electron Beam Melting (EBM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies

Rapid Tooling: Introduction to Rapid Tooling (RT), Conventional Tooling Vs RT, Need for RT. Rapid Tooling Classification: Indirect Rapid Tooling Methods: Arc Spray Metal Deposition, Investment Casting, Sand Casting, 3D Keltool process. Direct Rapid Tooling: Direct AIM, LOM Tools, DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP.

UNIT–IV:

AM Data Formats: Reengineering for Digital Representation, STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats. Mesh Refining by Sub division Techniques.

AM Software's: Need for AM software, Features of various AM software's like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL View 3 Data Expert and 3 D doctor, Surgi Guide, 3-matic, Simplant, Mesh Lab.

UNIT–V:

AM Applications: Application – Material Relationship, Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Jewelry Industry, Coin

Industry, GIS application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customized Implants & Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visualization of Biomolecules. Web Based Rapid Prototyping Systems

TEXT BOOK:

1. Rapid prototyping: Principles and Applications by Chua C.K., Leong K.F. and LIM C.S, World Scientific publications, Third Edition, 2010.

REFERENCE BOOKS:

1. Rapid Manufacturing by D.T. Pham and S.S. Dimov, Springer, 2001.
2. Wholers Report 2000 by Terry Wohlers, Wohlers Associates, 2000.
3. Rapid Prototyping & Engineering Applications by Frank W.Liou, CRC Press, Taylor & Francis Group, 2011.

AUTOMATION IN MANUFACTURING
(Professional Elective - II)

UNIT- I:

Introduction to Automation: Automation in Production Systems-Automated Manufacturing Systems, Computerized Manufacturing Support Systems, Reasons for Automation, Automation Principles and Strategies. Manufacturing operations, Production Concepts and Mathematical Models. Costs of Manufacturing Operations, Basic Elements of an Automated Systems, Advanced Automation Functions, Levels of automation.

UNIT- II:

Introduction to Material Handling: Overview of Material Handling Equipment, Considerations in Material Handling System Design, the 10 Principles of Material Handling. Material Transport Systems, Automated Guided Vehicle Systems, Monorails and other Rail Guided Vehicles, Conveyor Systems, Analysis of Material Transport Systems. Storage Systems, Storage System Performance, Storage Location Strategies, Conventional Storage Methods and Equipment, Automated Storage Systems, Engineering Analysis of Storage Systems. Automatic data capture-overview of Automatic identification methods, bar code technology, other ADC technologies.

UNIT - III:

Manual Assembly Lines - Fundamentals of Manual Assembly Lines, Alternative Assembly Systems, Design for Assembly, Analysis of Single Model Assembly Lines, Assembly Line balancing: largest candidate rule, Kilbridge and Wester method, and Ranked Positional Weights Method, Mixed Model Assembly Lines, Considerations in assembly line design.

UNIT- IV:

Transfer lines, Fundamentals of Automated Production Lines, Storage Buffers, and Applications of Automated Production Lines. Analysis of Transfer Lines with no Internal Storage, Analysis of Transfer lines with Storage Buffers.

UNIT- V:

Automated Assembly Systems, Fundamentals of Automated Assembly Systems, Design for Automated Assembly, and Quantitative Analysis of Assembly Systems - Parts Delivery System at Work Stations, Multi- Station Assembly Machines, Single Station Assembly Machines, Partial Automation.

TEXT BOOKS:

1. Automation, Production systems and computer integrated manufacturing by Mikel P. Groover,Pearson Education.

REFERENCE BOOKS:

1. CAD CAM: Principles, Practice and Manufacturing Management by Chris Mc Mohan, Jimmie Browne, Pearson edu. (LPE)
2. Automation by Buckinghsm W, Haper & Row Publishers, New York, 1961
3. Automation for Productivity by Luke H.D, John Wiley & Sons, New York, 1972.

INDUSTRIAL ROBOTICS
(Professional Elective - II)

COURSE OUTCOMES: Students will be able to

CO1: Summarize principles of Automation, Classification and Control systems of industrial Robots. [K2]
CO2: Apply various motion analysis principles to solve problems involving Manipulator Kinematics. [K4]
CO3: Apply Jacobian and Lagrangian principles to solve manipulator Dynamics Problems. [K3]
CO4: Summarize different types of Robot Programming Methods and robot languages. [K2]
CO5: Design of robot cell and robot applications in various fields [K3].

UNIT-I:
Introduction: Automation and Robotics, Robot anatomy configuration, motions joint motion and notation, work volume, robot drive system, control system and dynamic performance, precision of movement.
Control System and Components: basic concept and modals controllers control system analysis, robot actuators and feedback components (sensors): Internal & External Sensors, Positions sensors, velocity sensors - Desirable features, tactile, proximity and range sensors, uses sensors in robotics, Power Transmission Systems.

