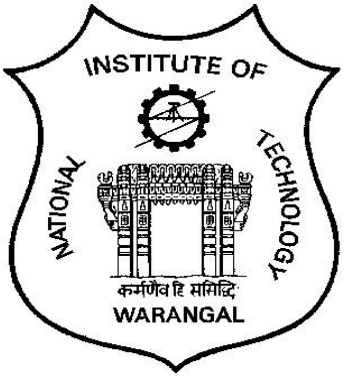
NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL



RULES AND REGULATIONS
SCHEME OF INSTRUCTION AND SYLLABII
FOR M.TECH PROGRAM

M.TECH IN MATERIALS TECHNOLOGY

Effective from 2016-17

DEPARTMENT OF METALLURGICAL & MATERIALS ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL

VISION

Towards a Global Knowledge Hub, striving continuously in pursuit of excellence in Education, Research, Entrepreneurship and Technological services to the society

MISSION

- Imparting total quality education to develop innovative, entrepreneurial and ethical future professionals fit for globally competitive environment.
- Allowing stake holders to share our reservoir of experience in education and knowledge for mutual enrichment in the field of technical education.
- Fostering product oriented research for establishing a self-sustaining and wealth creating centre to serve the societal needs.

DEPARTMENT OF METALLURGICAL & MATERIALS ENGINEERING VISION

Attain global recognition in research and training to meet challenging needs of Metallurgical and Materials Engineering with ethical and moral responsibility towards society.

MISSION

- Provide outstanding technical education for analysis, design and operation of metallurgical and materials systems.
- Keep abreast with rapid strides of technology and improve academic standards through innovative teaching and learning processes.
- Engage in quality research in metallurgical, materials and allied engineering areas.
- Develop academic linkages with leading industries for mutual benefit.

RULES AND REGULATIONS

M. Tech Degree Programs

1. INTRODUCTION:

Provision of these regulations shall come into force with effect from the academic year 2014 - 2015 and shall be applicable to all M.Tech courses (unless otherwise stated) offered by the Institute.

1.1 M.Tech Degree Programs are offered in the following specializations by the respective departments as listed below:

Department	Program	Course / Specialization (s)
Civil Engineering	M. Tech	1. Engineering Structures 2.Geotechnical Engineering 3.Transportation Engineering 4. Water Resources Engg. 5. Remote Sensing and GIS 6. Environmental Engineering 7. Construction Technology and Management
Electrical Engineering	M. Tech	1. Power Systems Engineering 2. Power Electronics and Drives
Mechanical Engineering	M. Tech	1. Thermal Engineering 2. Manufacturing Engineering 3. Computer Integrated Manufacturing 4. Machine Design 5. Automobile Engineering 6. Materials and Systems Engineering Design 7. Additive Manufacturing
Electronics and Communication Engineering	M. Tech	1. Electronic Instrumentation 2. VLSI System Design 3. Advanced Communication Systems
Metallurgical and Materials Engg.	M. Tech	1. Industrial Metallurgy 2. Materials Technology
Chemical Engineering	M. Tech	1. Computer Aided Process and Equipment Design 2. Process Control
Computer Science and Engineering	M. Tech	1. Computer Science and Engineering 2. Computer Science and Information Security

1.2 The provisions of these regulations shall be applicable to any new discipline that may be introduced from time to time.

1.3The sanction of stipend will be as per the guidelines prescribed AICTE/MHRD from time to time.

2. ADMISSION:

Admissions are made on All India basis for all the programs, with reservations as per Government of India norms. The selection criterion for admission into all the M.Tech. programs is based on valid GATE score. Candidates seeking admission into M.Tech. in Engineering should have passed BE/B.Tech. or equivalent degree in the subject concerned from a recognized University/Institute with First Class not less than 60% marks or equivalent CGPA of 6.5/10. In case of SC/ST candidates 55% marks or equivalent CGPA of 6.0/10 is the eligibility requirement. Eligibility and other criteria for admissions to M. Tech. courses of the Institute will be reviewed and decided by the Senate from time to time.

3. COURSE STRUCTURE:

An M. Tech. program is of 4-semester duration, out of which 2 semester course work followed by two semester dissertation work.
The total course package for an M. Tech. Degree program will typically consist of the following components.

a) Core Courses = 32 Credits
b) Elective Courses = 18 Credits
c) Seminar and Comprehensive Viva Voce = 04 Credits
d) Dissertation = 18 Credits

a) The Departmental Board of Studies will discuss and finalize the exact credits offered for the program for the above components ‘a’ to 'd’, the semester-wise distribution of the courses and credits, as well as the syllabii of all M. Tech. Programs offered by the department from time to time and recommend the same to the Senate for consideration and approval.

b) In order to qualify for a post graduate degree of the Institute, a student is required to complete all the credits specified in the scheme of instruction for that program as approved by the Senate from time to time.

4. ACADEMIC CALENDAR:

a) The academic year is divided into two semesters.
b) The senate shall approve the schedule of academic activities for an academic year including the dates of registration, Mid semester and End semester examinations, which shall be referred to as academic calendar of the year. Each semester will normally be of 19 weeks, which includes End semester examinations. It may be ensured that the minimum number of effective teaching weeks in a semester is 16.
c) Academic calendar declared by the Senate in the beginning of a semester shall also fix fest dates during which all the co-curricular and extra-curricular programs like Technical seminars / Spring Spree/Institute day/etc. must be organized.

5. RESIDENTIAL REQUIREMENT:

The Institute is essentially residential and unless otherwise exempted/permitted, every student shall be required to reside in and be a boarder of one of the halls of residence and mess to which he/she is assigned.

6. ATTENDANCE:

Attendance in all classes (lectures/tutorials, laboratories etc.) is compulsory. A student will not be permitted to appear in the end semester examination on grounds of unsatisfactory attendance. Minimum required attendance in each theory /laboratory course is 80% for appearing in the End Semester examination. There will not be any possibility of condoning the shortage for whatever reasons beyond this.

Attendance for both theory and laboratory courses shall be entered before the end of each working week by the concerned teacher through faculty portal of the Institute website. Students are advised to monitor the status of their attendance through student portal of the Institute website.

Absence without obtaining sanction of leave will be considered as an act of indiscipline and shall entail deduction from scholarship on pro rata basis.
No student can receive scholarship/fellowship from more than one source, either Government or Private.

7. LEAVES:

a) A post graduate student shall be entitled to the following kinds of leave during every academic year, counted from the date of commencement of the session concerned as prescribed in the academic calendar of the institute.

b) Any absence over and above the prescribed type of admissible leave shall entail deduction from the scholarship, beside other action as may be decided by the Institute.

Sl.No.	Leave	Maximum Number of days	Sanctioning authority
1.	Casual Leave	8 days per semester subjected to the condition that such leave will not be allowed for more than 6 days at a time. Casual leave cannot be combined with medical leave.	Head of the Department (HOD)
2.	Medical Leave	8 days per semester	HOD with Medical Certificate from the Institute Medical Officer.

8. REGISTRATION:

a) Every Student of the M.Tech. courses is required to be present and register at the commencement of each semester on the day fixed for and notified in the Academic calendar.

b) The registration will be organized departmentally under the supervision of the Head of the Department/ Coordinator of a respective specialization / program.

c) A student who does not register on the day announced for the purpose may be permitted, in consideration of any compelling reason, late registration within the first week on payment of additional late fee as prescribed by the Institute from time to time. Normally no late registration shall be permitted after the first week from the scheduled date.

d) Only those students will be permitted to register who have: (a) cleared all Institute and Hostel dues of the previous semesters (b) paid all required fees for the current semester, and (c) not been debarred from registering for a specified period on disciplinary action or any other ground.

e) The students will choose the subjects for registration in consultation with the Faculty Advisor. The students may also consult the Head of the Department/Division /Centre/Section/ any other teacher.

f) A student who has already registered may

(a) register for a new course in addition to the courses he/she has already registered for

(OR)

(b) opt for a new course in place of the one already registered for with the concurrence of the faculty advisor.

Any change of the course as permissible by sub-paras (a) and (b), above must however, be done within two weeks after registration.

g) A Student can register for a backlog subject either for (i) Study or for (ii) Examination. In case of Study, his / her previous marks are cancelled and will have to attend all classes and examinations along with next batch of students. Major changes in the time table shall not be entertained to accommodate backlog students. In case of registration for examination, he/she will not attend the classes, but will appear only for the end-semester examinations or make-up examinations as and when they are conducted. In such a case, the student shall be awarded only P grade, if he/she gets 40% or more marks in the end semester/makeup examination. Backlog students registering for study or examinations have to submit an undertaking that they will not change the status of their registration in the subject during the semester.

9. ASSESSMENT OF ACADEMIC PERFORMANCE:

a) There will be continuous assessment of the performance of students throughout the semester and grades will be awarded by the subject teacher.

b) Each theory subject in a semester is evaluated for 100 marks, with the following weightages.

Sub-component	**Weightage**
Continuous Evaluation	20 marks
Mid-semester Examination	30 marks
End-semester Examination	50 marks

c) The mid-semester examination will be conducted after 7 or 8 weeks of instruction. The Mid semester and End semester examinations will be conducted centrally by the examination section.

d) For assigning marks in continuous evaluation, minor(s)/surprise test/ assignment / quiz etc. may be conducted.

e) The mode and nature of the evaluation and the corresponding weightages may be intimated to the students at the beginning of the semester along with the lecture schedule.

f) Each laboratory course in a semester is evaluated for 100 marks, with the following weightages:

Sub-component	**Weightage**
Continuous evaluation (Lab report, Viva, Quiz etc.)	25 marks
Skill test	25 marks
End Semester examination	50 marks

g) COMPREHENSIVE VIVA-VOCE: The oral examination carrying 2 credits will cover the entire course of study up to I year II semester. The viva voce shall be conducted by an external examiner.

h) A Seminar Assessment Committee will be formed by the Head of the Department/Centre for the evaluation of performance at Seminars. Every student is expected to attend all the seminars of all the students of the batch held in the Department/Centre during the semester. Due weightage shall be given to a student's attendance in the overall evaluation of this requirement.

10. DISSERTATION EVALUATION:

a) 18 credits are assigned to the dissertation carried out by a student. The dissertation shall be submitted preferably by 15th June (but not earlier than 15th May). The method of evaluation is as per the guidelines given in Appendix-I.

b) The dissertation supervisor will periodically review the progress of the student and finally give his/her assessment of the work done by the student.

c) Dissertation and Viva-Voce: A student shall be required to submit a dissertation on the project work carried out by him/her. The guidelines for preparation of Dissertation shall be followed by every student as per guidelines given Appendix III. Three/four bound copies along with a soft copy of the dissertation shall be submitted to the Head of the Department/Centre within the last date prescribed in the Academic Calendar for the purpose.

d) Dissertation viva - voce will be held within the date fixed in the academic calendar and the grades will be finalized. External examiner for the evaluation of the dissertation at the end of fourth semester shall be from outside the Institution. The dissertation assessment committee constituted by the Head of the Department, along with the dissertation supervisor, shall be associated with the evaluation. The external expert who examines the Dissertation will conduct the viva voce.

e) Extension of dissertation work beyond the deadline of submission in very special case may be granted by the Dean - Academic on recommendation of the department/centre for a maximum period of 3 months. The viva-voce has to be completed within the extension period. The student shall not be eligible either for award of scholarship during the extension period or any medal/prize. However, if the student had been absent on medical grounds and his/her project had been extended, he/she may be eligible for award of medal or prize, if any. If the above mentioned extension period encroaches into the next semester, the student will have to pay the tuition fee on par with full time student.

11. DISSERTATION WORK IN COLLABORATION WITH INDUSTRY:

a) A student may, with the approval of the Head of the Department/Centre, visit an industry or a Research Laboratory for data collection, discussion of the dissertation, experimental work, survey, field studies, etc. during the project period. Projects sponsored by the industry or Research Laboratories will be encouraged and a close liaison with such organizations will be maintained.

b) A student may, with the approval of Head of the Department/Centre, do the dissertation work in collaboration with an industry, a Research and Development Organization. The student shall acknowledge the involvement and / or contribution of an industry, R&D organization in completing the project in his/her dissertation and a certificate to this effect, issued by the supervisor from the industrial organization, will be included in the dissertation.

c) It is mandatory for all students (especially those who do their project in an Industry, R&D organization in India or abroad) to make full disclosure of all data on which they wish to base their dissertation. They cannot claim confidentiality simply because it would come into conflict with the Industry's or R&D laboratory's own interests. Any tangible intellectual property other than copyright of dissertation may have to be assigned to the Institute. The copyright of the dissertation itself would however lie with the student as per the IPR policy in force.

d) In addition to the Supervisor from the department/centre guiding the project work, a Joint Supervisor may be appointed from the Industry and Research Laboratory with the approval of the DAC - PG &R. A certificate from the joint supervisor will be included in the dissertation. A member of faculty of the Institute, who is the internal supervisor, may, if felt necessary, visit the industry or the Research Laboratory in connection with the dissertation work of his/her student.

12. INDUSTRIAL TRAINING:

A student may undergo Industrial training upto a maximum of eight weeks, if he/she wishes, immediately after the completion of I Year II semester.

13. EVALUATION – GRADING SYSTEM:

❖ As a measure of student's performance a 7-scale grading system using the following letter grades and corresponding grade points per credit shall be followed. Grading will be done based on the absolute marks obtained.

Letter Grade	**Ex**	**A**	**B**	**C**	**D**	**P**	**F**
Grade Point	**10**	**9**	**8**	**7**	**6**	**5**	**0**

No student can pass without securing at least 40% marks.
Relative grading scheme shall be followed for all the PG Programs.
The cut-off (lower limit) for EX grade should not be less than 85%.
The cut-offs for other grades between P and EX are to be fixed carefully.

