# VISVESVARAYA TECHNOLOGICAL UNIVERSITY
# BELAGAVI


# MECHANICAL AND SMART MANUFACTURING

**BE/B.Tech. Scheme of Teaching and Examinations**
**Outcome Based Education (OBE) and Choice Based Credit System (CBCS) (Effective from the academic year 2018 – 19)**

**07.01.2023**

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
## Scheme of Teaching and Examination 2018 – 19
## Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
## (Effective from the academic year 2018 – 19)

**III SEMESTER**

| Sl. No | Course and Course Code | | Course Title | Teaching Department | Teaching Hours /Week | | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theory Lecture | Tutorial | Practical/ Drawing | Duration in hours | CIE Marks | SEE Marks | Total Marks | |
| | | | | | L | T | P | | | | | |
| 1 | BSC | 18MAT31 | Transform Calculus, Fourier Series and Numerical Techniques (Common to all Branches) | Mathematics | 2 | 2 | -- | 03 | 40 | 60 | 100 | 3 |
| 2 | PCC | 18 ME32 | Mechanics of Materials | ME | 3 | 2 | -- | 03 | 40 | 60 | 100 | 4 |
| 3 | PCC | 18 SM 33 | Thermodynamics | ME | 3 | 0 | -- | 03 | 40 | 60 | 100 | 3 |
| 4 | PCC | 18 SM 34 | Theory of Machines | ME | 3 | 0 | -- | 03 | 40 | 60 | 100 | 3 |
| 5 | PCC | 18 SM 35 | Material Science & Processing Technologies | ME | 3 | 0 | -- | 03 | 40 | 60 | 100 | 3 |
| 6 | PCC | 18 SM 36 | Manufacturing Process-I | ME | 3 | 0 | -- | 03 | 40 | 60 | 100 | 3 |
| 7 | PCC | 18 SM L37 | Material Testing Laboratory | ME | -- | 2 | 2 | 03 | 40 | 60 | 100 | 2 |
| 8 | PCC | 18 SML38 | Manufacturing Process-I Lab | ME | -- | 2 | 2 | 03 | 40 | 60 | 100 | 2 |
| 9 | HSMC | 18KVK39/49 | Vyavaharika Kannada (Kannada for communication)/ | HSMC | -- | 2 | -- | -- | 100 | -- | 100 | 1 |
| | | 18KAK39/49 | Aadalitha Kannada (Kannada for Administration) | | | | | | | | | |
| | | **OR** | | | | | | | | | | |
| | | 18CPC39 | Constitution of India, Professional Ethics and Cyber Law | | 1 | -- | -- | 02 | 40 | 60 | | |
| | | | | | Examination is by objective type questions | | | | | | | |
| | | | | **TOTAL** | **18 OR 19** | **10 OR 12** | **04** | **24 OR 26** | **420 OR 360** | **480 OR 540** | **900** | **24** |

**Note:** BSC: Basic Science, PCC: Professional Core, HSMC: Humanity and Social Science, NCMC: Non-credit mandatory course.

18KVK39 Vyavaharika Kannada (Kannada for communication) is for non-Kannada speaking, reading and writing students and 18KAK39 Aadalitha Kannada (Kannada for Administration) is for students who speak, read and write Kannada.

**Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | NCMC | 18MATDIP31 | Additional Mathematics - I | Mathematics | 02 | 01 | -- | 03 | 40 | 60 | 100 | 0 |

a) The mandatory non – credit courses Additional Mathematics I and II prescribed for III and IV semesters respectively, to the lateral entry Diploma holders admitted to III semester of BE/B. Tech programs, shall attend the classes during the respective semesters to complete all the formalities of the course and appear for the University examination. In case, any student fails to register for the said course/ fails to secure the minimum 40 % of the prescribed CIE marks, he/she shall be deemed to have secured F grade. In such a case, the students have to fulfill the requirements during subsequent semester/s to appear for SEE.

b) These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.

**Courses prescribed to lateral entry B. Sc degree holders admitted to III semester of Engineering programs**

Lateral entrant students from B.Sc. Stream, shall clear the non-credit courses Engineering Graphics and Elements of Civil Engineering and Mechanics of the First Year Engineering Programme. These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.

07.01.2023

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
## Scheme of Teaching and Examination 2018 – 19
## Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
## (Effective from the academic year 2018 – 19)

**IV SEMESTER**

| Sl. No | Course and Course Code | | Course Title | Teaching Department | Teaching Hours /Week | | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theory Lecture | Tutorial | Practical/ Drawing | Duration in hours | CIE Marks | SEE Marks | Total Marks | |
| | | | | | L | T | P | | | | | |
| 1 | BSC | 18MAT41 | Complex Analysis, Probability and statistics Methods | Mathematics | 2 | 2 | -- | 03 | 40 | 60 | 100 | 3 |
| 2 | PCC | 18 SM42 | Fluid Mechanics and Heat Transfer | ME | 3 | 2 | -- | 03 | 40 | 60 | 100 | 4 |
| 3 | PCC | 18 SM 43 | Manufacturing Process-II | ME | 3 | 0 | -- | 03 | 40 | 60 | 100 | 3 |
| 4 | PCC | 18 SM 44 | Mechanical Measurement and Metrology | ME | 3 | 0 | -- | 03 | 40 | 60 | 100 | 3 |
| 5 | PCC | 18 SM 45 | Data Structures and Programming | CS | 3 | 0 | -- | 03 | 40 | 60 | 100 | 3 |
| 6 | PCC | 18 ME 46 | Computer Aided Machine Drawing | ME | 1 | 4 | -- | 03 | 40 | 60 | 100 | 3 |
| 7 | PCC | 18 SM L47 | Manufacturing Process Lab-II | ME | -- | 2 | 2 | 03 | 40 | 60 | 100 | 2 |
| 8 | PCC | 18 SM L48 | Data Structures and Programming lab | CS | -- | 2 | 2 | 03 | 40 | 60 | 100 | 2 |
| 9 | HSMC | 18KVK49/49 | Vyavaharika Kannada (Kannada for communication)/ | HSMC | -- | 2 | -- | -- | 100 | -- | 100 | 1 |
| | | 18KAK49/49 | Aadalitha Kannada (Kannada for Administration) | | | | | | | | | |
| | | **OR** | | | | | | | | | | |
| | | 18CPH49 | Constitution of India, Professional Ethics and Cyber Law | | 1 | -- | -- | 02 | 40 | 60 | | |
| | | | | | Examination is by objective type questions | | | | | | | |
| | | | | **TOTAL** | **16** | **14** | **04** | **24** | **420** | **480** | **900** | **24** |
| | | | | | **OR** | **OR** | | **OR** | **OR** | **OR** | | |
| | | | | | **19** | **12** | | **26** | **360** | **540** | | |

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**Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | NCMC | 18MATDIP41 | Additional Mathematics - I | Mathematics | 02 | 01 | -- | 03 | 40 | 60 | 100 | 0 |

(a) The mandatory non – credit courses Additional Mathematics I and II prescribed for III and IV semesters respectively, to the lateral entry Diploma holders admitted to III semester of BE/B. Tech programs, shall attend the classes during the respective semesters to complete all the formalities of the course and appear for the University examination. In case, any student fails to register for the said course/ fails to secure the minimum 40 % of the prescribed CIE marks, he/she shall be deemed to have secured F grade. In such a case, the student have to fulfill the requirements during subsequent semester/s to appear for SEE.

(b) These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.

**Courses prescribed to lateral entry B. Sc degree holders admitted to III semester of Engineering programs**

Lateral entrant students from B.Sc. Stream, shall clear the non-credit courses Engineering Graphics and Elements of Civil Engineering and Mechanics of the First Year Engineering Programme. These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.

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**VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI**
**Scheme of Teaching and Examination 2018 – 19**
**Outcome Based Education(OBE) and Choice Based Credit System (CBCS)**
**(Effective from the academic year 2018 – 19)**

**V SEMESTER**

| Sl. No | Course and Course code | | Course Title | Teaching Department | Teaching Hours /Week | | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theory Lecture | Tutorial | Practical/ Drawing | Duration in hours | CIE Marks | SEE Marks | Total Marks | |
| | | | | | L | T | P | | | | | |
| 1 | PCC | 18ME51 | Management and Economics | ME | 2 | 2 | -- | 03 | 40 | 60 | 100 | 3 |
| 2 | PCC | 18SM52 | Machine Design | ME | 3 | 2 | -- | 03 | 40 | 60 | 100 | 4 |
| 3 | PCC | 18SM53 | Control Engineering | ME | 3 | 2 | -- | 03 | 40 | 60 | 100 | 4 |
| 4 | PCC | 18SM54 | Advanced Dynamics of Machinery | ME | 3 | -- | -- | 03 | 40 | 60 | 100 | 3 |
| 5 | PCC | 18SM55 | Mechatronics | ME | 3 | -- | -- | 03 | 40 | 60 | 100 | 3 |
| 6 | PCC | 18sM56 | Additive Manufacturing | ME | 3 | -- | -- | 03 | 40 | 60 | 100 | 3 |
| 7 | PCC | 18SML57 | Mechatronics Lab | ME | -- | 2 | 2 | 03 | 40 | 60 | 100 | 2 |
| 8 | PCC | 18SML58 | Smart Manufacturing Lab-1 | ME | -- | 2 | 2 | 03 | 40 | 60 | 100 | 2 |
| 9 | HSMC | 18CIV59 | Environmental Studies | Civil/ Environmental | 1 | -- | -- | 02 | 40 | 60 | 100 | 1 |
| | | | | **TOTAL** | **18** | **10** | **04** | **26** | **360** | **540** | **900** | **25** |

**Note:** PCC: Professional Core, HSMC: Humanity and Social Science.

**AICTE activity Points:** In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

07.01.2023

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
## Scheme of Teaching and Examination 2018 – 19
## Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
## (Effective from the academic year 2018 – 19)

**VI SEMESTER**

| Sl. No | Course and Course code | | Course Title | Teaching Department | Teaching Hours /Week | | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theory Lecture | Tutorial | Practical/ Drawing | Duration in hours | CIE Marks | SEE Marks | Total Marks | |
| | | | | | L | T | P | | | | | |
| 1 | PCC | 18SM61 | Finite Element Method | ME | 3 | 2 | -- | 03 | 40 | 60 | 100 | 4 |
| 2 | PCC | 18SM62 | Robotics and Automation | ME | 3 | 2 | -- | 03 | 40 | 60 | 100 | 4 |
| 3 | PCC | 18SM63 | Hydraulics and Pneumatics | ME | 3 | 2 | -- | 03 | 40 | 60 | 100 | 4 |
| 4 | PEC | 18SM64X | Professional Elective -1 | ME | 3 | -- | -- | 03 | 40 | 60 | 100 | 3 |
| 5 | OEC | 18SM65 | Industrial Internet of Things | ME/CSE | 3 | -- | -- | 03 | 40 | 60 | 100 | 3 |
| 6 | PCC | 18SML66 | Smart Manufacturing Lab 2 | ME | -- | 2 | 2 | 03 | 40 | 60 | 100 | 2 |
| 7 | PCC | 18SML67 | Computer Aided Modeling and Analysis Lab | ME | -- | 2 | 2 | 03 | 40 | 60 | 100 | 2 |
| 8 | MP | 18SMMP68 | Mini-project | ME | -- | -- | 2 | 03 | 40 | 60 | 100 | 2 |
| 9 | Internship | -- | Internship | To be carried out during the vacation/s of VI and VII semesters and /or VII and VIII semesters. | | | | | | | | |
| | | | | **TOTAL** | **15** | **10** | **06** | **24** | **320** | **480** | **800** | **24** |

**Note: PCC: Professional core, PEC: Professional ElectiveOE: Open Elective(Freezed),, MP: Mini-project.**

**Professional Elective -1**

| Course code under 18XX64X | Course Title | Course code under 18XX64X | Course Title |
|---|---|---|---|
| 18SME641 | **Cloud Computing** | 18SME643 | **Micro & Smart System Technology** |
| 18SME642 | **Composite Materials Technology** | 18SME644 | **Non Traditional machining** |

**Open Elective -A**

Students can select any one of the open electives offered by other Departments expect those that are offered by the parent Department (Please refer to the list of open electives under 18XX65X).
Selection of an open elective shall not be allowed if,

- The candidate has studied the same course during the previous semesters of the programme.
- The syllabus content of open elective is similar to that of the Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters of the programme.

Registration to electives shall be documented under the guidance of Programme Coordinator/ Advisor/Mentor.

**Mini-project work:**
Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students.
**CIE procedure for Mini-project:**
**(i) Single discipline:** The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.
The CIE marks awarded for the Mini-project work, shall be based on the evaluation of project report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.
**(ii) Interdisciplinary:** Continuous Internal Evaluation shall be group wise at the college level with the participation of all the guides of the college. The CIE marks awarded for the Mini-project, shall be based on the evaluation of project report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.
**SEE for Mini-project:**
**(i) Single discipline:** Contribution to the Mini-project and the performance of each group member shall be assessed individually in the semester end examination (SEE) conducted at the department.
**(ii) Interdisciplinary:** Contribution to the Mini-project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted separately at the departments to which the student/s belongs to.
**Internship:** All the students admitted to III year of BE/B. Tech shall have to undergo mandatory internship of 4 weeks during the vacation of VI and VII semesters and /or VII and VIII semesters. A University examination shall be conducted during VIII semester and the prescribed credit shall be included in VIII semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared fail and shall have to complete during subsequent University examination after satisfying the internship requirements.

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
## Scheme of Teaching and Examination 2018 – 19
## Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
## (Effective from the academic year 2018 – 19)

**VII SEMESTER**

| Sl. No | Course and Course code | | Course Title | Teaching Department | Teaching Hours /Week | | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theory Lecture | Tutorial | Practical/ Drawing | Duration in hours | CIE Marks | SEE Marks | Total Marks | |
| | | | | | L | T | P | | | | | |
| 1 | PCC | 18SM71 | Artificial intelligence and Machine Learning | ME | 3 | -- | -- | 03 | 40 | 60 | 100 | 3 |
| 2 | PCC | 18SM72 | Geometric Modeling for CAD & Computer Graphics | ME | 3 | -- | -- | 03 | 40 | 60 | 100 | 3 |
| 3 | PEC | 18SM73X | Professional Elective - 2 | ME | 3 | -- | -- | 03 | 40 | 60 | 100 | 3 |
| 4 | PEC | 18SM74X | Professional Elective - 3 | ME | 3 | -- | -- | 03 | 40 | 60 | 100 | 3 |
| 5 | OEC | 18SM75X | Product Design and Development | ME | 3 | -- | -- | 03 | 40 | 60 | 100 | 3 |
| 6 | PCC | 18SML76 | Computer Graphics & AR/VR Laboratory | ME | -- | 2 | 2 | 03 | 40 | 60 | 100 | 2 |
| | PCC | 18SML77 | Artificial intelligence and Machine Learning Lab | ME | -- | 2 | 2 | 03 | 40 | 60 | 100 | 2 |
| 7 | Project | 18SMP78 | Project Work Phase - 1 | ME | -- | -- | 2 | -- | 100 | -- | 100 | 1 |
| 8 | Internship | -- | Internship | (If not completed during the vacation of VI and VII semesters, it shall be carried out during the vacation of VII and VIII semesters ) | | | | | | | | |
| | | | | **TOTAL** | **15** | **04** | **06** | **18** | **340** | **360** | **700** | **20** |

**Professional Elective - 2**

| Course code under 18XX73X | Course Title | Course code under 18XX73X | Course Title |
|---|---|---|---|
| 18SM731 | **Design for Manufacture** | 18SM733 | **Automation and Robotics** |
| 18SM732 | **Lean Manufacturing** | 18SM734 | **Block Chain** |

**Professional Electives - 3**

| Course code under 18XX74X | Course Title | Course code under 18XX74X | Course Title |
|---|---|---|---|
| 18ME741 | **Management Information Systems** | 18ME743 | **Total Quality Management** |
| 18ME742 | **Tribology and Bearing Design** | 18ME744 | **Flexible Manufacturing Systems** |

**Open Elective –B (fREEZED)**

Students can select any one of the open electives offered by other Departments expect those that are offered by the parent Department (Please refer to the list of open electives under 18XX75X).

Selection of an open elective shall not be allowed if,

- The candidate has studied the same course during the previous semesters of the programme.
- The syllabus content of open elective is similar to that of the Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters of the programme.

Registration to electives shall be documented under the guidance of Programme Coordinator/ Advisor/Mentor.

**Project work:**

Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary project can be assigned to an individual student or to a group having not more than 4 students. In extraordinary cases, like the funded projects requiring students from different disciplines, the project student strength can be 5 or6.

**CIE procedure for Project Work Phase - 1:**

**(i) Single discipline:** The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the project work phase -1, shall be based on the evaluation of the project work phase -1 Report (covering Literature Survey, Problem identification, Objectives and Methodology), project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the Project report shall be the same for all the batch mates.

**(ii)** Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable.

The CIE marks awarded for the project work phase -1, shall be based on the evaluation of project work phase -1 Report (covering Literature Survey, Problem identification, Objectives and Methodology), project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

**Internship:** All the students admitted to III year of BE/B. Tech shall have to undergo mandatory internship of 4 weeks during the vacation of VI and VII semesters and /or VII and VIII semesters. A University examination shall be conducted during VIII semester and the prescribed credit shall be included in VIII semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared fail and shall have to complete during subsequent University examination after satisfying the Internship requirements.

07.01.2023

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
## Scheme of Teaching and Examination 2018 – 19
## Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
## (Effective from the academic year 2018 – 19)

**VIII SEMESTER**

| Sl. No | Course and Course code | | Course Title | Teaching Department | Teaching Hours /Week | | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theory Lecture | Tutorial | Practical/ Drawing | Duration in hours | CIE Marks | SEE Marks | Total Marks | |
| | | | | | L | T | P | | | | | |
| 1 | PCC | 18SME81 | **Advanced Smart Manufacturing Techniques** | ME | 3 | -- | -- | 03 | 40 | 60 | 100 | 3 |
| 2 | PEC | 18SME82X | **Professional Elective - 4** | ME | 3 | -- | -- | 03 | 40 | 60 | 100 | 3 |
| 3 | Project | 18SMEP83 | **Project Work Phase - 2** | ME | -- | -- | 2 | 03 | 40 | 60 | 100 | 8 |
| 4 | Seminar | 18MES84 | **Technical Seminar** | ME | -- | -- | 2 | 03 | 100 | -- | 100 | 1 |
| 5 | Internship | 18SM85 | Internship | Completed during the vacation/s of VI and VII semesters and /or VII and VIII semesters.) | | | | 03 | 40 | 60 | 100 | 3 |
| | | | **TOTAL** | | **06** | **--** | **04** | **15** | **260** | **240** | **500** | **18** |

**Note:** PCC: Professional Core, PEC: Professional Elective.

**Professional Electives - 4**

| Course code under 18XX82X | Course Title | Course code under 18XX82X | Course Title |
|---|---|---|---|
| 18ME821 | **Optimization Techniques** | 18ME823 | **Project Management** |
| 18ME822 | **Non-Destructive Testing and Evaluation** | 18ME824 | **Industrial Safety** |

**Project Work**

**CIE procedure for Project Work Phase - 2:**

**(i) Single discipline:** The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

**(ii) Interdisciplinary:** Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable.

The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

**SEE for Project Work Phase - 2:**

**(i) Single discipline:** Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted at the department.

**(ii) Interdisciplinary:** Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted separately at the departments to which the student/s belongs to.

**Internship:** Those, who have not pursued /completed the internship, shall be declared as fail and have to complete during subsequent University examination after satisfying the internship requirements.

**AICTE activity Points:** In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

Activity points of the students who have earned the prescribed AICTE activity Points shall be sent the University along with the CIE marks of 8th semester. In case of students who have not satisfied the AICTE activity Points at the end of eighth semester, the column under activity Points shall be marked NSAP (Not Satisfied Activity Points).

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY BELAGAVI

Scheme of Teaching and Examination and Syllabus

B.E. **MECHANICAL AND SMART MANUFACTURING**

III SEMESTER

**(Effective from Academic year 2020-21)**

**VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI**
**Scheme of Teaching and Examination 2018 – 19**
**Outcome Based Education(OBE) and Choice Based Credit System (CBCS)**
**(Effective from the academic year 2020-21)**

**Programme: MECHANICAL AND SMART MANUFACTURING**

**III SEMESTER**

| Sl. No | Course and Course Code | | Course Title | Teaching Department | Teaching Hours /Week | | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theory Lecture | Tutorial | Practical/ Drawing | Duration in hours | CIE Marks | SEE Marks | Total Marks | |
| | | | | | L | T | P | | | | | |
| 1 | BSC | 18MAT31 | Transform Calculus, Fourier Series and Numerical Techniques (Common to all Branches) | Mathematics | 2 | 2 | -- | 03 | 40 | 60 | 100 | 3 |
| 2 | PCC | 18 ME32 | Mechanics of Materials | ME | 3 | 2 | -- | 03 | 40 | 60 | 100 | 4 |
| 3 | PCC | 18 SM 33 | Thermodynamics | ME | 3 | 0 | -- | 03 | 40 | 60 | 100 | 3 |
| 4 | PCC | 18 SM 34 | Theory of Machines | ME | 3 | 0 | -- | 03 | 40 | 60 | 100 | 3 |
| 5 | PCC | 18 SM 35 | Material Science & Processing Technologies | ME | 3 | 0 | -- | 03 | 40 | 60 | 100 | 3 |
| 6 | PCC | 18 SM 36 | Manufacturing Process-I | ME | 3 | 0 | -- | 03 | 40 | 60 | 100 | 3 |
| 7 | PCC | 18 SM L37 | Material Testing Laboratory | ME | -- | 2 | 2 | 03 | 40 | 60 | 100 | 2 |
| 8 | PCC | 18 SML38 | Manufacturing Process-I Lab | ME | -- | 2 | 2 | 03 | 40 | 60 | 100 | 2 |
| 9 | HSMC | 18KVK39 | Vyavaharika Kannada (Kannada for communication)/ | HSMC | -- | 2 | -- | -- | 100 | -- | 100 | 1 |
| | | 18KAK39 | Balake Kannada (Kannada for Administration) | | | | | | | | | |
| | | **OR** | | | | | | | | | | |
| | | 18CPC39 | Constitution of India, Professional Ethics and Cyber Law | | 1 | -- | -- | 03 | 40 | 60 | | |
| | | | | | Examination is by objective type questions | | | | | | | |
| | | | | **TOTAL** | **17** | **10** | **04** | **24** | **420** | **480** | **900** | **24** |
| | | | | | **OR** | **OR** | | **OR** | **OR** | **OR** | | |
| | | | | | **18** | **08** | | **27** | **360** | **540** | | |

**Note:** BSC: Basic Science, PCC: Professional Core, HSMC: Humanity and Social Science, NCMC: Non-credit mandatory course.

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**Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs**

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
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(b)These Courses shall not beconsidered for vertical progression, but completion of the courses shall be mandatory for the award of degree.

**Continued**

**VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI**
**Scheme of Teaching and Examination 2018 – 19**
**Outcome Based Education(OBE) and Choice Based Credit System (CBCS)**
**(Effective from the academic year 2020-21)**

**Programme: MECHANICAL AND SMART MANUFACTURING**

**III SEMESTER (continued)**

**Courses prescribed to lateral entry B.Sc degree holders admitted to III semester of Engineering programs**

Lateral entrant students from B.Sc. Stream, shall clear the non-credit courses Engineering Graphics and Elements of Civil Engineering and Mechanics of the First Year Engineering Programme. These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.

**AICTE Activity Points to be earned by students admitted to BE/B.Tech/B.Plan day college programme (For more details refer to Chapter 6,AICTE Activity Point Programme, Model Internship Guidelines):**

Over and above the academic grades, every Day College regular student admitted to the 4 years Degree programme and every student entering 4 years Degree programme through lateral entry, shall earn 100 and 75 Activity Points respectively for the award of degree through AICTE Activity Point Programme. Students transferred from other Universities to fifth semester are required to earn 50 Activity Points from the year of entry to VTU. The Activity Points earned shall be reflected on the student's eighth semester Grade Card.

The activities can be can be spread over the years, anytime during the semester weekends and holidays, as per the liking and convenience of the student from the year of entry to the programme. However, minimum hours' requirement should be fulfilled. Activity Points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression.

In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

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**SEMESTER - III**

## TRANSFORM CALCULUS, FOURIER SERIES AND NUMERICAL TECHNIQUES
(Common to all Branches)

| | | | |
|---|---|---|---|
| Course Code | 18MAT31 | CIE Marks | 40 |
| TeachingHours/Week (L:T:P) | (2:2:0) | SEE Marks | 60 |
| Credits | 03 | Exam Hours | 03 |

**Course objectives:**

- To have an insight into Fourier series, Fourier transforms, Laplace transforms, Difference equations and Z-transforms.
- To develop the proficiency in variational calculus and solving ODE's arising in engineering applications, using numerical methods.

**Module-1**

**Laplace Transforms:** Definition and Laplace transform of elementary functions. Laplace transforms of Periodic functions and unit-step function – problems.
**Inverse Laplace Transforms:** Inverse Laplace transform - problems, Convolution theorem to find the inverse Laplace transform(without proof) and problems, solution of linear differential equations using Laplace transform.

**Module-2**

**Fourier Series:** Periodic functions, Dirichlet's condition. Fourier series of periodic functions period $2\pi$ and arbitrary period. Half range Fourier series. Practical harmonic analysis, examples from engineering field.

**Module-3**

**Fourier Transforms:** Infinite Fourier transforms, Fourier sine and cosine transforms. Inverse Fourier transforms. Simple problems.
**Difference Equations and Z-Transforms:** Difference equations, basic definition, z-transform-definition, Standard z-transforms, Damping and shifting rules, initial value and final value theorems (without proof) and problems, Inverse z-transform. Simple problems.

**Module-4**

**Numerical Solutions of Ordinary Differential Equations (ODE's):** Numerical solution of ODE's of first order and first degree- Taylor's series method, Modified Euler's method. Range - Kutta method of fourth order, Milne's and Adam-Bashforth predictor and corrector method (No derivations of formulae), Problems.

**Module-5**

**Numerical Solution of Second Order ODE's:**Runge-Kutta method and Milne's predictor and corrector method.(No derivations of formulae).
**Calculus of Variations:**Variation of function and functional, variational problems, Euler's equation, Geodesics, hanging chain, problems.

**Continued**

**Course outcomes:**

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

- CO1: Use Laplace transform and inverse Laplace transform in solving differential/ integral equation arising in network analysis, control systems and other fields of engineering.
- CO2: Demonstrate Fourier series to study the behaviour of periodic functions and their applications in system communications, digital signal processing and field theory.
- CO3: Make use of Fourier transform and Z-transform to illustrate discrete/continuous function arising in wave and heat propagation, signals and systems.
- CO4: Solve first and second order ordinary differential equations arising in engineering problems using single step and multistep numerical methods.
- CO5:Determine the extremals of functionals using calculus of variations and solve problems arising in dynamics of rigid bodies and vibrational analysis.

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

| Sl No | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbooks** | | | | |
| 1 | Advanced Engineering Mathematics | E. Kreyszig | John Wiley & Sons | 10th Edition, 2016 |
| 2 | Higher Engineering Mathematics | B.S. Grewal | Khanna Publishers | 44th Edition, 2017 |
| 3 | Engineering Mathematics | Srimanta Pal et al | Oxford University Press | 3rd Edition, 2016 |
| **Reference Books** | | | | |
| 1 | Advanced Engineering Mathematics | C.Ray Wylie, Louis C.Barrett | McGraw-Hill Book Co | 6th Edition, 1995 |
| 2 | Introductory Methods of Numerical Analysis | S.S.Sastry | Prentice Hall of India | 4th Edition 2010 |
| 3 | Higher Engineering Mathematics | B.V.Ramana | McGraw-Hill | 11th Edition,2010 |
| 4 | A Text Book of Engineering Mathematics | N.P.Bali and Manish Goyal | Laxmi Publications | 2014 |

**Web links and Video Lectures:**

1. http://nptel.ac.in/courses.php?disciplineID=111
2. http://www.class-central.com/subject/math(MOOCs)
3. http://academicearth.org/
4. VTU EDUSAT PROGRAMME - 20

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**MECHANICS OF MATERIALS**

| | | | |
|---|---|---|---|
| Course Code | 18ME32 | CIE Marks | 40 |
| Teaching Hours/Week (L:T:P) | (3:2:0) | SEE Marks | 60 |
| Credits | 04 | Exam Hours | 03 |

**Course objectives:**

- To know the different types of stresses and strains developed in the member subjected to axial, bending, shear, torsion & thermal loads.
- To know behaviour & properties of engineering materials.
- To understand the stresses developed in bars, compounds bars, beams, shafts, and cylinders.
- To understand the concepts of calculation of shear force and bending moment for beams with different supports.
- To expose the students to concepts of Buckling of columns and strain energy.