UNIT-II:
Motion Analysis and Control: Manipulator kinematics, position representation Homogeneous transformation, D-H Notation, D-H Transformation Matrix, Forward & Inverse transformations, problems on planar & spatial manipulators, Differential Kinematics, Jacobian Formulation, problems, manipulator path control: Slew, Joint Interpolated & Straight line motions, trajectory planning: Joint space scheme,Cartesian space scheme, Cubic Polynomial fit without and with via point, blending.

UNIT-III:
Robot Dynamics: Lagrange – Euler & Newton - Euler formulations, problems on two link planar manipulators, configuration of robot controller.
End Effectors: Grippers-types, operation, mechanism, force analysis, tools as end effectors consideration in gripper selection and design.
Machine Vision: Functions, Sensing and Digitizing-imaging, Devices, Lighting techniques, Analog todigital single conversion, Image storage, Image processing and Analysis-image data reduction, Segmentation feature extraction. Object recognition, training the vision system, Robotics application.

UNIT-IV:
Robot Programming: Lead through programming, Robot programming as a path in space, Motion interpolation, WAIT, SINGNAL AND DELAY commands, Branching capabilities and Limitations.
Robot Languages: Textual robot languages, Generation, Robot language structures, Elements and functions.

UNIT-V:
Robot Cell Design and Control: Robot cell layouts-Robot centered cell, In-line robot cell,Considerations in work cell design, Work cell control, Inter locks, Error detection, Work cell controller.
Robot Applications: Material transfer, Machine loading/unloading. Processing operations, Assembly and Inspection, Future Applications.

TEXT BOOKS:

1. Introduction to Robotics Mechanics & Control by John J. Craig, Pearson
2. Industrial robotics by Mikell P. Groover, McGraw Hill.

REFERENCE BOOKS:

1. Industrial robotics by Mikell P. Groover, McGraw Hill
2. Robotics by K.S.Fu, McGraw Hill.
3. Introduction to Robotics Mechanics & Control by John J. Craig, Pearson
4. Robot Analysis by Lung Wen Tsai, John Wiley & Sons
5. Robot Analysis and Control by Asada H. and J. E. Slotin, Wiley, New York

RESEARCH METHODOLOGY AND IPR

COURSE OUTCOMES: Students will be able to

CO1. Formulate a research problem for a given engineering domain. [K6]

CO2. Analyse the available literature for given research problem. [K4]

CO3. Develop technical writing and presentation skills. [K6]

CO4. Explain concepts related to patents, trademark and copyright. [K2]

CO5. Explain about developments in Intellectual Property Rights. [K2]

UNIT-I:
Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT-II:
Effective literature studies approaches, analysis, Plagiarism, Research ethics

UNIT-III:
Effective technical writing, how to write report, Paper Developing a Research Proposal, Format ofresearch proposal, a presentation and assessment by a review committee

UNIT-IV:
Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development.
International Scenario:International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT-V:
Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

TEXT BOOKS:
1. Wayne Goddard and Stuart Melville, ‐Research Methodology: An Introduction‖, 2nd Edition, Juta Academic
2. Halbert, ―Resisting Intellectual Property‖, Taylor & Francis Ltd ,2007

REFERENCES:
1. Ranjit Kumar, 2nd Edition, ―Research Methodology: A Step by Step Guide for beginners‖
3. Mayall, ‐Industrial Design‖, McGraw Hill, 1992.
4. Niebel, ―Product Design‖, McGraw Hill, 1974.
5. Asimov, ‐Introduction to Design‖, Prentice Hall, 1962.
6. Robert P. Merges, Peter S. Menell, Mark A. Lemley, ‐Intellectual Property in New Technological Age‖, 2016.
7. T. Ramappa, ‐Intellectual Property Rights Under WTO‖, S. Chand, 2008

ADVANCED COMPUTER AIDED DESIGN LAB (Lab - I)

COURSE OUTCOMES: Students will be able to

CO1: Perform the modelling of 2D and 3D trusses and predict the deflection and stress distributions. [K4]
CO2: Carryout the modelling of different beams and predict the stress distributions and deflections in the span. [K4]
CO3: Perform the finite element analysis in a plate and predict the maximum stress and strain in plane stress condition. [K4]
CO4: Perform the finite element analysis in a cylinder in axisymmetric condition and predict the stress distributions and deflections.[K4]
CO5: Carryout the modelling of different beams and predict the natural frequency using FEA.

