CURRICULUM & SYLLABUS

For

B.E. (Hons.) Mechanical Engineering with specialization in 3D Printing

(Choice Based Credit System)

(With effect from 2018)

DEPARTMENT OF MECHANICAL ENGINEERING

SRI CHANDRASEKHARENDRA SARASWATHI VISWA MAHAVIDYALAYA

SCSVMV

(Deemed to be University U/S 3 of UGC Act 1956)

Accredited with "A" Grade by NAAC

Enathur, Kanchipuram – 631 561

3D PRINTING - REGULATIONS 2018

These regulations are applicable to the students admitted from the AY 2019-20 onwards.

1. PRELIMINARY DEFINITIONS AND NOMENCLATURE

1. "**Degree**" referred to as Under-Graduate (UG) Degree, i.e., B.E. Degree.
2. **"Honours** Degree**"** referred to as Under-Graduate (UG) Degree specialization in emerging area of Home Discipline i.e., Mechanical Engineering to facilitate the students to choose additionally the specialized courses of their choice and to build their competence in special area. Students have to undergo additional courses and acquire more than required number of credits & maintaining CGPA – 8.0 during their period of study (4 years) and no history of arrears to obtain B. E (Hons)**.**
3. **"**Minor **Degree"** referred to as Under-Graduate (UG) Degree specialization in emerging areas other than the chosen discipline of Engineering. Students have to undergo additional courses in their special areas of interest and earn additional credits to obtain B. E with Minor Specialization.
4. **"**Programme" referred to as discipline of B.E. Degree programme like Mechanical Engineering.
5. **"Course"** referred to as a theory/practical subject studied in a semester.

2. ELIGIBILITY FOR ADMISSION

1. **Regular Admission**
   - Maximum age limit for the full-time course is 20 years.
   - Students seeking admission to the first semester of the eight semester B.E. -Degree programme shall be required to have a pass in Higher Secondary Examinations (Academic 10+2) or its equivalent examinations in any State/CBSE/IGCSE board with Mathematics, Physics and Chemistry. Passed 10+2 examination with Physics and Mathematics as compulsory subjects along with one of the Chemistry / Biotechnology / Biology / Technical Vocational subject / Computer Science / Information Technology / Informatics Practices / Agriculture / Engineering Graphics / Business Studies.
   - Obtained at least 50%, Marks (40% marks in case of candidates belonging to reserved category) in the above subject taken together.

2. **Lateral Entry Admission**
   Students who possess the Diploma in Engineering (Mechanical/Automobile or its equivalent) awarded by the State Board of Technical Education, Tamil Nadu

or its equivalent board are eligible to apply for Lateral entry admission to the third semester of B.E. Programme.

3. COURSES OFFERED

COURSE - I	:	B.E. – MECHANICAL ENGINEERING
COURSE – II	:	B.E. (HONS.) – MECHANICAL ENGINEERING in Specialization with 3D Printing
COURSE – III	:	B.E. (HONS.) – MECHANICAL ENGINEERING in Specialization with Electric Vehicles
COURSE – IV	:	B.E. (HONS.) – MECHANICAL ENGINEERING in Specialization with Robotics
COURSE – V	:	B.E. – MECHANICAL ENGINEERING with Minor degree in Cyber Security
COURSE – VI	:	B.E.– MECHANICAL ENGINEERING with Minor degree in Internet of Things (IoT)
COURSE – VII	:	B.E.-MECHANICAL ENGINEERING with Minor degree in Artificial Intelligence & Machine Learning
COURSE – VIII	:	B.E.–MECHANICAL ENGINEERING with Minor degree in Sensor Technology

A student may be offered admission to any one of the programmes of study. The recommended credit range for the above programmes are in between 170 to 192.

4. STRUCTURE OF PROGRAMMES

1. Categorization of Courses

Each B.E., programme will have a curriculum with syllabi comprising of Theory and Practical courses with well-defined Program Outcomes and Programme Educational Objectives (PEO) as per Outcome Based Education (OBE). The content of each course is designed based on the Course Outcomes (CO). The courses of a programme are categorized as follows:

1. **Basic Science Courses (BSC)** include Mathematics, Physics, Chemistry, Biology, Environmental Sciences, etc.
2. **Engineering Science Courses (ESC)** include Engineering Practices, Engineering Graphics, Basics of Electrical / Electronics / Mechanical / Computer Engineering, Instrumentation etc.
3. **Professional Core Courses (PCC)** include the core courses relevant to the Mechanical Engineering & chosen specialization.
4. **Professional Core Elective Courses (PCEC)** include the elective courses relevant to the chosen specialization.
5. **Professional Specialised Courses (PSC)** include the specialised courses relevant to the chosen specialization.
6. **Humanities and Social Sciences including Management courses (HSMC) & Open Electives Courses (OEC)** provide an opportunity to study a course from any discipline that includes the courses relevant to the chosen specialization. The student can choose from the curriculum of other B.E. / B. Tech. programmes and the courses offered by the Departments under the Faculty of Science and Humanities.
7. **Project Mechanical Engineering courses (PROJ-ME)**
8. **Mandatory Courses (MC) non-credit courses such as** Environmental Sciences, Induction Program, Indian Constitution, Essence of Indian Traditional Knowledge

2. Mandatory Two-Week Induction Programme

The students are expected to undergo a mandatory two-week induction programme comprising of physical activity, creative arts, universal human values, proficiency modules, lectures by eminent people, visits to local areas and familiarization to department/branch & innovations immediately after admission.

3. Number of courses per semester

The Curriculum of a semester shall normally have a blend of 4 to 7 lecture courses, except the final semesters, and 2-3 laboratory courses. However, the total number of courses per semester shall not exceed 10 (including EEC). Pre-final semester may have 1 design Project. The final semester may have a blend of 2 or 3 lecture courses and 1 innovative Project.

4. Credit Assignment

In assigning the credits for the courses, 1-hour lecture/week, 1-hour tutorial/week, 2 hours practical/week, 2 hours project work or seminar/week is equivalent to 1 credit.

5. Industrial Training / Internship

Student is expected to undergo In-plant training in any industry/organization during the programme of study. Every 2 weeks of internship/training at industry is equivalent to 1 credit. The credit will be awarded to the student based on the recommendation by the evaluation team, and the results will be sent to The Controller of Examinations after the approval by the Head of the Department.

6. Industrial Visit

Student is required to go for at least one Industrial Visit every year, starting from the second year of the Programme. The Heads of Departments shall ensure that necessary arrangements are made in this regard.

7. Medium of Instruction

The medium of instruction is English for all courses.

5. DURATION OF THE PROGRAMMES

1. A student is normally expected to complete the B.E. Programme in 4 years (8 Semesters), but in any case, not more than 7 years (14 Semesters).
2. Each semester shall normally consist of 90 working days (including examination days). The Head of the Department shall ensure that every faculty imparts instruction as per the number of periods specified in the syllabus, covering the full content of the syllabus for the course being taught.
3. **The** total duration for completion of the programme reckoned from the commencement of the first semester to which the student was admitted shall not exceed the maximum duration irrespective of the period of break of study.

6. COURSE ENROLLMENT AND REGISTRATION

1. Student, on admission, shall be assigned to a Faculty Advisor, who shall advice and counsel the student about the details of the academic programme and the choice of courses, considering the student's academic background and career objectives.

2. After registering for a course, a student shall attend the classes, satisfy the attendance requirements, earn continuous assessment marks and appear for the end semester examinations.
3. Each student on admission shall register for all the courses prescribed in the curriculum.
4. If a student fails to secure a pass in any theory or Laboratory course (including elective theory), he/she shall register for the same course in the immediate semester examinations by retaining the Continuous Assessment Marks already earned.
5. The student shall register Project-1 in VII Semester and Project-2 in VIII Semester.
6. The student who fails in any Project work (Project 1 / Project 2) shall register for the course again. In this case, the student shall attend the reviews and fulfil the attendance requirements.