**Module-1**

Stresses and Strains: Introduction, Properties of materials, Stress, Strain and Hooke's law, Stress strain diagram for brittle and ductile materials, True stress and strain, Calculation of stresses in straight, Stepped and tapered sections, Composite sections, Stresses due to temperature change, Shear stress and strain, Lateral strain and Poisson's ratio, Elastic constants and relations between them.

**Module-2**

Analysis of Stress and Strain: Introduction to three dimensional state of stress, Stresses on inclined planes, Principal stresses and maximum shear stress, Principal angles, Shear stresses on principal planes, Maximum shear tress, Mohr circle for plane stress conditions. Cylinders: Thin cylinder: Hoop's stress, maximum shear stress, circumferential and longitudinal strains, Thick cylinders: Lames equations.

**Module-3**

Shear Force and Bending Moment: Type of beams, Loads and reactions, Relationship between loads, shear forces and bending moments, Shear force and bending moments of cantilever beams, Pin support and roller supported beams subjected to concentrated loads, uniformly distributed constant / varying loads. Stress in Beams: Bending and shear stress distribution in rectangular, I and T section beams.

**Module-4**

Theories of Failure: Maximum Principal stress theory, Maximum shear stress theory. Torsion: Circular solid and hallow shafts, Torsional moment of resistance, Power transmission of straight and stepped shafts, Twist in shaft sections, Thin tubular sections, Thin walled sections.

**Module-5**

Columns: Buckling and stability, Critical load, Columns with pinned ends, Columns with other support conditions, Effective length of columns, Secant formula for columns. Strain Energy: Strain energy due to axial, shear, bending, torsion and impact load. Castigliano's theorem I and II and their applications.

**Course outcomes:**

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

- CO1: Understand simple, compound, thermal stresses and strains their relations and strain energy.
- CO2: Analyse structural members for stresses, strains and deformations.
- CO3: Analyse the structural members subjected to bending and shear loads.
- CO4: Analyse shafts subjected to twisting loads.
- CO5: Analyse the short columns for stability.

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

| Sl No | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Mechanics of Materials | Mechanics of Materials J M Gere, B J Goodno, | Cengage | Eighth edition 2013 |
| 2 | Fundamentals of Strength of Materials | P N Chandramouli | PHI Learning Pvt. Ltd | 2013 |
| 3 | Strength of Materials | R K Rajput | S. Chand and Company Pvt. Ltd | 2014 |
| **Reference Books** | | | | |
| 1 | Strength of Materials | R. Subramanian | Oxford | 2005 |
| 2 | Strength of Materials | S. S. Ratan | Tata McGraw Hill | 2nd Edition, 2008 |
| 3 | Mechanics of materials Strength of Materials | S C Pilli and N Balasubramanya | Cengage | 2019 |
| 4 | Mechanics of Materials F | Ferdinand Beer, Russell Johston, | McGraw Hill Education (India) Pvt. Ltd | Latest edition |
| 5 | Mechanics of Materials | R C Hibbeler | Pearson | Latest edition |
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**ENGINEERING THERMODYNAMICS**

| | | | |
|---|---|---|---|
| Course Code | 18SM32 | CIE Marks | 40 |
| TeachingHours/Week (L:T:P) | (3:2:0) | SEE Marks | 60 |
| Credits | 04 | Exam Hours | 03 |

**Course objectives:**

- Learn about thermodynamic system and its equilibrium
- Understand various forms of energy - heat transfer and work
- Study the basic laws of thermodynamics including, zeroth law, first law and second law.
- To understand the applications of the first and second laws of Thermodynamics to various gas processes and cycles.
- To study the Carnot Cycle and the concept of Entropy
- To understand the various Air standard and Vapor power cycles and their Performance.
- To understand the concepts related to Refrigeration and Air conditioning.
- To get conversant with Psychrometric Charts, Psychrometric processes, human comfort conditions.

**Module-1**

**Introduction:** Role of Thermodynamics in Engineering and Science, Applications of Thermodynamics: Power Generation, Thermal Environment Control, Cooling of Electrical Systems and Electronic Devices, Analysis of Manufacturing Processes. **Basic Definitions:** Thermodynamic System and Control Volume, Surroundings. Macroscopic and Microscopic Analysis. Definition of Substance, Properties of Substance, Intensive and Extensive, Mathematical Representation of Property, State of substance. Thermodynamic Equilibrium, Concept of Quasi Equilibrium Process and Cycle. Fundamental Units, Units of Force, Energy, Specific Volume, Pressure etc. Equality of Temperature, The Zeroth Law of Thermodynamics, Temperature Scales. **Pure Substance:** Definition of Pure Substance, Vapor - liquid - solid Phase Equilibrium, Equation of State for the Vapor Phase: Simple substance, Ideal Gas Characterization, Ideal Gas Equation, Compressibility Effects, Real Gases.

**Module-2**

**Heat and Work:** Definition of Thermodynamic Work, Units for Work, Forms of Work. Definition of Heat, Inter Convertibility of Heat/work into Work/heat, Governing Principles, Sign Convention. **First Law of Thermodynamics:** Statement of First Law of Thermodynamics: First Law for Cyclic Process, First Law for Change of State of a System. Internal Energy, A New Thermodynamic Property. Enthalpy, The Constant Volume and Constant Pressure Specific Heats, Internal Energy, Enthalpy and Specific Heats of An Ideal Gas, First Law as a Rate Equation, First Law Applied to a Control Volume. The SSSF and USUF Processes.

**Module-3**

**Second Law of Thermodynamics:** Definition of Heat Engine and Reservoirs, Kelvin-Planck and Clausius Statements of the Second Law, Reversible and Irreversible Engines and processes, Causes of Irreversibility, Internal and External Irreversibility. **Carnot Cycle:** Efficiency of a Carnot Cycle, Thermodynamic Temperature Scale, Ideal Gas Temperature Scale. **Entropy:** Clausius Inequality, Entropy - A Property of a System, Entropy of A Pure Substance, Entropy Change in Reversible Process, Thermodynamic Property Relation, Calculation of Change in Entropy, Principle of Increase of Entropy.

**Module-4**

**Analysis of Power Generation Cycles:** Air-standard Power Cycles, Concept, Carnot Cycle, Otto Cycles, Diesel Cycle, Dual Cycle, Brayton Cycle. Efficiency and Mean Effective Pressure. Vapor Power Cycles, Concept, Carnot Cycle, Rankine Cycle, Effect of Temperature and Pressure on The Rankine Cycle, Superheat Cycle, Reheat Cycle, Regenerative Cycle, Deviation of Actual Cycle from Ideal Cycles.

**Module-5**

**Analysis of Refrigeration Cycles:** Air-standard Cycles, Joule Cycle. Introduction to Refrigeration Systems, Vapor-compression Refrigeration Cycle, Vapor-absorption Cycle.

**Psychometrics and Air-conditioning Systems:** Psychometric properties of Air, Psychometric Chart, Analysing Air-conditioning Processes; Heating, Cooling, Dehumidification and Humidification, Evaporative Cooling. Cooling towers

**Course outcomes:**

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

- Explain fundamentals of thermodynamics and evaluate energy interactions across the boundary of thermodynamic systems.
- Evaluate the feasibility of cyclic and non-cyclic processes using second law of thermodynamics
- Apply the knowledge of entropy, reversibility and irreversibility to solve numerical problems and apply 1st law of thermodynamics to closed and open systems and determine quantity of energy transfers and change in properties
- Apply thermodynamic concepts to analyse the performance of gas power cycles.
- Apply thermodynamic concepts to analyse the performance of vapour power cycles
- Understand the principles and applications of refrigeration systems.
- Apply Thermodynamic concepts to determine performance parameters of refrigeration and air conditioning systems

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The student will have to answer five full questions, selecting one full question from each module.

| Sl No | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Basic and Applied Thermodynamics | P.K.Nag | Tata McGraw Hill | 2nd Ed., 2002 |
| 2 | Basic Engineering Thermodynamics | A.Venkatesh | Universities Press, | 2008 |
| 3 | Applications of Thermodynamics | V.Kadambi, T. R.Seetharam, K. B. Subramanya | Wiley Indian Private Ltd | 1st Edition 2019 |
| 4 | An Introduction to Thermo Dynamics | Y.V.C.Rao | Wiley Eastern Ltd | 2003 |
| **Reference Books** | | | | |
| 1 | Thermodynamics- An Engineering Approach | YunusA.Cenegal and Michael A.Boles | Tata McGraw Hill publications | 2002 |
| 2 | Thermodynamics for engineers | Kenneth A. Kroos and Merle C. Potter | Cengage Learning | 2016 |
| 3 | Engineering Thermodynamics | J.B.Jones and G.A.Hawkins | John Wiley and Sons. | |
| 4 | Thermodynamics | Radhakrishnan | PHI | 2nd revised edition |
| 5 | Principles of Engineering Thermodynamics | Michael J, Moran, Howard N. Shapiro | Wiley | 8th Edition |

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## THEORY OF MACHINES

| | | | |
|---|---|---|---|
| Course Code | 18SM34 | CIE Marks | 40 |
| Teaching Hours/Week (L:T:P) | (3:0:0) | SEE Marks | 60 |
| Credits | 03 | Exam Hours | 03 |

**Course objectives:**

- To understand the concept of machines, mechanisms and related terminologies.
- To expose the students to various mechanisms and motion transmission elements used in Mechanical Engineering.
- To analyze a mechanism for displacement, velocity and acceleration at any point in a moving link.
- To understand the theory of cams, gears and gear trains.

**Module-1**

**Mechanisms:** Definitions: Link , types of links, joint, types of joints kinematic pairs, Constrained motion, kinematic chain, mechanism and types , degrees of freedom of planar mechanisms, Equivalent mechanisms, Groshoff's criteria and types of four bar mechanisms, , inversions of of four bar chain, slider crank chain, Doubler slider crank chain and its inversions, Grashoff's chain. Mechanisms: Quick return motion mechanismsDrag link mechanism, Whitworth mechanism and Crank and slotted lever Mechanism. Straight line motion mechanisms, Peaucellier's mechanism and Robert's mechanism. Intermittent Motion mechanisms: Geneva wheel mechanism, Ratchet and Pawl mechanism, toggle mechanism, pantograph, condition for correct steering, Ackerman steering gear mechanism.

**Module-2**

**Velocity and Acceleration Analysis of Mechanisms (Graphical Method):** Velocity and acceleration analysis of four bar mechanism, slider crank mechanism. Mechanism illustrating Corioli's component of acceleration. Angular velocity and angular acceleration of links, velocity of rubbing. Velocity Analysis by Instantaneous Center Method: Definition, Kennedy's theorem, Determination of linear and angular velocity using instantaneous center method.

**Module-3**

**Velocity and Acceleration Analysis of Mechanisms (Analytical Method):** Velocity and acceleration analysis of four bar mechanism, slider crank mechanism using complex algebra method. Freudenstein's equation for four bar mechanism and slider crank mechanism. Function Generation for four bar mechanism.

**Module-4**

**Cams:** Classification of cams, Types of followers, Cam nomenclature, Follower motions and motion analysis, of SHM, Motion with uniform acceleration and deceleration, uniform velocity, cycloidal motion, Cam profile with offset knife edge follower, roller follower, flat faced follower.

**Module-5 Spur Gears:** Gear terminology, law of gearing, path of contact, arc of contact, contact ratio of spur gear. Interference in involute gears, methods of avoiding interference, condition and expressions for minimum number of teeth to avoid interference. Gear Trains: Simple gear trains, compound gear trains. Epicyclic gear trains: Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains, torque calculation in epicyclic gear trains.

**Course outcomes:**

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

- Knowledge of mechanisms and their motion.
- Understand the inversions of four bar mechanisms.
- Analyse the velocity, acceleration of links and joints of mechanisms.
- Analysis of cam follower motion for the motion specifications.
- Understand the working of the spur gears.
- Analyse the gear trains speed ratio and torque.

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

| Sl No | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Theory of Machines Kinematics and Dynamics | Sadhu Singh | Pearson | Third edition 2019 |
| 2 | Mechanism and Machine Theory | G. Ambekar | PHI | 2009 |
| **Reference Books** | | | | |
| 1 | Theory of Machines | Rattan S.S | Tata McGraw-Hill Publishing Company | 2014 |
| 2 | Mechanisms and Machines Kinematics, Dynamics and Synthesis | Michael M Stanisic | Cengage Learning | 2016 |
| | | | | |

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## MATERIAL SCIENCE & PROCESSING TECHNOLOGIES

| | | | |
|---|---|---|---|
| Course Code | 18SM35 | CIE Marks | 40 |
| Teaching Hours/Week (L:T:P) | (3:0:0) | SEE Marks | 60 |
| Credits | 03 | Exam Hours | 03 |

Course Objectives:

- The foundation for understanding the structure and various modes of failure in materials common in mechanical engineering.
- Topics are designed to explore the mechanical properties of metals and their alloys, polymers, ceramics ,smart materials and composites.
- The means of modifying such properties, as well as the processing and failure of materials.
- Concepts of use of materials for various applications are highlighted.

**Module-1**

**Basics, Mechanical Behaviour, Failure of Materials**

Introduction to Crystal Structure – Coordination number, atomic packing factor, Simple Cubic, BCC, FCC and HCP Structures, Crystal imperfections – point, line, surface and volume imperfections, Atomic Diffusion: Phenomenon, Fick's laws of diffusion;Factors affecting diffusion.

**Mechanical Behavior**:

Stress-strain diagrams showing ductile and brittle behavior of materials, Engineering and true strains, Linear and non-linear elastic behavior and properties, Mechanical properties in plastic range. Stiffness, Yield strength, Offset Yield strength, Ductility, Ultimate Tensile strength, Toughness, Plastic deformation of
single crystal by slip and twinning, Mechanisms of strengthening in metals

**Fracture:** Type I, Type II and Type III,

**Fatigue:** Types of fatigue loading with examples, Mechanism of fatigue, Fatigue properties, S-N diagram, Fatigue testing.

**Creep:** Description of the phenomenon with examples, three stages of creep, creep properties, Stress relaxation. Concept of fracture toughness.

**Module-2**

**Alloys, Steels, Solidification**

Concept of formation of alloys: Types of alloys, solid solutions, factors affecting solid solubility (Hume Rothery rules), Binary phase diagrams: Eutectic, and Eutectoid systems, Lever rule, Substitutional and interstitial solid solutions, Intermediate phases, Gibbs phase rule Effect of non- equilibrium cooling, Coring and
Homogenization Iron-Carbon (Cementite) diagram: description of phases, Specifications of steels. Solidification: Mechanism of solidification, Homogenous and Heterogeneous nucleation, Crystal growth, Numerical on lever rule

**Module-3**

**Heat Treatment, Ferrous and Non-Ferrous Alloys**

Heat treating of metals: Time-Temperature-Transformation (TTT) curves, Continuous Cooling Transformation (CCT) curves, Annealing: Recovery, Recrystallization and Grain growth, Types of annealing, Normalizing, Hardening, Tempering, Martempering, Austempering, Concept of hardenability, Factors affecting it , hardenability, surface hardening methods: carburizing, cyaniding, nitriding, flame hardening and induction hardening, Age hardening of aluminum-copper alloys

**Module-4**

**Polymers and polymerizations**: Structure and properties of thermoplastics and thermosets, Engineering Applications -property modifications -Mechanical and thermal behaviour –processing methods.

**Ceramics:** Nature and structure of Ceramics -Refractory Abrasives glasses -glass ceramics -Advanced ceramics processing methods.

**Other materials:** Smart materials and Shape Memory alloys, properties and applications.

**Module-5**

**Composites:** Definition; Classification and characteristics of composite materials, Volume fraction, Laminated composites, particulate composites, fibrous composites. Types of reinforcements, their shape and size, production and properties of fiber reinforced plastics, Metal Matrix composites and ceramic matrix composites and their Applications. Fundamentals of production of composites, Processes for production of composites, Constitutive relations of composites, Numerical problems on determining properties of composites.

**Course outcomes:**

- Describe the mechanical properties of metals, their alloys and various modes of failure.
- Understand the microstructures of ferrous and non-ferrous materials to mechanical properties.
- Explain the processes of heat treatment of various alloys.
- Understand the properties and potentialities of various materials available and material selection procedures.
- Know about composite materials and their processing as well as applications.

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The student will have to answer five full questions, selecting one full question from each module.

| Sl No | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Foundations of Materials Science and Engineering | Smith | McGraw Hill, | 4th Edition, 2009 |
| 2 | Material science and Engineering and Introduction, | William D. Callister | Wiley. | 2006 |
| **Reference Books** | | | | |
| 1 | Materials Science and Engineering | V.Raghavan | PHI | 2002 |
| 2 | The Science and Engineering of Materials | Donald R. Askland and Pradeep.P. Phule | Cengage Learning | 4lh Ed., 2003. |
| 3 | Mechanical Metallurgy | George Ellwood Dieter | McGraw-Hill | |
| 4 | ASM Handbooks | American Society of Metals | | |

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**SEMESTER - III**

## MANUFACTURING PROCESS-I

| | | | |
|---|---|---|---|
| Course Code | 20SM36 | CIE Marks | 40 |
| TeachingHours/Week (L:T:P) | (3:0:0) | SEE Marks | 60 |
| Credits | 03 | Exam Hours | 03 |

**Course objectives:**

- To provide knowledge of various casting process in manufacturing.
- To provide detailed information about the moulding processes.
- To Provide information on casting of ferrous and non-ferrous alloys and inspection techniques to detect defects.
- To acquaint with the basic knowledge on fundamentals of metal forming processes
- To study various metal forming processes.

**Module-1**

**INTRODUCTION & BASIC MATERIALS USED IN FOUNDRY**

**Introduction:** Definition, Classification of manufacturing processes. Metals cast in the foundry-classification, factors that determine the selection of a casting alloy.

Introduction to casting process & steps involved. Patterns: Definition, classification, materials used for pattern, various pattern allowances and their importance.

**Sand molding:** Types of base sand, requirement of base sand. Binder, Additives definition, need and types

**Preparation of sand molds:** Molding machines- Jolt type, squeeze type and Sand slinger. Study of important molding process: Green sand, core sand, dry sand, sweep mold, CO2 mold, shell mold, investment mold, plaster mold, cement bonded mold.Cores: Definition, need, types. Method of making cores, concept of gating (top, bottom, parting line, horn gate) and risering (open, blind) Functions and types

**Module-2**

**MELTING & METAL MOLD CASTING METHODS**

**Melting furnaces:** Classification of furnaces, Gas fired pit furnace, Resistance furnace, Coreless induction furnace, electric arc furnace, constructional features & working principle of cupola furnace.

**Casting using metal molds:** Gravity die casting, pressure die casting, centrifugal casting, squeeze casting, slush casting, thixocasting, and continuous casting processes.

**Module-3**

**SOLIDIFICATION & NON FERROUS FOUNDRY PRACTICE**

**Solidification**: Definition, Nucleation, solidification variables, Directional solidification-need and methods. Degasification in liquid metals-Sources of gas, degasification methods.

**Fettling and cleaning of castings:** Basic steps involved. Sand Casting defects- causes, features and remedies. Advantages & limitations of casting process.

**Nonferrous foundry practice**: Aluminum castings - Advantages, limitations, melting of aluminum using lift-out type crucible furnace. Hardeners used, drossing, gas absorption, fluxing and flushing, grain refining, pouring temperature. Stir casting set up, procedure, uses, advantages and limitations.

**Module-4**

**Mechanical Working of Metals:**

**Introduction to metal forming processes** & classification of metal forming processes. Hot working & cold working of metals.

**Forging:** Classification of forging processes. Forging machines equipment. Expressions for forging pressures & load in open die forging and closed die forging by slab analysis. Smith forging, drop forging & press forging. Forging Equipment, Defects in forging.

**Rolling**: Classification of rolling processes. Types of rolling mills, Variables of rolling process, expression for rolling load. Roll separating force, Rolling defects.

**Module-5**

**Drawing & Extrusion:** Drawing of wires, rods & pipes, Variables of drawing process. Difference between drawing & extrusion. Types of Extrusion: Direct, reverse, impact, hydrostatic extrusion. Dies for extrusion, stock penetration. Extrusion ratio of force equipment (with and without friction)

**Sheet Metal Operations:** Blanking, piercing, punching, drawing, draw ratio, drawing force, variables in Drawing, Trimming, and Shearing. Bending - types of bending dies, Bending force calculation, Embossing and coining. Types of dies: Progressive, compound and combination dies.

**Course outcomes:**

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

CO1: Understand the technology, variables and complexity involved in producing a casting.

CO2: Describe the casting process, preparation of Green, Core, dry sand molds and Sweep, Shell, Investment and plaster molds

CO3: Compare the Gravity, Pressure die, Centrifugal, Squeeze, slush and Continuous Metal mold castings.

CO4: Know about the special molding processes and when their use is warranted.

CO5: Explain the Solidification process and Casting of Non-Ferrous Metals

CO5: Compare the Gas fired pit, Resistance, Coreless, Electrical and Cupola Metal Furnaces.

CO6: Understand the concepts of different metal forming processes.

CO7: Apply the concepts of design of sheet metal dies to design different dies for simple sheet metal components

CO8: To approach metal forming processes both analytically and numerically

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The student will have to answer five full questions, selecting one full question from each module.

| Sl No | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Manufacturing Process-I | Dr.K. Radhakrishna | Sapna Book House | 5th Revised Edition 2009. |
| 2 | Manufacturing & Technology Foundry Forming and Welding | P.N.Rao | Tata McGraw Hill | 3rd Ed., 2003 |
| 3 | Workshop Technology | HazaraChoudhry | Media Promoters & Publishers Pvt. Ltd | Vol-II, 2004 |
| 4 | Production Technology | R. K. Jain | Khanna Publications | 2003 |
| 5 | Fundamentals of Metal casting | R.A.Flinn | Addison Wesley | 1963 |
| 6 | Principles of Metal casting | R.W. Heine, C.R.Lope r & P.C. Rosenthal | Tata McGraw Hill, | 2001 |
| **Reference Books** | | | | |
| 1 | Manufacturing Science | Amitabh Ghosh and | affiliated East West Press | 2003 |
| 2 | Fundamentals of Metal Machining and Machine. | G. Boothroyd | McGraw Hill | 2000 |
| 3 | Manufacturing Technology | SeropeKalpakjian , Steuen. R. Sechmid | Pearson Education Asia | 5th Ed. 2006 |
| 4 | Processes and Materials for Manufacturing | R.A. Lindberg | Pearson Education | 4th Ed. 2006 |

**B.E in Mechanical and Smart Manufacturing**
**Outcome Based Education (OBE) and Choice Based Credit System (CBCS)**
**SEMESTER - III**

## MATERIAL TESTING LABORATORY

| | | | |
|---|---|---|---|
| Course Code | 18MEL37 | CIE Marks | 40 |
| Teaching Hours/Week (L:T:P) | (2:2:0) | SEE Marks | 60 |
| Credits | 02 | Exam Hours | 03 |

### Course objectives:

- To learn the concept of the preparation of samples to perform characterization such as microstructure, volume fraction of phases and grain size.
- To understand mechanical behaviour of various engineering materials by conducting standard tests.
- To learn material failure modes and the different loads causing failure.
- To learn the concepts of improving the mechanical properties of materials by different methods like heat treatment, surface treatment etc.

| Sl. NO | Experiments |
|---|---|
| | **PART A** |
| 1 | Preparation of specimen for Metallographic examination of different engineering materials. To report microstructures of plain carbon steel, tool steel, gray C.I, SG iron, Brass, Bronze & composites. |
| 2 | Heat treatment: Annealing, normalizing, hardening and tempering of steel. Metallographic specimens of heat treated components to be supplied and students should report microstructures of furnace cooled, water cooled, air cooled, tempered steel. Students should be able to distinguish the phase changes in a heat treated specimen compared to untreated specimen. |
| 3 | Brinell, Rockwell and Vickers's Hardness tests on untreated and heat treated specimens. |
| 4 | To study the defects of Cast and Welded components using Non-destructive tests like: a) Ultrasonic flaw detection b) Magnetic crack detection c) Dye penetration testing. |
| | **PART B** |
| 5 | Tensile, shear and compression tests of steel/aluminium/cast iron/Plastic/Composites specimens using Universal Testing Machine |
| 6 | Torsion Test on steel bar. |
| 7 | Flexural Test on steel/aluminium/cast iron/Plastic/Composites specimens |
| 8 | Izod and Charpy Tests on steel/aluminium/cast iron/Plastic/Composites Specimen |
| 9 | To study the wear characteristics of ferrous and non-ferrous materials under different parameters. |
| 10 | Fatigue Test (demonstration only). |

### Course outcomes:

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

- Acquire experimentation skills in the field of material testing.
- Develop theoretical understanding of the mechanical properties of materials by performing experiments.
- Apply the knowledge to analyse a material failure and determine the failure inducing agent/s.
- Apply the knowledge of testing methods in related areas.
- Understand how to improve structure/behaviour of materials for various industrial applications

### Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

**Scheme of Examination:**

ONE question from part -A: 30 Marks
ONE question from part -B: 50 Marks
Viva -Voice: 20 Marks
Total: 100 Marks

**B.E in Mechanical and Smart Manufacturing**

**Outcome Based Education (OBE) and Choice Based Credit System (CBCS)**

**SEMESTER - III**

## MANUFACTURING PROCESS LAB-I

| | | | |
|---|---|---|---|
| Course Code | 18SML38 | CIE Marks | 40 |
| TeachingHours/Week (L:T:P) | (2:2:0) | SEE Marks | 60 |
| Credits | 02 | Exam Hours | 03 |

**Course Objectives:**

· To provide an insight into different sand preparation and foundry equipment.
· To provide an insight into different forging tools and equipment.
· To provide training to students to enhance their practical skills.
· To practically demonstrate precautions to be taken during casting and hot working.
· To develop team qualities and ethical principles.

| Sl. NO | Experiments |
|---|---|
| | **PART A** |
| **Preparation of sand specimens and conduction of the following tests:** | |
| 1 | Compression, Shear and Tensile tests on Universal Sand Testing Machine. |
| 2 | Permeability test |
| 3 | Sieve Analysis to find Grain Fineness Number(GFN) of Base Sand |
| 4 | Clay content determination in Base Sand |
| | **PART B** |
| **Foundry Practice** | |
| 5 | Use of foundry tools and other equipment's. |
| 6 | Preparation of molding sand mixture. |
| 7 | Preparation of green sand molds using two molding boxes kept ready for pouring.<br>• Using patterns (Single piece pattern and Split pattern)<br>• Without patterns. Incorporating core in the mold. (Core boxes).<br>Preparation of a casting (Aluminum or cast iron-Demonstration only) |
| | **PART C** |
| **Forging Operations** | |
| 9 | **Use of forging tools and other equipment's**<br>• Calculation of length of the raw material required to prepare the model considering scale losses.<br>• Preparing minimum three forged models involving upsetting, drawing and bending operations.<br>• Demonstration of forging model using Power Hammer. |

**Course outcomes:**

Students will be able to

- Demonstrate various skills of sand preparation, molding.
- Demonstrate various skills of forging operations.
- Work as a team keeping up ethical principles.