Note: Conduct any Ten exercises from the list given below:

1. Two- dimensional drawing using CAD software.
2. Three-dimensional drawing using CAD software.
3. Various Dimensioning and tolerancing techniques on typical products using CAD software.
4. Assembly and animation of simple assemblies like screw jack, bolt-nut mechanism, etc.
5. Truss analysis using FEA software.
6. Beam analysis using FEA software.
7. Frame analysis using FEA software.
    1. Buckling analysis
    2. Fracture analysis
    3. Analysis of laminated composites
    4. Modal Analysis
    5. Harmonic analysis
    6. Spectrum analysis
    7. Transient structural analysis
    8. Transient Thermal Analysis
    9. Couple-field analysis using FEA software.
    10. Rigid Body Dynamic Analysis

Software to be used: Any FEA software like Ansys, Hypermesh, NASTRAN etc.

COMPUTER AIDED MANUFACTURING LAB (Lab - II)

List of Experiments:

1. CNC programs for turning- 4 exercises
2. CNC programs for milling- 4 exercises
3. Robot programming- Lead through programming using teach product, forward kinematics, inverse kinematics, trajectory planning.

ADVANCED FINITE ELEMENT METHODS

COURSE OUTCOMES: Student will be able to

CO1: Apply direct stiffness, Rayleigh-Ritz, Galerkin method to solve engineering problems and outline the requirements for convergence.

CO2: Analyze linear 1D problems like bars and trusses;

CO3: Analyze 2D structural problems using CST element, solving 1Dheat conduction and convection heat transfer problems

CO4: Generating Isoperimetric formulation and solving numerical integration problems

CO5: Evaluate the Eigenvalues and Eigenvectors for stepped bar and beam, explain nonlinear geometric and material non linearity**.**

UNIT - I

FORMULATION TECHNIQUES: Methodology, Engineering problems and governing differential equations, finite elements, Variational methods potential energy method, Raleigh Ritz method, strong and weak forms, Galerkin and weighted residual methods, calculus of variations, Essential and natural boundary conditions.

UNIT – II

ONE-DIMENSIONAL ELEMENTS: Bar, trusses, beams and frames, displacements, stresses and temperature effects.

UNIT – III

TWO DIMENSIONAL PROBLEMS: CST, LST, four noded and eight nodded rectangular elements, Lagrange basis for triangles and rectangles, serendipity interpolation functions. Axisymmetric Problems: Axisymmetric formulations, Element matrices, boundary conditions. Heat Transfer problems: Conduction and convection, examples: - two dimensional fin.

UNIT – IV

ISOPARAMETRIC FORMULATION: Concepts, sub parametric, super parametric elements, numerical integration, Requirements for convergence, hrefinement and p-refinement, complete and incomplete interpolation functions, Pascal's triangle, Patch test.

UNIT – V

Finite elements in Structural Analysis: Static and dynamic analysis, eigen value problems, and their solution methods, case studies using commercial finite element packages.

TEXT BOOK:

1. Finite element methods by Chandrubatla & Belagondu.

REFERENCES:

2. J.N. Reddy, Finite element method in Heat transfer and fluid dynamics, CRC press, 1994
3. Zienckiwicz O.C. & R. L. Taylor, Finite Element Method, McGraw- Hill, 1983.
4. K. J. Bathe, Finite element procedures, Prentice-Hall, 1996

SIMULATION AND MODELING OF MANUFACTURINGSYSTEMS

COURSE OUTCOMES: Students are able to

CO1: Learn way of analyzing the systems (K4)

CO2: Classification of systems based nature of dynamics and knowledge of elements (K2)

CO3: To develop simulation model for dynamic discrete – event stochastic system (K3)

CO4: To run the model and collect the data

CO5: To analyze the output data of simulation for specified for performance measures bases on type of simulation and method of output data analysis (K4)

UNIT - I

System - ways to analyze the system - Model - types of models -Simulation - Definition - Types of simulation models - steps involved in simulation - Advantages & Disadvantages. Parameter estimation -estimator - properties - estimate - point estimate - confidence interval estimates - independent - dependent - hypothesis - types of hypothesis step- types l& 2 errors - Framing - string law of large numbers.

UNIT - II

Building of Simulation model validation - verification - credibility – their timing - principles of valid simulation Modeling - Techniques for verification - statistical procedures for developing credible model. Modeling of stochastic input elements - importance - various procedures - theoretical distribution - continuous - discrete their suitability in modeling.

UNIT - III

Generation of random variables - factors for selection methods – inverse transform - composition - convolution - acceptance - rejection - generation of random variables - exponential - uniform - Weibull – normal Bernoulli - Binomial uniform - Poisson - Simulation languages - comparison of simulation languages with general purpose languages Simulation languages vs Simulators - software features – statistical capabilities - G P S S - S1MAN- SIMSCRIPT - Simulation of WMJI queue - comparison of simulation languages.

UNIT - IV

Output data analysis - Types of Simulation w. r. t output data analysis – warm up period- Welch algorithm - Approaches for Steady – State Analysis - replication - Batch means methods - corn pan Sons.