- In case of bunching, the DAC-PG&R may review the reasons for bunching and modify the ranges, marginally. In all such cases, the modified ranges and the reasons should be presented to the Senate for its approval.
- In addition, there shall be four transitional grading symbols, which can be used by the examiners to indicate the special position of a student in a subject.
  - I for "Incomplete assessment", when the student misses the End- semester examination on Medical grounds (see rule 15.1).
  - R - for 'Insufficient attendance in the course (see rule 15.4).
  - W - for "Temporary withdrawal' from the Institute (see rule 19)
  - X - for "Debarred" on grounds of indiscipline /malpractices in examinations (see rule 20).

a) A semester Grade Point Average (SGPA) will be computed for each semester. The SGPA will be calculated as follows:

$$SGPA = \frac{\sum_{1}^{n} C_i GP_i}{\sum_{1}^{n} C_i}$$

Where C_i = Credit for the course

GP_i= the grade point obtained for the course
n = Number of subjects registered for the semester.

b) Starting from I Year II Semester a Cumulative Grade Point Average (CGPA) will be computed for every student at the end of every semester.

c) The CGPA would give the Cumulative performance of the student from the I Year I semester upto the end of the semester to which it refers and calculated as follows.

$$CGPA = \frac{\sum_1^m S_i C_i}{\sum_1^m C_i}$$

Where m= total number of semesters under consideration
C_i= total number of credits registered for during a particular semester.
S_i= SGPA of the semester.

d) The CGPA, SGPA and the grades obtained in all the subjects in a semester will be communicated to every student at the end of every semester.

e) Both SGPA and CGPA will be rounded off to the second place of decimal and recorded as such. Whenever these grade point averages are to be used for the purpose of determining the inter se merit ranking of a group of students, only the rounded off values will be used.

f) Transition Grades

(a) Grade I: When a student gets I Grade for any subject(s) during a semester, the SGPA of that semester and the CGPA at the end of that semester will be tentatively calculated ignoring this (these) subjects. After these transitional grades have been converted to appropriate grades, the SGPA for the semester and CGPA at the end of the semester will be recalculated after taking into account the new grades.
(b) About Grade F: When a student gets the 'F' grade in any subject during a semester, the SGPA and the CGPA from that semester onwards will be tentatively calculated, taking only 'zero point' for each such 'F' grade. After the 'F' grade has been substituted by better grades during a subsequent semester, the SGPA and CGPA of all the semesters starting from the earliest semester in which the 'F' grade has been updated, will be recomputed and recorded to take this change of grade into account.
(c) About grades R, W and X:When a student gets any of these transitional grades in any subject(s) during a semester, the SGPA of that semester and the CGPA at the end of that semester will be tentatively calculated by taking ‘zero point’ for these subject(s). After these transitional grades have been converted to appropriate grades, the SGPA for the semester and CGPA at the end of the semester will be recalculated after taking into account the new grades.

14. EXAMINATIONS:

14.1 The Institute Scholarship of a student will be withheld in case his/her CGPA at the end of any semester falls below 6.5. However, in the case of students belonging in to SC/ST it is 6.0. However, the scholarship will be restored with retrospective effect, based on recommendation of Head of the Department, the moment the CGPA crosses at least 6.5 (for SC/ST students 6.0).

14.2 A student will be permitted to submit the dissertation only if he/she completes all the courses as required in the program.

14.3 Student with “F” grade is eligible to appear for makeup examination(s) as and when they are conducted by the Institute.

14.4 A student whose performance in the project work has been unsatisfactory may be assigned additional work on the same problem or assigned a new problem. If the student is assigned additional work the student will have to complete the work and appear at the viva-voce as per the academic calendar fixed by the Senate. If the student is assigned a new problem on account of any reason, the student will have to submit the dissertation and complete the viva-voce by December 31 of that calendar year. The student will not be eligible for scholarship during the extended period of his/her stay but will have to pay semester fees during the extended period of stay.

14.5 A student who has failed in the comprehensive viva-voce shall be required to present himself/herself again within a period of two months for the viva-voce on a date to be fixed by the concerned Head of the Department /Centre.

15. THE GRADES 'I' AND 'R'

a) The grade "I" may be temporarily given to a student who is unable to appear in the end semester examination because of:
(a) Illness or accident, which disables the student from appearing in the examination. This must be duly certified by the Institute Medical Officer.
(b) A calamity in the family at the time of the examination which in the opinion of the Head of the Department/Centre and Dean-Student Affairs required the student to be away from the campus.

b) If a student is unable to appear in a mid-semester examination for any of the compelling reasons mentioned above, the teacher(s) concerned may use discretion, and take a test with the same weightage.

15.3 A student who has been awarded grade 'I' in a subject in the end-semester examination shall have to appear the makeup examination as and when conducted.

15.4 A Student who has insufficient attendance in a particular subject shall be awarded grade 'R'. He/she has to re-register for that course in the subsequent semester in which it is offered.

16. MAKEUP EXAMINATION:

a) Students appearing in Makeup examination shall be governed by the following rules:
Students with "F" or "I" Grade only are eligible to write makeup examination.
Students with "R" Grade are not eligible for writing the makeup examination.
A student, who has obtained 'F' grade in makeup examination, may register for the course either for "Study" or for "Examination". (See rule 8.7).

16.2 The schedule for makeup examination is given in the Academic calendar.

16.3 A student can register for makeup examinations in any number of courses.

16.4 Students registering for examination shall be awarded only P grade, if they get 40% or more marks in the end semester/makeup examination.

16.5 Students who have registered under study mode during an academic year and have appeared for makeup examination, will be graded according to the study mode grading applicable to the regular batch of students. In case, they get an 'F' grade as per the above criteria, the students who get 40% or more marks in the make-up examination shall be awarded 'P' grade by treating them as registered under 'Examination' Mode.

17. GRADUATION REQUIREMENTS:

a) In order to qualify for a PG degree of the institute, a student:
   i) Must have completed all the credit requirements for the degree, as prescribed by the senate with grade "P" or a higher grade in each of the subjects for which the student registered in all the semesters.
   ii) Must have obtained a CGPA of at least 5.0 at the end of the semester in which the student completes all the requirements (including the dissertation) for the degree.

b) The degree will be awarded to a qualified student only after
(a) The student has cleared all Institute and Hall/Hostel dues, if any, outstanding against the student and
(b) The student has returned all library books borrowed by him/her and also returned instruments, apparatus issued to him/her in good condition.

c) A student with a CGPA of 8.0 and above, passing all subjects in the first attempt, is considered eligible for the award of First Division with Distinction.

17.4 A student with a CGPA of 6.5 and above but less than 8.0 is considered eligible for the award of First Division.

17.5 A student with a CGPA of 5.0 and above but less than 6.5 is considered eligible for the award of Second Division.

18. CONDUCT AND DISCIPLINE:

Students shall conduct themselves within and outside the precincts of the institute in a manner befitting the students of an Institute of National importance. Detailed rules regarding conduct and discipline are given in Appendix-III.

19. TEMPORARY WITHDRAWAL:

a) A student who has been admitted to M.Tech. program may be permitted to withdraw temporarily for a period of one semester or more from the Institute on account of prolonged illness/acute problem in the family provided that:
b) The student applies to the Institute within 15 days of commencement of the semester or from the last date of attending the classes, stating fully the reasons for such withdrawal together with supporting documents and endorsement of the parent/guardian.
c) The institute is satisfied that, inclusive of the period of withdrawal, the student is likely to complete all the requirements for the degree within 5 years of admission to the Program.
d) There are no outstanding dues or demand from the Institute/Department/Centre/Hall of Residence / Library.
e) A student who has been granted temporary withdrawal will be required to pay tuition fee and other fees for the current semester when the student rejoins the program.
f) A student shall be granted only one such temporary withdrawal during the program.
g) A student, who wishes to join the job, after completion of the entire course work, may be permitted to pursue his dissertation on part-time basis provided:
    i. sufficient facilities are available in the organization where he/she is working
    ii. there is a competent supervisor in the organization
    iii. the minimum period for submission of dissertation work shall be double the amount of the balance period.
    iv. the dissertation of such a part time student shall be under the guidance of two supervisors, one from the organization and the other from the Institute.

20. MALPRACTICES:

Students are not allowed to leave the Examination Hall without submitting the answer script. They will not be permitted to enter the exam hall after 30 minutes of commencement of the exam and to leave the exam hall before 30 minutes of the closure of examination.

The nature of malpractice and the minimum punishment are indicated in the following table:

Sl. No	Nature of the Malpractice	Punishment
1	Taking answer booklets out of the examination hall, used or unused.	Fine of Rs. 1000/- per paper. In case of used answer booklets. In addition to the above, the candidate shall be awarded F Grade in that subject.
2	Verbal or oral communication to neighbouring students even after warning.	Taking away the answer script and asking the student to leave the hall.
3	Possession of any incriminating material inside the examination hall (whether used or not). For example: written or printed materials, bits, writings on scale, calculator, hand kerchief, dress, part of the body and hall Ticket etc., Possession of cell phones, programmable calculator, recording apparatus or any unauthorized electronic equipment. Copying from neighbour Exchange of question papers and other materials with some answers	In case of Mid /Sessional examination, award zero marks. In case of End semester examinations, award 'F' Grade. The candidate may be allowed to write make-up examination.

4	Possession of answer book of another candidate. Giving answer book to another candidate.	The candidate shall be awarded 'F' Grade in that particular subject.
5	Misbehaviour in the examination hall (Unruly conduct, threatening the invigilator, or any other examination officials). Involved in malpractice for the second or subsequent times of serial number 2–4.	Cancellation of all theory examinations registered in that semester and further debarred from continuing his/her studies for one year (two subsequent semesters). However the students are permitted to appear for makeup examinations of the previous semesters.
6	Cases of Impersonation	a) Handing over the impersonator (outsider) to the police with a complaint to take appropriate action. b)Cancelation of all examinations (all papers registered) for the bonafide student for whom the impersonation was done and further the bonafide student will be debarred from continuing his/her studies and writing all examinations for two years. c) If a student of this institute is found to impersonate a bonafide student, the impersonating student will be debarred from continuing his/her studies and writing all examinations for two years.
7	Physical assault causing injury to the invigilator or any examination officials.	Rustication from the Institute.

Any other type of malpractices reported, the enquiry committee may recommend appropriate punishment.

21. Certificate retention Fee: Students shall be charged with Certificate retention fees as per the details shown below:

All students –

- Who have passed in current and previous academic year - No charge.
- Who have passed in the last 2 to 10 academic years - Rs. 1,000
- Who have passed in the last 11 to 20 academic years - Rs. 5,000.
- Who have passed more than 20 academic years back - Rs. 10,000

22. STUDENT APPRAISAL:

It is mandatory for every student to submit the feedback on each and every course, he/she has undergone, at the end of every semester.

23. CHANGE OF REGULATIONS:

Not withstanding all that has been stated above, the Senate, has the right to modify any of the above rules and regulations from time to time. All such modifications shall be documented and numbered sequentially and shall be made available in the Institute website for the information of the students.

ACADEMIC COMMITTEES
FUNCTIONS AND RESPONSIBILITIES

DEPARTMENTAL ACADEMIC COMMITTEE POSTGRADUATE & RESEARCH (DAC -PG&R)

Head of the Department	Chairman
All Professors of the Dept. having Ph. D.	Members
All Associate Prof. of the Dept. having Ph. D.	Members
Two Assistant prof. of the Dept. having Ph. D. (by rotation for two years)	Members

NOTE:
The Head of the department will nominate one of the members as secretary.
There shall be one DAC-PG&R for every department, which is involved in the teaching for any of the PG degree program.

FUNCTIONS:

i. To monitor the conduct of all postgraduate courses and course work of M.Tech program.
ii. To ensure academic standards and excellence of the courses offered by the department.
iii. Review and approval of the grades.
iv. To consolidate the registration of the M.Tech students and communicate to the course instructors and Dean-Academic.
v. To consider any matter related to the postgraduate program(s) of the Department and make a suitable recommendation to the Senate.
vi. To monitor the progress of research of all the candidates of the Department
vii. To forward the recommendations of the Doctoral Scrutiny Committee and the panel of External Examiners as recommended by the DSC to the Dean-Academic.
viii. To take up any responsibility or function assigned by the Senate.

DEPARTMENTAL ACADEMIC APPEALS COMMITTEE (DAAC)

Head of the Department	Chairman	
Three faculty members of the Department	Members	(1 Professor. 1 Associate Prof. and 1 Asst. Professor)
One Professor from outside the Department	Member (Nominated by Dean-Academic)	

NOTE:

- There shall be one DAAC for every department.
- The Chairman may co-opt and / or invite more members.
- If the concerned instructor is a member of DAAC then he/she shall keep himself out of the Committee during deliberations.
- The quorum for each meeting shall be a minimum of THREE (Professor from outside department is mandatory).

FUNCTIONS:

i. To receive grievance /complaints in writing from the students regarding anomaly in award of grades due to bias, victimization, erratic evaluation, etc. and redress the complaints.
ii. To interact with the concerned course instructor and the student separately before taking the decision.
iii. The decision of the DAAC will be based on simple majority
iv. The recommendations of the DAAC shall be communicated to the Dean-Academic for further appropriate action as required.

DEPARTMENTAL BOARD OF STUDIES (PG&R)

1. Head of the Department	Chairman
2. All Professors of the Department	Members
3. All Associate Professors of the Dept.	Members
4. One Professor (Allied Department)	Member
5. Two Experts (One from Industry and one from Academia)	Members

Note:

- All the members must possess Ph. D.
- The Chairman will nominate one of the members as secretary.
- The Chairman may co-opt and / or invite more members including external experts while framing / revising the curriculum.

FUNCTIONS:

i. To develop the curriculum for the postgraduate courses offered by the department and recommend the same to the Senate.

ii. The Board of studies is required to meet at least once in two years.

Academic Audit Committee – Department (AACD)

Director's nominee	Chairman
Head of the Department	Convener
Department nominee	Member

Functions:

- To review the internal audit reports submitted by faculty
- To recommend corrective measures, if any.
- To send a consolidated report to Academic Audit Committee – Institute

Academic Audit Committee – Institute (AACI)

Director	Chairman
Dean – Academic	Member
Two Professors nominated by Director	Members
Associate Dean – Academic Audit	Convener

Functions:

- To review the recommendations of AACD of each department
- To initiate appropriate measures (counseling/ training etc.).

APPENDIX- I
DISSERTATION EVALUATION

Dissertation Evaluation:

The evaluation of the Dissertation work carrying 18 credits, is divided into two modules:

Part-A (at the end of II Year I Semester) 6 Credits
Part-B (at the end of II Year II Semester) 12 Credits

A student has to select a topic for his/her dissertation, based on his/her interest and the available facilities at the commencement of dissertation work. The supervisor will evaluate execution of the dissertation periodically.