**Conduct of Practical Examination:**

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

**Scheme of Examination:**

ONE question from part -A: 30 Marks
ONE question from part –B or C: 50 Marks
Viva -Voice: 20 Marks
Total: 100 Marks

**BE. in Mechanical and Smart Manufacturing**
**Outcome Base Education (OBE) and Choice Based Credit System (CBCS)**
**SEMESTER-III**

| | | | |
|---|---|---|---|
| Aadalitha Kannada | | CIE Marks | 100 |
| Course Code | 18 KAK39 | | |
| Teaching Hours/Week (L:T: P) | (0:2:0) | | |
| Credits | 01 | | |

## DqÀ½vÀ PÀ£ÀßqÀ PÀ°PÉAiÀÄ GzÉÝÃ±ÀUÀ¼ÀÄ :

- ¥ÀzÀ« «zÁåyð¼ÁVgÀÄªÀÅzÀjAzÀ DqÀ½vÀ PÀ£ÀßqÀzÀ ¥ÀjZÀAiÀÄ ªÀiÁrPÉÆqÀÄªÀÅzÀÄ.
- «zsÁåyðUÀ¼À°è PÀ£ÀßqÀ ¨sÁµÉAiÀÄ ªÁåPÀgÀtzÀ §UÉÎ CjªÀÅ ªÀÄÆr¸ÀÄªÀÅzÀÄ.
- PÀ£ÀßqÀ ¨sÁµÁ gÀZÀ£ÉAiÀÄ°è£À ¤AiÀÄªÀÄUÀ¼À£ÀÄß ¥ÀjZÀ¬Ä¸ÀÄªÀÅzÀÄ.
- PÀ£ÀßqÀ ¨sÁµÁ §gÀºÀzÀ°è PÀAqÀÄ§gÀÄªÀ zÉÆÃµÀUÀ¼ÀÄ ºÁUÀÆ CªÀÅUÀ¼À ¤ªÁgÀuÉ. ªÀÄvÀÄÛ ¯ÉÃR£À aºÉßUÀ¼À£ÀÄß ¥ÀjZÀ¬Ä¸ÀÄªÀÅzÀÄ.
- ¸ÁªÀiÁ£Àå CfðUÀ¼ÀÄ, ¸ÀPÁðj ªÀÄvÀÄÛ CgÉ ¸ÀPÁðj ¥ÀvÀæªÀåªÀºÁgÀzÀ §UÉÎ CjªÀÅ ªÀÄÆr¸ÀÄªÀÅzÀÄ.
- ¨sÁµÁAvÀgÀ ªÀÄvÀÄÛ ¥Àæ§AzsÀ gÀZÀ£É §UÉÎ D¸ÀQÛ ªÀÄÆr¸ÀÄªÀÅzÀÄ.
- PÀ£ÀßqÀ ¨sÁµÁ¨sÁå¸À ªÀÄvÀÄÛ ¸ÁªÀiÁ£Àå PÀ£ÀßqÀ ºÁUÀÆ DqÀ½vÀ PÀ£ÀßqÀzÀ ¥ÀzÀUÀ¼À ¥ÀjZÀAiÀÄ ªÀiÁrPÉÆqÀÄªÀÅzÀÄ.

## ¥Àj«r (¥ÀoÅå¥ÀÄ¸ÀÛPÀzÀ°ègÀÄªÀ «µÀAiÀÄUÀ¼À ¥ÀnÖ)

CzsÁåAiÀÄ - 1 PÀ£ÀßqÀ¨sÁµÉ - ¸ÀAQë¥ÀÛ «ªÀgÀuÉ.
CzsÁåAiÀÄ - 2 ¨sÁµÁ ¥ÀæAiÉÆÃUÀzÀ¯ÁèUÀÄªÀ ¯ÉÆÃ¥ÀzÉÆÃµÀUÀ¼ÀÄ ªÀÄvÀÄÛ CªÀÅUÀ¼À ¤ªÁgÀuÉ.
CzsÁåAiÀÄ - 3 ¯ÉÃR£À aºÉßUÀ¼ÀÄ ªÀÄvÀÄÛ CªÀÅUÀ¼À G¥ÀAiÉÆÃUÀ.
CzsÁåAiÀÄ - 4 ¥ÀævÀ ªÀåªÀºÁgÀ.
CzsÁåAiÀÄ - 5 DqÀ½vÀ ¥ÀvÀæUÀ¼ÀÄ.
CzsÁåAiÀÄ - 6 ¸ÀPÁðgÀzÀ DzÉÃ±À ¥ÀvÀæUÀ¼ÀÄ.
CzsÁåAiÀÄ - 7 ¸ÀAQë¥ÀÛ ¥Àæ§AzsÀ gÀZÀ£É (¦æ¸ÉÊ¸ï gÉÊnAUï), ¥Àæ§AzsÀ ªÀÄvÀÄÛ ¨sÁµÁAvÀgÀ.
CzsÁåAiÀÄ - 8 PÀ£ÀßqÀ ±À§Ý ¸ÀAUÀæºÀ.
CzsÁåAiÀÄ - 9 PÀA¥ÀÆålgï ºÁUÀÆ ªÀiÁ»w vÀAvÀæeÁÕ£À.
CzsÁåAiÀÄ - 10 ¥Áj¨sÁ¶PÀ DqÀ½vÀ PÀ£ÀßqÀ ¥ÀzÀUÀ¼ÀÄ ªÀÄvÀÄÛ vÁAwæPÀ / PÀA¥ÀÆålgï ¥Áj¨sÁ¶PÀ ¥ÀzÀUÀ¼ÀÄ.

## DqÀ½vÀ PÀ£ÀßqÀ PÀ°PÉAiÀÄ ¥sÀ°vÁA±ÀUÀ¼ÀÄ:

- DqÀ½vÀ ¨sÁµÉ PÀ£ÀßqÀzÀ ¥ÀjZÀAiÀÄªÁUÀÄvÀÛzÉ.
- «zÁåyðUÀ¼À°è PÀ£ÀßqÀ ¨sÁµÉAiÀÄ ªÁåPÀgÀtzÀ §UÉÎ CjªÀÅ ªÀÄÆqÀÄvÀÛzÉ.
- PÀ£ÀßqÀ ¨sÁµÁ gÀZÀ£ÉAiÀÄ°è£À ¤AiÀÄªÀÄUÀ¼ÀÄ ªÀÄvÀÄÛ ¯ÉÃR£À aºÉßUÀ¼ÀÄ ¥ÀjZÀ¬Ä¸À®àqÀÄvÀÛªÉ.
- ¸ÁªÀiÁ£Àå CfðUÀ¼ÀÄ, ¸ÀPÁðj ªÀÄvÀÄÛ CgÉ ¸ÀPÁðj ¥ÀvÀæªÀåªÀºÁgÀzÀ §UÉÎ CjªÀÅ ªÀÄÆqÀÄvÀÛzÉ.
- ¨sÁµÁAvÀgÀ ªÀÄvÀÄÛ ¥Àæ§AzsÀ gÀZÀ£É §UÉÎ D¸ÀQÛ ªÀÄÆqÀÄvÀÛzÉ.
- PÀ£ÀßqÀ ¨sÁµÁ¨sÁå¸À ªÀÄvÀÄÛ ¸ÁªÀiÁ£Àå PÀ£ÀßqÀ ºÁUÀÆ DqÀ½vÀ PÀ£ÀßqÀzÀ ¥ÀzÀUÀRÄ ¥ÀjZÀ¬Ä¸À®èqÀÄvÀÛªÉ.

| |
|---|
| **¥ÀjÃPÉëAiÀÄ «zsÁ£À : ¤gÀAvÀgÀ DAvÀjPÀ ªÀiË®åªÀiÁ¥À£À - CIE (Continuous Internal Ealuation )** PÁ¯ÉÃdÄ ªÀÄlÖzÀ°ÌAiÉÄ DAvÀjPÀ ¥ÀjÃPÉëAiÀÄ£ÀÄß 100 CAPÀUÀ½UÉ «±Àé«zÁå®AiÀÄzÀ ¤AiÀÄªÀÄUÀ¼ÀÄ ªÀÄvÀÄÛ ¤zÉÃð±À£ÀzÀAvÉ £ÀqÉ¸ÀvÀPÀÌzÀÄÝ. |
| **¥ÀoÀå¥ÀÄ¸ÀÛPÀ : DqÀ½vÀ PÀ£ÀßqÀ ¥ÀoÀå ¥ÀÄ¸ÀÛPÀ (Kannada for Administration)**<br>**¸ÀA¥ÁzÀPÀgÀÄ**<br>**qÁ. J¯ï wªÉÄäÃ±À**<br>**¥ÉÆæ. «. PÉÃ±ÀªÀªÀÄÆwð**<br>**¥ÀæPÀluÉ: ¥Àæ¸ÁgÁAUÀ, «±ÉéÃ±ÀégÀAiÀÄå vÁAwæPÀ «±Àé«zÁå®AiÀÄ, ¨É¼ÀUÁ«.** |

| | | | |
|---|---|---|---|
| **B. E. in Mechanical and Smart Manufacturing**<br>**Outcome Base Education (OBE) and Chice Based Credit System (CBCS)**<br>**SEMESTER- III** | | | |
| **Vyavaharika Kannada** | | **CIE Marks** | **100** |
| **Course Code** | **18KVK 39** | | |
| **Teaching Hours/Week (L:T: P)** | **(0:2:0)** | | |
| **Credits** | **01** | | |
| **Course Learing Objective:**<br>The course will enable the students to understand Kannada and communicate in Kannada Language. | | | |
| **Table of Contents:**<br>Chapter- 1: Vyavaharika Kannada - Parichaya (Introduction to Vyavaharika Kannada.)<br>Chapter- 2: Kannada Aksharamale haagu uchcharance(Kannada Alpabets and Pronunciation).<br>Chapter- 3: Sambhashanegaagi Kannada Padagalu (Kannada Vocabulary for Communication).<br>Chapter- 4: Kannada Grammar in Conversations (Sambhashaneyalli Kannada Vyakarana).<br>Chapter- 5:Activities in Kannada. | | | |
| **Course Outcomes:**<br>At the end of the course, the student will be able to understand Kannada and communicate in Kannada language. | | | |
| **¥ÀjÃPÉëAiÀÄ «zsÁ£À : ¤gÀAvÀgÀ DAvÀjPÀ ªÀiË®åªÀiÁ¥À£À - CIE (Continuous Intrnal Ealuation )** PÁ¯ÉÃdÄ ªÀÄlÖzÀ°èAiÉÄ DAvÀjPÀ ¥ÀjÃPÉëAiÀÄ£ÀÄß 100 CAPÀUÀ½UÉ «±Àé«zÁå®AiÀÄzÀ ¤AiÀÄªÀÄUÀ¼ÀÄ ªÀÄvÀÄÛ ¤zÉÃð±À£ÀzÀAvÉ £ÀqÉ¸ÀvÀPÀÌzÀÄÝ. | | | |
| **Text Book ¥ÀoÀå¥ÀÄ¸ÀÛPÀ : ªÁåªÀºÁjPÀ PÀ£ÀßqÀ ¥ÀoÀå ¥ÀÄ¸ÀÛPÀ (Vyavaharika Kannada Text Book)**<br>**¸ÀA¥ÁzÀPÀgÀÄ**<br>**qÁ. J¯ï wªÉÄäÃ±À**<br>**¥ÉÆæ. «. PÉÃ±ÀªÀªÀÄÆwð**<br>**¥ÀæPÀluÉ: ¥Àæ¸ÁgÁAUÀ, «±ÉéÃ±ÀégÀAiÀÄå vÁAwæPÀ «±Àé«zÁå®AiÀÄ, ¨É¼ÀUÁ«.** | | | |

**B.E in Mechanical and Smart Manufacturing**
**Outcome Based Education (OBE) and Choice Based Credit System (CBCS)**
**SEMESTER - III**

**CONSTITUTION OF INDIA, PROFESSIONAL ETHICS AND CYBER LAW**

| | | | |
|---|---|---|---|
| Course Code | 20CPC39/49 | CIE Marks | 40 |
| TeachingHours/Week (L:T:P) | (1:0:0) | SEE Marks | 60 |
| Credits | 01 | Exam Hours | 03 |

**Course objectives:**

- Know the fundamental political codes, structure, procedures, powers, and duties of Indian government institutions, fundamental rights, directive principles, and the duties of citizens
- Understand engineering ethics and their responsibilities; identify their individual roles and ethical responsibilities towards society.
- Know about the cybercrimes and cyber laws for cyber safety measures.

**Module-1**

**Introduction to Indian Constitution:** The Necessity of the Constitution, The Societies before and after the Constitution adoption. Introduction to the Indian constitution, The Making of the Constitution, The Role of the Constituent Assembly - Preamble and Salient features of the Constitution of India. Fundamental Rights and its Restriction and limitations in different Complex Situations. Directive Principles of State Policy (DPSP) and its present relevance in our society with examples. Fundamental Duties and its Scope and significance in Nation building.

**Module-2**

**Union Executive and State Executive:** Parliamentary System, Federal System, Centre- State Relations. Union Executive – President, Prime Minister, Union Cabinet, Parliament - LS and RS, Parliamentary Committees, Important Parliamentary Terminologies. Supreme Court of India, Judicial Reviews and Judicial Activism. State Executives – Governor, Chief Minister, State Cabinet, State Legislature, High Court and Subordinate Courts, Special Provisions (Articles 370.371,371J) for some States.

**Module-3**

**Elections, Amendments and Emergency Provisions:** Elections, Electoral Process, and Election Commission of India, Election Laws. Amendments - Methods in Constitutional Amendments (How and Why) and Important Constitutional Amendments. Amendments – 7,9,10,12,42,44, 61, 73,74, ,75, 86, and 91,94,95,100,101,118 and some important Case Studies. Emergency Provisions, types of Emergencies and its consequences.
**Constitutional special provisions:** Special Provisions for SC and ST, OBC, Women, Children and Backward Classes.

**Module-4**

**Professional / Engineering Ethics:** Scope & Aims of Engineering & Professional Ethics -Business Ethics, Corporate Ethics, Personal Ethics. Engineering and Professionalism, Positive and Negative Faces of Engineering Ethics, Code of Ethics as defined in the website of Institution of Engineers (India): Profession, Professionalism, and Professional Responsibility. Clash of Ethics, Conflicts of Interest. Responsibilities in Engineering Responsibilities in Engineering and Engineering Standards, the impediments to Responsibility. Trust and Reliability in Engineering, IPRs (Intellectual Property Rights), Risks, Safety and liability in Engineering

**Module-5**

**Internet Laws, Cyber Crimes and Cyber Laws:** Internet and Need for Cyber Laws, Modes of Regulation of Internet, Types of cyber terror capability, Net neutrality, Types of Cyber Crimes, India and cyber law, Cyber Crimes and the information Technology Act 2000, Internet Censorship. Cybercrimes and enforcement agencies.

**Course outcomes:**

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

CO1: Have constitutional knowledge and legal literacy.

CO2: Understand Engineering and Professional ethics and responsibilities of Engineers.

CO3: Understand the the cybercrimes and cyber laws for cyber safety measures.

**Question paper pattern:**

- The SEE question paper will be set for 100 marks and the marks scored by the students will Proportionately be reduced to 60. The pattern of the question paper will be objective type (MCQ).
- For the award of 40 CIE marks, refer the University regulations 2018.

| Sl No | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Constitution of India, Professional Ethics and Human Rights | Shubham Singles, Charles E. Haries, and et al | Cengage Learning India | 2018 |
| 2 | Cyber Security and Cyber Laws | Alfred Basta and et al | Cengage Learning India | 2018 |
| **Reference Books** | | | | |
| 3 | Introduction to the Constitution of India | Durga Das Basu | Prentice –Hall, | 2008. |
| 4 | Engineering Ethics | M. Govindarajan, S. Natarajan, V. S. Senthilkumar | Prentice –Hall, | 2004 |

**B.E in Mechanical and Smart Manufacturing**
**Outcome Based Education (OBE) and Choice Based Credit System (CBCS)**
**SEMESTER - III**

## ADDITIONAL MATHEMATICS – I

(Mandatory Learning Course: Common to All Branches)
(A Bridge course for Lateral Entry students under Diploma quota to BE/B.Tech programmes)

| | | | |
|---|---|---|---|
| Course Code | 20MATDIP31 | CIE Marks | 40 |
| Teaching Hours/Week (L:T:P) | (2:1:0) | SEE Marks | 60 |
| Credits | -- | Exam Hours | 03 |

**Course objectives:**

- To provide basic concepts of complex trigonometry, vector algebra, differential and integral calculus.
- To provide an insight into vector differentiation and first order ODE's.

**Module-1**

**Complex Trigonometry:** Complex Numbers: Definitions and properties. Modulus and amplitude of a complex number, Argand's diagram, De-Moivre's theorem (without proof).
**Vector Algebra:** Scalar and vectors. Addition and subtraction and multiplication of vectors- Dot and Cross products, problems.

**Module-2**

**Differential Calculus:** Review of elementary differential calculus. Polar curves –angle between the radius vector and the tangent pedal equation- Problems. Maclaurin's seriesexpansions, problems.
**Partial Differentiation:** Euler's theorem for homogeneous functions of two variables. Total derivatives-differentiation of composite function. Application to Jacobians of order two.

**Module-3**

**Vector Differentiation:** Differentiation of vector functions. Velocity and acceleration of a particle moving on a space curve. Scalar and vector point functions. Gradient, Divergence, Curl and Laplacian (Definitions only). Solenoidal and irrotational vector fields-Problems.

**Module-4**

**Integral Calculus:** Review of elementary integral calculus. Statement of reduction formulae for $\sin^n x, \cos^n x, and \sin^m x \times \cos^n x$ and evaluation of these with standard limits-Examples. Double and triple integrals, problems.

**Module-5**

**Ordinary differential equations (ODE's):** Introduction-solutions of first order and first degree differential equations: Variable Separable method, exact and linear differential equations of order one. Application to Newton's law of cooling.

**Course outcomes:**

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

- CO1: Apply concepts of complex numbers and vector algebra to analyze the problems arising in related area.
- CO2: Use derivatives and partial derivatives to calculate rate of change of multivariate functions.
- CO3: Analyze position, velocity and acceleration in two and three dimensions of vector valued functions.
- CO4: Learn techniques of integration including the evaluation of double and triple integrals.
- CO5: Identify and solve first order ordinary differential equations.

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

| Sl No | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook** | | | | |
| 1 | Higher Engineering Mathematics | B.S. Grewal | Khanna Publishers | 43rd Edition, 2015 |
| **Reference Books** | | | | |
| 1 | Advanced Engineering Mathematics | E. Kreyszig | John Wiley & Sons | 10th Edition, 2015 |
| 2 | Engineering Mathematics Vol. I | Rohit Khurana | Cengage Learning | 2015 |

****** END ******

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY
# BELAGAVI

Scheme of Teaching and Examination and Syllabus

B.E. **MECHANICAL AND SMART MANUFACTURING**

IVSEMESTER

**(Effective from Academic year 2020-21)**

**VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI**
**Scheme of Teaching and Examination 2018 – 19**
**Outcome Based Education(OBE) and Choice Based Credit System (CBCS)**
**(Effective from the academic year 2020-21)**

**Programme: MECHANICAL AND SMART MANUFACTURING**

**IV SEMESTER**

| Sl. No | Course and Course Code | | Course Title | Teaching Department | Teaching Hours /Week | | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theory Lecture | Tutorial | Practical/ Drawing | Duration in hours | CIE Marks | SEE Marks | Total Marks | |
| | | | | | L | T | P | | | | | |
| 1 | BSC | 18MAT41 | Complex Analysis, Probability and statistics Methods | Mathematics | 2 | 2 | -- | 03 | 40 | 60 | 100 | 3 |
| 2 | PCC | 18 SM42 | Fluid Mechanics and Heat Transfer | ME | 3 | 2 | -- | 03 | 40 | 60 | 100 | 4 |
| 3 | PCC | 18 SM 43 | Manufacturing Process-II | ME | 3 | 0 | -- | 03 | 40 | 60 | 100 | 3 |
| 4 | PCC | 18 SM 44 | Mechanical Measurement and Metrology | ME | 3 | 0 | -- | 03 | 40 | 60 | 100 | 3 |
| 5 | PCC | 18 SM 45 | Data Structures and Programming | CS | 3 | 0 | -- | 03 | 40 | 60 | 100 | 3 |
| 6 | PCC | 18 ME 46 | Computer Aided Machine Drawing | ME | 1 | 4 | -- | 03 | 40 | 60 | 100 | 3 |
| 7 | PCC | 18 SM L47 | Manufacturing Process Lab-II | ME | -- | 2 | 2 | 03 | 40 | 60 | 100 | 2 |
| 8 | PCC | 18 SM L48 | Data Structures and Programming lab | CS | -- | 2 | 2 | 03 | 40 | 60 | 100 | 2 |
| 9 | HSMC | 18KVK39/49 | Vyavaharika Kannada (Kannada for communication)/ | HSMC | -- | 2 | -- | -- | 100 | -- | 100 | 1 |
| | | 18KAK39/49 | Balake Kannada (Kannada for Administration) | | | | | | | | | |
| | | **OR** | | | | | | | | | | |
| | | 18CPC39/49 | Constitution of India, Professional Ethics and Cyber Law | | 1 | -- | -- | 03 | 40 | 60 | | |
| | | | | | Examination is by objective type questions | | | | | | | |
| | | | | **TOTAL** | **15 OR 16** | **12 OR 14** | **04** | **24 OR 27** | **420 OR 360** | **480 OR 540** | **900** | **24** |

**Note:** BSC: Basic Science, PCC: Professional Core, HSMC: Humanity and Social Science, NCMC: Non-credit mandatory course.

20KVK39Vyavaharika Kannada (Kannada for communication) is for non-kannada speaking, reading and writing students and 20KAK39 Aadalitha Kannada (Kannada for Administration) is for students who speak, read and write kannada.

**Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | NCMC | 18MATDIP31 | Additional Mathematics – I | Mathematics | 02 | 01 | -- | 03 | 40 | 60 | 100 | 0 |

(a)The mandatory non – credit courses Additional Mathematics I and II prescribed for III and IV semesters respectively, to the lateral entry Diploma holders admitted to III semester of BE/B.Tech programs, shall attend the classes during the respective semesters to complete all the formalities of the course and appear for the University examination. In case, any student fails to register for the said course/fails to secure the minimum 40 % of the prescribed CIE marks, he/she shall be deemed to have secured F grade. In such a case, the student have to fulfil the requirements during subsequent semester/s to appear for SEE.

(b)These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.

**Continued**

**VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI**
**Scheme of Teaching and Examination 2018 – 19**
**Outcome Based Education(OBE) and Choice Based Credit System (CBCS)**
**(Effective from the academic year 2020-21)**

**Programme: MECHANICAL AND SMART MANUFACTURING**

**IV SEMESTER (continued)**

**Courses prescribed to lateral entry B. Sc degree holders admitted to III semester of Engineering programs**

Lateral entrant students from B.Sc. Stream, shall clear the non-credit courses Engineering Graphics and Elements of Civil Engineering and Mechanics of the First Year Engineering Programme. These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.

**AICTE activity Points:** In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

**B.E MECHANICAL AND SMART MANUFACTURING**
**Outcome Based Education (OBE) and Choice Based Credit System (CBCS)**
**SEMESTER - IV**

**COMPLEX ANALYSIS, PROBABILITY AND STATISTICAL METHODS**
(Common to all branches)
[As per Choice Based Credit System (CBCS) scheme]

| | | | |
|---|---|---|---|
| Course Code | 18MAT41 | CIE Marks | 40 |
| Teaching Hours/Week (L:T:P) | (2:2:0) | SEE Marks | 60 |
| Credits | 03 | Exam Hours | 03 |

**Course objectives:**

- To provide an insight into applications of complex variables, conformal mapping and special functions arising in potential theory, quantum mechanics, heat conduction and field theory.
- To develop probability distribution of discrete, continuous random variables and joint probability distribution occurring in digital signal processing, design engineering and microwave engineering.

**Module-1**

**Calculus of complex functions:** Review of function of a complex variable, limits, continuity, and differentiability. Analytic functions: Cauchy-Riemann equations in Cartesian and polar forms and consequences.
**Construction of analytic functions:** Milne-Thomson method-Problems.

**Module-2**

**Conformal transformations:** Introduction. Discussion of transformations:$w = Z^2, w = e^z, w = z + \frac{1}{z}, (z \neq 0)$.Bilinear transformations- Problems.
**Complex integration:** Line integral of a complex function-Cauchy's theorem and Cauchy's integral formula and problems.

**Module-3**

**Probability Distributions:** Review of basic probability theory. Random variables (discrete and continuous), probability mass/density functions. Binomial, Poisson, exponential and normal distributions- problems (No derivation for mean and standard deviation)-Illustrative examples.

**Module-4**

**Statistical Methods:** Correlation and regression-Karl Pearson's coefficient of correlation and rank correlation -problems. Regression analysis- lines of regression –problems.
**Curve Fitting:** Curve fitting by the method of least squares- fitting the curves of the form-
$y = ax + b, y = ax^b \text{ and } y = ax^2 + bx + c.$

**Module-5**

**Joint probability distribution:** Joint Probability distribution for two discrete random variables, expectation and covariance.
**Sampling Theory:** Introduction to sampling distributions, standard error, Type-I and Type-II errors. Test of hypothesis for means, student's t-distribution, Chi-square distribution as a test of goodness of fit.

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

- Use the concepts of analytic function and complex potentials to solve the problems arising in electromagnetic field
- theory.
- Utilize conformal transformation and complex integral arising in aerofoil theory, fluid flow visualization and image
- processing.
- Apply discrete and continuous probability distributions in analyzing the probability models arising in engineering field.
- Make use of the correlation and regression analysis to fit a suitable mathematical model for the statistical data.
- Construct joint probability distributions and demonstrate the validity of testing the hypothesis.

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

| Sl No | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbooks** | | | | |
| 1 | Advanced Engineering Mathematics | E. Kreyszig | John Wiley & Sons | 10th Edition,2016 |
| 2 | Higher Engineering Mathematics | B.S. Grewal | Khanna Publishers | 44th Edition, 2017 |
| 3 | Engineering Mathematics | Srimanta Pal et al | Oxford University Press | 3rd Edition,2016 |
| **Reference Books** | | | | |
| 1 | Advanced Engineering Mathematics | C.Ray Wylie, Louis C.Barrett | McGraw-Hill | 6th Edition 1995 |
| 2 | Introductory Methods of Numerical Analysis | S.S.Sastry | Prentice Hall of India | 4th Edition 2010 |
| 3 | Higher Engineering Mathematics | B.V.Ramana | McGraw-Hill | 11th Edition,2010 |
| 4 | A Text Book of Engineering Mathematics | N.P.Bali and Manish Goyal | Laxmi Publications | 2014 |

**Web links and Video Lectures:**

1. http://nptel.ac.in/courses.php?disciplineID=111
2. http://www.class-central.com/subject/math(MOOCs)
3. http://academicearth.org/
4. VTU EDUSAT PROGRAMME - 20

**B.E in Mechanical and Smart Manufacturing**
**Outcome Based Education (OBE) and Choice Based Credit System (CBCS)**
**SEMESTER - IV**

**FLUID MECHANICS AND HEAT TRANSFER**

| | | | |
|---|---|---|---|
| Course Code | 18SM42 | CIE Marks | 40 |
| Teaching Hours/Week (L:T:P) | (3:2:0) | SEE Marks | 60 |
| Credits | 04 | Exam Hours | 03 |

**Course objectives:**

- To have a working knowledge of the basic properties of fluids and to understand the concept of surface tension and capillarity.
- To study the kinematics of fluid and to understand the flow characteristic and dynamics of flow field for various engineering applications.
- Study the modes of heat transfer.
- Learn how to formulate and solve 1-D steady and unsteady heat conduction problems.
- Apply empirical correlations for fully-developed laminar, turbulent internal flows and external boundary layer convective flow problems.
- Study the basic principles of heat exchanger analysis and thermal design.
- Understand the principles of boiling and condensation including radiation heat transfer related to engineering problems.

**Module-1**

**Introduction and Fluid Properties:** Definition of fluid, types of fluids, Properties of fluids-Mass density, Weight density, Specific volume, Specific gravity, Viscosity, Newton's law of viscosity, Phenomenon of surface tension and Capillarity. Simple numerical problems. **Fluid statics and Fluid Kinematics:** Pascal's law and hydrostatic law. Total pressure and centre of pressure acting on a vertical and inclined submerged surface. Types of fluid flow, rate of flow, Continuity equation, velocity and acceleration, velocity potential function, stream function and simple numerical problems.

**Module-2**

**Fluid Dynamics:** Equations of motion, Euler's Equation and Bernoulli's equation of motion. Momentum equation. Applications of Bernoulli's theorem such as venturi-meter, orifice meter (No derivation for discharge), rectangular and triangular notch, pitot tube. Viscous flow: viscous flow through circular pipes and between parallel pipes. simple numerical problems. **Boundary layer theory:** Boundary layer concept. Development of boundary layer. Hydrodynamic boundary layer. Definition of boundary layer thickness, displacement thickness, momentum thickness and energy thickness. Flow through pipes. Major losses- Darcy equation. Minor losses (No derivations).