UNIT - V

Applications of Simulation - flow shop system - job shop system - M/ MI1 queues with infinite and finite capacities - Simple fixed period inventory system – New boy paper problem.

TEXT BOOKS:

1. Simulation Modelling and Analysis / Law, A.M.& Kelton / Mc Graw Hill, Edition/ New York, 1991.
2. Simulation of Manufacturing Systems / Carrie A. / Wiley, NY, 1990.

REFERENCES:

1. Discrete Event System Simulation I Banks J. & Carson J.S., PH I Englewood Cliffs N/ 1984.
2. A Course in Simulation / Ross, S.M., McMillan, NY, 1990.
3. Simulation Modelling and S1MNET/ Taha HA. / PH, Englewood Cliffs, NJ, 1987

INTELLIGENT MANUFACTURING SYSTEMS
(ELECTIVE III)

COURSE OUTCOMES: Students are able to

CO1: Assess the performance of manufacturing systems manufacturing and enterprise integration (K4)

CO2: Develop a systematic approach for design and implementation of manufacturing systems (K3)

CO3: Categorize the Biological and Artificial Neuron (K4)

CO4: Design and planning manufacturing systems (K6)

CO5: Identification of method of technologies (K1)

UNIT I

Computer Integrated Manufacturing Systems Structure and functional areas of CIM system, - CAD, CAPP, CAM, CAQC,ASRS. Advantages of CIM. Manufacturing Communication Systems - MAP/TOP, OSI Model, Data Redundancy, Top- down and Bottom-up Approach, Volume of Information. Intelligent Manufacturing System Components, System Architecture and Data Flow, System Operation.

UNIT II

Components of Knowledge Based Systems - Basic Components of Knowledge Based Systems, Knowledge Representation, Comparison of Knowledge Representation Schemes, Interference Engine, Knowledge Acquisition.

UNIT III

Machine Learning - Concept of Artificial Intelligence, Conceptual Learning, Artificial Neural Networks-Biological Neuron, Artificial Neuron, Types of Neural Networks, Applications in Manufacturing.

UNIT IV

Automated Process Planning - Variant Approach, Generative Approach, Expert Systems for Process Planning, Feature Recognition, Phases of Process planning. Knowledge Based System for Equipment Selection (KBSES) – Manufacturing system design. Equipment Selection Problem, Modeling the Manufacturing Equipment Selection Problem, Problem Solving approaches in KBSES, Structure of the KRSES.

UNIT V

Group Technology: Models and Algorithms Visual Method, Coding Method, Cluster Analysis Method, Matrix Formation -Similarity Coefficient Method, Sorting-based Algorithms, Bond Energy Algorithm, Cost Based method, Cluster Identification Method, Extended CI Method. Knowledge Based Group Technology - Group Technology in Automated Manufacturing System. Structure of Knowledge based system for group technology (KBSCIT) — Data Base, Knowledge Base, Clustering Algorithm.

REFERENCES

1. Intelligent Manufacturing Systems/ Andrew Kusiak/Prentice Hall.
2. Artificial Neural Networks/ Yagna Narayana/PHI/2006
3..Automation,ProductionSystemsandCIM/GrooverM.P./PHI/2007
4. Neural networks: A comprehensive foundation/ Simon Hhaykin/ PHI.
5. Artificial neural networks/ B.Vegnanarayana/PHI

6. Neural networks in Computer intelligence/ Li Min Fu/ TMH/2003
7. Neural networks/ James A Freeman David M S kapura/ Pearson education/2004
8. Introduction to Artificial Neural Systems/Jacek M. Zurada/JAICO Publishing House Ed. 2006.

OPTIMIZATION AND RELIABILITY

COURSE OUTCOMES: Students are able to

CO1: Estimating the likely reliability of new designs, and for analyzing reliability data.

CO2: Train personnel in specific maintenance skills.

CO3: Advise on the acquisition, installation and operation of machinery.

CO4: Ensure environmental protection.

CO5: Understand the various applications of optimization.

UNIT - I

Classical optimization techniques: Single variable optimization with and without constraints, multi – variable optimization without constraints, multi – variable optimization with constraints – method of Lagrange multipliers, Kuhn-Tucker conditions.

UNIT - II

Numerical methods for optimization: Nelder Mead's Simplex search method, Gradient of a function, steepest descent method, Newton's method, types of penalty methods for handling constraints.

UNIT - III

Genetic algorithm (GA): Differences and similarities between conventional and evolutionary algorithms, working principle, reproduction, crossover, mutation, termination criteria, different Reproduction and crossover operators, GA for constrained optimization, draw backs of GA, Genetic Programming (GP): Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation, solving differential equations using GP.