7. RE`QUIREMENTS FOR APPEARING FOR THE END SEMESTER EXAMINATION

1. Student who has fulfilled the following conditions shall be deemed to have satisfied the attendance requirements for appearing for the end semester examination of a particular course.
2. Ideally every student is expected to attend all periods and earn 100% attendance. However, the student shall secure not less than 80% attendance, course wise, taking into account the number of periods required for that course, as specified in the curriculum.
3. If a student secures attendance between 70% and less than 80% in any course in the current semester, due to medical reasons (hospitalization / accident / specific illness) or due to participation in the College / University / State / National / International level Sports events, with prior permission from the Sports director, and Head of the Department concerned, the student shall be given exemption from the prescribed attendance requirement and the student shall be permitted to appear for the end semester examination of that course.
4. In all such cases, the students should submit the required documents on joining after the absence to the Head of the Department through the Faculty Advisor.
5. A student with an attendance between 40% and 70% in any course will fall under the category **"Semester Break"**, which means Students will not be permitted to attend the Regular End Semester Examinations for that course. If

a student has short fall of attendance in all the registered courses in "Semester Break", he/she would be permitted to move to the higher semester and has to repeat the current semester in the subsequent semester.

6. The student, whose attendance falls below 40% for a course in any semester, will be categorized as **"Detained"**, which means detained in the particular course for want of attendance and they will not be permitted to write the End semester exam for that course. Students will be asked to repeat the same course in the next year.
7. A student who has already appeared for a course in a semester and passed the examination is not entitled to reappear for the same course for improvement of grades.

8. FACULTY ADVISOR

To help the students in planning their courses of study and for general advice on the academic programme, the Head of the Department of the students will attach a certain number of students to a faculty of the Department, who shall function as Faculty Advisor for those students throughout their period of study. The Faculty Advisor shall advise the students in registering and reappearance (Arrear) registering of courses, authorize the process, monitor their attendance and progress and counsel them periodically. If necessary, the Faculty Advisor may also discuss with or inform the parents about the progress / performance of the students concerned.

9. CLASS COMMITTEE

The objective of the Class Committee is to improve the teaching-learning process. The functions of the class committee include:

1. Resolving difficulties experienced by students in the classroom and in the laboratories.
2. Clarifying the regulations of the degree programme and the details of rules therein.
3. Discussing the progress of academic schedule and deviations if any.
4. Evaluating the performance of the students of the class after each test and finding the ways and means of improvement.
5. Class committee consisting of faculty members who are teaching in that class, student representatives and a Head of the Department

6. The class committee shall meet 2-3 times in a semester as specified in the academic calendar. The Dean (Engg. & Tech) may participate in any class committee of the institution.
7. During these meetings, the representative of the class shall meaningfully interact and express the opinions and suggestions of the other students of the class to improve the effectiveness of the teaching-learning process.
8. The Head of the Department is required to prepare the minutes of the meeting, signed by the members and submit the same to Dean. In each meeting, the action taken report of the previous meeting is to be presented by the HOD.

10. SYSTEM OF EXAMINATION

Performance in each course of study shall be evaluated for a maximum of 100 marks based on one of the following:

1. Continuous assessment throughout the semester and a terminal examination at the end of the semester. The continuous assessment will carry 40 marks while the end-semester examination will carry 60 marks.
2. The end semester examination (Theory & Practical) of 3 hours duration shall be conducted by the Controller of Examinations between October to December during the Odd Semesters and between April to May during the Even semesters. All Practical examinations shall be conducted and evaluated at the Department itself on behalf of the Controller of Examinations.
3. For all the practical courses, students shall obtain bonafide certificate for the Observation cum Record completed from the Faculty in-charges / Head of the Department on or before the day of the practical examination.
4. For the project works, students shall obtain bonafide certificate for the project work completed from the project Guide and Head of the Department, at the end of the semester.
5. The semester examination for project work shall comprise of evaluation of the final report submitted by the project group (of not exceeding 4 students) by an external examiner. Further, the performance of each student of the project group would be evaluated in a viva-voce examination conducted by a committee consisting of an external examiner appointed by the Head of the Department/the Controller of Examination, Head of the Department or faculty nominated by Head of the Department and Guide of the project group.

6. Student can apply for re-valuation of his/her semester examination answer paper in theory courses within the stipulated period from the declaration of results, on payment of a prescribed fee, as specified by the Controller of Examinations from time to time. The Controller of Examination will arrange for going through the answer scripts by the students and to make appeals. The re-valuation results will be published before the commencement of supplementary examinations. Re-valuation is not permitted for practical courses, project work and industry supported courses.

11. PROCEDURE FOR AWARDING MARKS FOR CONTINUOUS ASSESSMENT

1. Theory courses

1. The award of marks for continuous assessment shall be normally based on two internal assessment tests and five Assignments / tutorials / seminars. The apportioning of marks shall be as follows:
    1. 30 marks for tests
    2. 10 marks for assignments/tutorials/seminars/Attendance

   However, the assessment pattern for awarding the continuous assessment marks may be designed by the course designers based on the nature of the course and is to be approved by the Academic Council.
2. The first and second Continuous Assessment Tests will be normally conducted at the mid and end of the semester respectively. Each test carries maximum of 30 marks.
3. There will be five assignments for each course which will be considered for awarding marks for assignment.
4. Both test and assignment marks put together is 40 marks maximum.
5. If a student fails in a theory course, the Continuous Assessment Marks already earned will be retained for subsequent reappearances.

2. Practical courses

The continuous assessment mark will be awarded as follows:

Observation-cum-Record in regular class works	: **15 marks**
Model Test	: **15 marks**
Viva	: **10 marks**

3. Project work

Head of the Department shall constitute a review committee comprises of Head of the Department or Faculty member nominated by Head of the Department and two faculty members. The student shall make presentation on the progress made by him / her before the committee. The total marks obtained in the three reviews shall be averaged to 40 marks.

- Every faculty member is required to maintain an Attendance and Continuous Assessment Record which consists of attendance marked for each lecture or practical or project work classes, the tests & assignment marks and record of class works (topics covered) separately for each course.

12. ELIGIBILITY FOR PASS IN EACH COURSE

1. A student who secures not less than 50% of total marks (both continuous assessment and end semester examination marks put together) in theory courses, practical courses shall be declared to have passed the examination.
2. If a student fails to secure a pass in a particular course, it is mandatory that he/she shall register for that course in the subsequent semester and attend the end semester examination. He/she should continue to register and appear for the examination till he /she secures a pass.
3. **Award of Grades**

Range of Total marks (Continuous assessment + End semester examination)	Letter Grade	Grade Point (GP)
Between 90 to 100	S	
Between 80 to 89	A	
Between 70 to 79	B	
Between 60 to 69	C	
Between 55 to 59	D	
Between 50 to 54	E	
Between 0 to 49	F	
Absent	AB	

Grade Point Average $GPA = \frac{\sum_{i=1}^{N} C_i G_{P_i}}{\sum_{i=1}^{N} C_i}$

N is the number of courses registered in a particular semester,
GP_i is the grade point obtained in i^{th} course and
C_i is the number of credits assigned to i^{th} course.

Cumulative GPA (CGPA) will be calculated when the student is declared to be eligible for the award of the degree. CGPA calculation is based on all the courses considered for the award of the degree.

13. ELIGIBILITY FOR THE AWARD OF DEGREE

A student shall be declared to be eligible for the award of the degree if he/she has satisfied the following:

1. A student seeking B.E., degree shall be required to undergo the prescribed courses of study and evaluation in the college for the specified duration and to pass all the examinations prescribed therefore.
2. He/ she should register for the courses prescribed in the curriculum of the respective degree programme, fulfil the requirement of credits in each category of credit distribution, pass in all mandatory courses in the curriculum and earn the specified total minimum number of credits.
3. No disciplinary action pending against the student.

14. CLASSIFICATION OF THE DEGREE AWARDED

1. **First class with Distinction**
   A student who qualifies for the award of degree having passed the examination in all registered courses in his / her first appearance (including industry supported courses), within Four years (Three Years for Lateral Entry students), and securing a CGPA of not less than 8.50 shall be declared to have passed in First class with distinction.

2. **First Class**
   A student who qualifies for the award of degree having passed the examination in all the courses within Four years (Three years for Lateral Entry students) and securing a CGPA of not less than 7.00 shall be declared to have passed in First class.