**Module-3**

**Introductory concepts and definitions:** Modes of heat transfer: Basic laws governing conduction, convection, and radiation heat transfer; Types of boundary conditions. General three-dimensional Heat Conduction Equation: Steady-state one-dimensional heat conduction problems (Without heat generation and Constant thermal conductivity). Simple numerical problems. **Brief Introduction to:** Variable thermal conductivity, heat generation, Thermal Resistances, Critical Thickness of Insulation in cylinder and spheres, Extended Surfaces or Fins, Fin Efficiency and Effectiveness, Applications, Transient heat conduction: Definition, Different cases (No numericals).

**Module-4**

**Numerical Analysis of Heat Conduction:** Introduction, one-dimensional steady conduction and one dimensional unsteady conduction, boundary conditions, solution methods. **Thermal Radiation:** Fundamental principles - Gray, White, Opaque, Transparent and Black bodies, Spectral emissive power, Wien's displacement law, Planck's laws, Stefan-Boltzmann law, Emissivity and Kirchhoff's Laws, View factor, Net radiation exchange between parallel plates, Radiation Shield.

**Module-5**

**Convection:** Newton's law of cooling, Dimensional analysis applied to forced and free convection, dimensionless numbers and their physical significance, empirical correlations for free and forced convection. Concepts of hydrodynamic and Thermal boundary layer. **Heat Exchangers:** Definition, Classification, applications, LMTD method, Effectiveness - NTU method. **Introduction to boiling and Condensation:** Pool boiling, film wise and drop wise Condensation.

**Course outcomes:**

**At the end of the course the student will be able to:**

- Identify and calculate the key fluid properties used in the analysis of fluid behaviour.
- Apply the knowledge of fluid statics, kinematics and dynamics while addressing problems of mechanical engineering.
- Understand the modes of heat transfer and apply the basic laws to formulate engineering systems.
- Understand and apply the basic laws of heat transfer to extended surface and unsteady state heat transfer problems.
- Analyze heat conduction through numerical methods and apply the fundamental principle to solve radiation heat transfer problems.
- Analyze heat transfer due to free and forced convective heat transfer.
- Understand the design and performance analysis of heat exchangers and their practical applications, Condensation and Boiling phenomena.

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The student will have to answer five full questions, selecting one full question from each module.

| Sl No | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Fluid Mechanics (SI Units) | Yunus A. Cengel John M.Cimbala | TataMcGraw Hill | 3rd Ed.,2014. |
| 2 | A Text Book of Fluid Mechanics | Dr.R.K.Bansal | Laxmi Publishers | January 2018 |
| 3 | Principals of heat transfer | Frank Kreith, Raj M. Manglik, Mark S. Bohn | Cengage learning | Seventh Edition 2011. |
| 4 | Heat transfer, a practical approach | Yunus A. Cengel | Tata Mc Graw Hill | Fifth edition |
| 5 | Heat & Mass Transfer | P K Nag | Tata Mc Graw Hill | April 2011 |
| **Reference Books** | | | | |
| 1 | Fundamentals of Fluid Mechanics | Munson, Young, Okiishi&Huebsch | John Wiley Publications | 7th edition |
| 2 | Introduction to Fluid Mechanics | Fox, McDonald | John Wiley Publications | 8th edition |
| 3 | Heat Transfer | Holman, J. P. | Tata McGraw Hill, New York | 9th Edition 2008 |
| 4 | Heat Transfer A Basic Approach | M. NecatiOzisik | Tata McGraw Hill, New York | 2005 |
| 5 | Fundamentals of Heat and Mass Transfer | Incropera, F. P. and De Witt, D. P | John Wiley and Sons, New York | 5th Edition 2006 |

## B.E Mechanical and Smart Manufacturing

**Outcome Based Education (OBE) and Choice Based Credit System (CBCS)**

**SEMESTER - III**

## MANUFACTURING PROCESS-II

| | | | |
|---|---|---|---|
| Course Code | 18SM43 | CIE Marks | 40 |
| Teaching Hours/Week (L:T:P) | (3:0:0) | SEE Marks | 60 |
| Credits | 03 | Exam Hours | 03 |

**Course objectives:**

- To introduce students to different machine tools in order to produce components having different shapes and sizes.
- To enrich the knowledge pertaining to relative motion and mechanics required for various machine tools.
- To develop the knowledge on mechanics of machining process and effect of various parameters on economics of
- machining.

**Module-1**

**MECHANICS OF MACHINING PROCESSES:** Orthogonal and Oblique cutting, Mechanics of Chip formation: Types of chips, chip-breakers, Chip reduction coefficient, shear angle, shear strain, Built- Up-Edge and its effect in metal cutting, Merchant's analysis of metal cutting process - Various forces, power and specific energy in cutting, Problems on Tool Geometry and Mechanics of Machining, Theories of Metal Cutting: Ernst & Merchant, theory, Modified Merchant's theory.

**Cutting Tool Materials, Geometry and Surface Finish**

Introduction, desirable Properties and Characteristics of cutting tool materials, cutting tool geometry, cutting fluids and its applications, surface finish, effect of machining parameters on surface finish.

**Module-2**

**TOOL WEAR, TOOL LIFE, MACHINABILTY AND MACHINING ECONOMICS:** Wear Mechanisms, Types of tool wear, Tool Life and Machinability, A brief treatment for single pass turning operations, Problems on Economics of Machining.

**Cutting Tool Materials:** Desirable Properties of tool materials, Characteristics of Cutting Tool Materials, Indexable inserts, Coated tools.

**Cutting Fluids**: Functions, characteristics and types, Selection of cutting fluid

**Module-3**

**LATHE AND OPERATIONS**

Centre Lathe-Construction- Various Operations, Taper Turning Methods, Thread Cutting operation, Lathe Attachments& Accessories.

**RECIPROCATING MACHINE TOOLS**

**Shaper** -Principal parts, Classification, Specification of shaper, Shaper Mechanisms, Hydraulic shaper. Cutting Speed, Feed, Depth of cut & machining time-Various shaper operations

Introduction to Planer -Principal parts and working of Double housing Planer, Principal parts of Slotter-Working of slotter

**Module-4**

**DRILLING AND MILLING MACHINES**

**Drilling**: Twist drill geometry –Radial drilling machine, Drilling operation, Jigs and Fixtures Definition-Need of Jigs and Fixtures Drill Jig-Locating devices.

**Milling:** Classification, Column and knee type milling machine - Milling cutters and classification-Fundamentals of milling processes-Milling operations. Indexing methods-Simple and compounding. Cutting speed, feed, depth of cut and machining time.

**Module-5**

**SUPER FINISHING PROCESSES**

Abrasive Processes- Grinding Wheel – Specifications And Selection, Types Of Grinding Process – Cylindrical Grinding, Surface Grinding, Centre less Grinding–Super finishing process- Honing, Lapping, Super Finishing, Polishing And Buffing

**NON CONVENTIONAL MACHINING PROCESS**

Unconventional Machining Process - Classification, Electron Beam Machining, Laser Beam Machining, Electric Discharge Machining, Ultrasonic Machining, Abrasive Jet Machining.

**Course outcomes:**

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

- Explain the construction & specification of various machine tools.
- Describe various machining processes pertaining to relative motions between tool & work piece.
- Discuss different cutting tool materials, tool nomenclature & surface finish.
- Apply mechanics of machining process to evaluate machining time.
- Analyze tool wear mechanisms and equations to enhance tool life and minimize machining cost.
- Understand the difference between conventional & Nonconventional machining

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The student will have to answer five full questions, selecting one full question from each module.

| Sl No | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Fundamentals of metal cutting and Machine Tools | B.L. Juneja, G.S. Sekhon and Nitin Seth, | New Age International Publishers 2nd Edition | 2003 |
| 2 | All about Machine Tools | Heinrich Gerling | New Age International Publishers revised 2nd Edition | 2006 |
| 3 | Workshop Technology | Hazara Choudhry | Media promoters and publishers Pvt Ltd | 2008 |
| 4 | Production Technology | R. K. Jain | Khanna Publications | 2003 |
| 5 | Workshop Technology | Raghuvamshi | Dhanpat Rai & CO | 2015 |
| **Reference Books** | | | | |
| 1 | Fundamental of Machining and Machine Tools. | Geoffrey Boothroyd and Winston A. | CRC Taylor& Francis, Third Edition. | Third Edition 2005 |
| 2 | Fundamentals of Metal Machining and Machine | G. Boothroyd | McGraw Hill | 2000 |
| 3 | Manufacturing Technology | SeropeKalpakjian , Steuen. R. Sechmid | Pearson Education Asia | 5th Ed. 2006 |
| 4 | Processes and Materials for Manufacturing | R.A. Lindberg | Pearson Education | 4th Ed. 2006 |
| 5 | Metal cutting principles | Milton C. Shaw | Oxford University Press, Second Edition | 2005 |

## B.E MECHANICAL AND SMART MANUFACTURING

**Outcome Based Education (OBE) and Choice Based Credit System (CBCS)**

**SEMESTER - IV**

## MECHANICAL MEASUREMENT AND METROLOGY

| | | | |
|---|---|---|---|
| Course Code | 18ME44 | CIE Marks | 40 |
| Teaching Hours/Week (L:T:P) | (3:0:0) | SEE Marks | 60 |
| Credits | 03 | Exam Hours | 03 |

**Course objectives:**

- To understand the concept of metrology and standards of measurement.
- To equip with knowledge of limits, fits, tolerances and gauging.
- To acquire knowledge of linear and Angular measurements, Screw thread and gear measurement & comparators.
- To understand the knowledge of measurement systems and methods with emphasis on different Transducers, intermediate modifying and terminating devices.
- To understand the measurement of Force, Torque, Pressure, Temperature and Strain.

**Module-1**

**Introduction to Metrology:** Definition, objectives of metrology, Material Standards, Wavelength Standards, Classification of standards, Line and End standards, Calibration of End bars. Numerical examples. Liner measurement and angular measurements: Slip gauges-Indian standards on slip gauges, Adjustable slip gauges, Wringing of slip gauges, Problems on building of slip gauges (M87, M112), Measurement of angle-sine bar, Sine centre, Angle gauges, Optical instruments for angular measurements. Autocollimator-Applications for measuring straightness and squareness.

**Module-2**

**System of Limits, Fits, Tolerance and Gauging:** Definitions, Tolerance, Tolerance analysis (addition & subtraction of tolerances) Inter changeability & Selective assembly. Class &grade of tolerance, Fits, Types of fits, Numerical on limits, fit and tolerance. Hole base system & shaft base system. Taylor's principle, Types of limit gauges, Numerical on limit gauge design. Comparators: Functional requirements, Classification, Mechanical- Johnson Mikrokator, Sigma comparators, Dial indicator, Electrical comparators, LVDT, Pneumatic comparators.

**Module-3**

**Measurement of screw thread and gear:** Terminology of screw threads, Measurement of major diameter, Minor diameter, Pitch, Angle and Effective diameter of screw threads by 2- wire and 3-wire methods, Best size wire. Screw thread gauges, Toolmaker's microscope. Gear tooth Measurements: Tooth thickness measurement using constant chord method, Addendum, Comparator method and Base tangent method, Measurement of pitch, Concentricity, Run out and In volute profile. Gear roll tester for composite error.

**Module-4**

**Measurement system and basic concepts of measurement methods:** Definition, Significance of measurement, Generalized measurement system, Static characteristics- Accuracy, Precision, Calibration, Threshold, Sensitivity, Hysteresis, Repeatability, Linearity, Loading effect, Dynamic characteristics- System response, Time delay. Errors in measurement, Classification of errors.

**Transducers:** Transfer efficiency, Primary and Secondary transducers, Electrical transducers, Mechanical, Electronic transducers, Relative comparison of each type of transducers.

**Intermediate Modifying and Terminating Devices:** Mechanical systems, Inherent problems, Electrical intermediate modifying devices, Input circuitry, Ballast circuit, Electronic amplifiers. Terminating devices, Cathode ray oscilloscope, Oscillographs.

**Module-5**

**Applied mechanical measurement:** Measurement of force, Torque, Pressure, Types of Dynamometers, Absorption dynamometer, Prony brake and Rope brake dynamometer, and Power Measuring Instruments. Use of elastic members, Bridgeman gauge, McLeod gauge, Pirani gauge.

**Measurement of strain and temperature:** Theory of strain gauges, Types, Electrical resistance strain gauge, Preparation and mounting of Strain gauges, Gauge factor, Methods of strain measurement, temperature compensation, Resistance thermometers, Thermocouple, Law of thermocouple, Pyrometer, Optical pyrometer.

**Course outcomes:**

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

- Understand the objectives of metrology, methods of measurement, standards of measurement & various measurement parameters.
- Explain tolerance, limits of size, fits, geometric and position tolerances, gauges and their design
- Understand the working principle of different types of comparators.
- Describe measurement of major & minor diameter, pitch, angle and effective diameter of screw threads.
- Explain measurement systems, transducers, intermediate modifying devices and terminating devices.
- Describe functioning of force, torque, pressure, strain and temperature measuring devices.

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

| Sl No | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Mechanical Measurements | Beckwith Marangoni and Lienhard | Pearson Education | 6th Ed., 2006 |
| 2 | Instrumentation, Measurement and Analysis | B C Nakra, K K Chaudhry | Tata McGraw Hill | 4th Ed. |
| 3 | Engineering Metrology | R.K. Jain | Khanna Publishers | 2009 |
| **Reference Books** | | | | |
| 1 | Engineering Metrology and Measurements | Bentley | Pearson Education | 2 nd edition. |
| 2 | Theory and Design for Mechanical Measurements, III edition | Richard S Figliola, Donald E Beasley | WILEY India Publishers | 8 th edition,2006 |
| 3 | Engineering Metrology | Gupta I.C | Dhanpat Rai Publications | First edition,2019 |
| 4 | Deoblin's Measurement system, | Ernest Deoblin, Dhanesh manick | McGraw–Hill | 2013 |
| 5 | Engineering Metrology and Measurements | N.V.Raghavendra and L. Krishnamurthy | Oxford University Press | First edition,2013 |

## B.E MECHANICAL AND SMART MANUFACTURING

**Outcome Based Education (OBE) and Choice Based Credit System (CBCS)**

**SEMESTER - IV**

## DATA STRUCTURES AND PROGRAMMING

| | | | |
|---|---|---|---|
| Course Code | 18SM45 | CIE Marks | 40 |
| Teaching Hours/Week (L:T:P) | (2:2:0) | SEE Marks | 60 |
| Credits | 03 | Exam Hours | 03 |

**Course objectives:**

- Understanding basic *data structures and algorithms*
- To assess how the choice of **data structures and algorithm** design methods impacts the performance of programs
- To solve problems using **data structures** such as linear lists, stacks, queues, binary trees and graphs and writing programs for these solutions.

**Module-1**

Introduction: Data Structures, Classifications (Primitive & Non-Primitive), Data structure Operations, Review of Arrays, Structures, Self-Referential Structures, and Unions. Pointers and Dynamic Memory Allocation Functions. Representation of Linear Arrays in Memory, dynamically allocated arrays, Array Operations: Traversing, inserting, deleting, searching, and sorting. Multidimensional Arrays, Polynomials and Sparse Matrices. Strings: Basic Terminology, Storing, Operations and Pattern Matching algorithms. Programming Examples. Text 1: Ch 1: 1.2, Ch2: 2.2 -2.7 Text 2: Ch 1: 1.1 -1.4, Ch 3: 3.1-3.3,3.5,3.7, Ch 4: 4.1-4.9,4.14 Ref 3: Ch 1: 1.4

**Module-2**

Stacks and Queues Stacks: Definition, Stack Operations, Array Representation of Stacks, Stacks using Dynamic Arrays, Stack Applications: Polish notation, Infix to postfix conversion, evaluation of postfix expression, Recursion - Factorial, GCD, Fibonacci Sequence, Tower of Hanoi, Ackerman's function. Queues: Definition, Array Representation, Queue Operations, Circular Queues, Circular queues using Dynamic arrays, Dequeues, Priority Queues, A Mazing Problem. Multiple Stacks and Queues. Programming Examples.
Text 1: Ch3: 3.1 -3.7 Text 2: Ch6: 6.1 -6.3, 6.5, 6.7-6.10, 6.12, 6.13

**Module-3**

Linked Lists: Definition, Representation of linked lists in Memory, Memory allocation; Garbage Collection. Linked list operations: Traversing, Searching, Insertion, and Deletion. Doubly Linked lists, Circular linked lists, and header linked lists. Linked Stacks and Queues. Applications of Linked lists – Polynomials, Sparse matrix representation. Programming Examples Text 1: Ch4: 4.1 -4.8 except 4.6 Text 2: Ch5: 5.1 – 5.10

**Module-4**

Trees: Terminology, Binary Trees, Properties of Binary trees, Array and linked Representation of Binary Trees, Binary Tree Traversals - Inorder, postorder, preorder; Additional Binary tree operations. Threaded binary trees, Binary Search Trees – Definition, Insertion, Deletion, Traversal, Searching, Application of Trees-Evaluation of Expression, Programming Examples Text 1: Ch5: 5.1 –5.5, 5.7 Text 2: Ch7: 7.1 – 7.9

**Module-5**

Graphs: Definitions, Terminologies, Matrix and Adjacency List Representation Of Graphs, Elementary Graph operations, Traversal methods: Breadth First Search and Depth First Search. Sorting and Searching: Insertion Sort, Radix sort, Address Calculation Sort. Hashing: Hash Table organizations, Hashing Functions, Static and Dynamic Hashing. Files and Their Organization: Data Hierarchy, File Attributes, Text Files and Binary Files, Basic File Operations, File Organizations and Indexing Text 1: Ch6: 6.1 –6.2, Ch 7:7.2, Ch 8:8.1-8.3 Text 2: Ch8: 8.1 – 8.7, Ch 9:9.1-9.3,9.7,9.9 Reference 2: Ch 16: 16.1 - 16.7

**Course outcomes:**

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

- Explain different types of data structures, operations and algorithms
- Apply searching and sorting operations on files
- Make use of stack, Queue, Lists, Trees and Graphs in problem solving
- Develop all data structures in a high-level language for problem solving

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

| Sl No | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Fundamentals of Data Structures in C | Ellis Horowitz and artaj Sahni | Universities Press | 2nd edition, 2014 |
| 2 | Data Structures | Seymour Lipschutz | Schaum's Outline Series', McGraw Hill Education, | 2014 |
| **Reference Books** | | | | |
| 1 | Data Structures: A Pseudocode Approach with C | Richard Gilberg, Behrouz A Forouzan | Course Technology Inc | 2nd edition, 2004 |
| 2 | Data Structures using C | Reema Thareja, | Oxford University Press | 2nd edition, 2014 |
| 3 | An Introduction to Data Structures with Applications | Jean-Paul Tremblay & Paul G. Sorenson | McGraw Hill | 2nd edition, 2014 |

**B.E MECHANICAL AND SMART MANUFACTURING**
**Outcome Based Education (OBE) and Choice Based Credit System (CBCS)**
**SEMESTER - IV**

## COMPUTER AIDED MACHINE DRAWING

| | | | |
|---|---|---|---|
| Course Code | 18ME46 | CIE Marks | 40 |
| Teaching Hours/Week (L:T:P) | (3:0:0) | SEE Marks | 60 |
| Credits | 03 | Exam Hours | 03 |

**Course objectives:**

- To acquire the knowledge of CAD software and its features.
- To familiarize the students with Indian Standards on drawing practices.
- To impart knowledge of thread forms, fasteners, keys, joints and couplings.
- To make the students understand and interpret drawings of machine components leading to preparation of assembly drawings manually and using CAD packages.
- To acquire the knowledge of limits, tolerance and fits and indicate them on machine drawings.

**Part-A**

**Part-A**

Introduction: Review of graphic interface of the software. Review of basic sketching commands and navigational commands. Starting a new drawing sheet. Sheet sizes. Naming a drawing, Drawing units, grid and snap. Conversion of pictorial views into orthographic projections of simple machine parts (with and without section). Hidden line conventions. Precedence of lines. Sections of Solids: Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders resting only on their bases (No problems on axis inclinations, spheres and hollow solids). True shape of sections. Conversion of pictorial views into orthographic projections of simple machine parts. Hidden line conventions. Precedence of lines. Conversion of pictorial views into orthographic projections of simple machine parts (with section planes indicated on the part). Thread Forms: Thread terminology, sectional views of threads. ISO Metric (Internal & External), BSW (Internal & External) square and Acme. Sellers thread, American Standard thread. Fasteners: Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grub screw, Allen screw.

**Part-B**

Keys: Parallel key, Taper key, Feather key, Gib-head key and Woodruff key. Joints: Cotter joint (socket and spigot), knuckle joint (pin joint) for two rods. Couplings: Split Muff coupling, Protected type flanged coupling, pin (bush) type flexible coupling, and universal coupling (Hooks' Joint).

**Module-3**

Limits, Fits and Tolerances: Introduction, Fundamental tolerances, Deviations, Methods of placing limit dimensions, machining symbols, types of fits with symbols and applications, geometrical tolerances on drawings. Standards followed in industry.

**Assembly Drawings: (Part drawings shall be given)**

**1. Plummer block (Pedestal Bearing)**
**2. Lever Safety Valve**
**3. I.C. Engine connecting rod**
**4. Screw jack (Bottle type)**
**5. Tailstock of lathe**
**6. Machine vice**
**7. Tool head of shaper.**

**Course outcomes:**

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

- Identify the national and international standards pertaining to machine drawing.
- Understand the importance of the linking functional and visualization aspects in the preparation of the part drawings.
- Apply limits and tolerances to assemblies and choose appropriate fits for given assemblies.
- Interpret the Machining and surface finish symbols on the component drawings.
- CO5: Preparation of the part or assembly drawings as per the conventions.

**Question paper pattern:**

**Scheme of Examination:** Two questions to be set from each Part A, part B and Part C. Student has to answer one question each from Part A and Part B for 25 marks each and one question from Part C for 50 marks.

**INSTRUCTION FOR COMPUTER AIDED MACHINE DRAWING (15ME36A/46A) EXAMINATION**

1. No restriction of timing for sketching/ computerization of solutions. The total duration is 3 hours.
2. It is desirable to do sketching of all the solutions before computerization.
3. Drawing instruments may be used for sketching.
4. For Part A and Part B, 2D drafting environment should be used.
5. For Part C, 3D environment should be used for parts and assembly, and extract 2D views of assembly.
6. Part A and Part B 25 Marks ( 15 marks for sketching and 10 marks for computer work)
7. Part C 50 Marks ( 20 marks for sketching and 30 marks for computer modelling)

| Sl No | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Machine Drawing | K.R. Gopala Krishna | Subhash Publication | 2005 |
| 2 | Machine Drawing | N.D.Bhat&V.M. Panchal | Charoratar publishing house | 2005 |
| **Reference Books** | | | | |
| 1 | A Text Book of Computer Aided Machine Drawing | S. Trymbaka Murthy | CBS Publishers, New Delhi | 2007 |
| 2 | Engineering drawing | P.S.Gill | S K Kataria and Sons | 2013 |
| 3 | Machine Drawing | N. Siddeshwar, P. Kanniah, V.V.S. Sastri | Tata McGraw Hill | 2006 |

## B.E Mechanical and Smart Manufacturing

**Outcome Based Education (OBE) and Choice Based Credit System (CBCS)**

**SEMESTER - IV**

## MANUFACTURING PROCESS LAB-II

| | | | |
|---|---|---|---|
| Course Code | 18SML47 | CIE Marks | 40 |
| Teaching Hours/Week (L:T:P) | (2:2:0) | SEE Marks | 60 |
| Credits | 02 | Exam Hours | 03 |

Course Objectives:

· To provide an insight to different machine tools, accessories and attachments
· To train students into machining operations to enrich their practical skills
· To inculcate team qualities and expose students to shop floor activities
· To educate students about ethical , environmental and safety standards

### Experiments

### PART A

**Preparation of three models on lathe involving**

Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning.

### PART B

- Cutting of V Groove/ dovetail / Rectangular groove using a shaper
- Cutting of Gear Teeth using Milling Machine

### PART C

**Demonstration**

- Demonstration of formation of cutting parameters of single point cutting tool using bench grinder / tool & cutter grinder. Demonstration of surface milling /slot milling
- CNC Turning & Milling operations

**Course outcomes:**

- Perform turning , facing , knurling , thread cutting, tapering , eccentric turning and allied operations, keyways / slots , grooves etc using shaper
- Perform gear tooth cutting using milling machine
- Understand the formation of cutting tool parameters of single point cutting tool using bench grinder / tool and cutter grinder, Surface Milling/Slot Milling
- Demonstrate precautions and safety norms followed in Machine Shop
- Exhibit interpersonal skills towards working in a team

**Conduct of Practical Examination:**

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

**Scheme of Examination:**

ONE question from part -A: 30 Marks
ONE question from part –B : 50 Marks
Viva -Voice: 20 Marks
Total: 100 Marks

**B.E MECHANICAL AND SMART MANUFACTURING**
**Outcome Based Education (OBE) and Choice Based Credit System (CBCS)**
**SEMESTER - IV**

## DATA STRUCTURES AND PROGRAMMING LAB

| | | | |
|---|---|---|---|
| Course Code | 18SML48 | CIE Marks | 40 |
| Teaching Hours/Week (L: T:P) | (2:2:0) | SEE Marks | 60 |
| Credits | 02 | Exam Hours | 03 |

**Course objectives:**

- Understand various linear and non-linear data structures
- Understanding various types of data structures and their applications

Descriptions (if any)
Implement all the experiments in C Language under Linux / Windows environment.

| Sl. NO | Experiments |
|---|---|
| 1 | Design, Develop and Implement a menu driven Program in C for the following Array operations<br>a. Creating an Array of N Integer Elements<br>b. Display of Array Elements with Suitable Headings<br>c. Inserting an Element (ELEM) at a given valid Position (POS)<br>d. Deleting an Element at a given valid Position(POS)<br>e. Exit.<br>Support the program with functions for each of the above operations. |
| 2 | Design, Develop and Implement a Program in C for the following operations on Strings<br>a. Read a main String (STR), a Pattern String (PAT) and a Replace String (REP)<br>b. Perform Pattern Matching Operation:<br>Find and Replace all occurrences of PAT in STR with REP if PAT exists in STR.<br>Report suitable messages in case PAT does not exist in STR<br>Support the program with functions for each of the above operations.<br>Don't use Built-in functions. |
| 3 | Design, Develop and Implement a menu driven Program in C for the following operations on STACK of Integers (Array Implementation of Stack with maximum size MAX)<br>a. Push an Element on to Stack<br>b. Pop an Element from Stack<br>c. Demonstrate how Stack can be used to check Palindrome<br>d. Demonstrate Overflow and Underflow situations on Stack<br>e. Display the status of Stack<br>f. Exit<br>Support the program with appropriate functions for each of the above operations |
| 4 | Design, Develop and Implement a Program in C for converting an Infix Expression to Postfix Expression. Program should support for both parenthesized and free parenthesized expressions with the operators: +, -, *, /, %(Remainder), ^(Power) and alphanumeric operands. |
| 5 | Design, Develop and Implement a Program in C for the following Stack Applications<br>a. Evaluation of Suffix expression with single digit operands and operators: +, -, *, /, %, ^<br>b. Solving Tower of Hanoi problem with n disks |
| 6 | Design, Develop and Implement a menu driven Program in C for the following operations on Circular QUEUE of Characters (Array Implementation of Queue with maximum size MAX)<br>a. Insert an Element on to Circular QUEUE<br>b. Delete an Element from Circular QUEUE<br>c. Demonstrate Overflow and Underflow situations on Circular QUEUE<br>d. Display the status of Circular QUEUE<br>e. Exit<br>Support the program with appropriate functions for each of the above operations |
| 7 | Design, Develop and Implement a menu driven Program in C for the following operations on Singly Linked List (SLL) of Student Data with the fields: USN, Name, Branch, Sem, Ph No<br>a. Create a SLL of N Students Data by using front insertion.<br>b. Display the status of SLL and count the number of nodes in it<br>c. Perform Insertion / Deletion at End of SLL<br>d. Perform Insertion / Deletion at Front of SLL(Demonstration of stack) |

| | |
|---|---|
| | e. Exit |
| 8 | Design, Develop and Implement a menu driven Program in C for the following operations on Doubly Linked List (DLL) of Employee Data with the fields: SSN, Name, Dept, Designation, Sal, PhNo<br>a. Create a DLL of N Employees Data by using end insertion.<br>b. Display the status of DLL and count the number of nodes in it<br>c. Perform Insertion and Deletion at End of DLL<br>d. Perform Insertion and Deletion at Front of DLL<br>e. Demonstrate how this DLL can be used as Double Ended Queue<br>f. Exit |
| 9 | Design, Develop and Implement a Program in C for the following operations on Singly Circular Linked List (SCLL) with header nodes<br>a. Represent and Evaluate a Polynomial $P(x,y,z) = 6x^2y^2z-4yz^5+3x^3yz+2xy^5z-2xyz^3$<br>b. Find the sum of two polynomials POLY1(x,y,z) and POLY2(x,y,z) and store the result in POLYSUM(x,y,z)<br>Support the program with appropriate functions for each of the above operations |
| 10 | Design, Develop and Implement a menu driven Program in C for the following operations on Binary Search Tree (BST) of Integers<br>a. Create a BST of N Integers: 6, 9, 5, 2, 8, 15, 24, 14, 7, 8, 5, 2<br>b. Traverse the BST in Inorder, Preorder and Post Order<br>c. Search the BST for a given element (KEY) and report the appropriate message<br>d. Exit |
| 11 | Design, Develop and Implement a Program in C for the following operations on Graph(G) of Cities<br>a. Create a Graph of N cities using Adjacency Matrix.<br>b. Print all the nodes reachable from a given starting node in a digraph using DFS/BFS method |
| 12 | Given a File of N employee records with a set K of Keys(4-digit) which uniquely determine the records in file F. Assume that file F is maintained in memory by a Hash Table(HT) of m memory locations with L as the set of memory addresses (2-digit) of locations in HT. Let the keys in K and addresses in L are Integers.<br>Design and develop a Program in C that uses Hash function H: K → →→ →L as H(K)=K mod m (remainder method), and implement hashing technique to map a given key K to the address space L. Resolve the collision (if any) using linear probing. |

**Course outcomes:**

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

- Analyze and Compare various linear and non-linear data structures
- Demonstrate the working nature of different types of data structures and their applications
- Develop, analyze and evaluate the searching and sorting algorithms
- Choose the appropriate data structure for solving real world problems

**Conduct of Practical Examination:**

1. All laboratory experiments (TWELVE nos) are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script
4. Marks distribution: Procedure + Conduction + Viva:15 + 70 +15 (100)
5. Change of experiment is allowed only once and marks allotted to the procedure part to be made zero.