The dissertation report shall have to be submitted as per the approved guidelines given in Appendix-IV.

For the purpose of assessment, the performance of a student in the dissertation may be divided into the following sub components:

At the end of II Year I semester (for 6 credits)

Assessment by the supervisor	50%
Assessment by the dissertation assessment committee of the Department	50%

At the end of IV semester (for 12 credits)

Assessment by the supervisor	50%
Assessment by the External Examiner	50%

An external examiner shall conduct the viva-voce Examination. A dissertation assessment committee constituted by the Head of the Department, along with the supervisor shall be involved in the conduct of the viva-voce examination.

APPENDIX-II

RULES RELATING TO RESIDENTIAL REQUIREMENT

1. All the students are normally expected to stay in the hostels and be a boarder of one of the messes.
2. Under special circumstances, the Director/Dean-Academic may permit a student to reside with his parent(s) within a reasonable distance from the institute. However, this permission may be withdrawn at the discretion of the Institute at any time considered appropriate without assigning any reason.
3. Married accommodation shall not be provided to any student of the undergraduate courses.
4. No student shall come into or give up the assigned accommodation in any Hall of residence without prior permission of the Chief Warden.
5. A student shall reside in a room allotted to him/her and may shift to any other only under the direction/permission of the Chief Warden.
6. Students shall be required to make their rooms available whenever required for inspection, repairs, maintenance or disinfecting and shall vacate the rooms when leaving for the vacation/ holidays.
7. Students shall be responsible for the proper care of the furniture; fan and other fittings in the rooms allotted to them and shall generally assist the Warden in ensuring proper use, care and security of those provided in the Halls for common use of all students.
8. Students will be responsible for the safe keeping of their own property. In the event of loss of any personal properly of a student due to theft, fire or any other cause the Institute shall accept no responsibility and shall not be liable for payment of any compensation.
9. Engaging personal attendants, keeping pets and use of appliances like electric heater, refrigerator, etc. by a student in Halls of Residence are prohibited.
10. All students must abide by the rules and regulations of the Halls of Residence as may be framed from time to time.
11. **It is mandatory for all ICCR students to stay in the Hostels.**

APPENDIX-III
STUDENTS' CONDUCT AND DISCIPLINARY CODE

It is the responsibility and duty of each and every student of the Institute to become acquainted with "Students Conduct and Disciplinary Code". It is presumed that every student from the date of his/her admission to the Institute has knowledge of this code. All students are required to strictly adhere to this code as a condition of their admission to the Institute and these rules would be binding on and enforceable against them or any one among them.

Section 1: Responsibilities of the Students

It shall be the responsibility of the students

a) To behave and conduct themselves in the Institute campus, hostels and premises in a dignified and courteous manner and show due respect to the authorities, employees and elders.
ii) To follow decent and formal dressing manners. Students should avoid clothing depicting illegal drugs, alcohol, prophane language, racial, sexual and vulgar captions etc.
iii) To access all educational opportunities and benefits available at the Institute and make good use of them to prosper academically and develop scientific temper.
iv) To respect the laws of the country, human rights and to conduct in a responsible and dignified manner at all times.
v) To report any violation of this Code to the functionaries under this Code.

Section 2: Behaviour of the Students

1. Groupism of any kind that would distort the harmony is not permitted.
2. Students are expected to spend their free time in the Library. They shall not loiter along the verandas or crowd in front of the offices or the campus roads. Students should refrain from sitting on places such as parapets, stairs, footpaths etc.
3. Possession or consumption of narcotic drugs and other intoxicating substances are strictly prohibited in the campus and hostels.
4. Silence shall be maintained in the premises of the Institute.
5. Students are not permitted to use mobile phones in the class room, library, computer centre, examination halls, etc.
6. **Students shall refrain from all activities considered as ragging which is a criminal offence.**
7. Students are prohibited from indulging in anti-institutional, anti-national, antisocial, communal, immoral or political expressions and activities within the campus and hostels.
8. Politically based students' and other organizations or outfits are not allowed in the campus. Students are strictly prohibited from organizing, attending or participating in any activity or agitation sponsored by politically based organizations.
9. Students shall not deface, disfigure, damage or destroy or cause any loss in any manner to all the public, private or Institute properties.
10. Without specific permission of the authorities, students shall not bring outsiders to the Institute or hostels.
11. No one shall bring, distribute or circulate unauthorized notices, pamphlets, leaflets etc within the campus or hostels. The possession, distribution or exhibition of any item by any means which is *per se* obscene is prohibited within the campus or on any property owned/ managed by the Institute.
12. No student shall collect money either by request or by coercion from others within the campus or hostels.
13. The Institute being a place of learning and an exclusive academic zone, nobody shall respond to any call for any form of strike, procession or agitation including slogan shouting, *dharna, gherao,* burning of effigy or indulge in anything which may harm the peaceful atmosphere of the Institution and shall eschew from violence in the campus and hostels and even out side.
14. Possession or usage of weapons, explosives or anything that causes injury/ damage to the life and limb or body of any human being or property is prohibited.
15. **Use of motorized vehicles within the Institute premises is strictly prohibited.**
16. Students shall only use the waste bins for dispensing waste materials within the campus including classrooms, hostels, offices, canteen and messes.
17. Any conduct which leads to lowering of the esteem of the Institute is prohibited.

18. **Any unauthorized tour/visit by individual or group of students shall be treated as a serious conduct violation and all such students will be imposed disciplinary penalties.**

Section 3: Disciplinary Sanctions

Any student exhibiting prohibited behaviour mentioned in this Code shall, depending upon the gravity of the misconduct or depending on its recurrence, be subjected to any of the following disciplinary sanctions. Any student who is persistently insubordinate, who is repeatedly or wilfully mischievous, who is guilty of fraud, in the opinion of the competent authority, is likely to have an unwholesome influence on his/ her fellow students, will be removed from the rolls.

I. Minor Sanctions

i. Warning or Reprimand: This is the least sanction envisaged in this Code. The student engaged in any prohibited behaviour will be issued a warning letter.
ii. Tendering Apology: The student engaged in any prohibited behaviour may be asked to tender an apology for his/her act and undertaking that he/she shall not indulge in such or any of the prohibited behaviour in future.

II. Major Sanctions

i. Debarring from Examinations: A student/group of students may be debarred from writing all/any/some of the examinations, which forms part of the academic program for which he/she/they has/ have joined.
ii. Suspension: A student may be suspended from the Institute for violation of any of the provisions of this Code. The period of suspension and conditions, if any, shall be clearly indicated in the communication addressed to the student. The student shall lose his/her attendance for the suspended period.
iii. Restitution: Restitution implies reimbursement in terms of money and/or services to compensate for personal injury or loss, damage/disfiguration to property of the Institute or any property kept in the premises of the Institute in any manner. The students/group of students may be asked to compensate for the loss that has been caused to any person or property of the Institute or any property kept in the premises of the Institute due to the act of vandalism perpetrated by the students. The students/group of students shall also be liable to put in their service to restore any loss or damage caused to any property and thereby bringing it to its original form if it is possible.
iv. Forfeiture: Caution deposit of any student engaged in any prohibited behaviour shall be forfeited.
v. Expulsion: This is the extreme form of disciplinary action and shall be resorted to only in cases where stringent action is warranted. Expulsion is the permanent dismissal of a student from the Institute. Such a student will not be eligible for readmission to any of the courses of this Institute.

Section 4: Functionaries under the Code

i) Heads of the Departments/ Faculty Advisors/Chief Warden/ Wardens of Hostels: As the persons in charge of the Departments/Hostels, the respective functionaries of all Teaching Departments and Hostels shall have the power and duty to take immediate action to curb any prohibitory behaviour as envisaged under this code. As these functionaries cannot single handedly manage all the issues, they can assign part of the work to the teachers and the teachers of all the departments/wardens have the responsibility to inform any incident of prohibited behaviour to the Heads of the Departments/ Chief Warden so that any serious issue can be settled before the same goes out of control. The Head of the Departments/ Chief Warden shall have the power to impose minor sanctions as envisaged under section 3(I) of this Code.

They can also recommend imposition of major sanctions as envisaged under Section 3(II) of this Code to the Director. The Head of the Departments/ Faculty Advisors/Chief Warden/ Wardens of Hostels while taking any action as envisaged in the code shall do so in an impartial manner and see to it that the sanction imposed/proposed is commensurate with the gravity of the prohibited behaviour. Any lapse on the part of a teacher/ Warden to report any instance of violence and misconduct on the part of the students shall be reported to the Director by the respective Head of the Departments/Chief Warden. The Wardens of Hostels shall be responsible for maintaining strict discipline and decorum in the hostel. He/she shall

specifically see to it that the inmates of the hostel do not involve themselves in violation of any clause under Section 2 of this Code.

ii) Deans

Any authority of the Institute with delegated powers shall have the power to visit/inspect any premises, buildings or any property of the Institute when there is a genuine doubt that any act of prohibited behaviour is taking place and can take any lawful actions to curb such behaviour. The HODs/ Faculty Advisors/Chief Warden/ Wardens of Hostels shall report to the Dean (Students) any instances of prohibited behaviour, who in turn shall bring it to the notice of the Director. The Dean (Students) shall forward the recommendations from the HODs/ Chief Warden to impose a major sanction under Section 3(II) of this Code to the Director after noting his observations. The Dean (Students) can also *suo moto* recommend action against any student/students indulging in prohibited behaviour which is brought to his/ her notice.

iii) Director

The Director shall be the ultimate authority in imposing major sanctions as envisaged under Section 3(II) against the students for acts of prohibited behaviour. The Director can also entertain any appeal from any student/students aggrieved by the action of any authority of the Institute under or subordinate to the Director and decide the case on merit.

Section 5: Right to Appeal

The student/students aggrieved by the action of any authority of the Institute under or subordinate to the Director can appeal to the Director and any student aggrieved by the action of the Director can appeal to the Senate. The decision of the Senate shall be final and binding on the students.

Section 6: Assistance from Law Enforcement Agencies

The Deans/ HoDs/ Chief Warden shall have the power and duty to call the Police immediately with the concurrence of the Director when there is a threat of Law and Order situation in the Campus and also when there is a genuine apprehension that any incident of rioting, vandalism or any other act prohibited by law is likely to take place. The Deans/ HoDs/ Chief Warden shall in such a case give a detailed report to the Director. The Director/ Deans/ HoDs/ Chief Warden can also arrange for video recording of the entire situation and take requisite actions through police and other concerned authorities.

Section 7: Grievance Redressal Committee

The Institute will also set up “Grievance Redressal Committee” where the students can air their grievances. The Committee shall consist of the Deans/ HoDs/ Chief Warden and also members of the Parent-Teacher Association. Till these committees are constituted, *ad-hoc* committees shall be formed by the Director.

Section 8: Undertaking by the Students

The students joining any academic program of the Institute will have to give an undertaking to the effect that he/she will comply with the provisions envisaged in this Code in letter and spirit and even if it is not given them as well, will be bound by the provisions of this Code.

Section 9: Opportunity for Hearing

No order other than the order suspending or warning a student shall be passed without giving an opportunity of hearing to the Student/ Students.

Section 10: Ultimate Authority

For all disciplinary matters related to students, the Director shall be the ultimate authority as provided herein.

Section 11: Amendments to the Code

The Senate of the Institute shall have the power to amend any of the provisions in this Code. The amendments shall be brought to the notice of the students and faculty of the Institute through notice put on the Institute web site, notice boards of the Institute or through emails.

APPENDIX-IV
GUIDELINES FOR PREPARATION OF DISSERTATION REPORTS

Preamble

While utmost attention must be paid to the content of the dissertation report, which is being submitted in partial fulfilment of the requirements of the M.Tech degree, it is imperative that a standard format be prescribed. The same format shall also be followed in preparation of the final soft copies to be submitted to the Library in future.

1. Organisation of the Dissertation

The dissertation report shall be presented in a number of chapters, starting with Introduction and ending with Summary and Conclusions. Each of the other chapters will have a precise title reflecting the contents of the chapter. A chapter can be subdivided into sections, subsections and sub-subsection so as to present the content discretely and with due emphasis. When the work comprises two or more mutually independent investigations, the dissertation report may be divided into two or more parts, each with an appropriate title. However, the numbering of chapters will be continuous right through, for example Part 1 may comprise Chapters 2 - 5, Part 2, Chapters 6 - 9.

1.1 Introduction

The title of Chapter 1 shall be Introduction. It shall justify and highlight the problem posed, define the topic and explain the aim and scope of the work presented in the dissertation report. It may also highlight the significant contributions from the investigation.

1.2 Review of Literature

This shall normally form Chapter 2 and shall present a critical appraisal of the previous work published in the literature pertaining to the topic of the investigation. The extent and emphasis of the chapter shall depend on the nature of the investigation.

1.3 Report on the present investigation

The reporting on the investigation shall be presented in one or more chapters with appropriate chapter titles. Due importance shall be given to experimental setups, procedures adopted, techniques developed, methodologies developed and adopted. While important derivations/formulae should normally be presented in the text of these chapters, extensive and long treatments, copious details and tedious information, detailed results in tabular and graphical forms may be presented in Appendices. Representative data in table and figures may, however, be included in appropriate chapters. Figures and tables should be presented immediately following their first mention in the text. Short tables and figures (say, less than half the writing area of the page) should be presented within the text, while large table and figures may be presented on separate pages. Equations should form separate lines with appropriate paragraph separation above and below the equation line, with equation numbers flushed to the right.

1.4 Results and Discussion

This shall form the penultimate chapter of the dissertation report and shall include a thorough evaluation of the investigation carried out and bring out the contributions from the study. The discussion shall logically lead to inferences and conclusions as well as scope for possible further future work.

1.5 Summary and Conclusions

This will be the final chapter of the dissertation report. A brief report of the work carried out shall form the first part of the Chapter. Conclusions derived from the logical analysis presented in the Results and Discussions Chapter shall be presented and clearly numerated, each point stated separately. Scope for future work should be stated lucidly in the last part of the chapter.

1.6 Appendix

Detailed information, lengthy derivations, raw experimental observations etc. are to be presented in separate appendices, which shall be numbered in Roman Capitals (e.g.