3. **Second Class**
   All other students (not covered in 14.1 and 14.2) who qualify for the award of degree having passed the examination in all the courses and fulfilling the requirements shall be declared to have passed in Second Class.

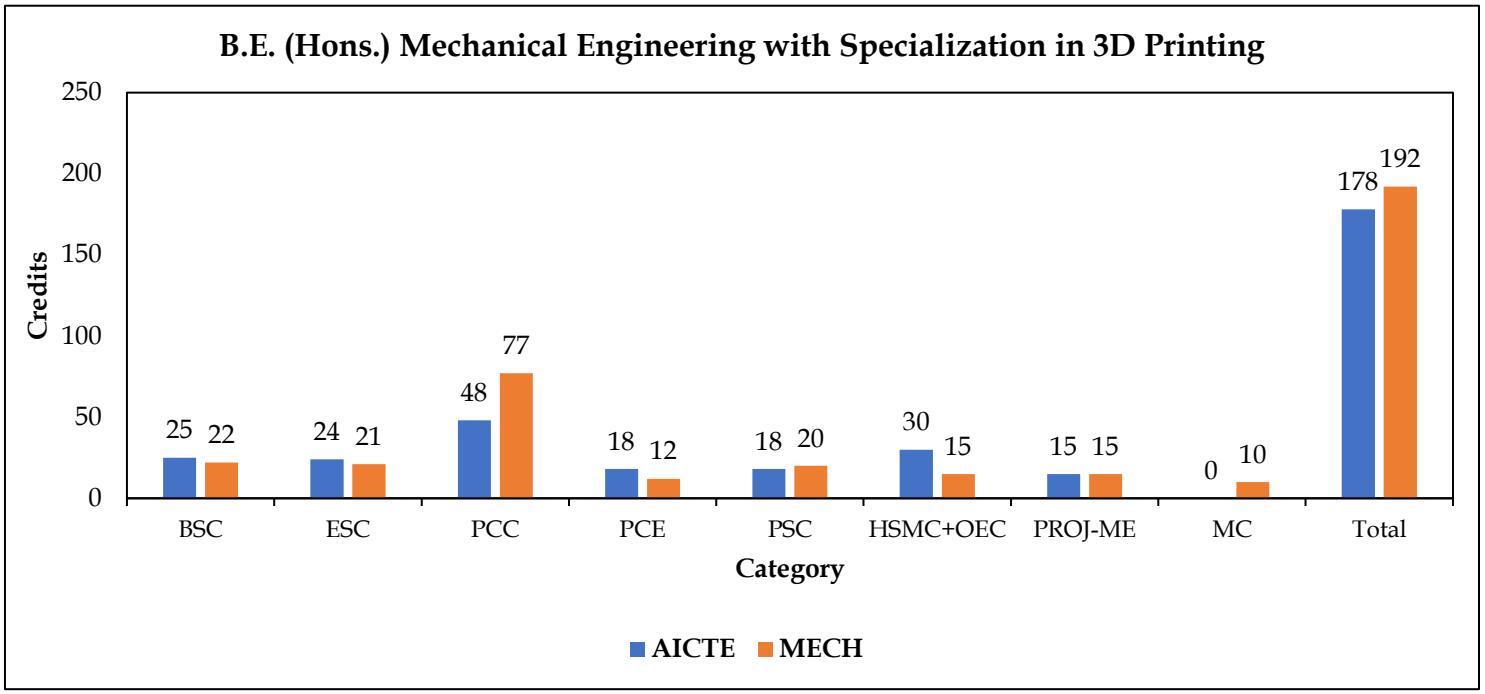
15. DISCIPLINE

1. Every student is required to observe discipline and decorous behavior both inside and outside the college and not to indulge in any activity, which will tend to bring down the prestige of the college. The Registrar shall constitute a disciplinary committee to enquire into acts of indiscipline and notify the institution about the disciplinary action recommended for approval. In case of any serious disciplinary action which leads to suspension or dismissal.
2. If a student indulges in malpractice in any test/examinations, the student shall be liable for punitive action as prescribed by the institution from time to time.

16. REVISION OF REGULATIONS AND CURRICULUM

The standing committee/Academic Council/ of the institution reserves the right to revise or change or amend the regulations, the scheme of examinations, the curriculum and the syllabi from time to time if found necessary.

DISTRIBUTION OF CREDITS				
SL. No	Course Category	As per AICTE regulation 2018	Credits	Percentage (%)
1.	Basic Science Courses (BSC)	25	22	13.5
2.	Engineering Science Courses (ESC)	24	21	13.0
3.	Professional Core Courses (PCC)	48	79	47.5
4.	Professional Core Electives Courses (PCE)	18	12	7.5
5.	Professional Specialised Courses (PSC)	18	20	12.5
6.	Humanities and Social Sciences including Management courses (HSMC) + Open Electives Courses (OEC)	30	15	9.25
7.	Project Mechanical Engineering courses (PROJ-ME)	15	15	9.25
8.	Mandatory Courses (MC)*	0	8*	*
* Not accountable for CGPA				
Total		178	192	100



EACH COURSE IN CATEGORY WISE								
B.E. (HONS.) MECHANICAL ENGINEERING WITH SPECIALIZATION IN 3D PRINTING								
Basic Science Courses (BSC)								
SL. No	**Semester**	**Course Category**	**Course Code**	**Name of the Course**	**Hours per week**			**Credit**
					L	**T**	**P**	
1	1	BSC		Mathematics –I (Calculus & Linear Algebra)	3	1	-	**4**
2	1	BSC		Engineering Chemistry	3	-	-	**3**
3	1	BSC		Chemistry Lab	-	-	3	**2**
4	2	BSC		Mathematics – II (Calculus, Ordinary Differential Equations, and Complex Variables)	3	1	-	**4**
5	2	BSC		Applied Physics for Engineers	3	-	-	**3**
6	2	BSC		Physics Lab	-	-	3	**2**
7	3	BSC		Mathematics III (PDE, Probability & Statistics)	3	1	-	**4**
Total Credits								**22**

Engineering Science Courses (ESC)								
SL. No	**Semester**	**Course Category**	**Course Code**	**Name of the Course**	**Hours per week**			**Credit**
					L	**T**	**P**	
1	1	ESC		Basic Electrical Engineering	3	-	-	**3**
2	1	ESC		Engineering Graphics & Design	2	-	2	**3**
3	1	ESC		Basic Electrical Engineering Lab	-	-	3	**2**
4	2	ESC		Programming for Problem Solving	2	1	-	**3**
5	2	ESC		Programming for Problem Solving Lab	-	-	3	**2**
6	2	ESC		Workshop/Manufacturing Practices Lab	-	-	3	**2**
7	3	ESC		Engineering Mechanics	2	1	-	**3**
8	4	ESC		Basic Electronics Engineering	3	-	-	**3**
Total Credits								**21**

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Humanities and Social Sciences including Management courses (HSMC)								
SL. No	Semester	Course Category	Course Code	Name of the Course	Hours per week			Credit
					L	T	P	
1	2	HSMC		English	2	1	-	**3**
2	6	HSMC		Operation Research & Management	2	1	-	**3**
3	8	HSMC		Engineering Economics	3	-	-	**3**
Total Credits								**09**

Mandatory Courses (MC)								
SL. No	Semester	Course Category	Course Code	Name of the Course	Hours per week			Credit
					L	T	P	
1	1	MC*		English Proficiency Certification	2	-	-	**1***
2	2	MC*		Environmental Science and Engineering*	2	-	-	**1***
3	3	MC*		Foreign Language Level – II and Above	-	-	-	**1***
4	4	MC		Sanskrit and Indian Culture	2	-	-	**1***
5	5	MC*		Soft Skill and Aptitude Certification	-	-	-	**1***
6	6	MC*		Technical Certification Course	-	-	-	**1***
7	7	MC*		Presentation / Publication in Conference / Seminar	-	-	-	**1***
8	8	MC*		Start ups				**1***
Total Credits								**8**