**B.E MECHANICAL AND SMART MANUFACTURING**
**Outcome Based Education (OBE) and Choice Based Credit System (CBCS)**
**SEMESTER - IV**

**ADDITIONAL MATHEMATICS – II**
(Mandatory Learning Course: Common to All Branches)
(A Bridge course for Lateral Entry students under Diploma quota toBE/B.Tech programmes)

| | | | |
|---|---|---|---|
| Course Code | 18MATDIP41 | CIE Marks | 40 |
| Teaching Hours/Week (L:T:P) | (2:1:0) | SEE Marks | 60 |
| Credits | -- | Exam Hours | 03 |

**Course objectives:**

- To provide essential concepts of linear algebra, second & higher order differential equations along with methods to solve them.
- To provide an insight into elementary probability theory and numerical methods.

**Module-1**

**Linear Algebra:** Introduction – rank of matrix by elementary row operations – Echelon form. Consistency of system of linear equations – Gauss elimination method. Eigen values and eigen vectors of a square matrix. Problems.

**Module-2**

**Numerical Methods:** Finite differences. Interpolation/extrapolation using Newton's forward and backward difference formulae (Statements only)-problems. Solution of polynomial and transcendental equations – Newton-Raphson and Regula-Falsi methods (only formulae)- Illustrative examples. Numerical integration: Simpson's one third rule and Weddle's rule (without proof) Problems.

**Module-3**

**Higher order ODE's:** Linear differential equations of second and higher order equations with constant coefficients. Homogeneous /non-homogeneous equations. Inverse differential operators.[Particular Integral restricted to $R(x) = e^{ax}, \frac{sinax}{cosax}, x^n \; for \; f(D)y = R(x)$.

**Module-4**

**Partial Differential Equations (PDE's):**Formation of PDE's by elimination of arbitrary constants and functions. Solution of non-homogeneous PDE by direct integration. Homogeneous PDEs involving derivative with respect to one independent variable only.

**Module-5**

**Probability:**Introduction. Samplespace and events. Axioms of probability. Addition&multiplication theorems. Conditional probability, Bayes's theorem, problems.

**Course outcomes:**
At the end of the course the student will be able to:
CO1: Solve systems of linear equations using matrix algebra.
CO2: Apply the knowledge of numerical methods in modelling and solving of engineering problems.
CO3: Apply the knowledge of numerical methods in modelling and solving of engineering problems.
CO4: Classify partial differential equations and solve them by exact methods.
CO5: Apply elementary probability theory and solve related problems.

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

| Sl No | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook** | | | | |
| 1 | Higher Engineering Mathematics | B.S. Grewal | Khanna Publishers | 43rd Edition, 2015 |
| **Reference Books** | | | | |
| 1 | Advanced Engineering Mathematics | E. Kreyszig | John Wiley & Sons | 10th Edition, 2015 |
| 2 | Engineering Mathematics Vol.I | RohitKhurana | Cengage Learning | 2015. |
| | | | | |

****** END ******

**B. TECH IN MECHANICAL AND SMART MANUFACTURING**
**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
**SEMESTER - V**

**Management and Economics**

| | | | |
|---|---|---|---|
| Course Code | **18ME51** | CIE Marks | 40 |
| Teaching Hours/Week (L:T:P) | 2:2:0 | SEE Marks | 60 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning Objectives:**

- To help the students to understand the fundamental concepts and principles of management; the basic roles, skills, functions of management, various organizational structures and basic knowledge of marketing.
- To impart knowledge, with respect to concepts, principles and practical applications of Economics, which govern the functioning of a firm/organization under different market conditions.

**Module-1**

Management: Introduction - Meaning - nature and characteristics of Management, Scope and Functional areas of management - Management as a science, art of profession - Management & Administration - Roles of Management, Levels of Management, Development of Management Thought- early management approaches – Modern management approaches. Planning: Nature, importance and purpose of planning process Objectives - Types of plans (Meaning Only) - Decision making Importance of planning - steps in planning & planning premises - Hierarchy of plans.

**Module-2**

Organizing and Staffing: Nature and purpose of organization Principles of organization - Types of organization - Departmentation Committees Centralization Vs Decentralization of authority and responsibility - Span of control - MBO and MBE (Meaning Only) Nature and importance of staffing--Process of Selection & Recruitment (in brief). Directing & Controlling: Meaning and nature of directing Leadership styles, Motivation Theories, Communication - Meaning and importance - coordination, meaning and importance and Techniques of Co Ordination. Meaning and steps in controlling - Essentials of a sound control system - Methods of establishing control (in brief).

**Module-3**

Introduction: Engineering and economics, Problem solving and decision making, Laws of demand and supply, Difference between Microeconomics & Macroeconomics, equilibrium between demand & supply, elasticity of demand, price elasticity, income elasticity. Law of Returns, Interest and interest factors, simple and compound interest, Cash flow diagrams, personal loans and EMI payment calculation with flexible interest rates, Discussion and problems.

**Module-4**

Present, future and annual worth and rate of returns: Basic present worth comparisons, Present worth-equivalence, Assets with unequal lives and infinites lives, future worth comparisons, payback comparisons, Equivalent annual worth comparisons, situations for annual worth comparisons. Asset life, Rate of return, minimum acceptable rate of return, IRR anomalies and misconceptions, Cost of capital, comparisons of all present future and annual worth with IRR, product costing, Discussions and problems.

**Module-5**

Costing and depreciation: Components of costs, estimation of selling price, marginal cost, first cost, all kinds of overheads, indirect cost estimation with depreciation, mensuration and estimation of material cost, cost estimation of mechanical process, idling time. Product costing (approaches to product costing), causes of depreciation, methods of computing depreciation charges, straight line method, declining balance method, sum of years method, sinking fund method, service output methods, taxation concepts, personal income taxes and corporate taxes, Discussions and problems.

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

CO1: Understand needs, functions, roles, scope and evolution of Management

CO2: Understand importance, purpose of Planning and hierarchy of planning and also1nalyse its types.

CO3: Discuss Decision making, Organizing, Staffing, Directing and Controlling.

CO4: Select the best economic model from various available alternatives.

CO5: Understand various interest rate methods and implement the suitable one.
CO6: Estimate various depreciation values of commodities.
CO7: Prepare the project reports effectively.

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

| Sl. No. | Title of the Book | Name of the Author/s | Name of the | Edition and |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Mechanical estimation | T.R. Banga& S.C. Sharma | Khanna Publishers | 17th edition 2015 |
| 2 | Engineering Economy | Riggs J.L | McGraw Hill | 4th edition |
| 3 | Engineering Economy | Thuesen H.G | PHI | 2002 |
| 4 | Principles of Management | Tripathy and Reddy | Tata McGraw Hill | 3rd edition 2006 |
| **Textbook/s** | | | | |
| 1 | Mechanical estimation | T.R. Banga& S.C. Sharma | Khanna Publishers | 17th edition 2015 |
| 2 | Engineering Economy | Riggs J.L | McGraw Hill | 4th edition |
| 3 | Engineering Economy | Thuesen H.G | PHI | 2002 |
| 4 | Principles of Management | Tripathy and Reddy | Tata McGraw Hill | 3rd edition 2006 |

**B. TECH IN MECHANICAL & SMART MANUFACTURING**
**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
**SEMESTER - V**

**MACHINE DESIGN**

| | | | |
|---|---|---|---|
| Course Code | **18SM52** | CIE Marks | 40 |
| Teaching Hours/Week (L:T:P) | 3:2:0 | SEE Marks | 60 |
| Credits | 04 | Exam Hours | 03 |

**Course Learning Objectives:**

1. To teach students how to apply the concepts of stress analysis, theories of failure and material science to analyze, design and/or select commonly used machine components.
2. To illustrate to students the variety of mechanical components available and emphasize the need to continue learning.
3. To teach students how to apply mechanical engineering design theory to identify and quantify machine elements in the design of commonly used mechanical systems.

**Module-1**

**Introduction to Mechanical Design** – Course Overview, Design Process; Materials – Material Properties, Materials Selection, Combined Loading, Failures Resulting from Static Loading – Static Strength, Stress Concentration, Failure Theories for Ductile and Brittle Materials, Cyclic Stress, Fatigue Regimes.

**Module-2**

**Fatigue of Structures:** S.N. curves, Endurance limit, Effect of mean stress, Goodman, Gerber and Soderberg relations and diagrams, Notches and stress concentrations, Neuber's stress concentration factors, plastic stress concentration factors – Notched S-N curves..

**Module-3**

**Design of couplings**: Couplings: Rigid and flexible coupling-types and applications, design of Flange coupling, and Bush and Pin type coupling. **Design of Permanent Joints**: Types of permanent joints-Riveted and Welded Joints. Riveted joints: Types of rivets, rivet materials, Caulking and fullering, analysis of riveted joints, joint efficiency, failures of riveted joints, boiler joints, riveted brackets.

**Module-4**

**Springs:** Types of springs - stresses in Helical coil springs of circular and non-circular cross sections. Tension and compression springs, springs under fluctuating loads, Leaf Springs: Stresses in leaf springs. Equalized stresses, Energy stored in springs, Torsion, Belleville and Rubber springs.

**Module-5**

**Fracture Mechanics:** Strength of cracked bodies, potential energy and surface energy, Griffith's theory, Irwin – Orwin extension of Griffith's theory to ductile materials, Stress analysis of cracked bodies.

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

CO1. Apply the principle of solid mechanics to design machine member under variable loading.
CO2. Introduce fatigue failure of materials
CO3. Ability to design Couplings and joints for industrial applications.
CO4. Ability to design various Springs for strength and stiffness.
CO5. Correctly apply fracture mechanics to predict brittle fracture. Identify and describe the basic fracture and fatigue mechanisms

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

| Sl No | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Design of Machine Elements, | V B Bhandari | Tata McGraw Hill | 4th Ed., 2016. |
| 2 | Machine Design | Shigley, J.E | McGraw Hill | |
| 3 | Fracture Mechanics Fundamentals and Applications | T.L. Anderson | Taylor and Francis Group Ltd., | 1s Ed., 2016 |
| **Reference Books** | | | | |
| 1 | Machine Design- an integrated approach | Robert L. Norton | Pearson Education | 2nd edition. |
| 2 | Design of Machine Elements | V.M. Faires | | |
| 3 | Machine Design | Hall, Holowenko, Laughlin (Schaum's Outline series) | Tata McGraw Hill Publishing | Special Indian Edition, 2008 |
| 4 | Elements of Machine Design | H.G.Patil, S.C.Pilli, R.R.Malagi, M.S.Patil | IK International | First edition,2019 |
| 5 | Elements of Fracture Mechanics | Prashant Kumar | Tata McGraw Hill, New Delhi, India | |

**Design Data Hand Book:**

[1] Design Data Hand Book, K. Mahadevan and Balaveera Reddy, CBS publication.

**Web links and Video Lectures:**

1. Design of Machine Elements I, IIT Kharagpur, https://nptel.ac.in/courses/112105124

**B.TECH IN MECHANICAL AND SMART MANUFACTURING**
**Outcome Based Education (OBE) and Choice Based Credit System (CBCS)**
**SEMESTER -V**

## Control Engineering

| | | | |
|---|---|---|---|
| Course Code | 18SM53 | CIE Marks | 40 |
| TeachingHours/Week (L: T:P) | (3:0:0) | SEE Marks | 60 |
| Credits | 03 | Exam Hours | 03 |

### Course objectives:

- Understand the basic concepts & mathematical modelling of systems.
- Modelling of mechanical, hydraulic, pneumatic and electrical systems.
- Representation of system elements by blocks and its reduction.
- Transient and steady state response analysis of a system.
- Frequency response analysis using polar plot.
- Frequency response analysis using bode plot.
- Analysis of system using root locus plots.

**Module-1**

**Introduction:** Concept of automatic controls, Open loop and closed loop systems, Concepts of feedback, requirements of an ideal control system, Types of controllers-Proportional, Integral, Differential, Proportional & Integral, Proportional Differential and Proportional Integral Differential controllers.

**Module-2**

**Modelling of Physical Systems:** Mathematical Models of Mechanical, Electrical, Thermal, Hydraulic and Pneumatic Systems.
**Analogous Systems:** Direct and inverse analogues for mechanical, thermal and fluid systems.
**Block diagram Algebra**: General representation of a feedback control system, transfer functions, rules of block diagram algebra, reduction of block diagram to obtain closed loop transfer function. Signal flow graphs, Mason's gain formula.

**Module-3**

**Steady state operation:** Steady state analysis for general block diagram for a control system, steady state characteristics, equilibrium in a system.
**Time Response of feedback control systems**: Standard test signals, Unit step response of First and Second order Systems. Time response specifications, Time response specifications of second order systems, steady state errors and error constants.
Routh's stability criterion for a control system.
**Root Locus Plots:** Root locus method: Significance of Root locus, angle and magnitude conditions, breakaway points, angles of departure and arrival, construction of Root locus using general rules and steps, Lead and Lag compensation

**Module-4**

**Frequency Domain Analysis:** Relationship between time and frequency response, Polar plot, Bode Plot, Nyquist plot and Nyquist stability criterion, Relative Stability, Phase and Gain Margins

**Module-5**

**Introduction to State variable analysis:** Concepts of state, state variable and state models for electrical systems, Solution of state equations.

### Course outcomes:

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

1. Recognize control system and its types, control actions.
2. Determine the system governing equations for physical models (Electrical, Thermal, Mechanical, Electro Mechanical).
3. Calculate the gain of the system using block diagram and signal flow graph.
4. Illustrate the response of 1st and 2nd order systems.
5. Determine the stability of transfer functions in complex domain and frequency domain.
6. Model a system by applying the concept of State Space analysis.

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

**Textbook:**


- J Nagrath and M Gopal, 'Control Systems Engineering', New Age International(P) Limited, Publishers, Fifth edition, 2005, ISBN: 81 - 224 - 2008-7.


**Reference Books:**


- K Ogata, 'Modern Control Engineering', Pearson Education Asia/ PHI, 4th Edition, 2002. ISBN 978 - 81 - 203 - 4010 - 7.
- Benjamin C. Kuo, 'Automatic Control Systems', John Wiley India Pvt. Ltd., 8th Edition, 2008.
- Joseph J Distefano III et al., 'Feedback and Control System', Schaum's Outline series, TMH, 2nd Edition, 2007.

**B. TECH IN MECHANICAL & SMART MANUFACTURING**
**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
**SEMESTER - V**

**ADVANCED DYNAMICS OF MACHINERY**

| | | | |
|---|---|---|---|
| Course Code | **18SM54** | CIE Marks | 40 |
| Teaching Hours/Week (L:T:P) | 3:2:0 | SEE Marks | 60 |
| Credits | 04 | Exam Hours | 03 |

**Course Learning Objectives:**

- To understand the force-motion relationship in components subjected to external forces and analysis of standard mechanisms.
- To understand the undesirable effects of unbalances resulting from prescribed motions in mechanism.
- To understand the effect of Dynamics of undesirable vibrations.
- To understand the principles in mechanisms used for speed control and stability control.
- To know the concepts of modelling mechanical systems using spring, mass and damper elements.
- To compute the natural and damped frequencies of free 1-DOF mechanical systems
- To analyze the vibrational motion of 1-DOF mechanical systems under harmonic excitation conditions.

**Module-1**

**Static force analysis:** Static equilibrium, analysis of four bar mechanism, slider crank mechanism, shaper mechanism. **Dynamic force analysis:** D'Alembert's principle, analysis of four bar and slider crank mechanism, shaper mechanism.

**Module-2**

**Balancing of Rotating Masses:** Static and Dynamic Balancing, Balancing of single rotating mass by balancing masses in same plane and in different planes. Balancing of several rotating masses by balancing masses in same plane and in different planes.

**Balancing of Reciprocating Masses:** Inertia Effect of crank and connecting rod, Single cylinder Engine, Balancing in multi cylinder-inline engine (primary and secondary forces), V-type engine, Radial engine – direct and reverse crank method.

**Module-3**

**Governors:** Types of Governors; Force Analysis of Porter and Hartnell Governors. Controlling Force, Stability, Sensitiveness, Isochronism, Effort and Power.

**Gyroscope:** Vectorial representation of angular motion, Gyroscopic couple. Effect of gyroscopic Couple on plane disc, ship, aeroplane, Stability of two wheelers and four wheelers.

**Module-4**

**Free vibrations:** Basic elements of vibrating system, Types of free vibrations, Longitudinal vibrations-Equilibrium method, D'Alembert's principle, Energy method, Rayleigh's method. Determination of natural frequency of single degree freedom systems, Effect of spring mass, Damped free vibrations: Under damped, over damped and critically damped systems. Logarithmic decrement.

**Module-5**

**Forced vibrations:** Undamped forced vibration of spring mass system, Damped forced vibrations, Rotating unbalance, Reciprocating unbalance, Vibration isolation, Support motion(absolute and relative motion), Transverse vibration of shaft with single concentrated load, several loads, uniformly distributed load, Critical speed.

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

CO1: Analyse the mechanisms for static and dynamic equilibrium.

CO2: Carry out the balancing of rotating and reciprocating masses

CO3: Analyse different types of governors used in real life situation.

CO4: Analyse the gyroscopic effects on disks, airplanes, stability of ships, two and four wheelers

CO5: Understand the free and forced vibration phenomenon.

CO6: Determine the natural frequency, force and motion transmitted in vibrating systems.

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

| Sl. No. | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Theory of Machines: Kinematics and Dynamics | Sadhu Singh | Pearson | Third edition 2019. |
| 2 | Mechanism and Machine Theory | G. Ambekar | PHI | 2009 |
| **Reference Books** | | | | |
| 1 | Theory of Machines | Rattan S.S. | Tata McGraw-Hill Publishing Company | 2014 |
| 2 | Mechanisms and Machines-Kinematics, Dynamics and Synthesis | Michael M Stanisic | Cengage Learning | 2016 |

**B.TECH IN MECHANICAL AND SMART MANUFACTURING**
**Outcome Based Education (OBE) and Choice Based Credit System (CBCS)**
**SEMESTER -V**

## Mechatronics

| | | | |
|---|---|---|---|
| Course Code | 18SM55 | CIE Marks | 40 |
| TeachingHours/Week (L: T:P) | (3:0:0) | SEE Marks | 60 |
| Credits | 03 | Exam Hours | 03 |

### Course objectives:

- Understand the evolution and development of Mechatronics as a discipline.
- Discuss the sensors and actuation systems used in Mechatronics applications
- Demonstrate the integration philosophy in view of Mechatronics technology
- Describe the architectural features and instructions of 32-bit microcontroller ARM Cortex M3.

**Module-1**

Introduction: What is Mechatronics?, Design process, Systems, Measurement systems, Control systems, PLC, Examples of mechatronic systems: Digital camera with autofocus, Engine management system.
Sensors and Transducers (only selected topics): Smart sensors, Pneumatic sensors, Proximity switches, Force, Fluid pressure, Piezoelectric sensors, Tactile sensor, Temperature. [Textbook-1]

**Module-2**

Pneumatic And Hydraulic Actuation Systems: Actuation systems, Pneumatic and hydraulic systems, Directional control valves, Pressure control valves, Servo and proportional control valves, Process control valves, Rotary actuators.
Mechanical Actuation Systems: Mechanical systems, Types of motion, Kinematic chains, Cams, Gears, Belt and chain drives, Bearings. [Textbook-1]

**Module-3**

Electrical Actuation Systems: Electrical systems, Mechanical switches, Solenoids, DC/AC Motors, Stepper Motors. [Textbook-1]
Interfacing Microcontrollers with Actuators: Introduction, Interfacing with general purpose three state transistors, Interfacing relays, Interfacing solenoids, Interfacing stepper motors, interfacing permanent magnet motors, Interfacing sensors, Interfacing with DAC, interfacing power supplies, Compatibility at an interface.
[Textbook-2]

**Module-4**

ARM Embedded Systems: Introduction, RISC design philosophy, ARM design philosophy, Embedded system hardware – AMBA bus protocol, ARM bus technology, Memory, Peripherals, Embedded system software – Initialization (BOOT) code, Operating System, Applications.
ARM Processor Fundamentals, ARM core dataflow model, registers, current program status register, Pipeline, Exceptions, Interrupts and Vector Table.
Text book3: Chapter 1, 2

**Module-5**

Introduction to the ARM Instruction set: Introduction, Data processing instructions, Load - Store instruction, Software interrupt instructions, Program status register instructions, Loading constants, Conditional Execution.
Text book3: Chapter 3

### Course outcomes:

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

1. Describe and analyze the mechatronic systems and their associated systems.
2. Discuss and illustrate the different types of sensors and actuation systems for different mechatronic applications.
3. Demonstrate the integration of mechatronic systems.
4. Describe the architectural features and instructions of 32-bit microcontroller ARM Cortex M3.

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

**Textbooks:**


1. "Electronic Control Systems in Mechanical and Mechatronics –Electrical Engineering", WBolton, Pearson Education, 1st Edition, 2005.
2. "Mechatronics: Principles and Applications", Godfrey C Onwubolu, Elsevier (BH) Publications, India Reprint 2013.
3. "ARM System Developers Guide", Andrew N Sloss, Dominic System and Chris Wright, Elsevier, Morgan Kaufman publisher, 1st Edition, 2008.


**Reference Books:**


- "Mechatronics: Principles, Concepts and applications", Nitaigour Premchand Mahailik, TMH, 2003.
- "ARM System-on-Chip Architecture", Steve Furber, Pearson, 2014.

**B.Tech. in MECHANICAL AND SMART MANUFACTURING**
**Outcome Based Education (OBE) and Choice Based Credit System (CBCS)**
**SEMESTER - V**

## Additive Manufacturing

| | | | |
|---|---|---|---|
| Course Code | 18SM56 | CIE Marks | 40 |
| Teaching Hours/Week (L: T:P) | (3:2:0) | SEE Marks | 60 |
| Credits | 04 | Exam Hours | 03 |

**Course objectives:**

The course enables students to

- Understand the additive manufacturing, polymerization and powder metallurgy processes
- Conceive, design, and implement products quickly and effectively, using the latest rapid prototyping methods and CAD/CAM technology.
- Learn to differentiate various process parameters associated with Rapid manufacturing technique .

**Module-1**

**Introduction to Additive Manufacturing:** Introduction to AM, AM evolution, Distinction between AM & CNC machining, Advantages of AM, AM process chain: Conceptualization, CAD, conversion to STL, Transfer to AM, STL file manipulation, Machine setup, build , removal and clean up, post processing.

**Classification of AM processes:** Liquid polymer system, Discrete particle system, Molten material systems and Solid sheet system. Post processing of AM parts: Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques.

**Guidelines for process selection:** Introduction, selection methods for a part, challenges of selection AM Applications: Functional models, Pattern for investment and vacuum casting, Medical models, art models, Engineering analysis models, Rapid tooling, new materials development, Bi-metallic parts, Re-manufacturing. Application examples for Aerospace, defence, automobile, Bio-medical and general engineering industries

**Module-2**

**Introduction to Rapid Prototyping (RP):** Definition of Prototype, Types of prototype, Need for the compression in product development, History of RP systems, Survey of applications, Growth of RP industry, classification of RP systems.

**Stereo lithography Systems:** Principle, Process parameters

**Module-3**

**Selective Laser Sintering:** Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications, FUSION DEPOSITION MODELLING: Principle, Process parameter, Path generation, Applications

**Solid Ground Curing:** Principle of operation, Machine details, Applications.

**Laminated Object Manufacturing:** Principle, of operation, LOM materials, process details, application.

**Concepts Modelers:** Principle, Thermal jet printer, Sander's model market, 3-D printer, Genisys Xs printer HP system 5, object Quadra systems, Laser Engineering Net Shaping (LENS)

**Module-4**

**Polymers & Powder Metallurgy Basic Concepts:** Introduction to Polymers used for additive manufacturing: polyamide, PF resin, polyesters etc. Classification of polymers, Concept of functionality, Polydispersity and Molecular weight [MW], Molecular Weight Distribution [MWD]

**Polymer Processing: Methods of spinning for additive manufacturing:** Wet spinning, Dry spinning. Biopolymers, Compatibility issues with polymers. Moulding and casting of polymers, Polymer processing techniques

**General Concepts: Introduction and History of Powder Metallurgy (PM)**, Present and Future Trends of PM Powder Production Techniques: Different Mechanical and Chemical methods, Atomisation of Powder, other emerging processes.

**Powder Shaping:** Particle Packing Modifications, Lubricants & Binders, Powder Compaction & Process Variables, Pressure & Density Distribution during Compaction, Isotactic Pressing, Injection Moulding, Powder Extrusion, Slip Casting, Tape Casting.

**Sintering:** Theory of Sintering, Sintering of Single & Mixed Phase Powder, Liquid Phase Sintering Modern Sintering Techniques, Physical & Mechanical Properties Evaluation, Structure-Property Correlation Study, Modern Sintering techniques

**Module-5**

**Rapid Tooling:** Indirect Rapid tooling -Silicon rubber tooling -Aluminium filled epoxy tooling, Spray metal tooling ,Cast kirksite ,3D keltool ,etc, Direct Rapid Tooling- Direct, AIM, Quick cast process, Copper polyamide, Rapid Tool ,DMILS, ProMetal etc.

**Software for Rp:** Stl files, Overview of Solid view, magics, imics, magic communicator, etc. Internet based software, Collaboration tools, RAPID Manufacturing Process Optimization: factors influencing accuracy, data preparation errors, Part building errors, Error in finishing, influence of build orientation.
Allied Processes: vacuum, casting, surface digitizing, surface generation from point cloud, surface modification — data transfer to solid models.