“Appendix IV”). Since reference can be drawn to published/unpublished literature in the appendices these should precede the “Literature Cited” section.

1.7 Literature Cited

This should follow the Appendices, if any, otherwise the Summary and Conclusions chapter. The candidates shall follow the style of citation and style of listing in one of the standard journals in the subject area consistently throughout his/her report, for example, IEEE in the Department of Electrical Engineering, Materials Transactions in Department of Metallurgical Engineering and Materials Science. However, the names of all the authors along with their initials and the full title of the article/monogram/book etc. have to be given in addition to the journals/publishers, volume, number, pages(s) and year of publication. Citation from websites should include the names(s) of author(s) (including the initials), full title of the article, website reference and when last accessed. Reference to personal communications, similarly, shall include the author, title of the communication (if any) and date of receipt.

1.8 Publications by the candidate

Articles, technical notes etc. on the topic of the dissertation report published by the candidate may be separately listed after the literature cited. This may also be included in the contents. The candidates may also include reprints of his/her publications after the literature citation.

1.9 Acknowledgements

The acknowledgments by the candidate shall follow the citation of literature, signed by him/her, with date.

2. DISSERTATION FORMAT

2.1 Paper

2.1.1 Quality: The dissertation report shall be printed / photo copied on white bond paper, whiteness 95% or above, weight 70 gram or more per square meter.

2.1.2 Size: The size of the paper shall be standard A4; height 297 mm, width 210 mm.

2.1.3 Type Setting,Text Processing and Printing: The text shall be printed employing Laserjet or Inkjet printer, the text having been processed using a standard text processor. The standard font shall be Times New Roman of 12 pts with 1.5 line spacing.

2.1.4 Page Format: The Printed Sheets shall have the following written area and margins:

Top Margin 15 mm
Head Height 3 mm
Head Separation 12 mm
Bottom Margin 22 mm
Footer 3 mm
Foot Separation 10 mm
Text Height 245 mm
Text Width 160 mm
When header is not used the top margin shall be 30 mm.

Left and Right Margins

Single sided
Left Margin 30mm
Right Margin 20 mm

2.1.5 Pagination: Page numbering in the text of the report shall be Hindu Arabic numerals at the centre of the footer. But when the candidate opts for header style the page number shall appear at the right and left top corner for the odd and even number pages, respectively. Page number “1” for the first page of the Introduction chapter shall not appear in print, only the second page will bear the number “2”. The subsequent chapters shall begin on a fresh page. When header style is chosen the first page of each chapter will not have the header and the page number shall be printed at the centre of the footer. Pagination for pages before the Introduction chapter shall be in lower case Roman numerals, e.g., “iv”.

2.1.6 Header: When the header style is chosen, the header can have the Chapter number and Section number (e.g., Chapter 2, Section 3) on even numbered page headers and Chapter title or Section title on the odd numbered page header.

2.1.7 Paragraph format: Vertical space between paragraphs shall be about 2.5 line spacing. The first line of each paragraph should normally be indented by five characters or 12mm. A candidate may, however, choose not to indent if he/she has provided sufficient paragraph separation. A paragraph should normally comprise more than one line. A single line of a paragraph shall not be left at the top or bottom of a page (that is, no windows or orphans should be left). The word at the right end of the first line of a page or paragraph should, as far as possible, not be hyphenated.

2.2 Chapter and Section Format

2.2.1 Chapter: Each chapter shall begin on a fresh page with an additional top margin of about 75mm. Chapter number (in Hindu-Arabic) and title shall be printed at the centre of the line in 6mm font size (18pt) in bold face using both upper and lower case (all capitals or small capitals shall not be used). A vertical gap of about 25mm shall be left between the Chapter number and Chapter title lines and between chapter title line and the first paragraph.

2.2.2 Sections and Subsections: A chapter can be divided into Sections, Subsections and Sub-sub Sections so as to present different concepts separately. Sections and subsections can be numbered using decimal points, e.g. 2.2 for the second section in Chapter 2 and 2.3.4 for the fourth Subsection in third Section of Chapter 2. Chapters, Sections and Subsections shall be included in the contents with page numbers flushed to the right. Further subsections need not be numbered or included in the contents. The Section and Sub-Section titles along with their numbers in 5 and 4mm (16 and 14 pt) fonts, respectively, in bold face shall be flushed to the left (not centred) with 15 mm space above and below these lines. In further subdivisions character size of 3 and 3.5 with bold face, small caps, all caps and italics may be used for the titles flushed left or centred. These shall not feature in the contents.

2.2.3 Table / Figure Format: As far as possible, tables and figures should be presented in portrait style. Small size table and figures (less than half of writing area of a page) should be incorporated within the text, while larger ones may be presented on separate pages. Table and figures shall be numbered chapter wise.

For example, the fourth figure in chapter 5 will bear the number Figure 5.4 or Fig 5.4 Table number and title will be placed above the table while the figure number and caption will be located below the figure. Reference for Table and Figures reproduced from elsewhere shall be cited in the last and separate line in the table and figure caption, e.g. (after McGregor[12]).

3 Auxiliary Format

3.1 Binding: The evaluation copies of the dissertation report may be spiral bound or soft bound. The final hard bound copies to be submitted after the viva-voce examination will be accepted during the submission of dissertation report with the following colour specification:

M.Tech. Dissertation (Gray)

3.2 Front Covers: The front covers shall contain the following details:

Full title of report in 6 mm 22 point's size font properly centred and positioned at the top. Full name of the candidate in 4.5 mm 15 point's size font properly centred at the middle of the page. A 40 mm dia replica of the Institute emblem followed by the name of department, name of the Institute and the year of submission, each in a separate line and properly centred and located at the bottom of page.

3.2.1 Lettering: All lettering shall be embossed in gold.

3.2.2 Bound back: The degree, the name of the candidate and the year of submission shall also be embossed on the bound (side) in gold.

3.3 Blank Sheets: In addition to the white sheets (binding requirement) two white sheets shall be put at the beginning and the end of the report.

3.4 Title Sheet: This shall be the first printed page of the Dissertation and shall contain the submission statement: the Dissertation Report submitted in partial fulfilment of the requirements of the M.Tech Degree, the name and Roll No. of the candidate, name(s)

of the Supervisor and Co-supervisor(s) (if any), Department, Institute and year of submission.

Sample copy of the 'Title Sheet' is appended (Specimen 'A').

3.5 Dedication Sheet: If the candidate so desires(s), he/she may dedicate his/her report, which statement shall follow the title page. If included, this shall form the page 1 of the auxiliary sheets but shall not have a page number.

3.6 Approval Sheet: In the absence of a dedication sheet this will form the first page and in that case shall not have a page number. Otherwise, this will bear the number two in Roman lower case “ii” at the centre of the footer. The top line shall be:

Dissertation Approval for M.Tech

A sample copy of the Approval Sheet is appended (Specimen `B')

3.7 Abstract: The 500 word abstract shall highlight the important features of the dissertation report and shall correspond to the electronic version to be submitted to the Library for inclusion in the website. The Abstract in the report, however, shall have two more parts, namely, the layout of the report giving a brief chapter wise description of the work and the key words.

3.8 Contents: The contents shall follow the Abstract and shall enlist the titles of the chapters, section and subsection using decimal notation, as in the text, with corresponding page number against them, flushed to the right.

3.8.1 List of Figures and Tables: Two separate lists of Figure captions and Table titles along with their numbers and corresponding page numbers against them shall follow the Contents.

3.9 Abbreviation Notation and Nomenclature: A complete and comprehensive list of all abbreviations, notations and nomenclature including Greek alphabets with subscripts and superscripts shall be provided after the list of tables and figures. As far as possible, generally accepted symbols and notation should be used.

Auxiliary page from dedication (if any) to abbreviations shall be numbered using Roman numerals in lower case, while the text starting from the Introduction shall be in Hindu Arabic.

The first pages in the both the cases shall not bear a page number.

3.10 A Declaration of Academic Honesty and Integrity: A declaration of Academic honesty and integrity is required to be included along with every dissertation report after the approval sheet. The format of this declaration is given in Specimen ‘C' attached.

****

Specimen 'A': Title Sheet

(Title)

Submitted in partial fulfilment of the requirements

of the degree of

(Master of Technology)

by

(Name of the Student)

(Roll No._____)

Supervisor (s):

_____

_____

_____

(Name of the Department)

NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL

(Year)

Specimen `B': Approval Sheet
This dissertation entitled (Title) by (Author Name) is approved for the degree of _____ (Degree details).

Examiners

_____
_____
_____
Supervisor (s)

_____
_____
_____
Chairman

_____
Date :_____
Place :_____

Specimen `C' – Declaration

I declare that this written submission represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

_____
(Signature)

_____
(Name of the student)

_____
(Roll No.)
Date: _____

Specimen `D' – Certificate

This is to certify that the dissertation work entitled " *name of the dissertation* " is a bonafide record of work carried out by "*Mr/Ms name of the student with Roll No.*", submitted to the faculty of "*name of the department* ", in partial fulfilment of the requirements for the award of the degree of Master of Technology in "*name of the program*" at National Institute of Technology, Warangal during the academic year ----------.

Name of the HOD	Name of the Supervisor
Head of the Department	Designation
Department of ----------	Department of ------
NIT Warangal	NIT Waranga

Graduate Attributes (GAs):

1. **Scholarship of Knowledge**: Acquire in-depth knowledge of specific discipline or professional area, including wider and global perspective, with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge, and integration of the same for enhancement of knowledge.

2. **Critical Thinking**: Analyze complex engineering problems critically, apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.

3. **Problem Solving**: Think laterally and originally, conceptualize and solve engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.

4. **Research Skill**: Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering.

5. **Usage of modern tools**: Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of the limitations.

6. **Collaborative and Multidisciplinary work**: Possess knowledge and understanding of group dynamics, recognize opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.

7. **Project Management and Finance**: Demonstrate knowledge and understanding of engineering and management principles and apply the same to one's own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economical and financial factors.

8. **Communication**: Communicate with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.

9. **Life-long Learning**: Recognize the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.

10. **Ethical Practices and Social Responsibility**: Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.

11. **Independent and Reflective Learning**: Observe and examine critically the outcomes of one's actions and make corrective measures subsequently, and learn from mistakes without depending on external feedback.

DEPARTMENT OF METALLURGICAL & MATERIALS ENGINEERING MASTER OF TECHNOLOGY IN MATERIALS TECHNOLOGY

PROGRAM EDUCATIONAL OBJECTIVES

PEO1.	Evaluate the performance of material systems using the relationship between structure, properties and processing.
PEO2.	Characterize materials and carry out research on advanced materials.
PEO3.	Design and develop effective and eco-friendly materials for generic and strategic applications.
PEO4.	Pursue life-long learning by enhancing knowledge and skills for professional advancement.

Mapping of Mission statements with program educational objectives

Mission Statement	PEO1	PEO2	PEO3	PEO4
MS1		√	√	
MS2	√	√		√
MS3	√	√	√	
MS4				√

Mapping of program educational objectives with graduate attributes

PEO	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11
PEO1	√	√	√	√		√			√		
PEO2	√	√	√		√		√				√
PEO3	√	√	√		√					√	
PEO4			√	√	√	√	√	√	√	√	√

PROGRAM OUTCOMES: At the end of the program the student will be able to:

PO1	Apply phase transformation phenomena to improve the performance of materials.
PO2	Apply principles of deformation to modify structure and properties of materials.
PO3	Characterize and evaluate materials for specific applications.
PO4	Design metallurgical processes to produce products as per specifications.
PO5	Evaluate products using non-destructive testing methods and modify processes.
PO6	Identify mechanisms for protecting engineering materials from degradation.
PO7	Synthesize ceramic, polymer, composite and non-ferrous materials.
PO8	Design advanced materials for aerospace, biological, nuclear and high temperature applications.
PO9	Apply project management techniques effectively to address issues related to metallurgical industries.
PO10	Practice professional ethics and engage in lifelong learning for improved professional advancement, moral and human values.

Mapping of program outcomes with program educational objectives

PO	PEO1	PEO2	PEO3	PEO4
1		3	2	
2		3	2	
3	3	1	1	
4		2	2	1
5	3	2	1	1
6		2	2	
7		1	3	1
8	1	2	2	2
9	1	1	1	3
10	1	1	1	3

1: Slightly 2: Moderately 3: Substantially

SCHEME OF INSTRUCTION

M. Tech. (MATERIALS TECHNOLOGY) Course Structure

I - Year I - Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	MM5101	Thermodynamics of Materials & Kinetics	4	0	0	4	PCC
2	MM5102	Materials Processing	4	0	0	4	PCC
3	MM5201	Mechanical Behaviour of Materials	4	0	0	4	PCC
4		Elective - I	3	0	0	3	DEC
5		Elective - II	3	0	0	3	DEC
6		Elective - III	3	0	0	3	DEC
7	MM5104	Materials Processing and Microstructural Evolution Laboratory	0	0	3	2	PCC
8	MM5105	Materials Testing and Evaluation Laboratory	0	0	3	2	PCC
9	MM5291	Seminar-I	0	0	3	1	PCC
		Total	21	0	9	26	

I - Year II - Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	MM5251	Phase Transformations in Materials	4	0	0	4	PCC
2	MM5252	Materials Characterization Techniques	4	0	0	4	PCC
3	MM5253	Nano Science and Technology	4	0	0	4	PCC
4		Elective - IV	3	0	0	3	DEC
5		Elective - V	3	0	0	3	DEC
6		Elective - VI	3	0	0	3	DEC
7	MM5254	Materials Characterization Laboratory	0	0	3	2	PCC
8	MM5155	Powder Processing Laboratory	0	0	3	2	PCC
9	MM5292	Seminar-II	0	0	3	1	PCC
		Total	21	0	9	26	

II - Year I - Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	MM6249	Dissertation Part-A				6	PCC
2	MM6242	Comprehensive Viva Voce				2	PCC
		Total				8	

II - Year II - Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	MM6299	Dissertation Part-B				12	PCC
		Total				12	

List of Electives

I Semester:

1. MM5111 Introduction to Materials (Mandatory for non Metallurgists)
2. MM5112 Environmental Degradation of Materials
3. MM5113 Energy Conservation and Pollution Control in Metallurgical Industries
4. MM5115 Rare and Reactive Metal Extraction
5. MM5116 Ceramics, Polymers and Composite Technology
6. MM5117 Biomaterials
7. MM5118 Advanced Non Ferrous Metal Extraction
8. MM5120 Special Steels
9. MM5121 Surface Engineering
10. MM5211 Additive Manufacturing
11. MM5212 Aerospace Materials
12. MM5213 Functional Materials
13. MM5214 Energy Materials

II Semester:

1. MM5161 Computer Applications in Materials Engineering
2. MM5163 Non Destructive Testing
3. MM5167 Failure Analysis
4. MM5171 Nuclear Materials
5. MM5261 Powder Processing Technology
6. MM5262 High Temperature Materials
7. MM5263 Smart Materials
8. MM5264 Electronic Materials
9. MM5265 Dislocation Theory
10. MM5266 Strengthening Mechanisms
11. MM5267 Experimental Techniques and Analysis
12. MM5268 Light Metals and Alloys

Credit Requirements

Category of Course	Credits required	Credits offered
Program Core Courses (PCC)	36	36
Departmental Elective Courses (DEC)	18	21
Dissertation (PCC)	18	18
Total	72	75

MM 5101	Thermodynamics of Materials & Kinetics	PCC	4 – 0 – 0	4 Credits

Pre-requisites: None

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

CO1	Understand terminologies, concepts and relationships governing the laws of thermodynamics
CO2	Calculate heat, work requirement and their conversions to each other for metallurgical processes
CO3	Evaluate metallurgical phenomena using concepts of thermodynamics
CO4	Design of alloy systems by applying the concepts of thermodynamics.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2									
CO2	2									
CO3	2									
CO4	2							2		

1: Slightly 2: Moderately 3: Substantially

Syllabus:

Thermodynamic foundations-Thermodynamic systems, variables, processes and equilibrium; First, second and third laws of thermodynamics; Statistical interpretation of entropy; Free energy functions and criteria for equilibrium; Thermodynamic relations among variables; Concept of chemical potential; Partial molal properties; Thermodynamics of solutions-Ideal and non-ideal solutions; Quasi-chemical model and regular solutions; Excess Gibbs energy of mixing for binary and higher order solutions; Multi-component dilute solutions and interaction parameters; Chemical reaction equilibrium, equilibrium constant and applications to materials and metallurgical systems; Phase rule and binary phase diagrams; Free energy composition diagrams; Phase equilibrium calculations; Introduction to ternary phase diagrams; Electrochemical systems, cell reactions and EMF, Formation of galvanic and concentration cells; Thermodynamics of surfaces and interfaces; Surface tension and surface energy; Absorption and adsorption; Gibbs Thompson effect; Reacting systems, gas phase reactions, Ellingham diagrams, Pourbaix diagrams.

Chemical Kinetics. Effect of temperature on reaction rate, Energy of activation, Order and rate of reactions. Homogeneous reactions. Heterogeneous reactions.

Reading:

1. C.H.P. Lupis: Chemical Thermodynamics of Materials, North-Holland, 1983.
2. Svein Stølen, Tor Grande, Neil L. Allan: Chemical Thermodynamics of Materials - Macroscopic and Microscopic Aspects, John Wiley & Sons Ltd., 2004.
3. D.R. Gaskell: Introduction to the Thermodynamics of Materials, 5th Ed, CRC Press, 2008.
4. R.A. Swalin: Thermodynamics of Solids, 2nd Ed., Wiley-VCH, 1972.
5. L.S. Darken and R.W. Gurry : Physical Chemistry of Metals, McGraw-Hill, 1953.
6. J.M. Smith: Chemical Engineering Kinetics, 3rd Ed., McGraw-Hill, 1981.
7. R.W. Balluffi, S.M. Allen and W.C. Carter: Kinetics of Materials, John Wiley & Sons, 2003.
8. N.A. Gokcen, R. G. Reddy: Thermodynamics, 2nd Ed, Springer, 1996.
9. J. Mackowiak: Physical Chemistry for Metallurgists, Pitman Press, 1967.
10. M.L. Kapoor: Chemical and Metallurgical Thermodynamics, Vols 1-2, Nemchand & Bros, 1984.
11. A. Ghosh: Text Book of Materials and Metallurgical Thermodynamics, Prentice Hall, 2003.
12. Y. K. Rao: Stoichiometry and Thermodynamics of Metallurgical Processes, CUP, 1985.
13. J. J. Moore: Chemical Metallurgy, Butterworth- Heinemann, 1994.
14. G. S. Upadhyaya, R. K Dube: Problems in Metallurgical Thermodynamics and Kinetics, Pergamon, 1982.

MM 5102	Materials Processing	PCC	4 – 0 – 0	4 Credits

Pre-requisites: None

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

CO1	Understand the basics of Microstructural aspects with the different processing of materials.
CO2	Understand the importance of structure-property correlation study of materials and its suitable applications.
CO3	Evaluate nucleation and growth kinetics of materials
CO4	Microstructural changes in different Heat Treatment processes
CO5	Development of special properties through Age Hardening, Thermo Mechanical treatment, Surface Hardening and Laser Treatment

Mapping of course outcomes with program outcomes

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

1: Slightly 2: Moderately 3: Substantially

Syllabus:

Introduction to Materials, Basic Properties of Materials and its Application, Concept of Materials Processing Techniques and Microstructural changes, Macrostructure-Microstructure, Grain formation, Solidification of Materials – Nucleation & Growth, Effect of variables on Microstructure, Different Structures, Microstructure of Die casted Components, Microstructural changes in different Metal working processes and joining, Thermo Mechanical Treatment (TMT), Structure-property Correlation Study of different Steels, Stainless Steel, Al/ Mg Alloys etc. Residual stress effect of Materials, Microstructural effect on Corrosion Property, Different Heat Treatments Processes, Concept of TTT/CCT Plots, Surface Hardening, Age hardening, Microstructure of Laser treated Materials.

Reading:

1. Chester T. Sims, Williams C. Hagel: The Super Alloys, John Wiley & Sons, 1992.
2. V. Raghavan: Materials Science and Engineering, PHI, New Delhi, 2004.
3. A. Upadhyaya, G S Upadhyaya: Materials Science and Engineering, Viva Books Pvt. Ltd, New Delhi, 2010.
4. R. Balasubramaniam (Adapted): Callister's Materials Science and Engineering, 7th Edition, Wiley India (P) Ltd., 2007.

MM 5201	Mechanical Behaviour of Materials	PCC	4 – 0 – 0	4 Credits

Pre-requisites: None

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

CO1	Interpret the relationship between structure of a material and its mechanical properties.
CO2	Apply the knowledge of plastic deformation of metals to design efficient metal working and performance of materials.
CO3	Apply the fracture mechanics principles to determine the fracture toughness of brittle and ductile materials.
CO4	Apply the knowledge of fatigue, creep and superplasticity phenomena to design processes for improved microstructure and properties.

Mapping of course outcomes with program outcomes

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

1: Slightly 2: Moderately 3: Substantially

Syllabus:

Crystal structures, elastic properties of materials, theoretical cohesive strength, plastic deformation of metals, Bauschinger effect, flow, yield and failure criteria, dislocations, stress field, energy, sources and motion, effect of temperature and strain rate, strengthening mechanisms, concepts of fracture mechanics, strain energy release rate, Griffith theory, KIC, CTOD, J integral, plastic zone, Fatigue, S-N Curve, fatigue mechanism, creep, creep mechanisms and super plasticity.

Reading:

1. R.W. Hertzberg: Deformation and Fracture Mechanics of Engineering Materials, 4th Ed., John Wiley & Sons, 1995.
2. M.A. Meyers, K.K. Chawla: Mechanical Behavior of Materials, Prentice Hall, 1999.
3. T.L. Anderson: Fracture Mechanics- Fundamentals and Applications, 3rd Ed., CRC Press, 2011.
4. G. E. Dieter: Mechanical Metallurgy, McGraw-Hill, 2002.

MM 5251	Phase Transformations in Materials	PCC	4 – 0 – 0	4 Credits

Pre-requisites: None

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

CO1	Apply thermodynamic principles to determine the phase diagrams of materials
CO2	Apply thediffusion kinetic principles for phase transformation in metals and alloys.
CO3	Analyze and interpret pearlitic, bainitic, martensitic, stress-induced, massive transformations in materials.
CO4	Apply knowledge of phase transformations to develop new materials.

Mapping of course outcomes with program outcomes

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

1: Slightly 2: Moderately 3: Substantially

Syllabus:

Introduction to thermodynamics and kinetics, basic crystallography, phase equilibria, phase diagrams, thermodynamics of transformations, free- energy vs composition curves in relation to phase diagrams, theory of nucleation and growth kinetics, diffusion in metals and materials, Pearlitic, bainitic, martensitic and massive transformations, spinoidal decomposition, precipitation phenomena, phase transformations in thin films, ceramics and glasses, shape memory effect, stress induced phase transformations.

Reading:

1. A. K. Jena, M.C. Chaturvedi: Phase Transformations in Materials, Prentice Hall, 1992.
2. D.A. Porter, K.E. Easterling: Phase Transformations in Metals and Alloys, Van Nostrand Reinhold (International), 1989.
3. P.G. Shewmon: Transformations in Metals, McGraw Hill Book Company, 1980.
4. S.P. Gupta: Solid State Phase Transformations, Allied Publishers, New Delhi, 2004.

MM 5252	Materials Characterization Techniques	PCC	4 – 0 – 0	4 Credits

Pre-requisites: None

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

CO1	Interpret various materials characterization techniques.
CO2	Understand the principle and operation of characterization equipments and the adjustment of operation variables to obtain good images / results
CO3	Select the characterization tool for specific application
CO4	Compare the principle and operation of different characterization tools such as optical microscope, Scanning electron microscopes and transmission electron microscope
CO5	Analyze the characterization results by various equipment

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1		3								
CO2	2	3								
CO3	2	3								
CO4		3								
CO5	2	3	2							

1: Slightly 2: Moderately 3: Substantially

Syllabus:

Optical Microscopy - Introduction, Optical principles, Instrumentation, Specimen preparation-metallographic principles, 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; Scanning Electron Microscopy (SEM) - Introduction, Instrumentation, Contrast formation, Operational variables, Specimen preparation, imaging modes, Applications, Limitations; X- Ray Diffraction (XRD) - Introduction, Basic principles of diffraction, X - ray generation, Instrumentation, Types of analysis, Data collection for analysis, Applications, Limitations; Scanning Probe Microscopy (SPM) & Atomic Force Microscopy (AFM) - Introduction, Instrumentation, Scanning Tunneling Microscopy-Basics, probe tips, working environment, operational modes, Applications, Limitations; Electron Probe Micro Analyzer (EPMA) - Introduction, Sample preparation, Working procedure, Applications, Limitations; 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; Thermal Analysis - 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.

Reading:

1. ASM Metals Handbook, Vol 3: Materials Characterization, ASM International, 2008.
2. Yang Leng: Materials Characterization- Introduction to Microscopic and Spectroscopic Methods, John Wiley & Sons (Asia), 2008.
3. Robert F. Speyer: Thermal Analysis of Materials, Marcel Dekker, 1994.
4. V.T. Cherapin, A.K. Mallik: Experimental Techniques in Physical Metallurgy, Asia Publishing House, 1967.

MM 5253	Nano Science and Technology	PCC	4 – 0 – 0	4 Credits

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

CO1	Understand the significance, properties and applications of nanomaterials
CO2	Identify, formulate, and solve nano science and nanotechnology related engineering problems.
CO3	Correlate synthesis, properties and applications of nano materials
CO4	Interpolate the effect of size reduction on optical, electrical, electronic, mechanical, magnetic and thermal properties of materials.
CO5	List the use of nanomaterials in the field of nano fluidics, NEMS, photonic crystals and biomimetic.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1		1					2		
CO2	2		1							
CO3			2							
CO4			2			2				
CO5								2		

1: Slightly 2: Moderately 3: Substantially

Syllabus:

Significance, properties and applications nanomaterials, carbon nano structures, nano indentation, super plastic behaviour of nanomaterials, Ceramic nanosystems, quantum confinement, effect of size reduction on optical, electrical, electronic, mechanical, magnetic and thermal properties of materials, nano electronics, Nano fluidics, NEMS, photonic crystals, biomimetic nano structures.

Reading:

1. Sulabha K. Kulkarni: Nanotechnology Principles and Practices, Capital Publishing Company, 2007.
2. H. Hosono, Y. Mishima, H. Takezoe, K.J.D Mackenzie: Nanomaterials- From Research to Applications, Elsevier, 2008.
3. Massimilano Di Ventra, S. Evoy, James R. Heflin Jr: Introduction to Nanoscale Science and Technology, Springer, 2009.
4. Charles P. Poole Jr., Frank J. Owens: Introduction to Nanotechnology, Wiley India, New Delhi, 2010.

MM 5111	Introduction to Materials	DEC	3– 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand the impact of crystal structure and defects on properties of materials
CO2	Interpret unary & binary phase diagrams and predict microstructures
CO3	Describe the relation between processing, structure and mechanical properties of materials
CO4	Classify ferrous and non-ferrous alloys and their applications.

Mapping of course outcomes with program outcomes

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

1: Slightly 2: Moderately 3: Substantially

Syllabus:

Types of materials, bonding in materials, properties (physical, mechanical, thermal, electrical, electronic & magnetic) of materials, crystalline/ amorphous materials, basics of crystallography, defects (0D, 1D, 2D& 3D) in crystalline materials, phase rule, solid solutions, phase diagrams, invariant reactions, iron-iron carbide phase diagram, heat treatment of metals & alloys. Important classes of ferrous and non-ferrous alloys and their applications, basics of polymeric, ceramic and composite materials & their applications. Shaping of materials, structure-(mechanical) property correlation in metallic alloys. Different forms of carbon and its applications, bulk metallic glasses, metallic foams, high entropy alloys.

Reading:

1. William F. Hosford: Materials for Engineers, Cambridge University Press, 2008.
2. V. Raghavan: Materials Science and Engineering, 5th Ed., PHI, 2010.
3. William D. Callister: Materials Science and Engineering, Wiley India, 2010.
4. Van Vlack: Elements of Materials Science and Engineering, 6th Ed., Pearson India, 2002.