UNIT – IV

Multi-Objective GA: Pareto's analysis, Non-dominated front, multi – objective GA, Non-dominated sorted GA, convergence criterion, applications of multi-objective problems.

UNIT V

Applications of Optimization in Design and Manufacturing systems: Some typical applications like optimization of path synthesis of a four bar mechanism, minimization of weight of a cantilever beam, optimization of springs and gears, general optimization model of a machining process, optimization of arc welding parameters, and general procedure in optimizing machining operations sequence.

TEXT BOOKS:

1. Optimal design – Jasbir Arora, Mc Graw Hill (International) Publishers
2. Optimization for Engineering Design – Kalyanmoy Deb, PHI Publishers
3. Engineering Optimization – S.S.Rao, New Age Publishers

REFERENCES:

1. Genetic algorithms in Search, Optimization, and Machine learning – D.E.Goldberg, Addison-Wesley Publishers
2. Genetic Programming- Koza
3. Multi objective Genetic algorithms - Kalyanmoy Deb, PHI Publishers

QUALITY ENGINEERING IN MANUFACTURING
(ELECTIVE-III)

COURSE OUTCOMES: Students are able to

CO1: Student able to know Quality System and there production design inVarious tolerances.[K2]
CO2: Student able to Learn tolerance and parameter for different types of design strategys. [K3]
CO3: Student able to apply Analysis of Variance ANOVA types in different level factors. [K2]
CO4: Student able to find Orthogonal Arrays on various strategies and different experimental Results. [K3]
CO5: Student able to know six sigma and technical methodologysin process improvement.[K3]

UNIT - I

Quality Value and Engineering: An overall quality system, quality engineering in production design, quality engineering in design of production processes. Loss Function and Quality Level: Derivation and use of quadratile loss function, economic consequences of tightening tolerances as a means to improve quality, evaluations and types tolerances.(N-type,S-type and L-type)

UNIT II:

Tolerance design and tolerancing: Functional limits, tolerance design for N-type. L-type and S- type characteristics, tolerance allocation for multiple components. Parameter and Tolerance Design: Introduction to parameter design, signal to noise ratios, Parameter design strategy, some of the case studies on parameter and tolerance designs.

UNIT - III

Analysis of Variance (ANOVA): Introduction to ANOVA, Need for ANOVA, NO-way ANOVA, Oneway ANOVA, Two-way ANOVA, Critique of F-test, ANOVA for four level factors, multiple level factors.

UNIT - IV

Orthogonal Arrays: Typical test strategies, better test strategies, efficient test strategies, steps in designing, conducting and analyzing an experiment. Interpolation of Experimental Results: Interpretation methods, percent contributor, estimating the mean.

UNIT - V

Six Sigma and The Technical System: Six sigma DMAIC methodology, tools for process improvement, six sigma in services and small organizations, statistical foundations, statistical methodology.

REFERENCES:

1. Taguchi Techniques for Quality Engineering / Phillip J. Ross / McGraw Hill/ Intl. II Edition, 1995.
2. Quality Engineering in Production systems I G. Taguchi, A. Elsayed et al / Mc.Graw Hill Intl. Edition, 1989.
3. Taguchi Methods explained: Practical steps to Robust Design / Papan P. Bagchi I Prentice Hall Pvt. Ltd., New Delhi.

ADVANCED MECHATRONICS
(ELECTIVE – IV)

UNIT-I

Mechatronics systems, elements, levels of mechatronics system, Mechatronics design process, system, measurement systems, control systems, microprocessor-based controllers, advantages and disadvantages ofmechatronics systems. Sensors and transducers, types, displacement, position, proximity, velocity, motion , force,acceleration, torque, fluid pressure, liquid flow, liquid level, temperature and light sensors.

UNIT-II

Solid state electronic devices, PN junction diode, BJT, FET, DIA and TRIAC. Analog signal conditioning,amplifiers, filtering. Introduction to MEMS & typical applications.

UNIT-III

Hydraulic and pneumatic actuating systems, Fluid systems, Hydraulic and pneumatic systems,components, control valves, electro-pneumatic, hydro-pneumatic, electro-hydraulic servo systems: Mechanical actuating systems and electrical actuating systems.

UNIT-IV

Digital electronics and systems, digital logic control, micro processors and micro controllers, programming,process controllers, programmable logic controllers, PLCs versus computers, application of PLCs for control.

UNIT-V

System and interfacing and data acquisition, DAQS , SCADA, A to D and D to A conversions; Dynamic models and analogies, System response. Design of mechatronics systems & future trends.