**Course outcomes:**

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

- Implementation of different Additive Manufacturing Techniques
- Express the concept of product design stages and methods, thereby making him a better product designer.
- Assess and implement RP techniques for specific application leading to better ROI for the company that uses RP machines

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

| Sl No | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Stereo 1ithography and other RP & M Technologies | Paul F. Jacobs | SME NY | 1996 |
| 2 | Rapid Manufacturing | Flham D.T & Dinjoy S.S | Verlog London | 2001 |
| 3 | "Rapid Prototyping: Principles & Applications" | Chua Chee Kai, Leong Kah Fai, | World Scientific, | 2003 |
| 4 | Principles of Polymerization | G Odian | Wiley Inerscience John Wiley and Sons | 4th edition,2005 |
| 5 | Powder Metallurgy Technology | | Cambridge International Science Publishing | 2002 |
| **Reference Books** | | | | |
| 1 | Wohler's Report 2000 | Terry Wohler's | Wohler's Association | 2000 |
| 2 | Rapid prototyping materials | B Gurumurthi | IISc,Bangalore | |

**B.TECH IN MECHANICAL AND SMART MANUFACTURING**
**Outcome Based Education (OBE) and Choice Based Credit System (CBCS)**
**SEMESTER - V**

## Mechatronics Lab

| | | | |
|---|---|---|---|
| Course Code | **18SML57** | CIE Marks | 40 |
| Teaching Hours/Week (L: T:P) | (2:2:0) | SEE Marks | 60 |
| Credits | 02 | Exam Hours | 03 |

### Course objectives:

- To write programs in ARM ALP for basic mathematical operations.
- To understand, develop and deploy the ARM microcontroller-based interfacing of sensors and actuators.

| Sl. NO | Experiments |
|---|---|
| **Conduct the following experiments by writing Assembly Language Program (ALP) using ARM Cortex M3 Registers using an evaluation board/simulator and the required software tool.** | |
| 1 | Write an ALP to i) multiply two 16-bit binary numbers. ii) add two 64-bit numbers. |
| 2 | Write an ALP to find the sum of first 10 integer numbers. |
| 3 | Write an ALP to find factorial of a number. |
| 4 | Write an ALP to add an array of 16-bit numbers and store the 32-bit result in internal RAM. |
| 5 | Write an ALP to find the square of a number (1 to 10) using look-up table. |
| 6 | Write an ALP to find the largest/smallest number in an array of 32 numbers. |
| 7 | Write an ALP to arrange a series of 32-bit numbers in ascending/descending order. |
| 8 | i) Write an ALP to count the number of ones and zeros in two consecutive memory locations.<br>ii)Write an ALP to Scan a series of 32-bit numbers to find how many are negative. |
| **Conduct the following experiments on an ARM CORTEX M3 / LPC 2148 / any ARM microcontroller series evaluation board using evaluation version of Embedded 'C' & Keil µvision-4 tool/compiler.** | |
| 9 | Interface a Stepper motor and rotate it in clockwise and anti-clockwise direction. |
| 10 | Interface a DAC and generate Triangular and Square waveforms. |
| 11 | Display the Hex digits 0 to F on a 7-segment LED interface, with a suitable delay in between. |
| 12 | Interface a simple Switch and display its status through Relay / Buzzer / LED. |

**Revised Bloom'sTaxonomy Level: L1 – L4**

### Course outcomes:

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

1. Write ALP for implementation of specific arithmetic or logical operations.
2. Write programs to demonstrate functioning of various devices interfaced to ARM processor.
3. Develop programs for ARM processors to implement real world problems.
4. Design and develop mini projects.

### Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

### Scheme of Examination:

| | | |
|---|---|---|
| ONE question from part A: | | 30 Marks |
| ONE question from part B: | | 50 Marks |
| Viva –Voice | : | 20 Marks |
| Total | : | 100 Marks |

**B.TECH IN MECHANICAL AND SMART MANUFACTURING**
**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
**SEMESTER –V**

**SMART MANUFACTURING LAB-I**

| | | | |
|---|---|---|---|
| Course Code | **18SML58** | CIE Marks | 40 |
| Teaching Hours/Week (L:T:P) | 0:2:2 | SEE Marks | 60 |
| Credits | 02 | Exam Hours | 03 |

**Course Learning Objectives:**

- Learn CAD Modelling Techniques for RP
- Generating STL files from the CAD Models
- Fabricate using RP Machine
- Develop the skill to operate the Robot
- Learn different Robotic programming languages.

| Sl. No. | Experiments |
|---|---|
| 1. | Review of CAD Modelling Technique and Introduction to RP. |
| 2. | Forming Groups and Assigning creative Idea. |
| 3. | Generating STL files from the CAD Models and Working on STL files. |
| 4. | Modeling Creative Designs in CAD Software |
| 5. | Assembling Creative Designs in CAD Software. |
| 6. | Processing the CAD data in catalyst software(Selection of Tool path generation). |
| 7. | Simulation in Catalyst (or any other)software. |
| 8. | Sending the tool path data to FDM RP(or any other)machine. |
| 9. | Fabricating the physical part on FDM RP machine. |
| 10. | Removing the supports& post processing (Cleaning the Surfaces) |
| 11. | Demonstrating Creative working Models. |
| 12. | Converting CT/MRI Scan data into STL files using MIMICS software (Demo) |
| | **Demonstration Experiments ( For CIE )** |
| 13. | Forward and inverse kinematics of two axis planar articulated robot using analytical and DH algorithm using Lego NXT. |
| 14. | Forward and inverse kinematics to control hand movements in NAO. |
| 15. | Study and Selection of Gripper. |
| 16. | Implementation of trajectory planning algorithm for straight line motion using Matlab and executing PID based control of two axis planar articulated robot in Lego NXT. |
| 17. | Analysis and Simulation using FANUC Robo guide software(or any other)and real time programming of Fanuc M710i. |
| 18. | Robot (or any other). |
| 19. | Programming of Adept Cobra S600 SCARA robot (or any other). |
| 20. | Forward and inverse kinematics of two axis planar articulated robot using analytical and DH algorithm using Lego NXT. |

**Course Outcomes:**

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

- Optimize the process parameters of FDM Machine to improve the quality of the parts produced.
- Build complex engineering assemblies in plasticmaterials with less process planning.
- Improve surface finish of fabricated plastic components for the engineering applications.
- Design and fabricate working models for the conceptual testing applications.
- Apply forward and inverse kinematic solutions.

Implement trajectory planning algorithm.

**Conduct of Practical Examination:**

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

**Scheme of Examination:**

| | | |
|---|---|---|
| ONE question from part A: | | 30 Marks |
| ONE question from part B: | | 50 Marks |
| Viva –Voice | : | 20 Marks |
| Total | : | 100 Marks |

**B.TECH IN EMECHANICAL AND SMART MANUFACTURING**
**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
**SEMESTER – V**

**ENVIRONMENTAL STUDIES**

| | | | |
|---|---|---|---|
| Course Code | **18CIV59** | CIE Marks | 40 |
| Teaching Hours / Week (L:T:P) | (1:0:0) | SEE Marks | 60 |
| Credits | 01 | Exam Hours | 02 |

**Module - 1**

**Ecosystems** (Structure and Function): Forest, Desert, Wetlands, Riverine, Oceanic and Lake. 02 Hrs
**Biodiversity:** Types, Value; Hot-spots; Threats and Conservation of biodiversity, Forest Wealth, and Deforestation.

**Module - 2**

**Advances in Energy Systems** (Merits, Demerits, Global Status and Applications)**:** Hydrogen, Solar, OTEC, Tidal and Wind. 02 Hrs
**Natural Resource Management** (Concept and case-studies): Disaster Management, Sustainable Mining, Cloud Seeding, and Carbon Trading.

**Module - 3**

**Environmental Pollution** (Sources, Impacts, Corrective and Preventive measures, Relevant Environmental Acts, Case-studies)**:** Surface and Ground Water Pollution; Noise pollution; Soil Pollution and Air Pollution.02 Hrs
**Waste Management & Public Health Aspects:** Bio-medical Wastes; Solid waste; Hazardous wastes; E-wastes; Industrial and Municipal Sludge.

**Module - 4**

**Global Environmental Concerns** (Concept, policies and case-studies): Ground water depletion/recharging, Climate Change; Acid Rain; Ozone Depletion; Radon and Fluoride problem in drinking water; Resettlement and rehabilitation of people, Environmental Toxicology.

**Module - 5**

**Latest Developments in Environmental Pollution Mitigation Tools (Concept and Applications):** G.I.S. & Remote Sensing, Environment Impact Assessment, Environmental Management Systems, ISO14001; Environmental Stewardship- NGOs. 03 Hrs
**Field work:** Visit to an Environmental Engineering Laboratory or Green Building or Water Treatment Plant or Waste water treatment Plant; ought to be Followed by understanding of process and its brief documentation.

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

- CO1: Understand the principles of ecology and environmental issues that apply to air, land, and water issues on a global scale,
- CO2: Develop critical thinking and/or observation skills, and apply them to the analysis of a problem or question related to the environment.
- CO3: Demonstrate ecology knowledge of a complex relationship between biotic and abiotic components.
- CO4: Apply their ecological knowledge to illustrate and graph a problem and describe the realities that managers face when dealing with complex issues.

**Question paper pattern:**

- The Question paper will have 100 objective questions.
- Each question will be for 01 marks
- Student will have to answer all the questions in an OMR Sheet.
- The Duration of Exam will be 2 hours.

| Sl. No. | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Environmental Studies | Benny Joseph | Tata Mc Graw – Hill. | 2nd Edition, 2012 |

| | | | | |
|---|---|---|---|---|
| 2. | Environmental Studies | S M Prakash | Pristine Publishing House, Mangalore | 3rd Edition, 2018 |
| 3 | Environmental Studies – From Crisis to Cure | R Rajagopalan | Oxford Publisher | 2005 |
| **Reference Books** | | | | |
| 1 | Principals of Environmental Science and Engineering | Raman Sivakumar | Cengage learning, Singapur. | 2nd Edition, 2005 |
| 2 | Environmental Science – working with the Earth | G.Tyler Miller Jr. | Thomson Brooks /Cole, | 11th Edition, 2006 |
| 3 | Text Book of Environmental and Ecology | Pratiba Sing, AnoopSingh& Piyush Malaviya | Acme Learning Pvt. Ltd. New Delhi. | 1st Edition |

**B.TECH IN MECHANICAL AND SMART MANUFACTURING**
**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
**SEMESTER - VI**

**FINITE ELEMENT METHOD**

| | | | |
|---|---|---|---|
| Course Code | **18SM61** | CIE Marks | 40 |
| Teaching Hours /Week (L:T:P) | 3:2:0 | SEE Marks | 60 |
| Credits | 04 | Exam Hours | 03 |

**Course Learning Objectives:**

- To learn the basic principles of finite element analysis procedure
- To understand the design and heat transfer problems with application of FEM.
- Solve 1 D, 2 D and dynamic problems using Finite Element Analysis approach.
- To learn the theory and characteristics of finite elements that represent engineering structures.
- To learn and apply finite element solutions to structural, thermal, dynamic problem to develop the knowledge and skills needed to effectively evaluate finite element analyses

**Module-1**

**Introduction to Finite Element Method:** General steps of the finite element method. Engineering applications of finite element method. Advantages of the Finite Element Method.

**Boundary conditions:** Homogeneous and non-homogeneous for structural, heat transfer and fluid flow problems. Potential energy method, Rayleigh Ritz method, Galerkin's method, Displacement method of finite element formulation. Convergence criteria, Discretisation process

**Types of elements:** 1D, 2D and 3D, Node numbering, Location of nodes. Strain- displacement relations, Stress-strain relations, Plain stress and Plain strain conditions, temperature effects. **Interpolation models:** Simplex, complex and multiplex elements, linear interpolation polynomials in terms of global coordinates 1D, 2D, 3D Simplex Elements.

**Module-2**

**Introduction to the stiffness (Displacement) method:** Introduction, Derivation of stiffness matrix, Derivation of stiffness matrix for a spring element, Assembly the total stiffness matrix by superposition. One-Dimensional Elements-Analysis of Bars and Trusses, Linear interpolation polynomials in terms of local coordinate's for1D, 2Delements. Higher order interpolation functions for 1D quadratic and cubic elements in natural coordinates, Constant strain triangle, Four-Nodded Tetrahedral Element (TET 4), Eight-Nodded Hexahedral Element (HEXA 3 8), 2D iso-parametric element, Lagrange interpolation functions.

**Module-3**

**Beams and Shafts:** Boundary conditions, Load vector, Hermite shape functions, Beam stiffness matrix based on Euler-Bernoulli beam theory, Examples on cantilever beams, propped cantilever beams, Numerical problems on simply supported, fixed straight and stepped beams using direct stiffness method with concentrated and uniformly distributed load.

**Torsion of Shafts:** Finite element formulation of shafts, determination of stress and twists in circular shafts.

**Module-4**

**Heat Transfer:** Basic equations of heat transfer: Energy balance equation, Rate equation: conduction, convection, radiation, 1D finite element formulation using vibration method, Problems with temperature gradient and heat fluxes, heat transfer in composite sections, straight fins.

**Fluid Flow:** Flow through a porous medium, Flow through pipes of uniform and stepped sections, Flow through hydraulic net works.

**Module-5**

**Axi-symmetric Solid Elements:** Derivation of stiffness matrix of axisymmetric bodies with triangular elements, Numerical solution of axisymmetric triangular element(s) subjected to surface forces, point loads, angular velocity, pressure vessels.

**Dynamic Considerations:** Formulation for point mass and distributed masses, Consistent element mass matrix of one dimensional bar element, truss element, axisymmetric triangular element, quadrilateral element, beam element. Lumped mass matrix of bar element, truss element, Evaluation of eigen values and eigen vectors, Applications to bars, stepped bars, and beams

**Assignment:**

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

CO1: Identify the application and characteristics of FEA elements such as bars, beams, plane and iso-parametric elements.

CO2: Develop element characteristic equation and generation of global equation.

CO3: Formulate and solve Axi-symmetric and heat transfer problems.

CO4: Apply suitable boundary conditions to a global equation for bars, trusses, beams, circular shafts, heat transfer, fluid flow, axi-symmetric and dynamic problems

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

| Sl No | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | A first course in the Finite Element Method | Logan, D. L | Cengage Learning | 6th Edition 2016 |
| 2 | Finite Element Method in Engineering | Rao, S. S | Pergaman Int. Library of Science | 5th Edition 2010 |
| 3 | Finite Elements in Engineering | Chandrupatla T. R | PHI | 2nd Edition 2013 |
| **Reference Books** | | | | |
| 1 | Finite Element Method | J.N.Reddy | McGraw -Hill International Edition | |
| 2 | Finite Elements Procedures | Bathe K. J | PHI | |
| 3 | Concepts and Application of Finite Elements Analysi | Cook R. D., et al. | Wiley & Sons | 4th Edition 2003 |

E- Learning
VTU, E- learning

**B.TECH IN MECHANICAL AND SMART MANUFACTURING**
**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
**SEMESTER - VI**

**ROBOTICS AND AUTOMATION**

| | | | |
|---|---|---|---|
| Course Code | **18SM62** | CIE Marks | 40 |
| Teaching Hours /Week (L:T:P) | 3:2:0 | SEE Marks | 60 |
| Credits | 04 | Exam Hours | 03 |

**Course Learning Objectives:**

- To identify potential areas for automation and justify need for automation.
- To select suitable major control components required to automate a process or an activity
- To study the various parts of robots and fields of robotics.
- To study the various kinematics and inverse kinematics of robots.
- To study the control of robots for some specific applications

**Module-1**

**Introduction to automation:** Basic elements of an automated system, advanced automation functions, levels of automation, process industries versus discrete manufacturing industries, continuous versus discrete control, computer process control. Hardware components for automation and process control, sensors, actuators, analog to digital converters, digital to analog converters, input/output devices for discrete data.

**Module-2**

**Automated production lines:** Fundamentals of automated production lines, application of automated production lines, analysis of transfer lines, automated assembly systems, fundamentals of automated assembly systems, quantitative analysis of assembly systems, automatic identification methods, barcode technology, radio frequency identification, other AIDC technologies

**Module-3**

**Industrial Robotics:** Robotic configuration, robot anatomy and related attributes, robot control systems, end effectors, sensors in robotics, industrial robot applications, robot accuracy and repeatability, different types of robots, various generations of robots, degrees of freedom – Asimov's laws of robotics, dynamic stabilization of robots.

**Module-4**

**Spatial descriptions and transformations:** Robot actuators and Feedback components: Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors, comparison. Position sensors –potentiometers, resolvers, encoders –Velocity sensors, Tactile sensors, Proximity sensors. Manipulator Kinematics: Homogeneous transformations as applicable to rotation and translation -D-H notation, Forward and inverse kinematics.

**Module-5**

**Robot programming:** Introduction, levels of robot programming, requirements of robot programming language, problems pertaining to robot programming languages, offline programming systems, central issues in OLP systems, automating subtasks in OLP systems, simple programs on robot applications.

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

CO1: Translate and simulate a real time activity using modern tools and discuss the Benefits of automation.

CO2: Identify suitable automation hardware for the given application.

CO3: Recommend appropriate modelling and simulation tool for the given manufacturing Application.

CO4: Explain the basic principles of Robotic technology, configurations, control and Programming of Robots.

CO5: Explain the basic principles of programming and apply it for typical Pick & place, Loading & unloading and palletizing applications

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

| Sl No | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Computer Integrated Manufacturing | Mikell P. Groover | Pearson | 3rd edition, 2009 |
| 2 | Introduction to robotics mechanics and control | John J. Craig | Pearson | 3rd edition, 2009 |
| **Reference Books** | | | | |
| 1 | Robotics for Engineers | Yoram Koren | McGraw Hill International | 1st edition, 1985. |
| 2 | Industrial Robotics | Weiss, Nagel | McGraw Hill International | 2nd edition, 2012 |
| 3 | Robotic Engineering - An Integrated approach | Klafter, Chmielewski and Negin | PHI | 1st edition, 2009 |
| 4 | Computer Based Industrial Control | Krishna Kant | EEE-PHI | 2nd edition,2010 |
| 5 | An Introduction to Automated Process Planning System | Tiess Chiu Chang & Richard A. Wysk. | | |

**B. TECH IN MECHANICAL AND SMART MANUFACTURING**
**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
**SEMESTER – VI**
**Professional Elective- 1**

**HYDRAULICS AND PNEUMATICS**

| | | | |
|---|---|---|---|
| Course Code | **18SM63** | CIE Marks | 40 |
| Teaching Hours /Week (L:T:P) | 3:0:0 | SEE Marks | 60 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning Objectives:**

- To examine concepts centering on sources of hydraulic power, rotary and linear actuators, distribution systems, hydraulic flow in pipes, and control components in fluid power systems.
- Exposure to build and interpret hydraulic and pneumatic circuits related to industrial applications.
- To familiarize with logic controls and trouble shooting

**Module-1**

**Introduction to Hydraulic Power:** Pascal's law, The Source of Hydraulic Power: Pumps Pumping theory, pump classification, gear pumps, vane pumps, piston pumps, pump performance, variable displacement pumps.

**Hydraulic Actuators and Motors:** Linear Hydraulic Actuators [cylinders], Mechanics of Hydraulic Cylinder loading, Hydraulic Rotary Actuators, Gear motors, vane motors and piston motors.

**Module-2**

**Control Components in Hydraulic Systems:** Directional Control Valves – Symbolic representation, Constructional features, pressure control valves – direct and pilot operated types, flow control valves.

**Maintenance of Hydraulic systems:** Hydraulic oils – Desirable properties, general type of fluids, sealing devices, reservoir system, filters and strainers, problem caused by gases in hydraulic fluids, wear of moving parts due to solid particle contamination, temperature control, trouble shooting.

**Module-3**

**Hydraulic Circuit Design and Analysis:** Control of single and Double – acting Hydraulic cylinder, regenerative circuit, pump unloading circuit, Double pump Hydraulic system, Counter Balance Valve application, Hydraulic cylinder sequencing circuits. Locked cylinder using pilot check valve, cylinder synchronizing circuits, speed control of hydraulic cylinder, speed control of hydraulic motors, accumulators and accumulator circuits

**Module-4**

**Pneumatic Controls:** Choice of working medium, characteristics of compressed air, preparation of compressed air- Driers, Filters, Regulators, Lubricators, Distribution of compressed air- Piping layout. Pneumatic Actuators: Linear cylinders – Types, conventional type of cylinder working, end position cushioning, seals. Rod – less cylinders – types, working advantages. Rotary cylinder types construction.

**Directional Control valves:** Design and constructional aspects, poppet valves, slide valves spool valve, suspended seat type slide valve.

**Simple Pneumatic Control:** Direct and indirect actuation pneumatic cylinders. Flow control valves and speed control of cylinders supply air throttling and exhaust air throttling use of quick exhaust valve

**Module-5**

**Multi-cylinder Applications:** Coordinated and sequential motion control. Motion and control diagrams – Signal elimination methods. Cascading method – principle. Practical application examples (up to two cylinders) using cascading method (using reversing valves).

**Electro-Pneumatic control:** Principles-signal input and output pilot assisted solenoid control of directional control valves, use of relay and contactors. Control circuitry for simple single cylinder applications.

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

- Introduce basics of Hydraulics and pneumatics.
- Describe Various components of hydraulic system and maintenance of hydraulic system
- Design hydraulic system. · Describe layout and details of pneumatic system

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

| Sl No | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Pneumatic systems - Principles and Maintenance | Majumdar S.R | Tata McGraw-Hill | 2005 |
| 2 | Fluid Power with applications | Anthony Esposito | Pearson edition | 2000 |
| **Reference Books** | | | | |
| 1 | Hydraulics and pneumatics | Andrew Par | Jaico Publishing House | 2005 |
| 2 | Industrial Hydraulics | John Pippenger, Tyler | McGraw Hill International | 1980 |
| 3 | Hydraulic Control Systems | Herbert E. Merritt | John Wiley and Sons, Inc | |

**B.TECH IN MECHANICAL AND SMART MANUFACTURING**
**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
**SEMESTER – VI**
**Professional Elective- 1**

**CLOUD COMPUTING**

| | | | |
|---|---|---|---|
| Course Code | **18SM641** | CIE Marks | 40 |
| Teaching Hours /Week (L:T:P) | 3:0:0 | SEE Marks | 60 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning Objectives:**

- Explain the fundamentals of cloud computing
- Illustrate the cloud application programming and aneka platform
- Contrast different cloud platforms used in industry

**Module-1**

**Introduction, Cloud Infrastructure:** Cloud computing, Cloud computing delivery models and services, Ethical issues, Cloud vulnerabilities, Cloud computing at Amazon, Cloud computing the Google perspective, Microsoft Windows Azure and online services, Open-source software platforms for private clouds, Cloud storage diversity and vendor lock-in, Energy use and ecological impact, Service level agreements, User experience and software licensing. Exercises and problems.

**Module-2**

**Cloud Computing: Application Paradigms.:** Challenges of cloud computing, Architectural styles of cloud computing, Workflows: Coordination of multiple activities, Coordination based on a state machine model: The Zookeeper, The Map Reduce programming model, A case study: The Gre The Web application, Cloud for science and engineering, High-performance computing on a cloud, Cloud computing for Biology research, Social computing, digital content and cloud computing.

**Module-3**

**Cloud Resource Virtualization:** Virtualization, Layering and virtualization, Virtual machine monitors, Virtual Machines, Performance and Security Isolation, Full virtualization and paravirtualization, Hardware support for virtualization, Case Study: Xen a VMM based paravirtualization, Optimization of network virtualization, vBlades, Performance comparison of virtual machines, The dark side of virtualization, Exercises and problems

**Module-4**

**Cloud Resource Management and Scheduling:** Policies and mechanisms for resource management, Application of control theory to task scheduling on a cloud, Stability of a two-level resource allocation architecture, Feedback control based on dynamic thresholds, Coordination of specialized autonomic performance managers, A utility-based model for cloud-based Web services, Resourcing bundling: Combinatorial auctions for cloud resources, Scheduling algorithms for computing clouds, Fair queuing, Start-time fair queuing, Borrowed virtual time, Cloud scheduling subject to deadlines, Scheduling MapReduce applications subject to deadlines, Resource management and dynamic scaling, Exercises and problems

**Module-5**

**Cloud Security, Cloud Application Development:** Cloud security risks, Security: The top concern for cloud users, Privacy and privacy impact assessment, Trust, Operating system security, Virtual machine Security, Security of virtualization, Security risks posed by shared images, Security risks posed by a management OS, A trusted virtual machine monitor, Amazon web services: EC2 instances, Connecting clients to cloud instances through firewalls, Security rules for application and transport layer protocols in EC2, How to launch an EC2 Linux instance and connect to it, How to use S3 in java, Cloud-based simulation of a distributed trust algorithm, A trust management service, A cloud service for adaptive data streaming, Cloud based optimal FPGA synthesis .Exercises and problems.

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

- Compare the strengths and limitations of cloud computing
- Identify the architecture, infrastructure and delivery models of cloud computing
- Apply suitable virtualization concept.
- Choose the appropriate cloud player

- Address the core issues of cloud computing such as security, privacy and interoperability25
- Design Cloud Services
- Set a private cloud

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

| Sl No | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Cloud Computing Theory and Practice | Dan C Marinescu | Elsevier(MK) | 2013 |
| **Reference Books** | | | | |
| 1 | Rajkumar Buyya , James Broberg, Andrzej Goscinski | Computing Principles and Paradigms | Willey | 2014 |
| 2 | Cloud Computing Implementation, Management and Security | John W Rittinghouse, James F Ransome | CRC Press | 2013 |

**B.TECH IN MECHANICAL AND SMART MANUFACTURING**
**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
**SEMESTER – VI**
**Professional Elective- 1**

**COMPOSITE MATERIALS TECHNOLOGY**

| | | | |
|---|---|---|---|
| Course Code | **18SM642** | CIE Marks | 40 |
| Teaching Hours/Week (L:T:P) | 3:0:0 | SEE Marks | 60 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning Objectives:**

- To know the behaviour of constituents in the composite materials
- To Enlighten the students in different types of reinforcement
- To Enlighten the students in different types of matrices
- To develop the student's skills in understanding the different manufacturing methods available for composite material.
- To understand the various characterization techniques
- To illuminate the knowledge and analysis skills in applying basic laws in mechanics to the composite materials.

**Module-1**

**Introduction to Composite Materials:** Definition, classification & brief history of composite materials.
**Constituent of composite materials:** Reinforcements, Matrix, Coupling agents, coatings & fillers.
**Reinforcements:** Introduction, Glass Fibers, Boron Fibers, Carbon Fibers, Organic Fibers, Ceramic Fibers, Whiskers, Other Non-oxide Reinforcements, Comparison of Fibers
**Matrix Materials:** Polymers, Metals and Ceramic Matrix Materials.
**Interfaces:** Wettability, Crystallographic nature of interface, types of bonding at the interface and optimum interfacial bond strength.

**Module-2**

**Polymer Matrix Composites (PMC): Processing of PMC's;** Processing of Thermoset Matrix Composites, Thermoplastic Matrix Composites, Sheet Moulding Compound and carbon reinforced polymer composites. Interfaces in PMC's, Structure & Properties of PMC's, applications
**Metal Matrix Composites:** Types of metal matrix composites, Important Metallic Matrices, Processing, Interfaces in Metal Matrix Composites, Properties & Applications.

**Module-3**

**Ceramic Matrix Composites (CMC): Processing of CMC's;** Cold Pressing & Sintering, Hot Pressing, Reaction Bonding Processes, Infiltration, Directed Oxidation, In Situ Chemical Reaction Technique, Sol-Gel, Polymer Infiltration & Pyrolysis, Electrophoretic Deposition, Self-Propagating High Temperature Synthesis. Interfaces, properties and applications of CMC's.
**Carbon Fiber/Carbon Matrix Composites:** Processing of Carbon/Carbon Composites, Oxidation protection of Carbon/Carbon Composites, Properties of Carbon/Carbon Composites, and application of Carbon/Carbon Composites.
**Multi-filamentary Superconducting Composites:** The Problem of Flux Pinning, Types of Super Conductor, Processing & structure of Multi filamentary superconducting composites. Applications of multi-filamentary superconducting composites**.**

**Module-4**

**Nonconventional Composites:** Introduction, **Nanocomposites;** Polymer clay nanocomposites, self healing composites, self-reinforced composites. Biocomposites, **Laminates;** Ceramic Laminates, Hybrid Composites.
**Performance/Characterization of Composites: Static Mechanical Properties;** Tensile Properties, Compressive Properties, Flexural Properties, In-Plane Shear Properties, Interlaminar Shear Strength.
**Fatigue Properties;** Tension–Tension Fatigue, Flexural Fatigue. **Impact Properties;** Charpy, Izod, and Drop-Weight Impact Test.

**Module-5**

**Micromechanics of Composites:** Density, Mechanical Properties**;** Prediction of Elastic Constants, Micromechanical Approaches, Halpin-Tsai Equations, Transverse Stresses, Thermal properties. Numerical Problems.

**Macromechanics of Composites**: Introduction, Elastic constants of an isotropic material, elastic constants of a lamina, relationship between engineering constants and reduced stiffnesses and compliances.

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

CO1: Use different types of manufacturing processes in the preparation of composite materials

CO2: Analyze the problems on macro mechanical 27ehavior of composites

CO3: Analyze the problems on micromechanical 27ehavior of Composites

CO4: Determine stresses and strains relation in composites materials.