MM 5112	Environmental Degradation of Materials	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	List various atmospheres responsible for corrosion.
CO2	Classify various corrosion forms and the mechanisms involved.
CO3	Understand the various corrosion combating techniques.
CO4	Calculate corrosion rate using Tafel extrapolation and linear polarization techniques.
CO5	Compare high temperature metal-gas reactions and corrosion of metals at high temperature in atmospheres such as sulphur dioxide, chlorine etc.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1						2				
CO2	2		2			2				
CO3	2					2				
CO4			2							
CO5	2		2			2		1		

1: Slightly 2: Moderately 3: Substantially

Syllabus:

Importance of corrosion, causes of corrosion, electrochemical Mechanism, Dry-cell Analogy and Faraday's law, Types of cells, Environmental Aspects, Metallurgical Aspects, Types of corrosion Damage, Methods of corrosion Prevention, Stray current Corrosion, Cathodic Protection, Metallic coatings, Inorganic Coatings, Organic coatings, Inhibitors and Passivators, Corrosion Rate Measurement, Linear Polarisation Techniques, Tafel Extrapolation, Oxidation, Thermodynamics of Oxidation, Free Energy- Temperature Diagrams, Protective and Non-Protective Scales, Equations of Oxidation, Hot Corrosion, Hot corrosion of Copper, Reactive Element Effect (REE), Corrosion of Metals by Sulphur Compounds at high Temperature.

Reading:

1. Mars Guy Fontana: Corrosion Engineering, Tata McGraw-Hill Education, New York, 2005.
2. H.H. Uhlig, R. Winston Revie: An Introduction to Corrosion and Corrosion Engineering, 4th Ed, John Wiley & Sons, 2008.
3. P. R. Roberge: Corrosion Engineering- Principles and Practice, McGraw Hill, 2008.
4. Zaki Ahamad: Principles of Corrosion Engineering and Corrosion Control, Elsevier, 2006.
5. Einar Bardal: Corrosion and Protection, Springer, 2004.

MM 5113	Energy Conservation and Pollution Control in Metallurgical Industries	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understanding forms and source of energy
CO2	Interpret the environmental effect of different energy sources.
CO3	Apply their knowledge to use energy efficiently.
CO4	Evaluate the method of gas recovery and gas cleaning in processing industries
CO5	Compare energy sources like solid, liquid and gaseous fuels

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	2								
CO2		2							1	
CO3		2								
CO4	1	2								
CO5	2	1								

1: Slightly 2: Moderately 3: Substantially

Syllabus:

Forms of energy, energy conversion, energy sources and resources, Review of commercial energies from solid, liquid and gaseous fuels, Nuclear energy systems, Improving energy efficiency in extractive metallurgical processes, Recycling of energy, Gas recovery in metal processing industries, gas cleaning and removal of particulate matter from gases.

Reading:

1. J.H. Harker, J.R. Backhurst: Fuel and Energy, Academic Press, London, 1981.
2. C. B. Gill: Non-Ferrous Extractive Metallurgy, John Wiley, 1980.
3. S. P. Mahajan: Pollution Control in Process Industries, Tata McGraw Hill, 1985.

MM 5115	Rare and Reactive Metal Extraction	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understanding the importance and application of refractory and rare metals.
CO2	Identify the extraction and refining techniques of refractory and reactive metals
CO3	Compare the principles, techniques and limitations of chemical/ pyro-chemical methods of upgrading ores.
CO4	Explain the purification of concentrates/ compounds and production of intermediate salts
CO5	Evaluate flow sheets for the extraction of uranium, zirconium, titanium, beryllium, niobium, tantalum, tungsten, molybdenum and vanadium.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1		2							
CO2	2							1		
CO3	2									
CO4	2									
CO5	2							2		

1: Slightly 2: Moderately 3: Substantially

Syllabus:

Refractory and reactive metals and their applications - Principles. Techniques and limitations of chemical /pyro-chemical methods of upgrading ores- Purification of concentrates / compounds and production of intermediate salts- Basic chemistry of rare / reactive metal reduction and refining- Flow sheets for the extraction of uranium, zirconium, titanium, Beryllium, Niobium, Tantalum, Tungsten, Molybdenum and Vanadium.

Reading:

1. C.A. Hampel: Rare Metals Hand Book, Robert E. Krieger Publishing Company, 1971.
2. Fathi Habashi: Hand Book of Extractive Metallurgy, Vols. II & III, Wiley-VCH, 1997.

MM 5116	Ceramics, Polymers and Composite Technology	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Differentiate the properties of metals, ceramics, polymers and composite materials
CO2	Interpret crystallinity and molecular forces in polymers on the final property of polymers.
CO3	Understanding of different Processing routes of ceramics
CO4	Understanding of different Processing routes of ceramics
CO5	Calculate the effect of volume fraction of reinforcement in composites'

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1							3			
CO2							2			
CO3							3			
CO4							3			
CO5							2			

1: Slightly 2: Moderately 3: Substantially

Syllabus:

Ceramics: Introduction properties, oxide and non-oxide ceramics, crystal structure, processing routes, advanced ceramics and applications of ceramics. Polymers: Introduction, properties, degree of polymerization, classification and applications. Composite materials: Introduction, classification, properties, processing routes and applications. Rule of mixtures, fracture mechanics of composites.

Reading:

1. David W. Richerson: Modern Ceramic Engineering, Mercel Dekker, NY, 1992.
2. M.N. Rahman: Ceramic Processing and Sintering, Mercel Dekker, 2003.
3. Manas Chanda, Salil K. Roy: Industrial Polymers, Specialty Polymers, and their Applications, Taylor & Francis Group, LLC, 2008.
4. K. K. Chawla: Composite Materials Science and Engineering, 2nd Ed, Springer-Verlag, New York, 1998.
5. William D. Callister Jr: Materials Science and Engineering- An introduction, 6th Ed, John Wiley & Sons, Inc., 2004.
6. D. Hull, T.W. Clyne: An Introduction to Composite Materials, 2nd Ed, CUP, New York, 1996.

MM 5117	Biomaterials	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Select materials for bio applications based on required properties.
CO2	Design the flow sheet for the preparation of biomaterials.
CO3	Analyze materials and formulate biocompatible products based on the knowledge of biological functional materials and Latex products.
CO4	Comprehend the metallurgy of stainless steels, cobalt based alloys; titanium based alloys and apply knowledge to evaluate bio-compatible materials.

Mapping of course outcomes with program outcomes

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

1: Slightly 2: Moderately 3: Substantially

Syllabus:

Properties of Materials, Materials in Medical Applications, Stainless steel alloys, Cobalt based alloys, titanium based alloys, polymers, Bioresorbable and Bio erodible materials, bioceramics, porous ceramics, bioactive glasses, calcium phosphates, collagen, thin films, grafts and coatings, biological functional materials Latex products.

Reading:

1. D. Shi: Biomaterials and Tissue Engineering, Springer, 2004.
2. Buddy D. Ratner: Bio Material Science- An introduction to Materials in Medicine, Elsevier, 2004.
3. S. V. Bhatt: Biomaterials, Narosa, 2002.

MM 5118	Advanced Non-Ferrous Metal Extraction	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand the basic principle of hydrometallurgical process for extraction of zinc, copper, lead and aluminum.
CO2	Identify different ores of metals and appropriately choose them for economical extraction.
CO3	Select an appropriate technique in the processing of the ores for extraction of common, light and nuclear reactor metals
CO4	Collect sufficient information for development of flow sheets for various metals and choose suitable equipment for the extraction.
CO5	Sketch suitable flow sheets to utilize the right kind of equipment/furnace.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2		1							
CO2	2							2		
CO3	2							2		
CO4		2								
CO5	2									

1: Slightly 2: Moderately 3: Substantially

Syllabus:

Brief review of traditional methods of metal production of common metals such as copper, zinc, lead, aluminium - advanced converters for copper extraction- Hydrometallurgical processes for the extraction of zinc- flow sheets for the extraction of thorium, niobium, cobalt, zirconium, tungsten, molybdenum and gold.

Reading:

1. C.A. Hampel: Rare Metals Hand Book, Robert E. Krieger Publishing Company, 1971.
2. Fathi Habashi: Hand Book of Extractive Metallurgy, Vols. II & III, Wiley-VCH, 1997.

MM 5120	Special Steels	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Represent the problems in developing high strength steels
CO2	Understand the basic concepts of special steels with regard to their manufacturing, processing, heat treatments and micro-structural evaluation.
CO3	Classify dual phase steels, TRIP steels, TWIP steels, UHS steels, maraging steels and stainless steels
CO4	Understand the principles of micro-alloying and thermo-mechanical processing
CO5	Analyze the problems associated with heat treatment of tool steels and ultrafine grained steels.

Mapping of course outcomes with program outcomes

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

1: Slightly 2: Moderately 3: Substantially

Syllabus:

Introduction to steels, development of high strength steels. Review of properties of various steels. HSLA steels, principles of micro alloying and thermo- mechanical processing, dual phase steels, TRIP steels, TWIP steels; bainitic steels, ultra high strength low alloy steels, high alloy secondary hardening steels, maraging steels; stainless steels & high nitrogen stainless steels, ultra-fine grained steels and methods of producing ultrafine grained microstructure. Tool steels and special issues in heat treatment of tool steels.

Reading:

1. W.C. Leslie: Physical Metallurgy of Steels, Tech Books, 1991.
2. F.B. Pickering: Physical Metallurgy and Design of Steels, Applied Science Publishers, 1978.
3. H. K. D. H. Bhadeshia: Bainite in Steels- Transformations, Microstructure and Properties, CUP, 2001.
4. George Adam Roberts, Richard Kennedy, G. Krauss: Tool Steels, 5th Ed., ASM, 1998.
5. Albert M. Hall: Introduction to Today's Ultrahigh-strength Structural Steels, ASTM Special Technical Publication, 1973.
6. R.F. Decker: Source Book on Maraging Steels, ASM, 1979.

MM 5121	Surface Engineering	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand the importance, need of surface engineering and review past, present and future status of surface engineering.
CO2	Analyze the factors responsible for damage of the surfaces by corrosion, wear, and wear mechanisms.
CO3	Comprehend the laser processing, electrons & ion beam processing of surfaces, to characterize and evaluate coatings.
CO4	Evaluate economics, energy consumption in designing surface engineering processes.

Mapping of course outcomes with program outcomes

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

1: Slightly 2: Moderately 3: Substantially

Syllabus:

Importance and need of surface engineering, Past, present and future status of surface engineering; Damage of the surfaces by corrosion and wear, wear mechanisms and categories of wear, Substrates and their pre-treatments, Purpose and scope of surface coatings, Overlay and diffusion coatings, surface modifications by diffusion coatings, by overlaying coatings, by heat treatment, surface processing by laser, electrons and ions, Characterization and Evaluation of coatings, Economics and energy considerations, and designing of surface engineering processes.

Reading:

1. Tadeusz Burakowski, Tadeusz Wierzchon: Surface Engineering of Metals- Principles, Equipment, Technologies, CRC Press, 1999.
2. K. G. Budinski: Surface Engineering for Wear Resistance, Prentice Hall, 1998.
3. Howard E. Boyer (Ed): Case Hardening of Steel, ASM, 2011.
4. ASM Metal Hand Book, Vol 20: Surface Engineering, ASM, 2004.

MM 5211	Additive Manufacturing	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand the basic concepts of Additive Manufacturing
CO2	Differentiate AM with conventional process
CO3	Select materials and processes for AM
CO4	Understand concepts of reverse engineering

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1				3				2		
CO2				3				2		
CO3				3				2		
CO4				3				2		
CO5										

1: Slightly 2: Moderately 3: Substantially

Syllabus:

Introduction, Evolution, Advantages and Applications of AM; CAD & Reverse Engineering; AM process chain. Liquid Based And Solid Based Additive Manufacturing Systems: Classification – Liquid based system – Stereolithography Apparatus (SLA)- Principle, process, advantages and applications – Solid based system –Fused Deposition Modeling – Principle, process, advantages and applications, Laminated Object Manufacturing. Powder Based Additive Manufacturing Systems: Selective Laser Sintering – Principles of SLS process – Process, advantages and applications, Three Dimensional Printing – Principle, process, advantages and applications- Laser Engineered Net Shaping (LENS), Electron Beam Melting. Guidelines for process selection; Post processing of AM parts.

Reading:

1. C.K. Chua, K.F. Leong, C.S. Lim: Rapid prototyping- Principles and applications, 3rd Ed., World Scientific Publishers, 2010.
2. A. Gebhardt: Rapid prototyping, Hanser Gardener Publications, 2003.
3. L.W. Liou, F.W. Liou: Rapid Prototyping and Engineering applications: A tool box for prototype development, CRC Press, 2007.
4. A.K. Kamrani, E.A. Nasr: Rapid Prototyping- Theory and Practice, Springer, 2006.
5. P.D. Hilton, P.F. Jacobs: Rapid Tooling- Technologies and Industrial Applications, CRC Press, 2000.
6. Ian Gibson, David W Rosen, Brent Stucker: Additive Manufacturing Technologies- Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010
7. D.T. Pham, S.S. Dimov: Rapid Manufacturing- The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer, 2001.

MM 5212	Aerospace Materials	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Comprehend the requirements of materials used in aerospace and land based gas turbine engines.
CO2	Identify components used in aeroplanes, space vehicles, missiles and apply knowledge to provide appropriate solutions for processing, testing, performance evaluation.
CO3	Apply the knowledge of creep, fatigue and high temperature corrosion principles to improve the performance of gas turbine engines
CO4	Design advanced materials for the aeroplane and space applications

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1							2	2		
CO2								2		
CO3		2	2							
CO4							2	2		

1: Slightly 2: Moderately 3: Substantially

Syllabus:

Requirements of space and aerospace materials, land base and aerospace materials, Identification of components of aero planes, space vehicles and missiles, materials usage in each sections and criticality of the components and their materials selection, gas turbine and aero engines, Creep, fatigue and corrosion, Ni and Co based super alloys, Special steels, Titanium alloys, Intermetallics, ceramics and their composites, New High strength materials

Reading:

1. Michael F. Ashby: Materials Selection in Mechanical Design, Butterworth-Heinemann, 2005.
2. George F. Titterton: Aircraft Materials and Processes, Himalayan Books, New Delhi, 1998.
3. F.C. Campbell: Manufacturing Technology for Aerospace Structural Materials, Elsevier, UK, 2006.
4. Balram Gupta: Aerospace Materials with Material Technology for Engineers, Vol 1-4, S. Chand & Co., New Delhi, 1996 and 2002.