REFERENCES:

1. MECHATRONICS Integrated Mechanical Electronics Systems/KP Ramachandran & GK Vijaya Raghavan/WILEY India Edition/2008
2. Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering by W Bolton, Pearson Education Press, 3rd edition, 2005.
3. Mechatronics Source Book by Newton C Braga, Thomson Publications, Chennai.
4. Mechatronics - N. Shanmugam / Anuradha Agencies Publishers.
5. Mechatronics System Design / Devdas shetty/Richard/Thomson.
6. Mechatronics/M.D.Singh/J.G.Joshi/PHI.
7. Mechatronics - Electronic Control Systems in Mechanical and Electrical Engg. 4th Edition, Pearson, s2012 W. Bolton

3. Mechatronics - Principles and Application Godfrey C. Onwubolu, Wlsevier, 2006 Indian print

DESIGN AND MANUFACTURING OF MEMS AND MICRO SYSTEMS (ELECTIVE – IV)

COURSE OUTCOMES: Students will be able to

CO1: Explain the concepts of MEMS, Micro systems and applications of MEMS.[K2]

CO2: Describe the various methods of microsystems design and fabrication.[K2]

CO3: Analyze the concepts of engineering mechanics for microsystems design.[K4]

CO4: Analyze the concepts of thermal and fluid flow in microsystems design.[K4]

CO5: Illustrate the materials used and manufacturing methods used for microsystems and MEMS.[K2]

UNIT I

Overview and working principles of Mems And Microsystems MEMS & Microsystems, Evolution of Microfabrication, Microsystems & Microelectronics, Microsystems & Miniaturization, Applications of MEMS in Industries, Micro sensors, Micro actuation, MEMS with Micro actuators Micro accelerometers, Micro fluids.

UNIT II

Engineering Science for Microsystems Design And Fabrication: Atomic structure of Matter, Ions and Ionization, Molecular Theory of Mater and Intermolecular Force, Doping of Semiconductors, The iffusion Process, Plasma Physics, Electrochemistry, Quantum Physics

UNIT III

Engineering Mechanics for Microsystems Design: Static Bending of thin Plates, Mechanical Vibration, Thermo mechanics Fracture Mechanics, Thin-Film Mechanics, Overview of Finite Element Stress Analysis

UNIT IV

Thermo Fluid Engineering & Microsystems Design: Overview of Basics of Fluid Mechanics in Macro and Meso scales, Basic equations in Continuum Fluid dynamics, Laminar Fluid Flow in Circular Conduits, Computational Fluid Dynamics, Incompressible Fluid Flow in Micro conduits, Fluid Flow in Sub micrometer and Nano scale, Overview of Heat conduction in Solids, Heat Conduction in Multilayered Thin films and in solids in sub micrometer scale, Design Considerations, Process Design Mechanical Design, Mechanical Design using FEM, Design of a Silicon Die for a Micro pressure Sensor.

UNIT V

Materials For MEMS & Microsystems And Their Fabrication: Substrates and Wafers, Active substrate materials, Silicon as a substrate material, Silicon Compounds, Silicon Piezoresistors, Gallium Arsenide, Quartz, Piezoelectric Crystals and Polymers, Photolithography, Ion implantation, Diffusion and oxidation, chemical and physical vapor deposition, Etching, Bulk micro manufacturing, Surface Micromachining, The LIGA Process

REFERENCES

1. MEMs & Microsystems: Design & Manufacture/ Tai-Ran Hsu/Tata Mc-Graw Hill., ed./2002
2. An Introduction to Microelectromechanical Systems Engineering/ Maluf, M./ Artech House, Boston, 2000
3. Micro robots and Micromechanical Systems/ Trimmer, W.S.N/ Sensors & Actuators, vol19, no.1989.
4. Applied Partial Differential Equations/ Trim, D.W/ PWS-Kent Publishing/ Boston 1990.

ADVANCES IN NANO TECHNOLOGY
(ELECTIVE – IV)

COURSE OUTCOMES: Students can able to
CO1: Understand the fundamentals of nano technology
CO2: Understand various approaches for nanomaterial synthesis.
CO3: Aware of various morphological techniques
CO4: Understand the fundamentals of Metal and semiconductor nanoparticles
CO5: Understand the importance of carbon based nanomaterials.

UNIT-I
Introduction Size and shape dependence of material properties at the nanoscale, why is small good, limits to smallness, scaling relations, can nano-Robots walk and nanoplanes fly, Nanoscale elements in conventional technologies, Mechanics at nanoscale, Enhancement of mechanical properties with decreasing size, Nano electromechanical systems, nanomachines, Nanofluidics, filtration, sorting, Molecular motors.

UNIT-II
Top-down and bottom-up nanofabrication, The Intel-IBM approach to nanotechnology: lithography, etching, ion implantation, thin film deposition, Electron beam lithography, Soft lithography: Nanoimprinting and microcontact printing, Solution/plasma-phase nanofabrication, sol-gel methods, template techniques.