CO5: Understand and effective use of properties in design of composite structures

CO6: Perform literature search on a selected advanced material topic.

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

| Sl. No. | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Composite Material Science and Engineering | Krishan K. Chawla | Springer | Third Edition First Indian Reprint 2015 |
| 2 | Fibre-Reinforced Composites, Materials, Manufacturing, and Design | P.K. Mallick | CRC Press, Taylor & Francis Group | Third Edition |
| 3 | Mechanics of Composite Materials & Structures | MadhijitMukhopadhay | Universities Press | 2004 |
| **Reference Books** | | | | |
| 1 | Mechanics of Composite materials | Autar K. Kaw | CRC Taylor & Francis | 2nd Ed, 2005 |
| 2 | Stress analysis of fiber Reinforced Composites Materials | Michael W, Hyer | Mc-Graw Hill International | 2009 |
| 3 | Mechanics of Composite Materials | .Robert M. Jones | Taylor & Francis | 1999 |

**E- Learning**

• VTU, E- learning

**B. TECH IN MECHANICAL AND SMART MANUFACTURING**
**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
**SEMESTER – VI**
**Professional Elective- 1**

**MICRO AND SMART SYSTEM TECHNOLOGY**

| | | | |
|---|---|---|---|
| Course Code | **18SM643** | CIE Marks | 40 |
| Teaching Hours /Week (L:T:P) | 3:0:0 | SEE Marks | 60 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning Objectives:**

- Gain knowledge of Smart Materials, Sensors & Actuators, Microsystems.
- Understand the Operation of Smart Devices & Systems, Electronic Circuits & Control for MEMS, Methodology of Micro-manufacturing.

**Module-1**

Introduction to Micro and Smart systems :Miniaturization, Microsystems versus MEMS, Micro-fabrication, Smart Materials, Structures & Systems, Integrated Microsystems ,Application of Smart Materials & Microsystems.

**Module-2**

Micro and Smart Devices and Systems: Principles and Materials: Definitions and salient features of sensors, actuators, and systems. Sensors: silicon capacitive accelerometer, piezo resistive pressure sensor, Portable blood analyzer, conduct metric gas sensor. Actuators: Micro mirror Array for Video Projection, Piezoelectric based inkjet print head, electrostatic comb-drive, and Magnetic micro relay experimental modal analysis, machine condition monitoring and diagnosis.

**Module-3**

Micromachining Technologies: Silicon as a Material for Micromachining, Silicon wafer preparation, thin-film deposition techniques, Lithography, Etching, Silicon micro machining:surface micromachining, bulk micromachining. Specialized Materials for Microsystems..

**Module-4**

Electronics Circuits for Micro and Smart Systems. Semiconductor devices: Diode, Schottky diode,Tunnel diode,BJT ,MOSFET,CMOS circuits ,Electronics Amplifiers ,Op-Amp based circuits .

**Module-5**

Implementation of Controllers for MEMS & Case Studies of Integrated Microsystems. Design Methodology, PID controller, Circuit Implementation, Digital controller, Microcontroller & PLC. Case Studies of Integrated Microsystems: BEL pressure sensor, design considerations, performance parameters, and Smart Structure in vibration control.

**Course Outcomes:** At the end of the course, the student will be able to:
CO1:Have knowledge of Smart Materials, Sensors &Actuators ,Microsystems.
CO2: Understand the Working Methodology of Smart Devices & Systems, Electronic Circuits & Control for MEMS, Methodology of Micro-manufacturing

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

| Sl. No. | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Micro and Smart Systems | G.K.Ananthasuresh, K.J.Vinoy, S.Gopalakrishnan, K.N.Bhat, V.K.Aatre | Wiley India | 2010 |
| **Reference Books** | | | | |
| 1 | Design and Development Methodogies, Smart Material | V. Varadan, K. J. Vinoy, S. | Wiley India | |
| 2 | MEMS | Nitaigour Premchand Mahalik, | TMH | 2007 |
| 3 | MEMS & Microsystems Design and Manufacture | Tai-Ran Hsu | Tata Mc-Graw-Hill | |
| 4 | Mechanical Vibrations and Noise engineering | Amberkar A.G. | PHI | |
| **E- Learning**<br>• VTU, E- learning | | | | |

**B.TECH IN MECHANICAL AND SMART MANUFACTURING**
**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
**SEMESTER –VI**
**Professional Elective- 1**

**Non Traditional machining**

| | | | |
|---|---|---|---|
| Course Code | **18SM644** | CIE Marks | 40 |
| Teaching Hours/Week (L:T:P) | 3:0:0 | SEE Marks | 60 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning Objectives:**

- To learn various concepts related to modern machining processes & their applications.
- To appreciate the differences between conventional and non-conventional machining processes.
- To acquire a functional understanding of non-traditional manufacturing equipment.
- To know about various process parameters and their influence on performance and their applications.
- To impart knowledge on various types of energy involved in non-traditional machining processes.

**Module-1**

Introduction to Non-traditional machining, Need for Non-traditional machining process, Comparison between traditional and non-traditional machining, general classification Non-traditional machining processes, classification based on nature of energy employed in machining, selection of non-traditional machining processes, Specific advantages, limitations and applications of non-traditional machining processes

**Module-2**

**Ultrasonic Machining (USM):** Introduction, Equipment and material process, Effect of process parameters: Effect of amplitude and frequency, Effect of abrasive grain diameter, effect of slurry, tool & work material. Process characteristics: Material removal rate, tool wear, accuracy, surface finish, applications, advantages & limitations of USM. Abrasive Jet Machining (AJM): Introduction, Equipment and process of material removal, process variables: carrier gas, type of abrasive, work material, stand-off distance (SOD).

**Module-3**

**ELECTROCHEMICAL MACHINING (ECM):** Introduction, Principle of electro chemical machining, ECM equipment, elements of ECM operation, Chemistry of ECM. ECM Process characteristics: Material removal rate, accuracy, surface finish. Process parameters: Current density, Tool feed rate, Gap between tool & work piece, velocity of electrolyte flow, type of electrolyte, its concentration temperature, and choice of electrolytes.

**ECM Tooling:** ECM tooling technique & example, Tool & insulation materials. Applications ECM: Electrochemical grinding and electrochemical honing process. Advantages, disadvantages and application of ECG, ECH. CHEMICAL MACHINING (CHM): Elements of the process, Resists (maskants), Etchants. Types of chemical machining process-chemical blanking process, chemical milling process. Process characteristics of CHM: material removal rate, accuracy, surface finish, advantages, limitations and applications of chemical machining process.

**Module-4**

**ELECTRICAL DISCHARGE MACHINING (EDM):** Introduction, mechanism of metal removal, EDM equipment: spark erosion generator (relaxation type), dielectric medium-its functions & desirable properties, electrode feed control system. Flushing types; pressure flushing, suction flushing, side flushing, pulsed flushing. EDM **process parameters:** Spark frequency, current & spark gap, surface finish, Heat Affected Zone. Advantages, limitations & applications of EDM, Electrical discharge grinding, Traveling wire EDM. PLASMA ARC MACHINING (PAM): Introduction, non-thermal generation of plasma, equipment mechanism of metal removal, Plasma torch, process parameters, process characteristics. Safety precautions. Safety precautions, applications, advantages and limitations.

**Module-5**

**LASER BEAM MACHINING (LBM):** Introduction, generation of LASER, Equipment and mechanism of metal removal, LBM parameters and characteristics, Applications, Advantages & limitations. ELECTRON BEAM MACHINING (EBM): Introduction, Principle, equipment and mechanism of metal removal, applications, advantages and limitations

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

CO1: Understand the compare traditional and non-traditional machining process and recognize the need for Non- traditional machining process.

CO2: Understand the constructional features, performance parameters, process characteristics, applications, advantages and limitations of USM, AJM and WJM.

CO3: Identify the need of Chemical and electro-chemical machining process along with the constructional features, process parameters, process characteristics, applications, advantages and limitations.

CO4: Understand the constructional feature of the equipment, process parameters, process characteristics, applications, advantages and limitations EDM & PAM.

CO5: Understand the LBM equipment, LBM parameters, and characteristics. EBM equipment and mechanism of metal removal, applications, advantages and limitations LBM & EBM

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

| Sl. No | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Modern Machining Process | P.C Pandey and H S Shah | McGraw Hill Education India Pvt. Ltd. | 2000 |
| 2 | Production technology | HMT | McGraw Hill Education India Pvt. | 2001 |
| **Reference Books** | | | | |
| 1 | New Technology | Dr. Amitabha Bhattacharyya | The Institute of Engineers (India) | 2000 |

**B.TECH IN MECHANICAL AND SMART MANUFACTURING**
**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
**SEMESTER –VI**
**OPEN ELECTIVE**

**INDUSTRIAL INTERNET OF THINGS**

| | | | |
|---|---|---|---|
| Course Code | **18SM65** | CIE Marks | 40 |
| Teaching Hours/Week (L:T:P) | 3:0:0 | SEE Marks | 60 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning Objectives:**
The objective of this subject is make students aware about this latest technology, its application and to identify future scope for better manufacturing system.

**Module-1**

**Understanding Industrial Internet of Things (IIoT)**: Industrial Internet of Things and Cyber Manufacturing Systems, Application map for Industrial Cyber Physical Systems, Cyber Physical Electronics production.

**Module-2**

**Modeling of CPS and CMS**: Modeling of Cyber Physical Engineering and manufacturing, Model based engineering of supervisory controllers for cyber physical systems, formal verification of system, components, Evaluation model for assessments of cyber physical production systems.

**Module-3**

**Architectural Design Patterns for CMS and IIoT**: CPS-based manufacturing and Industries 4.0., Integration of Knowledge base data base and machine vision, Interoperability in Smart Automation, Enhancing Resiliency in Production Facilities through CPS. Communication and Networking of IIoT.

**Module-4**

**Evaluation of Workforce and Human Machine Interaction**: Worker and CPS, Strategies to support user intervention. Introduction to Advance manufacturing and Innovation Ecosystems.

**Module-5**

**Application of IIoT**: Smart Metering, e-Health Body Area Networks, City Automation, Automotive Applications, Home Automation, Smart Cards, Plant Automation, Real life examples of IIOT in Manufacturing Sector.

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

- Describe Industrial Internet of Things and Cyber Physical manufacturing.
- Demonstrate Cyber Physical and Cyber Manufacturing systems.
- Describe Architectural design patterns for industrial Internet of Things.
- Evaluation of Workforce and Human Machine Interaction and Application of Industrial Internet of Things.

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

| Sl No | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Industrial Internet of Things Cyber Manufacturing Systems | Sabina Jeschke, Christian Brecher Houbing Song , Danda B | Rawat Editors | |
| 2 | The Internet of Things Connecting | Hakima Chaouchi | Willy Publications | ISBN : 978-1- |

| | | | | |
|---|---|---|---|---|
| | Objects to the Web | | | 84821- 140-7, |
| | The Internet of Things: Key Applications and Protocols, , | Olivier Hersent, David Boswarthick, Omar Elloumi | 2nd Edition, Willy Publications | ISBN: 978-1-119-99435-0 |
| **Reference Books** | | | | |
| 1 | Inside the Internet of Things (IoT), | | Deloitte University Press | |
| 2 | Internet of Things- From Research and Innovation to Market Deployment | | ; By Ovidiu & Peter; River Publishers Series | |

**B.TECH IN MECHANICAL AND SMART MANUFACTURING**
**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
**SEMESTER –VI**

**SMART MANUFACTURING LAB-2**

| | | | |
|---|---|---|---|
| Course Code | **18SML66** | CIE Marks | 40 |
| Teaching Hours/Week (L:T:P) | 0:2:2 | SEE Marks | 60 |
| Credits | 02 | Exam Hours | 03 |

**Course Learning Objectives:**

The students will be able

- To understand the concepts of natural frequency, logarithmic decrement, damping and damping ratio.
- To understand the techniques of balancing of rotating masses and influence of gyroscopic couple.
- To verify the concept of the critical speed of a rotating shaft.
- To illustrate the concept of stress concentration using Photo elasticity.
- To appreciate the equilibrium speed, sensitiveness, power and effort of a Governor.
- To illustrate the principles of pressure development in an oil film of a hydrodynamic journal bearing.
- To visualize different mechanisms and cam motions

| Sl. No. | Experiments |
|---|---|
| | **PART A** |
| 1. | Modeling of Metal Parts in CAD Software. |
| 2. | Body/head scanning using Sense 3D Scanner. |
| 3. | Object Scanning using EinScan 3D Scanner. |
| 4. | Slicing of corrected STL files in SLM RP Tools Software. |
| 5. | Process Parameters (laser power, scan speed, hatch width, hatch space, etc.,) Optimization in PSW Software for fabrication on SLM RP Machine. |
| 6. | Laser path generation in DMDCAM Software for fabrication on LENS Machine. |
| 7. | Laser path generation in UG CAM Software for fabrication on Microstereolithography (MSL) RP machine. |
| 8. | Fabrication of Metal parts on SLM RP Machine. |
| 9. | Fabrication of Metal parts on LENS RP Machine. |
| | **PART B** |
| 10. | Building and testing a low-cost desktop 3D printer. |
| 11. | Post-processing of Fabricated metal parts by Wire EDM. |
| 12. | Post-processing of Fabricated metal parts by Shot-peening, polishing, etc., to improve the surface quality of the produced parts. |

**Course Outcomes:**

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

- Model complex geometry of engineering components.
- Make use of point cloud data to reconstruct industrial and medical components.
- Evaluate the process parameters of SLM and LENS metal AM machines to improve the quality of the parts produced.
- Improve surface finish of fabricated components by post-processing techniques.

  Construct low cost desktop 3D Printer and test for performance.

**Conduct of Practical Examination:**

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

**07.01.2023**

**Scheme of Examination:**

| | | |
|---|---|---|
| ONE question from part A: | | 30 Marks |
| ONE question from part B: | | 50 Marks |
| Viva –Voice | : | 20 Marks |
| Total | : | 100 Marks |

**B.TECH IN MECHANICAL AND SMART MANUFACTURING**
**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
**SEMESTER - VI**

**COMPUTER AIDED MODELLING AND ANALYSIS LAB**

| | | | |
|---|---|---|---|
| Course Code | **18SML67** | CIE Marks | 40 |
| Teaching Hours /Week (L:T:P) | 0:2:2 | SEE Marks | 60 |
| Credits | 02 | Exam Hours | 03 |

**Course Learning Objectives:**

- To acquire basic understanding of Modeling and Analysis software
- To understand the concepts of different kinds of loading on bars, trusses and beams, and analyze the results pertaining to various parameters like stresses and deformations.
- To lean to apply the basic principles to carry out dynamic analysis to know the natural frequencies of different kind of beams.

| Sl. No. | Experiments |
|---|---|
| | **PART A** |
| 1 | **Study of a FEA package and modeling and stress analysis of:**<br>a. Bars of constant cross section area, tapered cross section area and stepped bar<br>b. Trusses – (**Minimum 2 exercises of different types)**<br>c. Beams – Simply supported, cantilever, beams with point load , UDL, beams with varying load etc. **(Minimum 6 exercises)**<br>d. Stress analysis of a rectangular plate with a circular hole. |
| | **PART B** |
| 2 | Thermal Analysis – 1D & 2D problem with conduction and convection boundary conditions **(Minimum 4 exercises of different types )** |
| 3 | Dynamic Analysis to find:<br>a) Natural frequency of beam with fixed – fixed end condition<br>b) Response of beam with fixed – fixed end conditions subjected to forcing function<br>c) Response of Bar subjected to forcing functions |
| | **PART C(only for demo)** |
| 4 | a. Demonstrate the use of graphics standards (IGES, STEP etc) to import the model from modeler to solver.<br>b. Demonstrate one example of contact analysis to learn the procedure to carry out contact analysis.<br>c. Demonstrate at least two different types of example to model and analyze bars or plates made from composite material. |

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

CO1: Use the modern tools to formulate the problem, create geometry, descritize, apply boundary conditions to solve problems of bars, truss, beams, and plate to find stresses with different-loading conditions.

CO2: Demonstrate the ability to obtain deflection of beams subjected to point, uniformly distributed and varying loads and use the available results to draw shear force and bending moment diagrams.

CO3: Analyze and solve 1D and 2D heat transfer conduction and convection problems with different boundary conditions.

CO4: Carry out dynamic analysis and finding natural frequencies of beams, plates, and bars for various boundary conditions and also carry out dynamic analysis with forcing functions.

**Conduct of Practical Examination:**

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.

**Scheme of Examination:**

**07.01.2023**

| |
|---|
| One Question from Part A - 40 Marks<br>One Question from Part B - 40 Marks<br>Viva-Voce - 20 Marks |

**B.TECH IN MECHANICAL AND SMART MANUFACTURING**
**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
**SEMESTER – VII**

**ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING**

| | | | |
|---|---|---|---|
| Course Code | **18SM71** | CIE Marks | 40 |
| Teaching Hours / Week (L:T:P) | 3:0:0 | SEE Marks | 60 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning Objectives:**

- Explain Artificial Intelligence and Machine Learning
- Illustrate AI and ML algorithm and their use in appropriate applications

**Module-1**

What is artificial intelligence?, Problems, problem spaces and search, Heuristic searchtechniques

**Module-2**

Knowledge representation issues, Predicate logic, Representaiton knowledge using rules. Concpet Learning: Concept learning task, Concpet learning as search, Find-S algorithm, Candidate Elimination Algorithm, Inductive bias of Candidate Elimination Algorithm

**Module-3**

Bayesian Learning: Introduction, Bayes theorem, Bayes theorem and concept learning, ML and LS error hypothesis, ML for predicting, MDL principle, Bates optimal classifier, Gibbs algorithm, Navie Bayes classifier, BBN, EM Algorithm

**Module-4**

Bayesian Learning: Introduction, Bayes theorem, Bayes theorem and concept learning, ML and LS error hypothesis, ML for predicting, MDL principle, Bates optimal classifier, Gibbs algorithm, Navie Bayes classifier, BBN, EM Algorithm

**Module-5**

Instance-Base Learning: Introduction, k-Nearest Neighbour Learning, Locally weightedregression, Radial basis function, Case-Based reasoning.
Reinforcement Learning: Introduction, The learning task, Q-Learning

**Assignment**:

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

- Appaise the theory of Artificial intelligence and Machine Learning.
- Illustrate the working of AI and ML Algorithms.
- Demonstrate the applications of AI and ML.

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

| Sl. No. | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Machine Learning | Tom M Mitchell | McGraw Hill Education | 1st Edition 2017 |
| 2 | Artificial Intelligence | Elaine Rich, Kevin K and S B Nair | McGraw Hill Education | 3rd Edition 2017 |

| **Reference Books** | | | | |
|---|---|---|---|---|
| 1 | Artificial Intelligence | Saroj Kaushik | Cengage learning | |
| 2 | | | | |
| 3 | Artificial Intelligence: A Modern Approach | Stuart Rusell, Peter Norving | Pearson Education | 2nd Edition |
| 4 | Hands-On Machine Learning with Scikit-Learn and Tensor Flow: Concepts, Tools, and Techniques to Build Intelligent Systems | AurÈlienGÈron | Shroff/O'Reilly Media | 1st Edition, 2017 |
| 5 | The Elements of Statistical Learning | Trevor Hastie, Robert Tibshirani, Jerome Friedman, h | springer series | 2nd edition |
| 6 | Introduction to machine learning | Ethem Alpaydın | MIT Press | second edition |
| 7 | Artificial Intelligence and Machine Learning | Srinvivasa K G and Shreedhar | Cengage | |

**B.Tech. in MECHANICAL AND SMART MANUFACTURING**
**Outcome Based Education (OBE) and Choice Based Credit System (CBCS)**
**SEMESTER - VII**

## Geometric Modelling for CAD & Computer Graphics

| | | | |
|---|---|---|---|
| Course Code | 18SM72 | CIE Marks | 40 |
| Teaching Hours/Week (L: T:P) | (3:0:0) | SEE Marks | 60 |
| Credits | 03 | Exam Hours | 03 |

**Course objectives:**

Students will be able to:

- Know the overview of how computers can assist in mechanical component design
- Understand the meaning of Geometric Modelling & Computer Graphics and its application in design of components
- Use 2D & 3D transformations for effective viewing
- Mathematically represent curves, surfaces & solids
- Understand various drawing algorithms
- Understand how realistic image can be formed

**Module-1**

**Geometric Modelling**: Introduction and scope; **Computer Graphics:** Introduction & scope

**Transformations :** Representation of points, Transformations: Rotation, Reflection, Scaling, Shearing, Combined Transformations, Translations and Homogeneous Coordinates, A geometric interpretation of homogeneous coordinates, Over all scaling, Points at infinity, Rotation about an arbitrary point, Reflection through an arbitrary line, Rotation about an axis parallel to coordinate axis, Rotation about an arbitrary axis in space, Reflection through an arbitrary plane.

**Module-2**

**Types and Mathematical Representation of Curves**: Curve representation, Explicit, Implicit and parametric representation. Nonparametric and parametric representation of Lines, Circles, Ellipse, Parabola, Hyperbola, Conics. Parametric representation of synthetic curve, Hermite cubic splines, Bezier curves: Blending function, Properties, generation, B-spline curves- Cox-deBoor recursive formula, Properties, Open uniform basis functions, Non-uniform basis functions, Periodic B-spline curve.

**Types and Mathematical Representation of Surfaces:** Surface entities and parametric representation- Plane, Ruled, surface of revolution, Offset surface, Coons patch, Bezier surface, B-spline surface.

**Module-3**

**Types and Mathematical Representation Solids:**Solid entities: Block, Cylinder, Cone, Sphere, Wedge, Torus, Solid representation, Fundamentals of solid modeling, Set theory, Regularized set operations, Set membership classification, Half spaces, Basic elements, Building operations, Boundary representation and Constructive solid geometry, Basic elements, Building operations.

**Scan Conversion and Clipping:** Representation of points, lines, Drawing Algorithms: DD algorithm, Bresenham's integer line algorithm, Bresenham's circle algorithm, Polygon filling algorithms: Scan conversion, Seed filling, Scan line algorithm. Viewing transformation, Clipping - Points, lines, Text, Polygon, Cohen-Sutherland line clipping, Sutherland-Hodgmen algorithm.

**Module-4**

**Visual Realism:** Introduction, Hidden line removal, Visibility of object views, Visibility techniques: Minimax test, Containment test, Surface test, Silhouttes, Homogeneity test, Sorting, Coherence, Hidden surface removal- Z-buffer algorithm, Warnock's algorithm, Hidden solid removal - ray tracing algorithm, Shading, Shading models, Diffuse reflection, Specular reflection, Ambient light, Shading of surfaces: Constant shading, Gourand shading, Phong shading, Shading enhancements, Shading Solids, Ray tracing for CSG, Z-buffer algorithm for B-rep and CSG

**Module-5**

**Applications:** Colouring- RGB, CMY, HSV, HSL colour models, Data Exchange: Evolution of Data exchange, IGES, PDES, Animation: Conventional animation-key frame, In between, Line testing, Painting, Filming, Computer animation, Entertainment and Engineering Animation, Animation system hardware, Software architecture, Animation types, Frame buffer, Colour table, Zoom- pan-scroll, Cross bar, Real time play back, Animation techniques- key frame, Skelton. Path of motion and p-curves.

**Course outcomes:**

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

- Design free form surfaces for the given application
- Develop solid model of any given component
- Recognize how a visual image can be an effective means of communication
- Acquire and develop the skills needed to creatively solve visual communication problems.
- Understand, develop and employ visual hierarchy using images and text.

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

| Sl No | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | CAD/CAM-Theory and Practice | IbrahamZeid | McGraw Hill, | 2006 |
| 2 | Mathematical Elements for Computer Graphics | David Rogers & Alan Adams | Tata McGraw Hill | 2002 |
| **Reference Books** | | | | |
| 3 | Computer Graphics- Schaum's Outline | Xiang Z, Plastock, R. A | McGraw Hill | 2007 |
| 4 | Computer Graphics- Principles and Practice- | Foley, van Dam, Feiner and Hughes | Addison Wesley | 1996 |
| 5 | Computer Graphics | Sinha A N., Udai A D | Tata McGraw Hill | 2008 |
| 6 | Computer Graphics with OpenGL Version | Donald Hearn & Pauline Baker | Pearson Education | 3rd /4th Edition, 2011 |
| 7 | Interactive Computer Graphics- A Top Down approach with OpenGL | Edward Angel | Pearson Education | 5th Edition, 2008 |

**B.TECH IN MECHANICAL AND SMART MANUFACTURING**
**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
**SEMESTER – VII**
**Professional Elective-2**

**DESIGN FOR MANUFACTURING**

| | | | |
|---|---|---|---|
| Course Code | **18SM731** | CIE Marks | 40 |
| Teaching Hours /Week (L:T:P) | 3:0:0 | SEE Marks | 60 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning Objectives:**

- To educate students on factors to be considered in designing parts and components with focus on manufacturability.
- To expose the students to dimensional tolerances, geometric tolerances and true position tolerance techniques in manufacture.
- To impart the knowledge on design considerations for designing components produced using various machining operations like turning, drilling, milling, grinding etc.
- To educate the students on design rules and recommendations for processes like casting, welding, forgings powder metallurgy and injection moulding.

**Module-1**

**Introduction:** Definition, need for DFM, DFM approach for cost reduction, general design guide lines of DFM, advantages and disadvantages, application of DFM in industries, Design for Quality Manufacturability, DFQM approach, designing for economical production. Design for Excellence (DFX).

**Engineering Tolerancing:** Basics of dimensional tolerancing, Redundancy, tolerance allocation, Review of relationship between attainable tolerance grades and different machining processes. Geometrical tolerances. Process capability, mean, variance, skewness, kurtosis, process capability indices- Cp, and Cpk. Cumulative effect of tolerance- Sure fit law and truncated normal law, problems.

**Module-2**

**True positional theory:** Comparison between coordinate and true position method of feature location. True position tolerance- virtual size concept, concepts of datum and changing datum, floating and fixed fasteners, projected tolerance zone and functional gages. Concept of Zero true position tolerance. Simple problems on true position tolerancing.

**Selective Assembly:** Interchangeable part manufacture and selective assembly. Deciding the number of groups -model-1: group tolerance of mating parts equal, model- 2: total and group tolerances of shaft equal. Control of axial play- introducing secondary machining operations, and laminated shims; examples.

**Module-3**

**Datum Features:** Functional datum, datum for manufacturing, changing the datum; examples.

**Component Design:** Design features to facilitate machining: drills, milling cutters, keyways, Doweling procedures, counter sunk screws, Reduction of machined area, simplification by separation, simplification by amalgamation, Design for machinability, Design for economy, Design for clampability, Design for accessibility. Designing for heat treatment, roller burnishing, and economical de-burring.

**Module-4**

**Design of components with casting considerations:** Pattern, mould, and parting line. Cored holes and machined holes. Identifying the possible and probable parting lines. Castings requiring special sand cores. Designing to obviate sand cores.

**Welding considerations:** Advantages of weldments over other design concepts, design requirements and rules, redesign of components for welding; case studies.

**Module-5**

**Forging considerations** -requirements and rules-redesign of components for forging and case studies.

Design of components for powder metallurgy- requirements and rules-case studies.

Design of components for injection moulding- requirements and rules-case studies.

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

CO1: Select proper materials and manufacturing processes for designing products/components by applying the relevant principles for ease and economic production.

CO2: Identify faulty design factors leading to increased costs in producing mechanical components.

CO3: Apply appropriate design tolerances – dimensional, geometric and true position tolerances for the production processes of mechanical components.

CO4: Apply the concepts related to reducing machined areas, simplification by amalgamation and separation, clampability, accessibility etc., in the design of mechanical components.

CO5: Analyse the design of castings, weldments, forgings, powder metallurgy components and suggest design modifications to reduce the cost.