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Professional Core Courses (PCC)								
SL. No	**Semester**	**Course Category**	**Course Code**	**Name of the Course**	**Hours per week**			**Credit**
					L	**T**	**P**	
1.	3	PCC		Fluid Mechanics & Machinery	2	1	-	**3**
2.	3	PCC		Thermodynamics	3	-	-	**3**
3.	3	PCC		Materials Engineering	3	-	-	**3**
4.	3	PCC		Fluid Mechanics and Machinery Lab	-	-	3	**2**
5.	3	PCC		Materials and Metallurgy Lab	-	-	3	**2**
6.	4	PCC		Applied Thermodynamics	3	-	-	**3**
7.	4	PCC		Strength of Materials	2	1	-	**3**
8.	4	PCC		Kinematics of Machines	2	1	-	**3**
9.	4	PCC		Manufacturing Processes	3	-	-	**3**
10.	4	PCC		Thermal Engineering Lab	-	-	3	**2**
11.	4	PCC		Strength of Materials Lab	-	-	3	**2**
12.	5	PCC		Heat and Mass Transfer	3	-	-	**3**
13.	5	PCC		Dynamics of Machines	2	1	-	**3**
14.	5	PCC		Instrumentation and Control	3	-	-	**3**
15.	5	PCC		Design of Machine Elements	3	-	-	**3**
16.	5	PCC		Manufacturing Technology	3	-	-	**3**
17.	5	PCC		Metrology and Quality Control	3	-	-	**3**
18.	5	PCC		Machine Drawing Practical	-	-	3	**2**
19.	5	PCC		Manufacturing Technology Lab	-	-	3	**2**
20.	5	PCC		Dynamics and Measurements Lab	-	-	3	**2**
21.	6	PCC		Automobile Engineering	3	-	-	**3**
22.	6	PCC		Power Plant Engineering	3	-	-	**3**
23.	6	PCC		CAD/CAM	3	-	-	**3**
24.	6	PCC		Heat Transfer Lab	-	-	3	**2**
25.	6	PCC		CAD/CAM Lab	-	-	3	**2**
26.	7	PCC		Design of Transmission Systems	3	-	-	**3**
27.	7	PCC		Mechatronics	3	-	-	**3**
28.	7	PCC		Computer Aided Analysis Lab	-	-	3	**2**
29.	7	PCC		Mechatronics Lab	-	-	3	**2**
30.	8	PCC		Automation in Manufacturing	3	-	-	**3**
Total Credits								**79**

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Professional Core Electives Courses (PCE)								
SL. No	**Semester**	**Course Category**	**Course Code**	**Name of the Course**	**Hours per week**			**Credit**
					L	**T**	**P**	
1.	6	PCE -I		Finite Element Analysis	3	-	-	**3**
2.	6	PCE -I		Fluid Power Systems	3	-	-	
3.	6	PCE -I		Product Design & Development	3	-	-	
4.	6	PCE -I		3D Printing	3	-	-	
5.	6	PCE -I		Tribology	3	-	-	
6.	7	PCE - II		Refrigeration & Air Conditioning	3	-	-	**3**
7.	7	PCE - II		I.C. Engines	3	-	-	
8.	7	PCE - II		Turbo Machines	3	-	-	
9.	7	PCE - II		Energy Conservation in Industries	3	-	-	
10.	7	PCE - II		Gas Dynamics & Jet Propulsion	3	-	-	
11.	7	PCE - III		Sustainable Manufacturing	3	-	-	**3**
12.	7	PCE - III		Design for Manufacturing	3	-	-	
13.	7	PCE - III		Theory of Metal Forming	3	-	-	
14.	7	PCE - III		Digital Manufacturing	3	-	-	
15.	7	PCE - III		Composite Materials	3	-	-	
16.	8	PCE - IV		Total Quality Management	3	-	-	**3**
17.	8	PCE - IV		Entrepreneurship Development	3	-	-	
18.	8	PCE - IV		Non-Traditional Machining Process	3	-	-	
19.	8	PCE - IV		Non Destructive Evaluation	3	-	-	
20.	8	PCE - IV		Flexible Manufacturing Systems	3	-	-	
Total Credits								**12**

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Professional Specialised Courses (PSC)								
SL. No	**Semester**	**Course Category**	**Course Code**	**Name of the Course**	**Hours per week**			**Credit**
					L	**T**	**P**	
1.	3	PSC		Polymer Engineering	3	-	-	**3**
2.	3	PSC		3D Printing Processes & Applications	3	-	-	**3**
3.	4	PSC		Materials & Characterisation Techniques	3	-	-	**3**
4.	4	PSC		3D Printing Machines & Systems	3	-	-	**3**
5.	5	PSC		Medical Applications in 3D Printing	3	-	-	**3**
6.	6	PSC		Rapid Tooling & Industrial Applications	3	-	-	**3**
7.	7	PSC		Rapid Prototyping Lab	-	-	2	**2**
Total Credits								**20**

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Project Mechanical Engineering courses (PROJ-ME)								
SL. No	Semester	Course Category	Course Code	Name of the Course	Hours per week			Credit
					L	T	P	
1	7	PROJ		Design and Fabrication Project	-	-	4	**2**
2	7	PROJ-ME		Industrial Internship and Training	-	-	-	**3**
3	8	PROJ-ME		Project Work	-	-	12	**10**
Total Credits								**15**

Open Electives Courses (OEC)								
SL. No	Semester	Course Category	Course Code	Name of the Course	Hours per week			Credit
					L	T	P	
1.	6	OEC - I		Cloud Computing	3	-	-	**3**
2.	6	OEC - I		Web Design	3	-	-	
3.	6	OEC - I		Digital Image Processing	3	-	-	
4.	6	OEC - I		Data Analysis	3	-	-	
5.	6	OEC - I		Astro-Physics	3	-	-	
6.	6	OEC - I		Business Administration	3	-	-	
7.	6	OEC - I		Chemistry in Crime Investigation	3	-	-	
8.	6	OEC - I		Bioinformatics	3	-	-	
9.	6	OEC - I		Finance for Non Finance Managers	3	-	-	
10.	6	OEC - I		Fuel Cell and Batteries	3	-	-	
11.	7	OEC - II		Autotronics	3	-	-	
12.	7	OEC - II		Artificial Intelligence & Machine Learning	3	-	-	
13.	7	OEC - II		Nano Technology & Surface	3	-	-	**3**
14.	7	OEC - II		Disaster Management & Mitigation	3	-	-	
15.	7	OEC - II		Robotics	3	-	-	
16.	7	OEC - II		HR Management	3	-	-	
17.	7	OEC - II		Nuclear and particle physics	3	-	-	
18.	7	OEC - II		Internet of Things (IOT)	3	-	-	
19.	7	OEC - II		Psychology	3	-	-	
20.	7	OEC - II		Statistical methods with excel	3	-	-	
21.	7	OEC - II		Key Board	3	-	-	
22.	7	OEC - II		Logistics and Supply Chain	3	-	-	
23.	7	OEC - II		Violin	3	-	-	
24.	7	OEC - II		Vocal Music	3	-	-	
Total Credits								**06**

B.E. (HONS.) MECHANICAL ENGINEERING WITH SPECIALIZATION IN 3D PRINTING							
SEMESTER - I (First year)							
SL. No	**Course Category**	**Course Code**	**Name of the Course**	**Hours per week**			**Credit**
				L	**T**	**P**	
1.	BSC		Mathematics –I (Calculus & Linear Algebra)	3	1	-	**4**
2.	BSC		Engineering Chemistry	3	-	-	**3**
3.	ESC		Basic Electrical Engineering	3	-	-	**3**
4.	ESC		Engineering Graphics & Design	2	-	2	**3**
5.	BSC		Chemistry Lab	-	-	3	**2**
6.	ESC		Basic Electrical Engineering Lab	-	-	3	**2**
7.	MC*		English Proficiency Certification	2	-	-	**1***
* Not accountable for CGPA							
Total				**11**	**01**	**08**	**17+1***

SEMESTER - II (First year)							
SL. No	**Course Category**	**Course Code**	**Name of the Course**	**Hours per week**			**Credit**
				L	**T**	**P**	
1.	HSMC		English	2	1	-	**3**
2.	BSC		Mathematics – II	3	1	-	**4**
3.	BSC		Applied Physics for Engineers	3	-	-	**3**
4.	ESC		Programming for Problem Solving	2	1	-	**3**
5.	MC*		Environmental Science and Engineering*	2	-	-	**2***
6.	BSC		Physics Lab	-	-	3	**2**
7.	ESC		Programming for Problem Solving Lab	-	-	3	**2**
8.	ESC		Workshop/Manufacturing Practices Lab	-	-	3	**2**
* Not accountable for CGPA							
Total				**12**	**03**	**09**	**19+2***