MM 5213	Functional Materials	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Classify functional materials
CO2	Understand basic concepts and structure and properties of a broad spectrum of functional materials
CO3	Relate the properties of functional materials to their structure
CO4	Select materials for typical engineering applications

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1			3							
CO2			3							
CO3			3							
CO4			3							

1: Slightly 2: Moderately 3: Substantially

Syllabus:

The Origin of FMs, Potential Applications of FMs, Classification of FMs, Bulk FMs, Wear Resistant FMs. Processing Techniques: Powder metallurgy route, Melt processing route, Advanced techniques like Impeller Dry Blending (IDB) Process.

Basic idea based on lessons from nature, graded microstructure -characteristic dimensions and spatial variations, volume fraction, rules of mixture and effective field parameters; characterization of properties of FMs, macrostructural thermomechanical properties, effective material properties for ceramic-metal FMs, basic mathematical modeling.

Specific properties of functional materials: Shape memory metals, Invar alloys, Magnetic materials, Electric contact materials, Conducting thermoplastics and polymer composites, Surface coatings, Biomaterials and Electronic, ionic and mixed electron-ion conductors.

Materials for sensors, waste heat recovery, batteries and fuel cells, solar energy harvesting, Reflective and antireflective layers.

Reading:

1. D.D.L. Chung: Engineering Materials for Technological Needs, Vol. 2- Functional Materials: Electrical, Dielectric, Electromagnetic, Optical and Magnetic Applications, World Scientific Publishing, 2010.
2. D.D.L. Chung: Composite Materials- Functional Materials for Modern Technologies, Springer, 2002.
3. Hui-Shen Shen: Functionally Graded Materials - Nonlinear Analysis of Plates and Shells, CRC Press, 2009.
4. Y. Miyamoto, W.A. Kaysser, B.H. Rabin, A. Kawasaki, R.G. Ford (Eds): Functionally Graded Materials- Design, Processing and Applications, Springer, 1999.

MM 5214	Energy Materials	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand the basic concepts of different materials used in various stages of energy production
CO2	Understand the basic concepts of materials used in energy storage
CO3	Understand the effect of radiations on materials properties
CO4	Select materials for thermal, hydro, solar or nuclear power generation

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1								2		
CO2								2		
CO3								2		
CO4								2		

1: Slightly 2: Moderately 3: Substantially

Syllabus:

Structures and properties nuclear materials, nuclear fuels, control rods, coolant, moderator, shielding; reprocessing of nuclear fuel, safer nuclear waste disposal. Effects of α, β,γ rays on creep, fatigue, tensile, and other properties of materials. Materials for fuel cells, solar energy, thermal power generation, hydro power generation and power plant components. Energy storage materials, biofuels, biological fuel cell technologies, sustainable energy.

Reading:

1. J.C. Bryan: Introduction to Nuclear Science, CRC Press, 2009.
2. G.S. Was: Fundamentals of Radiation Materials Science, Springer, 2007.
3. C.O. Smith: Nuclear Reactor Materials, Addison-Wesley, 1967.
4. J.T.A. Roberts: Structural Materials in Nuclear Power Systems, Plenum Press, 2013.
5. Wolf Vielstich, Arnold Lamm, Hubert A. Gasteiger, Harumi Yokokawa: Handbook of Fuel Cells, John Wiley & Sons, 2003.
6. D Roddy (Ed): Advanced Power Plant Materials, Design and Technology, Woodhead Publishing Series in Energy No. 5 and CRC Press, 2010.

MM 5161	Computer Application in Materials Engineering	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Model using finite element analysis and monte-carlo method
CO2	Understand the limitations of finite element analysis and monte-carlo method.
CO3	Differentiate between microstructure modeling and processing modeling
CO4	Identify the critical aspects in mathematical modeling of physical concepts
CO5	Design a computational model independently for a particular concept and evaluate the understanding of reduced experiment work

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1			2	2		1				
CO2			2	2						
CO3			2	2	1	1				
CO4			1	1						
CO5										2

1: Slightly 2: Moderately 3: Substantially

Syllabus:

Computer Basics and programming, Techniques in Computer simulation, Finite Element Analysis, Monte-Carlo Methods, Mathematical Modelling of Physical Concepts, Microstructure Modelling, Process Modelling, Integrated Selection of Materials and Processes, Calculation of materials properties starting from microscopic theories.

Reading:

1. R J Arsenault, J R Beeler Jr, D M Easterling (Eds): Computer Simulation in Materials Science, ASMInternational, 1986.
2. K. Ohno, K. Esfarjani, and Y. Kawazoe: Computational Materials Science - From Ab Initio to Monte Carlo Methods, Springer, 1999.
3. Wolfram Hergert, Arthur Ernst, Markus Dane: Computational Materials Science - From Basic Principles to Materials Properties, Springer, 2004.

MM 5163	Non Destructive Testing	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand the basic principles of different NDT processes (Visual Inspection, Eddy Current Testing, Liquid Penetrant Testing, Magnetic Particle Testing, Radiographic Testing and Ultrasonic Testing)
CO2	Differentiate NDT processes
CO3	Select NDT processes
CO4	Apply Precautions against radiation hazards in NDT processes

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1			2		3					
CO2			2		3					
CO3			2		3					
CO4			2		3					
CO5										

1: Slightly 2: Moderately 3: Substantially

Syllabus:

Introduction to NDT, advantages and classifications of NDT processes; visual inspection: principles of inspection equipments used. Eddy Current Testing: Principle, influencing factors, Advantages, limitations and applications. Liquid penetration testing: Principle, Characteristics, precautions, advantages, limitations and applications. Magnetic Particle Testing: Principle, methods to generate magnetic fields, Method of De-Magnetization. Radiographic Testing: Principle, equipment & methodology, influencing factors, Radiograph Interpretation, Precautions against radiation hazards. Ultrasonic Testing: Principle, Testing Techniques Ultrasonic Propagation, probes, Transducers, applications, advantages and limitation.

Reading:

1. J. Prasad, C.G.K. Nair: Non-Destructive Testing and Evaluation of Materials, Tata McGraw Hill, 2011.
2. Paul E. Mix: Introduction to Nondestructive Testing- A Training Guide, John Wiley & Sons, 2005.
3. Louis Cartz: Nondestructive testing- radiography, ultrasonics, liquid penetrant, magnetic particle, eddy current, ASM International, 1995.
4. ASM Metals Handbook, Vol 17: Non-Destructive Examination and Quality Control, 9th Ed, ASM, 1989.
5. Don.E. Bray, Roderic K. Stanley: Nondestructive Evaluation- A Tool in Design, Manufacturing, and Service, Revised Ed, CRC Press, 1997.

MM 5167	Failure Analysis	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand factors responsible failure of materials
CO2	Differentiate fracture modes and failure mechanisms for ductile, brittle, fatigue, creep, corrosion and wear failure
CO3	Determine fracture toughness of brittle and ductile materials
CO4	Predict life of materials under fatigue loading
CO5	Analyze failure through case studies and select tools for failure analysis

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1			2							
CO2		1	2							
CO3		1	2							
CO4			2							
CO5			2							

1: Slightly 2: Moderately 3: Substantially

Syllabus:

Aims of failure analysis, Prime factors in the premature failure of metallic components and structures, Tools and techniques in failure analysis, Types of failures: ductile, brittle, fatigue, creep, corrosion, wear etc., fractography, mixed mode and fatigue failures, Failure mechanisms, Embrittlement phenomena, environmental effects, Failures due to faulty heat treatments, Failures in metal forming and welding, Case studies in failure analysis, Prevention of failures, case histories of component failures.

Reading:

1. ASM Metals Hand Book, Vol 11: Failure Analysis and Prevention, ASM, 2002.
2. S. Suresh: Fatigue of Materials, 2nd Ed., CUP, 1998.
3. D. Broek: Elementary Engineering Fracture Mechanics, 3rd Rev. Ed., Springer, 1982.

MM 5171	Nuclear Metallurgy	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Recognize the importance of nuclear energy and radio isotopes for our country.
CO2	Recall the fundamentals of nuclear engineering and various techniques used for the disposal of nuclear reactor wastes
CO3	Classify the nuclear reactors and list out the components and recognize the materials required for various components of the reactor.
CO4	Compare the nuclear reactor fuels to be used in reactors.
CO5	Evolve flow sheets for the processing of nuclear reactor materials such as uranium, thorium, zirconium and beryllium.
CO6	List the units for radiation and understand the effects of radiation on solids, its hazards and shielding.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1										2
CO2										2
CO3										2
CO4										2
CO5										2
CO6										2

1: Slightly 2: Moderately 3: Substantially

Syllabus:

Fundamental Concepts, Binding Energy, Fission Chain Reaction, Nuclear Reactors and Nuclear Power, Classification of nuclear Reactors, Materials for Reactors, Fuel Fabrication, Cladding, Properties of reactor fuels, Production of Nuclear reactor Fuels and other Materials such as uranium, thorium, plutonium, zirconium etc., Fuel Reprocessing, Radio Active Waste Disposal, Radiation Doses and hazard Assessment, Radiation hazards and Shielding, History of Radiation Effects, Radiation Units, Biological Effects of Radiation, Radiation Affects Materials, Medical Applications of Nuclear Technology, Nuclear Power Reactors in India.

Reading:

1. J. Kenneth Shultis, Richard E. Faw: Fundamentals of Nuclear Science and Engineering, Marcel Dekkar, 2002.
2. John R. Lamarash: Introduction to Nuclear Engineering, 2nd Ed., Addison Wesley,1983.
3. S. Glasstone, A. Sesnoke: Nuclear Reactor Engineering, CBS Publishers, 2003.
4. Bodansky: Nuclear Energy- Practices and Projects, Springer, 2004.

5261	Powder Processing Technology	PCC	4 – 0 – 0	4 Credits

Pre-requisites: None

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

CO1	Understand the basics of powder processing techniques and their applications
CO2	Select suitable powder characterization technique
CO3	Differentiate different powder processing techniques
CO4	Understand the fundamentals of powder sintering, Modern Sintering techniques and Structure-Property Correlation study of Sintered Components
CO5	Production of Gears, friction parts, Filters, Carbide tool, Bearings, Biomaterials for Industrial applications, Pollution Control in Powder Metallurgy based Industry

Mapping of course outcomes with program outcomes

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

Syllabus:

Introduction and History of Powder Metallurgy (PM), SWOT analysis of PM, Different Mechanical and Chemical methods, Atomization of Powder etc., Particle Size & Shape Distribution, Electron Microscopy of Powder, Interparticle Friction, Compression ability, Powder Structure, Chemical Characterization, Particle Packing Modifications, Different shaping processes, Theory of Sintering, Sintering of Single & Mixed Phase Powder, Liquid Phase Sintering (LPS), Sintering Variables, Modern Sintering Techniques, Production of Filters, Gears, Friction parts, Carbide tool, Tungsten Filaments, Self-Lubricating Bearings, Porous Materials, Biomaterials etc., Laser Engineering Net Shaping (LENS), Selective laser sintering (SLS) of powder, Defects analysis and Structure-Property of sintered components, Pollution problem in PM based industry, Application of PM in Indian industry.

Reading:

1. G.S. Upadhyaya: Powder Metallurgy Technology, Cambridge International, 2002.
2. J. S. Hirschhorn: Introduction to Powder Metallurgy, APMI, Princeton, NJ, 1976.
3. ASM Handbook, Vol 7: Powder Metallurgy, W.B. Eisen (Ed), ASM, 2004.
4. R.M. German: Sintering Theory and Practice, Wiley-VCH, 1996.

MM 5262	High Temperature Materials	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Select materials for various temperature ranges
CO2	Develop materials for high temperature applications
CO3	Interpret the influence of creep, thermal fatigue, oxidation, high temperature corrosion, erosion and ageing on materials.
CO4	Analyze life of creep resistant steels, superalloys, ceramics and polymers at elevated temperature.
CO5	List the usage of high strength steels and spring steels

Mapping of course outcomes with program outcomes

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

1: Slightly 2: Moderately 3: Substantially

Syllabus:

Introduction and Elevated temperature characteristics of engineering materials, Creep mechanism, high temperature oxidation and hot corrosion. Super-alloys, Titanium alloys, Refractory metals & alloys, Structural intermetallics, Ceramics, High temperature steels, High temperature polymers, composites. Thermal barrier coatings.

Reading:

1. M.N. Rahman: Ceramic Processing and Sintering, Mercel Dekker, 2003.
2. S. Somiya (Ed): Handbook of Advanced Ceramics, Parts 1 & 2, Academic Press, 2006.
3. Neil Birks, Gerald H. Meier, Frederick S. Pettit: Introduction to the High Temperature Oxidation of Metals, 2nd Ed., CUP, 2009.
4. Roger C. Reed: The Super-alloys- Fundamentals and Applications, CUP, 2008.
5. Sudhansu Bose: High Temperature Coatings, Butterworth-Heinemann, 2007.
6. K. L. Mittal: Polyimides and Other High Temperature Polymers- Synthesis, Characterization and Applications, Brill Academic Publications, 2009.

MM 5263	Smart materials	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Select materials for sensor applications based on required properties.
CO2	Comprehend the principles of operation of optical fibers, actuators, and methods of analyses employed in smart materials.
CO3	Evaluate shape memory materials, electro rheological fluids for newer applications.
CO4	Analyze vibration suppression, shape control, sizing and optimization of smart materials by finite element methods.

Mapping of course outcomes with program outcomes

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

1: Slightly 2: Moderately 3: Substantially

Syllabus:

Composites, Smart materials and their properties, Piezoelectric, magneto structure, Shape memory materials, Electro Rheological fluids, Optical fibers, actuation, sensing and control augmentation, distributed/discrete sensing and actuation, methods of analyses, finite elements, applications: Vibration suppression, shape control, sizing and optimization.

Reading:

1. M.V.Gandhi, B.S. Thompson: Smart Materials and Structures, Chapman & Hall, 1992.
2. L.Meirovitch: Dynamics and Control of Structures, John Wiley, 1992.