UNIT-III
Imaging/characterization of nanostructures, General considerations for imaging, scanning probe techniques: SEM, STM, AFM, NSOM.

UNIT-IV
Metal and semiconductor nanoparticles, Synthesis, stability, control of size, Optical and electronic properties, Ultra-sensitive imaging and detection with nanoparticles, bioengineering applications, Catalysis. Semiconductor and metal nanowires Vapor/liquid/solid growth and
Other synthesis techniques, Nanowire transistors and sensors.

UNIT-V
CARBON NANOTUBES
Structure and synthesis,Electronic, vibrational, and mechanical properties, How can C nanotubes enable faster computers, brighter TV screens, and stronger mechanical reinforcement

TEXT BOOKS:
1. Nanoscale Science and Technology by Kelsall, Hamley, and Geoghegan, Wiley (2005)
2. Introduction to Nanoscale Science and Technology by Di Ventra, Evoy,and Heflin, Kluwer Academic Publishers (2004).

REFERENCES:
1. Introduction to Nanotechnology by Poole and Owens, Wiley (2003)
2. Nanochemistry: A Chemical Approach to Nanomaterials, Ozin and Arsenault, RSC Publishing (2006).

SIMULATION OF MANUFACTURING SYSTEMS LAB

1. Writing of manual part programming using ISO codes for turning and milling operations, Use of tool radius compensation and canned cycles, Check the program for syntax errors, lists errors and locations, show the tool path through graphical simulation using EXSL-WIN or other CAM Packages.
2. Modelling of simple machine parts (Turning and Milling) and generating machine codes using standard NX CAM or other CAM Packages
3. Creating and simulating a process flow and optimizing the layout, calculation of various times related to manufacturing systems in an industry using any of the product planning and control packages like Delmia, Robostudio etc.

MATERIAL CHARECTERIZATION LAB

List of Experiments

1. Preparation and study of the Microstructure of pure metal

2 Preparation and study of the Microstructure of Mild Steel

3 Rockwell Hardness Tests

4 Tension Test

5. Study on Characterization techniques of Nanomaterials

6. Compression Nanomaterials: Synthesis and Applications

ADVANCED MATHEMATICAL METHODS IN ENGINEERING

COURSE OUTCOMES:

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

1. ***Analyze*** and develop the mathematical model of thermal system.
2. ***Analyze*** the reliability and maintainability of the series and parallel thermal system.
3. Able to ***solve*** differential equations using numerical techniques.

SYLLABUS CONTENTS:

ORDINARY DIFFERENTIAL EQUATIONS: First-order equations (Linear, Equidimensional, Separable Exact, Homogeneous,); Second-order linear differential equations (homegeneous and non-homogeneous); Solution methods such as undetermined coefficients and variation o parameters.

PARTIAL DIFFERENTIAL EQUATIONS: First order partial differential equations; Second order linear partial differential equations; Canonical forms; Fourier series, Second order equation (Parabolic, Elliptic and Hyperbolic) in rectangular, cylindrical polar and spherical coordinate systems; Solution techniques such as separation of variables, eigen-function expansions, integral transforms (Fourier and Laplace transforms); D'Alembert's solution for the Wave equation; Maximum principle for Elliptic equations; Variational methods for approximate solutions of differential equations.

- Standard discrete and continuous distributions like Binomial, Poisson, Normal, Exponential etc. Central Limit Theorem and its significance. Some sampling distributions like c2, t, F.
- **ANOVA:** One – way, Two – way with/without interactions, Latin
- Squares ANOVA technique, Principles of Design Of Experiments, some standard designs such as CRD, RBD, LSD.
- Some of the relevant topics required for ANOVA (sample estimates and test hypothesis) may also be included.

REFERENCES:

1. J.B. Doshi, ―Differential Equations for Scientists and Engineers‖, Narosa, 2010.
2. Peter O'Neil, ―Advanced Engineering Mathematics‖, Seventh Edition, Cengage Learning, 2012 (Indian Edition).
3. Michael Greenberg, ―Advanced Engineering Mathematics‖, Second Edition, Pearson Education, 2002 (Indian Edition).
4. Jennings. A., Matrix Computation for Engineers and Scientists. John Wiley and Sons, 1992.
5. Prem.K.Kythe, Pratap Puri, Michael R.Schaferkotter, Introduction to Partial Differential
6. Equations and Boundary Value problems with Mathematics, CRC Press, 2002.
7. Kreyszig, Erwin, I.S., Advanced Engineering Mathematics, Wiley, 1999.
8. Ramamurthy. V., Computer Aided Design in Mechanical Engineering., Tata McGraw Hill Publishing Co., 1987
9. Fundamental Concepts in the Design of Experiments, 5th Ed., by Hicks and Turner
10. Devore, Jay L., Probability and Statistics for Engineering and the Sciences, 5th edition, Brooks- Cole (1999)

COMPUTER GRAPHICS

COURSE OUTCOMES: Students can able to
CO1: Explain the, computer input devices, hard copy devices. [K2]
CO2: Apply mathematical principles in Line drawing algorithms [K3]
CO3: Explain Polygon clipping, character clipping, 3D- clipping. [K2]
CO4: Summarize the principles of Cartesian and homogeneous coordinate systems[K3]
CO5: Explain about algorithms, shading algorithm, Comparison of shading algorithms[K2]

UNIT - I
Introduction to computer graphics: Color CRT raster scan monitors, plasma display & liquid crystal display monitors, computer input devices, hard copy devices.