SEMESTER - III (Second year)							
SL. No	**Course Category**	**Course Code**	**Name of the Course**	**Hours per week**			**Credit**
				L	**T**	**P**	
1.	BSC		Mathematics III (PDE, Probability & Statistics)	3	1	-	**4**
2.	ESC		Engineering Mechanics	2	1	-	**3**
3.	PCC		Fluid Mechanics & Machinery	2	1	-	**3**
4.	PCC		Thermodynamics	3	-	-	**3**
5.	PCC		Materials Engineering	3	-	-	**3**
6.	**PSC**		**Polymer Engineering**	**3**	**-**	**-**	**3**
7.	**PSC**		**3D Printing Processes & Applications**	**3**	**-**	**-**	**3**
8.	PCC		Fluid Mechanics and Machinery Lab	-	-	3	**2**
9.	PCC		Materials and Metallurgy Lab	-	-	3	**2**
10.	MC*		Foreign Language Level – II and Above (German, French, Japanese, etc..,)	-	-	-	**1***
* Not accountable for CGPA							
Total				**19**	**03**	**06**	**26+1***

SEMESTER - IV (Second year)							
SL. No	**Course Category**	**Course Code**	**Name of the Course**	**Hours per week**			**Credit**
				L	**T**	**P**	
1.	ESC		Basic Electronics Engineering	3	-	-	**3**
2.	PCC		Applied Thermodynamics	3	-	-	**3**
3.	PCC		Strength of Materials	2	1	-	**3**
4.	PCC		Kinematics of Machines	2	1	-	**3**
5.	PCC		Manufacturing Processes	3	-	-	**3**
6.	**PSC**		**Materials Characterisation & Techniques**	**3**	**-**	**-**	**3**
7.	**PSC**		**3D PrintingMachines&Systems**	**3**	**-**	**-**	**3**
8.	MC*		Sanskrit and Indian Culture	2	-	-	**2***
9.	PCC		Thermal Engineering Lab	-	-	3	**2**
10.	PCC		Strength of Materials Lab	-	-	3	**2**
* Not accountable for CGPA							
Total				**21**	**02**	**06**	**25+2***

SEMESTER - V (Third year)							
SL. No	**Course Category**	**Course Code**	**Name of the Course**	**Hours per week**			**Credit**
				L	**T**	**P**	
1.	PCC		Heat and Mass Transfer	3	-	-	**3**
2.	PCC		Dynamics of Machines	2	1	-	**3**
3.	PCC		Instrumentation and Control	3	-	-	**3**
4.	PCC		Design of Machine Elements	3	-	-	**3**
5.	PCC		Manufacturing Technology	3	-	-	**3**
6.	PCC		Metrology and Quality Control	3	-	-	**3**
7.	**PSC**		**Medical Applications in 3D Printing**	**3**	**-**	**-**	**3**
8.	PCC		Machine Drawing Practical	-	-	3	**1**
9.	PCC		Manufacturing Technology Lab	-	-	3	**2**
10.	PCC		Dynamics and Measurements Lab	-	-	3	**1**
11.	MC*		Soft Skill and Aptitude Certification	-	-	-	**1***
* Not accountable for CGPA							
Total				**20**	**01**	**09**	**25+1***

SEMESTER - VI (Third year)							
SL. No	**Course Category**	**Course Code**	**Name of the Course**	**Hours per week**			**Credit**
				L	**T**	**P**	
1.	HSMC		Operation Research & Management	2	1	-	**3**
2.	PCC		Automobile Engineering	3	-	-	**3**
3.	PCC		Power Plant Engineering	3	-	-	**3**
4.	PCC		CAD/CAM	3	-	-	**3**
5.	**PSC**		**Rapid Tooling & Industrial Applications**	**3**	**-**	**-**	**3**
6.	PEC		Professional Elective – I	3	-	-	**3**
7.	OEC		Open Elective – I	3	-	-	**3**
8.	PCC		Heat Transfer Lab	-	-	3	**2**
9.	PCC		CAD/CAM Lab	-	-	3	**2**
10.	MC**		Technical Certification Course	-	-	-	**1***
*Not accountable for CGPA							
Total				**20**	**01**	**06**	**25+1***

SEMESTER - VII (Fourth year)							
SL. No	**Course Category**	**Course Code**	**Name of the Course**	**Hours per week**			**Credit**
				L	**T**	**P**	
1.	PCC		Design of Transmission Systems	3	-	-	**3**
2.	PCC		Mechatronics	3	-	-	**3**
3.	PEC		Professional Elective – II	3	-	-	**3**
4.	PEC		Professional Elective – III	3	-	-	**3**
5.	OEC		Open Elective – II	3	-	-	**3**
6.	PCC		Computer Aided Analysis Lab	-	-	3	**2**
7.	PCC		Mechatronics Lab	-	-	3	**2**
8.	**PSC**		**Rapid Prototyping Lab**	**-**	**-**	**2**	**2**
9.	PROJ-ME		Design and Fabrication Project	-	-	4	**2**
10.	PROJ-ME		Industrial Internship and Training	-	-	-	**3**
11.	MC**		Presentation / Publication in Conference / Seminar	-	-	-	**1***
* Not accountable for CGPA							
Total Credits				**15**	**-**	**12**	**26+1***

SEMESTER - VIII (Fourth year)							
SL. No	**Course Category**	**Course Code**	**Name of the Course**	**Hours per week**			**Credit**
				L	**T**	**P**	
1.	PCC		Automation in Manufacturing	3	-	-	**3**
2.	HSMC		Engineering Economics	3	-	-	**3**
3.	PEC		Professional Elective – IV	3	-	-	**3**
4.	PROJ-ME		Project Work	-	-	12	**10**
5.	MC*		Start ups				**1***
* Not accountable for CGPA							
Total Credits				**09**	**-**	**12**	**19+1***

PROFESSIONAL ELECTIVE COURSES							
SL. No	**Category**	**Code**	**Course Title**	**Hours per week**			**Credit**
				L	**T**	**P**	
1.	**PEC-I**		Finite Element Analysis	**3**	**-**	**-**	**3**
2.			Fluid Power Systems				
3.			Product Design & Development				
4.			3D Printing				
5.			Tribology				
6.	**PEC-II**		Refrigeration & Air Conditioning	**3**	**-**	**-**	**3**
7.			I.C. Engines				
8.			Turbo Machines				
9.			Energy Conservation in Industries				
10.			Gas Dynamics & Jet Propulsion				
11.	**PEC-III**		Sustainable Manufacturing	**3**	**-**	**-**	**3**
12.			Design for Manufacturing				
13.			Theory of Metal Forming				
14.			Digital Manufacturing				
15.			Composite Materials				
16.	**PEC-IV**		Total Quality Management	**3**	**-**	**-**	**3**
17.			Entrepreneurship Development				
18.			Non-Traditional Machining Process				
19.			Non Destructive Evaluation				
20.			Flexible Manufacturing Systems				

OPEN ELECTIVE COURSES							
SL. No	Category	Code	Course Title	Hours per week			Credit
				L	T	P	
1.	OEC – I		Cloud Computing	3	-	-	3
2.			Web Design				
3.			Digital Image Processing				
4.			Data Analysis				
5.			Astro-Physics				
6.			Business Administration				
7.			Chemistry in Crime Investigation				
8.			Bioinformatics				
9.			Finance for Non Finance Managers				
10.			Fuel Cell and Batteries				
11.			Autotronics				
12.			Artificial Intelligence & Machine Learning				
13.	OEC - II		Nano Technology & Surface Engineering	3	-	-	3
14.			Disaster Management & Mitigation				
15.			Robotics				
16.			HR Management				
17.			Nuclear and particle physics				
18.			Internet of Things (IOT)				
19.			Psychology				
20.			Statistical methods with excel				
21.			Key Board				
22.			Logistics and Supply Chain				
23.			Violin				
24.			Vocal Music				

Course Title	POLYMER ENGINEERING	Credits	L T P C
Course Code			3 0 0 3
Course Category			
Learning Level			

OBJECTIVES

- To explain the relationship between polymer properties (thermal, rheological, mechanical), and polymer microstructure and molecular weight.
- To relate polymer properties to their processing and uses for 3D Printing.
- To explain methods for determining the microstructure and molecular weight of polymers.
- To describe different types of polymerization process, polymer processing and the significance for 3D Printing.
- To understand the applications and design concepts for use of polymer in device manufacturing.