MM 5264	Electronics Materials	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Comprehend the physics and manufacturing processes of the semiconductor materials and wafer technology.
CO2	Apply the knowledge in manufacturing the ICs based on patterning, surface preparation to exposure, photomasking, photoresist, etching and resistor stripping.
CO3	Understand the vapor phase epitaxy, molecular beam epitaxy, MOCVD, deposited films and select the appropriate method for a given device manufacturing.
CO4	Design methods for improving life of electronic products based on photolithography process, antireflective coating deposition processes.

Mapping of course outcomes with program outcomes

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

1: Slightly 2: Moderately 3: Substantially

Syllabus:

Semiconductor materials, Wafer Technology, Basic patterning and surface preparation to exposure, photomasking, photoresist and their performance factors, Etching, dry and wet etching, resistor stripping, Chemical vapor deposition, Plasma Enhanced CVD, Vapor phase epitaxy, molecular beam epitaxy, MOCVD, deposited films, Photolithography process, Antireflective coatings.

Reading:

1. Peter Van Zant: Microchip Fabrication, 4th Ed., McGraw Hill, 2000.
2. James R. Chelikowsky: Electronic Materials- A New Era in Materials Science, Springer, 2001.

MM 5265	Dislocation Theory	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand basic concepts of deformation in crystalline solid and review elastic theory
CO2	Correlate deformation and dislocation
CO3	Differentiate dislocation movement in BCC, FCC and HCP structured materials
CO4	Understand fundamental concepts of dislocation and kinetics of dislocation flow
CO5	Interpret tensile response of crystalline solid

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1		3						2		
CO2		3						2		
CO3		3						2		
CO4		3						2		
CO5		3						2		

1: Slightly 2: Moderately 3: Substantially

Syllabus:

General aspects of deformation in crystalline solids, review of elasticity theory and stress field around stationary and moving dislocation, forces on a dislocation including concepts of self-energy, line tension, chemical forces and forces between dislocations for varied configurations of dislocation, kinetics of dislocation flow, dislocations in FCC structures, dislocations in BCC, HCP, ordered and superlattice structures, jogs and intersection of dislocations incorporating concepts of elementary, composite and extended jogs, dislocations dipoles, attractive and repulsive junctions, origin and multiplication of dislocations, dislocation arrays and crystal boundaries; Interpretation of tensile response of crystalline solids including theories related to yielding, flow stress and work-hardnening, dislocations and creations of discontinuities.

Reading:

1. M.N.Shetty: Dislocations and Mechanical Behaviour of Metals, PHI, 2013.
2. J.P. Hirth, J. Lothe: Theory of Dislocations, Wiley, 1981.
3. Derek Hull, D.J. Bacon: Introduction to Dislocations, Elsevier, 2001.

MM 5266	Strengthening Mechanisms	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand concepts on theoretical strength of crystals, activation energy, stages and theories of strain hardening.
CO2	Apply the knowledge of strengthening modes to design and process materials for high performance.
CO3	Understand characteristic features martensitic, bainitic transformations and apply knowledge to process materials for efficient performance.
CO4	Process to produce stronger materials based on comprehending the concepts on strengthening by point defects and grain refinement.

Mapping of course outcomes with program outcomes

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

1: Slightly 2: Moderately 3: Substantially

Syllabus:

Theoretical strength of crystals, activation volume and energy, Stages and theories of strain hardening, Elastic modulus, electrical, chemical and configurational interactions, Order hardening, Yield point, strain ageing and Snoek effect, precipitation, solution and dispersion hardening, Mechanism and characteristic features of martensitic and bainitic transformations. Strengthening due to defects and grain refinement.

Reading:

1. Derek Hull, D.J. Bacon: Introduction to Dislocations, Elsevier, 2001.
2. ASM Hand Book, Vol 8: Mechanical Testing and Evaluation, ASM, 2000.
3. G.E. Dieter: Mechanical Metallurgy, McGraw Hill, 1988.

MM 5267	Experimental Techniques and Analysis	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand the principle of operation of scanning electron microscope, transmission electron microscope, field emission and field ion microscope
CO2	Understand the operation of dilatometers and interferometers for characterization of materials
CO3	Interpret image of optical microscope, SEM and TEM
CO4	Identify suitable specimen preparation technique for a particular characterization method
CO5	Differentiate thermal analysis and differential thermal analysis

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1			2							
CO2			2							
CO3			2							
CO4			2							
CO5			2							

1: Slightly 2: Moderately 3: Substantially

Syllabus:

Thermal analysis of phase transformations: ordinary thermal method, inverse rate curves, Differential thermal analysis, Derived differential thermal analysis, thermal analysis at high temperatures, thermal analysis with rapid heating and cooling. Thermal gravimetric analysis: TG design and experimental concerns. Cahn microbalance operation. Simultaneous thermal analysis. Dilatometry: Single push rod dilatometer, dual push rod dilatometer, calibration. Interferometry: Principles, Michelson interferometer, dilatometric interferometer. Growth of single crystals by zone melting. Basic Introduction about Transmission Electron Microscope (TEM): Comparison with Optical Microscope and X-ray Diffraction, Properties of Electrons, Electron Beam/ Specimen Interaction. Design of Electron Microscope: Signal Detectors, Electron Lenses, Resolving Power, Image Formation, Arrangement for Microscopy and Diffraction. Specimen Preparation andImage Interpretation: Case studies. Field Emission Microscope, Field Ion Microscope. Scanning Electron Microscope (SEM), Principles of Microprobe Analysis.

Reading:

1. Robert F Speyer: Thermal Analysis of Materials, Marcel Dekker, 1994.
2. Kauffmann: Characterization of Materials, Vols I-II, John Wiley, 2005.
3. ASM Handbook, Vol 10: Materials Characterization, ASM, 2004.

MM 5268	Light Metals and Alloys	DEC	3–0–0	3 Credits

Pre-requisites: MM5101–Thermodynamics of Materials and Kinetics

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

CO1	Understand the relationship between Processing, Microstructure and Properties.
CO2	Design and develop Al - alloys for automotive applications
CO3	Apply the concepts of microstructure design for high strength Mg-alloy development
CO4	Apply the concepts of processing for controlling the properties of Ti-alloys

Mapping of course outcomes with program outcomes

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

1: Slightly 2: Moderately 3: Substantially

Syllabus:

General introduction - strengthening by solid solution, precipitation, dispersion, grain refining and work hardening. Production of aluminium, magnesium, titanium by various methods. Aluminum Alloys - Designation, temper and characteristics of cast and wrought aluminum alloys. Magnesium alloys - Alloy designation and tempers, casting alloys, wrought alloys, latest trends in applications of Mg alloys. Titanium alloys - alpha alloys, alpha –beta alloys, beta alloys, fabrication, Heat treatments. Metal-matrix composites - principles, processing, properties and applications.

Reading:

1. I.J.Polmear, Light Alloys – From Traditional Alloys to Nanocrystals, Fourth Edition, Butterworth Heinemann, 2005.
2. R.W.Heine, C.R.Loper, P.C.Rosenthal, Principles of Metal Casting, Tata McGraw Hill Education, 2008.
3. D.H. Kirkwood, M. Suery, P. Kapranos, H.V. Atkinson, K.P. Young, Semisolid Processing of Alloys, Springer Series in Materials science, 2010.
4. M. Gupta, N.M.L. Sharon, Magnesium, Magnesium Alloys, and Magnesium Composites, Wiley, 2011
5. G. Lutjering, J.C. Williams, Titanium, Springer, 2007
6. T.W. Clyne, P.J. Withers, An introduction to metal-matrix composites, Cambridge University Press, 1993.

MM 5104	Materials Processing and Microstructural Evolution Laboratory	PCC	0 – 0 – 3	2 Credits

Pre-requisites: None

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

CO1	Demonstrate casting of low melting alloys
CO2	Evaluate microstructure of cast and heat treated specimens
CO3	Demonstrate coating and corrosion through electrolytic cell
CO4	Demonstrate material deformation process using rolling, sheet metal forming, and wire drawing technique.

Mapping of course outcomes with program outcomes

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

1: Slightly 2: Moderately 3: Substantially

Syllabus:

Synthesis of alloys, Heat treatment of high carbon steels and Al- alloys, Ageing of Aluminum alloys, Electrodeposition, plating and refining, Anodizing, Material forming by extrusion and injection molding, Rolling and sheet metal forming / tape casting / wire drawing, joining of metals, Thin film preparation / coating, Surface modification using fluidized bed.

Reading:

1. S.H. Avner: Introduction of Physical Metallurgy, McGraw Hill, 1987.
2. G.E. Dieter: Mechanical Metallurgy, McGraw Hill, 1987.
3. Brian Cantor, K. O'Reilly: Solidification and Casting, IOP Publications, 2003.
4. George E. Totten, Hong Liang: Surface Modification and Mechanisms- Friction, Stress and Reaction Engineering, Marcel Dekker, 2005.

MM 5105	Materials Testing and Evaluation Laboratory	PCC	0 – 0 – 3	2 Credits

Pre-requisites: MM5201– Mechanical Behaviour of Materials

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

CO1	Demonstrate hardness testing techniques and its applications
CO2	Demonstrate tensile, compression and impact testing techniques and its applications
CO3	Demonstrate creep and stress rupture test and their implications
CO4	Estimate material degradation through pitting corrosion technique

Mapping of course outcomes with program outcomes

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

1: Slightly 2: Moderately 3: Substantially

Syllabus:

Hardness, Tensile, Compression, Impact, wear, and erosion testing, Microhardness and indentation fracture toughness, Creep and stress rupture tests, fatigue testing, Corrosion tests - Pitting corrosion, NDT techniques- Ultrasonic, magnetic particle, die penetrant test, Polarization studies.

Reading:

1. G.E. Dieter: Mechanical Metallurgy, McGraw Hill, 1987.
2. Kenneth C Ludema: Friction, Wear and Lubrication- A textbook in Tribology, CRC Press, 1996.
3. Paul E. Mix: Introduction to Nondestructive Testing- A Training Guide, John Wiley & Sons, 2005.

MM5254	Materials Characterization Laboratory	PCC	0 – 0 – 3	2 Credits

Pre-requisites: MM5151 – Materials Characterization Techniques

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

CO1	Prepare specimens for optical, SEM and TEM observations
CO2	Analyze the crystal structure using X-ray diffraction technique
CO3	Analyze the composition of material using SEM-EDS technique
CO4	Select a technique to characterize a material for a given application

Mapping of course outcomes with program outcomes

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

1: Slightly 2: Moderately 3: Substantially

Syllabus:

DSC, TGA, XRD, Analysis of residual stresses and texture, Phase analysis and lattice parameter calculations, SEM, EDX, optical microscopy, Gas chromatograph, UV- Visible spectroscopy, Chemical analysis of materials including C-O-H-N-S, SEM of ceramic materials, Atomic Force microscopy and scanning Tunneling Microscopy.

Reading:

1. B.D. Cullity: Elements of X-ray Diffraction, Pearson Education, 2013.
2. Kauffmann: Characterization of Materials, John Wiley, 2003.
3. D.G. Brandon: Modern Techniques in Metallography, Butterworths, 1966.
4. F. Weinberg: Tools and Techniques in Physical Metallurgy, Vols I & II, Marcel Dekkar, 1970.
5. ASM Metal Hand book, Vol 10: Materials Characterization, ASM Int, 2004.

MM 5155	Powder Processing Laboratory	PCC	0 – 0 – 3	2 Credits

Pre-requisites: None

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

CO1	Produce powder using ball milling, wet-chemical technique, reactive synthesis technique (SHS)
CO2	Differentiate powder properties produced through above mentioned techniques
CO3	Demonstrate the effect of compaction pressure, particle geometry, binders and lubricant on the green strength
CO4	Demonstrate the effect of sintering time, temperature and environment on sintered properties.
CO5	Evaluate microstructures of synthesized powders and sintered components.

Mapping of course outcomes with program outcomes

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

1: Slightly 2: Moderately 3: Substantially

Syllabus

Ball milling of powders, Chemical synthesis of powders, Electrolytic synthesis of iron powder, Cementation of powders, Determination of size and size distribution of metal powders, Determination of apparent density, tap density, flow rate of metal powders, Determination of surface area, Compaction of metal powders and determination of green density, Sintering of metal powders and determination of sintered density.

Reading:

1. G.S. Upadhyaya: Powder Metallurgy, Cambridge Publishing, 2002.
2. P.C. Angelo, R. Subramanian: Powder Metallurgy- Science, Technology and Applications, PHI, 2008.
3. Suk-Joong L. Kang: Sintering- Densification, Grain growth and Microstructure, Elsevier, 2005.

MM 5291	Seminar-I	PCC	0 – 0 – 3	1 Credits

Pre-requisites: None

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

CO1	Communicate with group of people on different topics
CO2	Prepare a seminar report that includes consolidated information on a topic

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1									3	3
CO2									3	3

1: Slightly 2: Moderately 3: Substantially

MM 5292	Seminar-II	PCC	0 – 0 – 3	1 Credits

Pre-requisites: None

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

CO1	Communicate with group of people on different topics
CO2	Prepare a seminar report that includes consolidated information on a topic

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1									3	3
CO2									3	3

1: Slightly 2: Moderately 3: Substantially

MM 6242	Comprehensive Viva-Voce	PCC	2 Credits

Pre-requisites: None

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

CO1	Demonstrate an understanding of advanced topics
CO2	Explain the principles and phenomena, and their applications

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1									3	3
CO2		2							3	3

1: Slightly 2: Moderately 3: Substantially

MM 6249	Dissertation Part A	PCC	6 Credits

Pre-requisites: None

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

CO1	Identify the problem based on literature survey
CO2	Formulate the problem
CO3	Identify the methods or techniques required for the solution
CO4	Develop the solution methodology

Mapping of course outcomes with program outcomes

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

1: Slightly 2: Moderately 3: Substantially

MM 6299	Dissertation Part B	PCC	12 Credits

Pre-requisites: MM6149 – Dissertation Part A

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

CO1	Implement the methods/techniques identified in dissertation part-A
CO2	Analyze and interpret the results obtained
CO3	Compare the results obtained from the work with literature report
CO4	Demonstrate the original contribution to knowledge

Mapping of course outcomes with program outcomes

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

1: Slightly 2: Moderately 3: Substantially