UNIT - II
Raster scan graphics: Line drawing algorithms – DDA & Bresenham algorithms, circle generation, general function rasterization, displaying lines, characters and polygons. Filling algorithms: polygon filling, edge fill algorithm, seed fill algorithm, fundamentals of antialiasing and half toning.

UNIT - III
Line CLIPPING: Simple visibility algorithm, Cohen-Sutherland subdivision line clipping algorithm, mid point sub division algorithm. Polygon clipping: polygon clipping, reentrant polygon clipping – Sutherland – Hodgeman algorithm, character clipping, 3D- clipping.

UNIT - IV
Transformations: Cartesian and homogeneous coordinate systems two dimensional and three dimensional transformations – scaling, rotation, Shearing, Zooming, viewing transformation, reflection, rotation about an axis, concatenation.

UNIT - V
Rendering: Hidden line removal algorithms, surface removal algorithms, painters, Warnock, Z-buffer algorithm. Shading algorithms: Constant intensity algorithm, Phong's shading algorithm, gourand shading algorithm, Comparison of shading algorithms.

TEXT BOOKS:
1. Procedural elements for computer graphics-D.F.Rogers, Tata McGraw- Hill.
2. Computer Graphics-Donald Hearn & M.P. Bakers.
3. Computer graphics-Harrington.

OPEN ELECTIVES
BUSINESS ANALYTICS

UNIT1:

BUSINESS ANALYTICS: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

UNIT 2:

TRENDINESS AND REGRESSION ANALYSIS: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

UNIT 3:

ORGANIZATION STRUCTURES OF BUSINESS ANALYTICS: Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

UNIT 4:

FORECASTING TECHNIQUES: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Model Curriculum of Engineering & Technology PG Courses Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

UNIT 5:

DECISION ANALYSIS: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

UNIT 6:

RECENT TRENDS IN : Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

REFERENCE:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

OPEN ELECTIVES
INDUSTRIAL SAFETY

UNIT-I:

INDUSTRIAL SAFETY: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT-II:

FUNDAMENTALS OF MAINTENANCE ENGINEERING: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT-III:

WEAR AND CORROSION AND THEIR PREVENTION: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT-IV:

FAULT TRACING: Fault tracing-concept and importance, decision treeconcept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic,automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler,
vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT-V:

PERIODIC AND PREVENTIVE MAINTENANCE: Periodic inspection-concept and need, egreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

REFERENCE:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

OPEN ELECTIVES
OPERATIONS RESEARCH

UNIT 1

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models

UNIT 2

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

UNIT 3

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

UNIT 4

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

UNIT 5

Competitive Models,Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

REFERENCES:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

OPEN ELECTIVE
COMPOSITE MATERIALS

UNIT–I:

INTRODUCTION: Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix.
Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT – II

REINFORCEMENTS: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

UNIT – III

MANUFACTURING OF METAL MATRIX COMPOSITES: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

UNIT–IV

MANUFACTURING OF POLYMER MATRIX COMPOSITES: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.

UNIT – V

STRENGTH: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximumstrain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TEXT BOOKS:

1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.

References:

1. Hand Book of Composite Materials-ed-Lubin.
2. Composite Materials – K.K.Chawla.
3. Composite Materials Science and Applications – Deborah D.L. Chung.
4. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W.Tasi.

OPEN ELECTIVE
WASTE TO ENERGY

UNIT-I

INTRODUCTION TO ENERGY FROM WASTE: Classification of waste as fuel – Agro based, Forestresidue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNIT-II

BIOMASS PYROLYSIS: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods -Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT-III

BIOMASS GASIFICATION: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT-IV

BIOMASS COMBUSTION: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT-V

BIOGAS: Properties of biogas (Calorific value and composition) - Biogas plant technology and status Bio energy system - Design and constructional features - Biomass resources and their classification Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass sification pyrolysis and liquefaction - biochemical conversion - anaerobic digestion Types of biogas Plants Applications - Alcohol production from biomass - Bio diesel production Urban waste to energy conversion - Biomass energy programme in India.

REFERENCES:

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.