UNIT–I BASIC CONCEPTS

Types of Polymers and Polymerizations - Polymer Composition and Structure, Polymerization Mechanism, Nomenclature of Polymers - Nomenclature Based on Source, Nomenclature Based on Structure, IUPAC, Structure-Based Nomenclature System, Trade Names and Nonnames, Linear, Branched, and Crosslinked Polymers, Molecular Weight, Physical State, Crystalline and Amorphous Behavior, Determinants of Polymer Crystallinity, Thermal Transitions, Applications of Polymers - Mechanical Properties, Elastomers, Fibers, and Plastics.

UNIT - II POLYMERIZATION & ITS TECHNIQUES

Polymerization - Process Conditions, Multichain Polymerization, Crosslinking, Molecular Weight Distributions in Nonlinear Polymerizations, Crosslinking Technology, Step Copolymerization. Polymerisation Techniques - Reactivity of Functional Groups, Kinetics of Step Polymerization, Accessibility of Functional Groups, Equilibrium Considerations, Cyclization versus Linear Polymerization, Molecular Weight Control in Linear Polymerization, Molecular Weight Distribution in Linear Polymerization.

UNIT–III- POLYMERS

High-Performance Polymers, Inorganic and Organometallic Polymers, Dendritic Polymers, Enzymatic Polymerizations, Polymerization in Supercritical Carbon Dioxide, Cycloaddition Polymerization, Spiro Polymers, Pseudopolyrotoxanes and Polyrotoxanes.

UNIT–IV EMULSION POLYMERIZATION

Description of Process, Quantitative Aspects, Characteristics of Emulsion Polymerization – Initiators, Surfactants, Other Components, Propagation and Termination Rate Constants, Energetics, Molecular Weight and Particle Size Distributions, Surfactant-Free Emulsion Polymerization, Other Emulsion Polymerization Systems, Living Radical Polymerization.

UNIT–V REACTIONS OF POLYMERS

Principles of Polymer Reactivity, Crosslinking, Reactions of Cellulose, Reactions of Poly(vinyl acetate), Aromatic Substitution, Cyclization, Other Reactions, Graft Copolymers, Block Copolymers, Polymers as Carriers or Supports, Polymer Reagents, Polymer Catalysts, Polymer Substrates.

CO	COURSE OUTCOMES	PO
Upon completion of this course, Students should be able to		
1.	Explain the relationship between polymer properties (thermal, rheological, mechanical), and polymer microstructure and molecular weight.	
2.	Relate polymer properties to their processing and uses for additive manufacturing.	
3.	Explain methods for determining the microstructure and molecular weight of polymers.	
4.	Describe different types of polymerization process, polymer processing and the significance for AM.	
5.	Understand the applications and design concepts for use of polymer in device manufacturing.	
TEXT BOOK		
1.	G. Odian, Principles of Polymerization, Wiley Inerscience, John Wiley and Sons, 4th edition, 2005	
REFERENCES		
1.	V.R. Gowarikar Polymer Science, , New Age Int., 2002	
2.	F.W. Billmeyer Jr, Polymer Science, Inter science Publisher John Wiley and Sons, 3rd edition 1999.	

Course Title	3D PRINTING PROCESSES & APPLICATIONS	Credits	L T P C
Course Code			3 0 0 3
Course Category			
Learning Level			

OBJECTIVES

- To Know the importance of 3D printing in Manufacturing
- To know the different 3D Printing Technologies
- To select a suitable material for 3D Printing
- To observe the different methods for Post-processing of 3D Printing parts
- To Understand the applications of 3D Printing in Automobile, Aerospace, Bio-medical etc.

UNIT–I INTRODUCTION AND BASIC PRINCIPLES

3D Printing, Generic 3D Printing Process, Benefits of 3D Printing, Distinction Between 3D Printing and CNC Machining, Other Related Technologies

Development of 3D Printing Technology: Introduction, Computers, Computer-Aided Design Technology, Other Associated Technologies, The Use of Layers, Classification of 3D Printing Processes, Metal Systems, Hybrid Systems, Milestones in 3D Printing Development, 3D Printing around the World.

UNIT - II 3D PRINTING PROCESS CHAIN & PHOTOPOLYMERIZATION PROCESSES

Eight Steps in Additive Manufacture, Variations from One 3D Printing Machine to Another, Metal Systems, Maintenance of Equipment, Materials Handling Issues, Design for 3D PRINTING.

Introduction to Photopolymerization Processes: Photopolymerization Materials, Reaction Rates, Vector Scan SL, SL Resin Curing Process, SL Scan Patterns, Vector Scan Micro stereolithography, Mask Projection Photopolymerization Technologies and Processes, Two-Photon SL.

UNIT–III POWDER BED FUSION PROCESSES & EXTRUSION-BASED SYSTEMS

Powder Bed Fusion Processes: Introduction, SLS Process Description, Powder Handling, Approaches to Metal and Ceric Part Creation, Variants of Powder Bed Fusion Processes, Process Par3D Printingeters, Applied Energy Correlations and Scan Patterns, Typical Materials and Applications, Materials - Capabilities and Limitations.

Extrusion-Based Systems: Introduction, Basic Principles, Plotting and Path Control, Materials, Limitations of FDM, Bioextrusion, Other Systems.

UNIT–IV DESIGN, GUIDELINES FOR PROCESS SELECTION & SOFTWARE ISSUES

Design for 3D Printing - Design for Manufacturing and Assembly, Core DFM for 3D Printing Concepts and Objectives, 3D Printing Unique Capabilities, Exploring Design Freedoms, Design Tools for 3D Printing.

Guidelines for Process Selection - Selection Methods for a Part, Challenges of Selection, Preliminary Selection, Production Planning and Control.

Software Issues for 3D Printing - Preparation of CAD Models – the STL File, Problems with STL Files, STL File Manipulation, Beyond the STL File, Additional Software to Assist 3D Printing.

UNIT–V MEDICAL APPLICATIONS & FUTURE DIRECTIONS FOR 3D PRINTING

Medical Applications for 3D Printing - Use of 3D Printing to Support Medical Applications, Software Support for Medical Applications, Limitations of 3D Printing for Medical Applications, Further Development of Medical 3D Printing Applications.

Use of Multiple Materials in 3D Printing - Discrete Multiple Material Processes, Porous Multiple Material Processes, Blended Multiple Material Processes, Embedded Component 3D Printing, Commercial Applications Using Multiple Materials, Future Directions, Business Opportunities and Future Directions

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CO	COURSE OUTCOMES	PO
Upon completion of this course, Students should be able to		
1.	Importance of 3D printing in Manufacturing	
2.	Different 3D Printing Technologies	
3.	Select suitable materials for 3D Printing	
4.	Different methods for Post-processing of 3D Printing parts	
5.	Applications of 3D Printing in Automobile, Aerospace, Bio-medical etc.	
TEXT BOOK		
1.	Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010	
REFERENCES		
1.	Chua Chee Kai, Leong Kah Fai, "Rapid Prototyping: Principles & Applications", World Scientific, 2003.	
2.	Ali K. Kamrani, Emand Abouel Nasr, "Rapid Prototyping: Theory & Practice", Springer, 2006.	
3.	D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer 2001.	

Course Title	MATERIALS AND CHARACTERIZATION TECHNIQUES	Credits	L T P C
Course Code			3 0 0 3
Course Category			
Learning Level			

OBJECTIVES

- To interpret various materials characterization techniques.
- To understand the principle and operation of characterization equipment and the adjustment of operation variables to obtain good images / results
- To select the characterization tool for specific application
- To compare the principle and operation of different characterization tools such as optical microscope, Scanning electron microscopes and transmission electron microscope
- To analyze the characterization results by various equipment

UNIT–I OPTICAL MICROSCOPY

Introduction, Optical principles, Instrumentation, Specimen preparation-metallographic principles, Imaging Modes, Applications, Limitations.

UNIT - II SEM, TEM & XRD

Scanning Electron Microscopy (SEM) - Introduction, Instrumentation, Contrast formation, Operational variables, Specimen preparation, imaging modes, Applications, Limitations.
Transmission Electron Microscopy (TEM) - Introduction, Instrumentation, Specimen preparation-pre thinning, final thinning, Image modes- mass density contrast, diffraction contrast, phase contrast, Applications, Limitations.
X- Ray Diffraction (XRD) - Introduction, Basic principles of diffraction, X - ray generation, Instrumentation, Types of analysis, Data collection for analysis, Applications, Limitations

UNIT–III THERMAL ANALYSIS

Introduction, Basics of thermodynamics and heat transfer, Common characteristics- Instrumentation, experimental parameters, Different types used for analysis, Differential thermal analysis, Differential Scanning Calorimetry, Thermogravimetry, Dilatometry, Dynamic mechanical analysis- Basic principles, Instrumentation, working principles, Applications, Limitations.

UNIT–IV SPM, AFM & EPMA

Scanning Probe Microscopy (SPM) - Introduction, Instrumentation, Scanning Tunneling Microscopy-Basics, probe tips, working environment, operational modes, Applications, Limitations.
Atomic Force Microscopy (AFM) - basic principles, instrumentation, operational modes, Applications, Limitations
Electron Probe Micro Analyzer (EPMA) - Introduction, Sample preparation, Working procedure, Applications, Limitations

UNIT–V X- RAY SPECTROSCOPY FOR ELEMENTAL ANALYSIS

Introduction, Characteristics of X-rays, X- ray Fluorescence Spectrometry, Wavelength Dispersive Spectroscopy-Instrumentation, Working procedure, Applications, Limitations, Energy Dispersive Spectroscopy - Instrumentation, Working procedure, Applications, Limitations

CO	COURSE OUTCOMES	PO
Upon completion of this course, Students should be able to		
1.	Interpret various materials characterization techniques.	
2.	Understand the principle and operation of characterization equipment and the adjustment of operation variables to obtain good images / results	
3.	Select the characterization tool for specific application	
4.	Compare the principle and operation of different characterization tools such as optical microscope, Scanning electron microscopes and transmission electron microscope	
5.	Analyze the characterization results by various equipment	
TEXT BOOK		
1.	Yang Leng, Materials Characterization, Introduction to Microscopic and Spectroscopic Methods, John Wiley & Sons (Asia) Pte Ltd., 2008	
REFERENCES		
1.	ASM Handbook: Materials Characterization, ASM International, 2008.	
2.	Robert F. Speyer, Thermal Analysis of Materials, Marcel Dekker Inc., New York, 1994.	
3.	V. T. Cherapin and A. K. Mallik, Experimental Techniques in Physical Metallurgy, Asia Publishing House, 1967.	
4.	S.J.B. Reed, Electron Microprobe Analysis, Cambridge University Press, London, 1975.	

Course Title	3D PRINTING MACHINES & SYSTEMS	Credits	L T P C
Course Code			3 0 0 3
Course Category			
Learning Level			

OBJECTIVES

- To understand the construction of basic 3D Printing machines
- To understand the Energy delivery, Material delivery, Nozzle and Heating Systems
- To know the Optical & Optoelectronic components in 3D Printing
- To know the environmental control systems
- To understand the Pre-processing & Post processing techniques in 3D printing

UNIT–I INTRODUCTION TO 3D PRINTING MACHINES & PROCESSES

Introduction to 3D Printing Machines: Historical Perspectives, Rapid Prototyping - An Integral Part of Time Compression Engineering, RP Information Workflow.
Rapid Prototyping Processes: Classification of Rapid Prototyping Processes, Processes Involving a Liquid - Solidification of a Liquid Polymer, Solidification of an Electroset Fluid: Electrosetting (ES), Solidification of Molten Material, Processes Involving Discrete Particles, Processes Involving Solid Sheets.

UNIT - II RAPID PROTOTYPING SYSTEMS

Stereolithography Apparatus, Solid Ground Curing Systems, Fused Deposition Modelling Systems, Selective Laser Sintering Systems, Laminated Object Manufacturing Systems, Paper Lamination Technology Laser Engineering Net Shaping Systems.

UNIT–III TECHNICAL, TECHNOLOGICAL CAPABILITIES & APPLICATIONS OF RAPID PROTOTYPING TECHNOLOGY

Technical Characteristics and Technological Capabilities of Concept: Modellers, 3D Systems ThermoJet™ Printer, Sanders Model Maker II, Z-Corporation Z402 3D Printer, Stratasys Genisys Xs 3D Printer, JP System, Object Quadra System
Applications of Rapid Prototyping Technology: Functional Models, Pattern for Investment and Vacuum Casting, Medical Models, Art Models, Engineering Analysis Models.

UNIT–IV INDIRECT & DIRECT METHODS FOR RAPID TOOL PRODUCTION

Indirect Methods for Rapid Tool Production: Role of Indirect Methods in Tool Production, Metal Deposition Tools, RTV Tools, Epoxy Tools, Ceramic Tools, Cast Metal Tools, Investment Casting, Fusible Metallic Core, Sand Casting, Keltool Process.
Direct Methods for Rapid Tool Production: Classification of Direct Rapid Tool Methods, Direct ACESTM Injection Moulds, Laminated Object Manufactured Tools, DTM RapidToo1 Process, SandForm EOS DirectTool Process, Direct Metal Tooling using 3Dp, Topographic Shape Formation.

UNIT–V APPLICATIONS OF RAPID TOOLING TECHNOLOGY & PROCESS OPTIMISATION

Insert Design, Insert Finishing, Rapid Tooling Inserts Wear Resistance, Case Studies.
RPT Optimisation - Factors Influencing Accuracy - Data Preparation, Errors due to Tessellation, Errors due to Slicing, Part Building, Part Building Errors in the SL Process, Part Building Errors in the SLS Process, Part Finishing, Selection of Part Build Orientation, Orientation Constraints of the SL Process, Orientation Constraints of the SLS Process.

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CO	COURSE OUTCOMES	PO
Upon completion of this course, Students should be able to		
1.	Understand the construction of basic 3D Printing machines	
2.	Understand the Energy delivery, Material delivery, Nozzle and Heating Systems	
3.	Know the Optical & Optoelectronic components in 3D Printing	
4.	Know the environmental control systems	
5.	Understand the Pre-processing & Post processing techniques in 3D printing	
TEXT BOOK		
1.	D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer Science & Business Media, 2012.	
REFERENCES		
1.	Chee Kai Chua, Kah Fai Leong, 3D Printing and Additive Manufacturing: Principles and Applications: Fourth Edition of Rapid Prototyping	
2.	Andreas Gebhardt, Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing, Hanser Publications, 2012	
3.	Peter Hilton & Paul Jacobs, Rapid Tooling: Technologies and Industrial Applications, CRC Press, 2000	

Course Title	MEDICAL APPLICATIONS IN 3D PRINTING	Credits	L T P C
Course Code			3 0 0 3
Course Category			
Learning Level			

OBJECTIVES

- To apply the concepts of medical imaging, 3D scanning and digitizing for accurate 3D model construction.
- To identify the errors during processing of medical image data and minimize them.
- To select the suitable material for the given medical application.
- To analyze and select an additive manufacturing technology for a given medical application.
- To analyze and design the virtual models of the patient for planning the surgery.

UNIT–I RAPID PROTOTYPING FOR MEDICAL APPLICATIONS

Overview, Workshop on Medical Applications for Reverse Engineering and Rapid Prototyping, Background on Rapid Prototyping, Stereolithography and Other Resin-type Systems, Fused Deposition Modelling and Selective Laser Sintering, Droplet/Binder Systems, Related Technology: Microsystems and Direct Metal Systems, File Preparation, Relationship with Other Technologies, Disadvantages with RP for Medical Applications.

UNIT - II BIOMODELLING

Introduction, Surgical Applications of Real Virtuality - Cranio-maxillofacial biomodelling, Use of real virtuality in customized cranio-maxillofacial prosthetics, Biomodel-guided stereotaxy, Vascular biomodelling, Skull-base tumour surgery, Spinal surgery, Orthopaedic biomodelling, Case Studies

UNIT–III BIOBUILD SOFTWARE FOR MEDICAL DATA TRANSFER

Introduction, Medical Imaging: from Medical Scanner to 3D Model, Computer Approach in Dental Implantology. BioBuild Paradigm - Importing a dataset, Volume reduction, Anatomical orientation confirmation, Volume editing, Image processing, Build orientation optimization, 3D visualization, RP file generation, Future Enhancements.

UNIT–IV SCAFFOLD-BASED TISSUE ENGINEERING & ORTHOPEDIC IMPLANTS

Introduction, Medical Imaging: from Medical Scanner to 3D Model, Computer Approach in Dental Implantology. BioBuild Paradigm - Importing a dataset, Volume reduction, Anatomical orientation confirmation, Volume editing, Image processing, Build orientation optimization, 3D visualization, RP file generation, Future Enhancements.

Introduction to orthopedic implants, Electron Beam Melting Technology, Direct Fabrication of Titanium Orthopedic Implants - EBM fabrication of custom knee implants, EBM fabrication of custom bone implants, Direct fabrication of bone ingrowth surfaces.

UNIT–V MODELLING, ANALYSIS AND FABRICATION OF BELOW-KNEE PROSTHETIC SOCKETS USING RAPID PROTOTYPING

Introduction, Computer-Facilitated Approach, Rapid Socket Manufacturing Machine, Overview of the RSMM, Future Development of Medical Applications for Advanced Manufacturing Technology - Scanning Technology, RP Technology, Direct Manufacture, Tissue Engineering, Business

3D PRINTING - REGULATIONS 2018

CO	COURSE OUTCOMES	PO
Upon completion of this course, Students should be able to		
1.	Apply the concepts of medical imaging, 3D scanning and digitizing for accurate 3D model construction.	
2.	Identify the errors during processing of medical image data and minimize them.	
3.	Select the suitable material for the given medical application.	
4.	Analyze and select an additive manufacturing technology for a given medical application.	
5.	Analyze and design the virtual models of the patient for planning the surgery.	
TEXT BOOK		
1.	Ian Gibson, Advanced Manufacturing Technology for Medical Applications, John Wiley, 2005.	
REFERENCES		
1.	Paulo Bartolo and Bopaya Bidanda, Bio-materials and Prototyping Applications in Medicine, Springer, 2008.	
2.	Joseph D. Bronzino, The Biomedical Engineering Hand Book, 3rd Edition, CRC Press, 2006	

Course Title	RAPID TOOLING & INDUSTRIAL APPLICATIONS	Credits	L T P C
Course Code			3 0 0 3
Course Category			
Learning Level			

OBJECTIVES

- To identify suitable rapid tooling technique for rapid product development.
- To model the suitable tooling method for the given industrial application.
- To identify the errors during development of tool and minimize them.
- To design and fabricate the tool for the given medical application
- To design and fabricate the tool for the given automobile application

UNIT–I BASICS, DEFINITIONS, AND APPLICATION LEVELS

Additive Manufacturing – Layer Manufacturing, The Principle of Layer-Based Technology, Application Levels, Indirect Processes, Classes of Machines for Additive Manufacturing.

UNIT - II LAYER MANUFACTURING PROCESSES

Direct Layer Manufacturing Processes, Polymerization - Laser-Stereolithography, Polymer Printing and – Jetting, Digital Light Processing, Micro Stereolithography. Sintering and Melting - Laser Sintering – Selective Laser Sintering (LS – SLS), Laser Melting – Selective Laser Melting (SLM), Electron Beam Melting. Extrusion – Fused Layer Modeling, Powder-Binder Bonding – Three-Dimensional Printing - Z-Corporation, Prometal, Voxeljet. Layer Laminate Manufacturing (LLM), Machines for Additive Manufacturing – Fabricators, Printers

UNIT–III APPLICATIONS OF RAPID PROTOTYPE TOOLING

Data Processing and Application Workflow - AM Process Chain, Application Workflow. Applications of AM - Automotive Industries and Suppliers. Aerospace Industry, Consumer Goods, Toy Industry, Art and History of Art, Foundry and Casting Technology, Mold and Die Making for Plastic Injection Molding and Metal Die Casting, Medical, Architecture and Landscaping.

UNIT–IV ADDITIVE MANUFACTURING DESIGN AND STRATEGIES

Potential of AM, Potentials and Resulting Perspectives - Complex Geometries, Integrated Geometry, Integrated Functionalities, Multi-Material Parts and Graded Materials. AM-Based New Strategies – Customization.

UNIT–V MATERIALS, DESIGN, AND QUALITY ASPECTS FOR ADDITIVE MANUFACTURING

Materials for AM - Anisotropic Properties, Basic Isentropic Materials, Graded and Composite Materials. Engineering Design Rules for AM - Tolerances – Digital to Object, Design Freedom, Relative Fit, Flexures, Hinges, and Snap-Fits, Orientation and Clamping, Drillings (Bores), Gaps, Pins, and Walls. AM Properties, Selection, Build Management

CO	COURSE OUTCOMES	PO
Upon completion of this course, Students should be able to		
1.	Identify suitable rapid tooling technique for rapid product development.	
2.	Model the suitable tooling method for the given industrial application.	
3.	Identify the errors during development of tool and minimize them.	
4.	Design and fabricate the tool for the given medical application	
5.	Design and fabricate the tool for the given automobile application	

TEXT BOOK	
1.	Andreas Gebhardt, Understanding Additive Manufacture: Rapid Prototyping, Rapid Tooling and Rapid Manufacture, Hanser Publishers, 2013.
REFERENCES	
1.	D.T. Pham and S.S Dimov, Rapid Manufacturing: The Technogies and Applications of Rapid Prototyping & Rapid Tooling, Springer, 2001.
2.	Peter Hilton and Paul F Jacobs, Rapid Tooling Technologies and Industrial Applications, Marcel Dekker Inc, New York, 2001.
3.	Wanlong Wang, Henry W. Stoll and James G. Conley, Rapid Tooling Guidelines for Sand Casting, Springer, 2010.

Course Title	RAPID PROTOTYPING LABORATORY	Credits	L T P C
Course Code			3 0 0 3
Course Category			
Learning Level			

OBJECTIVES

- To optimize the process parameters of FDM machine to improve the quality of the parts produced.
- To build complex engineering assemblies in plastic material with less process planning.
- To improve surface finish of fabricated plastic components for the engineering applications.
- To design and fabricate working models for the conceptual testing applications.

DETAILED SYLLABUS

1. Review of CAD Modeling Techniques and Introduction to RP
2. Forming Groups & Assigning Creative Idea
3. Generating STL files from the CAD Models & Working on STL files
4. Modeling Creative Designs in CAD Software
5. Assembling Creative Designs in CAD Software
6. Processing the CAD data in Catalyst software (Selection of Orientation, Supports generation, Slicing, Tool path generation)
7. Simulation in Catalyst Software
8. Sending the tool path data to FDM RP machine
9. Fabricating the physical part on FDM RP machine
10. Removing the supports & post processing (cleaning the surfaces)
11. Demonstrating Creative Working Models
12. Converting CT/MRI scan data into STL file using MIMICS software (Demo)

CO	COURSE OUTCOMES	PO
Upon completion of this course, Students should be able to		
1.	Optimize the process parameters of FDM machine to improve the quality of the parts produced.	
2.	Build complex engineering assemblies in plastic material with less process planning.	
3.	Improve surface finish of fabricated plastic components for the engineering applications.	
4.	Design and fabricate working models for the conceptual testing applications.	

TEXT BOOK

1.	Chua Chee Kai., Leong Kah Fai., Chu Sing Lim, Rapid Prototyping: Principles and Applications in Manufacturing, World Scientific, 2010.

REFERENCES

1.	FDM Dimension 768 RP Machine Manual, Stratasys INC., USA, 2006.
2.	Mojo 3D Printer Manual, Stratasys INC., USA, 2013.