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

| Sl No | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Designing for Manufacture | Peck H | Pitman Publications | 1983 |
| 2 | Engineering Design: A Materials and processing Approach | Dieter, G.E. | McGraw Hill Co.Ltd | 2000 |
| 3 | Handbook of Products Design for Manufacturing: A Practical Guide to Low-cost Production | Bralla, James G. | McGraw Hill, New York | 1986 |
| **Reference Books** | | | | |
| 1 | Engineering Design | Eggert, R.J | Pearson Education, Inc., New Jersey | 2005 |
| 2 | Engineering Design | Matousek , R | Blackie and Son Limited, Glasgow | 1967 |
| 3 | Engineering Design for Manufacture | Kalandar Saheb, S.D and Prabhakar, O. | ISPE | 1999 |
| 4 | Design for Economical Production | Trucks, H.E. | Mich., Dearborn, SME | 2 nd ed.,1987 |
| 5 | Processes and Materials of Manufacture | Linberg, Roy A. | Allyn and Bacon, Boston, U.S.A. | 4 th ed., 1990 |

**B.TECH IN MECHANICAL AND SMART MANUFACTURING**
**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
**SEMESTER – VII**
**Professional Elective 2**

**LEAN MANUFACTURING**

| | | | |
|---|---|---|---|
| Course Code | **18SM732** | CIE Marks | 40 |
| Teaching Hours / Week (L:T:P) | 3:0:0 | SEE Marks | 60 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning Objectives:**

- To enable students to design a globally competitive manufacturing organization using lean manufacturing principles;
- To develop the skills to implement lean manufacturing in industry and manage the change process to achieve continuous improvement of efficiency and productivity.

**Module-1**

**Framework of Toyota Production System:** Just in time production system. JIT Logic -Pull system Japanese approach to production elimination of waste - JIT implementation requirements JIT application for job shops, Case studies.

**Adaptable Kanban System:** Kanban rules, supplier Kanban and sequence schedule used by supplier, Monthly information & daily information.

**Text Book 1 :** Chapter 1- Chapter 2

**Additional Interests:** Prepare Kanban Chart for a manufacturing plant

**Module-2**

**The rise of mass production:** The rise & fall of Mass Production Mass production, work force, organization, tools, product –logical limits of Mass production, Sloan as a necessary compliment to Ford. Case study:- Rouge Production Plant.

**The rise of lean production:** - Birth place, concrete example, company as community, Final assembly plant, product development and engineering

**Text Book 2 :** Chapter 2

**Additional Interests:** List out Lean Management Concepts. And Frame Work of Lean Manufacturing

**Module-3**

**Reduction of setup times- Concepts and Techniques:** Setup Concepts, practical procedures for reducing setup time.

**Standardization of operations:** Machine layout, multi-function workers and job rotation. Improvement activities to reduce work force and increase worker morale -foundation for improvements

**Text Book 1 :** Chapter 8, Chapter 9, Chapter 10, Chapter 11, Chapter 12

**Additional Interests:** Use any lean Six Sigma Statistical Analysis tool and learn to analyze data using 7QC tools.

**Module-4**

**House of Lean** -5S's and Waste Walks, Visual Management, Value Stream Mapping-Understanding the current state and designing the future state

**Managing lean enterprise:** - Finance, Career ladders, geographic spread and advantages of global enterprise.

**Additional Interests:** Develop VSM Current and Future state diagram using Microsoft Visio or Similar Software Package.

**Module-5**

**Six sigma concepts:** History, definitions, Statistical definitions, quality levels, Technical aspects, Six sigma for all: benefits to organizations, customers, suppliers and employers, Design for Six Sigma, DMAIC principles, DMADV principles, merits and demerits.

**Text Book 5**

**Additional Interests**: Suggested to read The Certified Six Sigma Green Belt Handbookby Roderick A. Munro and Govindarajan Ramu (ISBN-10: 0873898915)

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

• Identify how a production line can be run efficiently

• Reflect upon the critical skills and evaluate their own performance

• Relate concepts such as 'Just in Time manufacturing' and 'Lean manufacturing to the context of an assembly line.

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module

| Sl No | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Toyota Production System - An integrated approach to Just in Time | Yasuhiro Monden | - Engineering aild Management Press -Institute of Industrial Engineers | 1983 |
| 2 | The Machine that changed the World. The Story of Lean 100 Production | James P Womack, Daniel T Jones, and Daniel Roos | Harper Perennial edition published | 1991 |
| 3 | Gemba Kaizen: A Commonsense Approach to a Continuous Improvement Strategy | Masaaki Imai | Second Edition Hardcover | 2012 |
| 4 | Value Stream Mapping : How to Visualize Work and Align Leadership for Organizational Transformation | Karen Martin , Mike Osterling | | 2016 |
| **Reference Books** | | | | |
| 1 | The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer | Jeffrey K. Liker | Toyota | |
| 2 | Learning to See: Value Stream Mapping to Add Value and Eliminate MUDA | Mike Rother and John Shook | | 1$^{ST}$ Edition |

**B.TECH IN MECHANICAL AND SMART MANUFACTURING**
**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
**SEMESTER – VII**
**Professional Elective 2**

**AUTOMATION & ROBOTICS**

| | | | |
|---|---|---|---|
| Course Code | **18SM733** | CIE Marks | 40 |
| Teaching Hours /Week (L:T:P) | 3:2:0 | SEE Marks | 60 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning Objectives:**

- To identify potential areas for automation and justify need for automation.
- To select suitable major control components required to automate a process or an activity
- To study the various parts of robots and fields of robotics.
- To study the various kinematics and inverse kinematics of robots.
- To study the control of robots for some specific applications.

**Module-1:**

**Introduction to automation:**
Basic elements of an automated system, advanced automation functions, levels of automation, process industries versus discrete manufacturing industries, continuous versus discrete control, computer process control. Hardware components for automation and process control, sensors, actuators, analog to digital converters, digital to analog converters, input/output devices for discrete data

**Module-2:**

**Automated production lines:**
Fundamentals of automated production lines, application of automated production lines, analysis of transfer lines, automated assembly systems, fundamentals of automated assembly systems, quantitative analysis of assembly systems, automatic identification methods, barcode technology, radio frequency identification, other AIDC technologies

**Module-3: Industrial Robotics**

Robotic configuration, robot anatomy and related attributes, robot control systems, end effectors, sensors in robotics, industrial robot applications, robot accuracy and repeatability, different types of robots, various generations of robots, degrees of freedom – Asimov's laws of robotics, dynamic stabilization of robots.

**Module-4: Spatial descriptions and transformations**

Robot actuators and Feedback components: Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors, comparison. Position sensors –potentiometers, resolvers, encoders –Velocity sensors, Tactile sensors, Proximity sensors. Manipulator Kinematics: Homogeneous transformations as applicable to rotation and translation -D-H notation, Forward and inverse kinematics.

**Module-5: Robot programming**

Introduction, levels of robot programming, requirements of robot programming language, problems pertaining to robot programming languages, offline programming systems, central issues in OLP systems, automating subtasks in OLP systems, simple programs on robot applications.

**Course Outcomes:** At the end of the course, the student will be able to:
CO1: Translate and simulate a real time activity using modern tools and discuss the Benefits of automation.
CO2: Identify suitable automation hardware for the given application.
CO3: Recommend appropriate modelling and simulation tool for the given manufacturing Application.
CO4: Explain the basic principles of Robotic technology, configurations, control and Programming of Robots.
CO5: Explain the basic principles of programming and apply it for typical Pick & place, Loading & unloading and palletizing applications

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

| Sl. No. | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Computer Integrated Manufacturing | Mikell P. Groover | Pearson | 3rd edition, 2009 |
| 2 | Introduction to robotics mechanics and control | John J. Craig | Pearson | 3rd edition, 2009 |
| **Reference Books** | | | | |
| 1 | Robotics for Engineers | Yoram Koren | McGraw Hill International | 1st edition, 1985. |
| 2 | Industrial Robotics | Weiss, Nagel | McGraw Hill International | 2nd edition, 2012 |
| 3 | Robotic Engineering - An Integrated approach | Klafter, Chmielewski and Negin | PHI | 1st edition, 2009 |
| 4 | Computer Based Industrial Control | Krishna Kant | EEE-PHI | 2nd edition,2010 |
| 5 | An Introduction to Automated Process Planning System | Tiess Chiu Chang & Richard A. Wysk. | | |

**B.TECH IN MECHANICAL AND SMART MANUFACTURING**
**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
**SEMESTER – VII**
**Professional Elective 2**
**BLOCKCHAIN TECHNOLOGY**
**(Effective from the academic year 2018 -2019)**
**SEMESTER – VII**

| | | | |
|---|---|---|---|
| **Subject Code** | **18SM734** | **CIE Marks** | 40 |
| **Number of Contact Hours/Week** | 3:0:0 | **SEE Marks** | 60 |
| **Total Number of Contact Hours** | 40 | **Exam Hours** | 3 Hrs |

**CREDITS – 03**

**Course Learning Objectives:** This course will enable students to:

- Define and Explain the fundamentals of Blockchain
- Illustrate the technologies of blockchain
- Decribe the models of blockchain
- Analyze and demonstrate the Ethereum

**Module – 1**

Blockchain 101: Distributed systems, History of blockchain, Introduction to blockchain, Types of blockchain, CAP theorem and blockchain, Benefits and limitations of blockchain.
**Text Book 1: Chapter 1**

**Module-2**

Decentralization and Cryptography:
Decentralization using blockchain, Methods of decentralization, Routes to decentralization, Decentralized organizations.
Cryptography and Technical Foundations: Cryptographic primitives, Asymmetric cryptography, Public and private keys
**Text Book 1: Chapter 2,Chapter 4**

**Module-3**

Bitcoin and Alternative Coins
A: Bitcoin, Transactions, Blockchain, Bitcoin payments B: Alternative Coins
Theoretical foundations, Bitcoin limitations, Namecoin, Litecoin, Primecoin, Zcash
**Text Book 1: Chapter 3, Chapter 6, Chapter 8**

**Module-4**

Smart Contracts and Ethereum 101:
Smart Contracts: Definition, Ricardian contracts.
Ethereum 101: Introduction, Ethereum blockchain, Elements of the Ethereumblockchain, Precompiled contracts.
**Text Book 1: Chapter 10**

**Module-5**

Alternative Blockchains: Blockchains
Blockchain-Outside of Currencies: Internet of Things, Government, Health, Finance, Media
Text Book 1: Chapter 17

**Course outcomes:** The students should be able to:

- Define and Explain the fundamentals of Blockchain
- Illustrate the technologies of blockchain
- Decribe the models of blockchain
- Analyze and demonstrate the Ethereum
- Analyze and demonstrate Hyperledger fabric

**Question Paper Pattern:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Textbook:**

1.**Mastering Blockchain - Distributed ledgers, decentralization and smart contracts explained, Imran Bashir, Packt Publishing Ltd, Second Edition, ISBN 978-1-78712-544-5, 2017**

**Reference Books:**

1. Blockchain Technology (Concepts and applications), Kumar saurabh, Ashutosh saxena, Wiley, 2020
2. Bitcoin and Cryptocurrency Technologies, Arvind Narayanan, Joseph Bonneau, Edward Felten,2016
3. Blockchain Basics: A Non-Technical Introduction in 25 Steps, Daniel Drescher, Apress, First Edition, 2017
4. Mastering Bitcoin: Unlocking Digital Cryptocurrencies, Andreas M. Antonopoulos, O'Reilly Media, First Edition, 2014

**B.TECH IN MECHANICAL AND SMART MANUFACTURING**
**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
**SEMESTER – VII**
**Professional Elective 3**

**TRIBOLOGY AND BEARING DESIGN**

| | | | |
|---|---|---|---|
| Course Code | **18ME742** | CIE Marks | 40 |
| Teaching Hours /Week (L:T:P) | 3:0:0 | SEE Marks | 60 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning Objectives:**

- To educate the students on the importance of friction, the related theories/laws of sliding and rolling friction and the effect of viscosity of lubricants.
- To expose the students to the consequences of wear, wear mechanisms, wear theories and analysis of wear problems.
- To make the students understand the principles of lubrication, lubrication regimes, theories of hydrodynamic and the advanced lubrication techniques.
- To expose the students to the factors influencing the selection of bearing materials for different sliding applications.
- To introduce the concepts of surface engineering and its importance in tribology.

**Module-1**

Introduction to tribology: Historical background, practical importance, and subsequent use in the field. Lubricants: Types and specific field of applications. Properties of lubricants, viscosity, its measurement, effect of temperature and pressure on viscosity, lubrication types, standard grades of lubricants, and selection of lubricants.

**Module-2**

Friction: Origin, friction theories, measurement methods, friction of metals and non-metals. Wear: Classification and mechanisms of wear, delamination theory, debris analysis, testing methods and standards. Related case studies.

**Module-3**

Hydrodynamic journal bearings: Friction forces and power loss in a lightly loaded journal bearing, Petroff's equation, mechanism of pressure development in an oil film, and Reynold's equation in 2D. Introduction to idealized journal bearing, load carrying capacity, condition for equilibrium, Sommerfeld's number and it's significance; partial bearings, end leakages in journal bearing, numerical examples.

**Module-4**

Plane slider bearings with fixed/pivoted shoe: Pressure distribution, Load carrying capacity, coefficient of friction, frictional resistance in a fixed/pivoted shoe bearing, center of pressure, numerical examples. Hydrostatic Lubrication: Introduction to hydrostatic lubrication, hydrostatic step bearings, load carrying capacity and oil flow through the hydrostatic step bearing, numerical examples. Introduction to Hydrostatic journal bearings.

**Module-5**

Bearing Materials: Commonly used bearings materials, and properties of typical bearing materials. Advantages and disadvantages of bearing materials. Introduction to Surface engineering: Concept and scope of surface engineering. Surface modification – transformation hardening, surface melting, thermo chemical processes. Surface Coating – plating, fusion processes, vapor phase processes. Selection of coating for wear and corrosion resistance.

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

CO1: Understand the fundamentals of tribology and associated parameters.

CO2: Apply concepts of tribology for the performance analysis and design of components

experiencing relative motion

CO3: Analyse the requirements and design hydrodynamic journal and plane slider bearings for a given application.

CO4: Select proper bearing materials and lubricants for a given tribological application.

CO5: Apply the principles of surface engineering for different applications of tribology.

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

| Sl. No. | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Introduction to Tribology | B. Bhushan | John Wiley & Sons, Inc., New York | 2002 |
| 2 | Engineering Tribology | Prasanta Sahoo | PHI Learning Private Ltd, New Delhi | 2011 |
| 3 | Engineering Tribology | J. A. Williams | Oxford Univ. Press | 2005 |
| **Reference Books** | | | | |
| 1 | Introduction to Tribology in bearings | B. C. Majumdar | Wheeler Publishing | |
| 2 | Engineering Tribology | G. W. Stachowiak and A. W. Batchelor | Butterworth-Heinemann | 1992 |
| 3 | Friction and Wear of Materials | Ernest Rabinowicz | John Wiley &Sons | 1995 |
| 4 | Basic Lubrication Theory | A. Cameron | Ellis Hardwoods Ltd., UK | |
| 5 | Handbook of tribology: materials, coatings and surface treatments | B.Bhushan, B.K. Gupta | McGraw-Hill | 1997 |

**B.TECH IN MECHANICAL AND SMART MANUFACTURING**
**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
**SEMESTER – VII**
**Professional Elective 3**

## TOTAL QUALITY MANAGEMENT

| | | | |
|---|---|---|---|
| Course Code | **18ME743** | CIE Marks | 40 |
| Teaching Hours /Week (L:T:P) | 3:0:0 | SEE Marks | 60 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning Objectives:**

- Understand various approaches to TQM
- Understand the characteristics of quality leader and his role.
- Develop feedback and suggestion systems for quality management.
- Enhance the knowledge in Tools and Techniques of quality management.

**Module-1**

Principles and Practice: Definition, basic approach, gurus of TQM, TQM Framework, awareness, defining quality, historical review, obstacles, benefits of TQM. Quality Management Systems: Introduction, benefits of ISO registration, ISO 9000 series of standards, ISO 9001 requirements.

**Module-2**

Leadership: Definition, characteristics of quality leaders, leadership concept, characteristics of effective people, ethics, the Deming philosophy, role of TQM leaders, implementation, core values, concepts and framework, strategic planning communication, decision making.

**Module-3**

Customer Satisfaction and Customer Involvement: Customer Satisfaction: customer and customer perception of quality, feedback, using customer complaints, service quality, translating needs into requirements, customer retention, case studies. Employee Involvement – Motivation, employee surveys, empowerment, teams, suggestion system, recognition and reward, gain sharing, performance appraisal, unions and employee involvement, case studies.

**Module-4**

Continuous Process Improvement: process, the Juran trilogy, improvement strategies, types of problems, the PDSA Cycle, problem-solving methods, Kaizen, reengineering, six sigma, case studies. Statistical Process Control: Pareto diagram, process flow diagram, cause and effect diagram, check sheets, histograms, statistical fundamentals, Control charts, state of control, out of control process, control charts for variables, control charts for attributes, scatter diagrams, case studies.

**Module-5**

**Sustainable Cooling Technologies:**
Total Productive Maintenance (TPM): Definition, Types of Maintenance, Steps in introduction of TPM in an organization, Pillars of TPM – 5S, Jishu Hozen, Quality Maintenance, Planned Maintenance. Quality by Design (QbD): Definition, Key components of QbD, Role of QbD in Pharmaceutical Industry, Benefits and Challenges of QbD. Environmental Management Systems (EMS): Definition, Basic EMS, EMS under ISO 14001, Costs and Benefits of EMS.

**Course Outcomes:** At the end of the course, the student will be able to:
CO1: Explain the various approaches of TQM
CO2: Infer the customer perception of quality
CO3: Analyse customer needs and perceptions to design feedback systems.
CO4: Apply statistical tools for continuous improvement of systems
CO5: Apply the tools and technique for effective implementation of TQM.

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.

- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

| Sl. No. | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Total Quality Management | Dale H. Besterfield | Pearson Education India, | Edition 03. ISBN: 8129702606, |
| 2 | Total Quality Management for Engineers | M. Zairi | Wood head Publishing | ISBN:18557 3024 3 |
| **Reference Books** | | | | |
| 1 | Managing for Quality and Performance Excellence | James R. Evans and William M Lindsay | Cengage Learning | 9th edition |
| 2 | Four revolutions in management | Shoji Shiba, Alan Graham, David Walden | Oregon | 1990 |
| 3 | Organizational Excellence through TQM | H. Lal | New age Publications | 2008 |
| 4 | Engineering Optimization Methods and Applications | A Ravindran, K, M. Ragsdell | Willey India Private Limited | 2nd Edition,2006 |
| 5 | Introduction to Operations Research- Concepts and Cases | F.S. Hillier. G.J. Lieberman | Tata McGraw Hill | 9 th Edition, 2010 |

**B.TECH IN MECHANICAL AND SMART MANUFACTURING**
**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
**SEMESTER – VII**
**Professional Elective 3**

**FLEXIBLE MANUFACTURING SYSTEMS**

| | | | |
|---|---|---|---|
| Course Code | **18ME744** | CIE Marks | 40 |
| Teaching Hours /Week (L:T:P) | 3:0:0 | SEE Marks | 60 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning Objectives:**

- To Introduce the concepts of planning, scheduling and FMS
- To understand group technology concepts and justification.

**Module-1**

PLANNING, SCHEDULING AND CONTROL OF FLEXIBLE MANUFACTURING SYSTEMS: Introduction to FMS– development of manufacturing systems – benefits – major elements – types of flexibility – FMS application and flexibility –single product, single batch, n – batch scheduling

**Module-2**

COMPUTER CONTROL AND SOFTWARE FOR FLEXIBLE MANUFACTURING SYSTEMS: Introduction – composition of FMS– hierarchy of computer control –computer control of work center and assembly lines – FMS supervisory computer control

**Module-3**

FMS SIMULATION AND DATA BASE: Application of simulation – model of FMS– simulation software – limitation – manufacturing data systems – data flow – FMS database systems – planning for FMS database

**Module-4**

GROUP TECHNOLOGY AND JUSTIFICATION OF FMS Introduction – matrix formulation – mathematical programming formulation –graph formulation – knowledge based system for group technology – economic justification of FMS

**Module-5**

APPLICATIONS OF FMS AND FACTORY OF THE FUTURE FMS: Application in machining, sheet metal fabrication, prismatic component production – aerospace application – FMS development towards factories of the future – artificial intelligence and expert systems in FMS

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

CO1 Explain the concepts of Planning, Scheduling and control of Flexible Manufacturing systems

CO2 Perform Planning, Scheduling and control of Flexible Manufacturing systems

CO3 Apply flexible manufacturing system to perform simulation on software's use of group technology to product classification

CO4 Apply the concept of artificial intelligence and expert systems in FMS

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

| Sl. No. | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Handbook of flexible manufacturing systems | Jha, N.K | Academic Press Inc. | 1991. |
| **Reference Books** | | | | |
| 1 | CAD/CAM/CIM | Radhakrishnan P. and Subramanyan S | Wiley Eastern Ltd., New Age International Ltd | 1994 |
| 2 | "Flexible manufacturing systems: recent development | Raouf, A. and Ben-Daya, M., Editors | Elsevier Science | 1995 |
| 3 | "Automation, Production Systems and Computer Integrated Manufacturing | Groover M.P | Prentice Hall of India Pvt., New Delhi | 1996 |
| 4 | Manufacturing Engineering and Technology | Kalpakjian | Addison-Wesley Publishing Co. | 1995 |

**B.Tech in Mechanical and Smart Manufacturing**
**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
**SEMESTER – VII**
**Open Elective**

**PRODUCT DESIGN AND DEVELPOMENT**

| | | | |
|---|---|---|---|
| Course Code | **18SM75** | CIE Marks | 40 |
| Teaching hours/Week(L:T:P) | 3:0:0 | SEE Marks | 60 |
| Credits | 03 | Exams hours | 03 |

Course Learning Objectives:

- To Understand the principles of generic development process; product planning; customer need analysis for new product design and development.
- To enhance the understanding of setting product specifications and generate, select, screen, and test concepts for new product design and development.
- To apply the principles of product architecture and the importance of industrial design principles and DFM principles for new product development.
- To expose the different Prototyping techniques, Design of Experiment principles to develop a robust design and importance to patent a developed new product.
- Applying the concepts of economics principles; project management practices in development of new product

Module-1

**Introduction:** Characteristics of successful product development, Design and development of products, duration and cost of product development, the challenges of product development.

**Development Processes and Organizations**: A generic development process, concept development: the front-end process, adopting the generic product development process, the AMF development process, product development organizations, the AMF organization.

**Product Planning:** The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process

**Module-2**

**Identifying Customer Needs**: Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process.

**Product Specifications:** What are specifications, when are specifications established, establishing target specifications, setting the final specifications.

**Concept Generation**: The activity of concept generation, clarifies the problem, search externally, search internally, explore systematically, reflect on the results and the process.

**Module-3**

**Concept Selection:** Overview of methodology, concept screening, and concept scoring,

**Concept Testing**: Define the purpose of concept test, choose a survey population, choose a survey format, communicate the concept, measure customer response, interpret the result, reflect on the results and the process.

**Product Architecture**: What is product architecture, implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues.

**Module-4**

**Industrial design**: Assessing the need for industrial design, the impact of industrial design,

industrial design process, managing the industrial design process, assessing the quality of industrial design.

**Design for Manufacturing**: Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors.

**Prototyping:** Prototyping basics, principles of prototyping, technologies, planning for prototypes.

**Module-5**

**Product Development Economics:** Elements of economic analysis, base case financial mode, Sensitive analysis, project trade-offs, influence of qualitative factors on project success, qualitative analysis. **Managing Projects**: Understanding and representing task, baseline project planning, accelerating projects, project execution, postmortem project evaluation.

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

CO1:Understand the design phases
CO2:Formulate need statement and specifications
CO3:Apply decision making statement
CO4: Apply the adopt Prototyping techniques and Design of Experiment principles to develop
a robust design and document a new product for patent.
CO5: Apply of the concepts of economics principles; project management practices in accelerating the new product development activity.

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

| Sl. No. | Title of the book | Name of the author/s | Name of the publisher | Edition and year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Product Design and Development | Karl.T.Ulrich, Steven D Eppinger | Irwin McGrawHill | 2000 |
| **Reference Books** | | | | |
| 1 | Product Design and Manufacturing | A C Chitale and R C Gupta,. | PHI | 3rd Edition, 2003 |
| 2 | New Product Development - | Timjones. Butterworth Heinmann - | Oxford. UCI | 1997 |
| 3 | Product Design for Manufacture and Assembly - | GeofferyBoothroyd, Peter Dewhurst and Winston Knight - | CRC Press, Taylor and Francis Group | 2002 |
| 4 | Product Design, | Prashant Kumar, | PHI Learning Pvt. Ltd., | ISBN:978-81-203-4427-3,2012, |

**B.TECH IN MECHANICAL AND SMART MANUFACTURING**
**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
**SEMESTER - VII**

## Artificial intelligence and Machine Learning Lab

| | | | |
|---|---|---|---|
| Course Code | **18SML77** | CIE Marks | 40 |
| Teaching Hours /Week (L:T:P) | 0:2:2 | SEE Marks | 60 |
| Credits | 02 | Exam Hours | 03 |

**Course Learning Objectives:**

AI is an introductory course in Artificial Intelligence. The goal is to acquire knowledge on intelligent systems and agents, formalization of knowledge, reasoning with and without uncertainty, machine learning and applications at a basic level.

| Sl. No. | Experiments |
|---|---|
| | |

### Programs List:

1. Implement A* Search algorithm.

2. Implement AO* Search algorithm.

3. For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate-Elimination algorithmto output a description of the set of all hypotheses consistent with the training examples.

4. Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge toclassify a new sample.

5. Build an Artificial Neural Network by implementing the Backpropagation algorithm and test the same using appropriate data sets.

6. Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.

7. Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program.

8. Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions. Java/Python ML library classes can be used for this problem.

9. Implement the non-parametric Locally Weighted Regressionalgorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs

**Course Outcomes:** At the end of the course,
The student should be able to:

- Implement and demonstrate AI and ML algorithms.
- Evaluate different algorithms.

**Conduct of Practical Examination:**
1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once, and 15% Marks allotted to the procedure part to be made zero.

Scheme of Examination:
One question from Part A: 40 marks
One question from Part B: 40 Marks
Viva voce: 20 Marks
Total: 100 Marks

**B.TECH IN MECHANICAL AND SMART MANUFACTURING**
**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
**SEMESTER - VII**

## Computer Graphics & AR/VR Laboratory

| | | | |
|---|---|---|---|
| Course Code | **18SML76** | CIE Marks | 40 |
| Teaching Hours /Week (L:T:P) | 0:2:2 | SEE Marks | 60 |
| Credits | 02 | Exam Hours | 03 |

**Course Learning Objectives:**
It provides the necessary theoretical background and demonstrates the application of computer science to graphics. The course further allows students to develop programming skills in computer graphics through programming assignments.

| Sl. No. | Experiments |
|---|---|
| | **PART - A** |
| 1 | Application areas of Computer Graphics, overview of graphics systems, video-display devices, raster-scan systems, random scan systems, graphics monitors and work stations and input devices Output primitives: Points and lines, line drawing algorithms, mid-point circle and ellipse algorithms. Filled area primitives: Scan line polygon fill algorithm, boundary-fill and flood fill algorithms. |
| | **PART - B** |
| 2 | Installation of Unity and Visual Studio, setting up Unity for VR development, understanding documentation of the same. |
| 3 | Demonstration of the working of HTC Vive, Google Cardboard, Google Daydream and Samsung gear VR. |
| 4 | Develop a scene in Unity that includes:<br>i. a cube, plane and sphere, apply transformations on the 3 game objects.<br>ii. ii. add a video and audio source. |

**Conduct of Practical Examination:**
1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once, and 15% Marks allotted to the procedure part to be made zero.

Scheme of Examination:
One question from Part A: 40 marks
One question from Part B: 40 Marks
Viva voce: 20 Marks
Total: 100 Marks

07.01.2023

**B.TECH IN MECHANICAL AND SMART MANUFACTURING**
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**SEMESTER - VIII**

**Advanced Smart Manufacturing Techniques**

| | | | |
|---|---|---|---|
| Course Code | **18SM81** | CIE Marks | 40 |
| Teaching Hours /Week (L:T:P) | 3:0:0 | SEE Marks | 60 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning Objectives:**

- Understand energy scenario, energy sources and their utilization
- Learn about energy conversion methods
- Study the principles of renewable energy conversion systems.

**Module-1**

**STEAM GENERATORS** Coal and ash handling, Generation of steam using forced circulation, high and supercritical pressures, LaMount, Benson, Velox, Loeffer, Schmidt steam generators, Cooling towers and Ponds, Accessories such as Superheaters, De-superheater, Economizers, Air preheaters.

**Module-2**

**Solar Energy**: Introduction, Solar radiation at the earth's surface, Solar radiation measurements, Flat plate collectors, Focussing collectors, Solar pond, Solar electric power generation-Solar photovoltaics.
**Biomass Energy**: Photosynthesis, photosynthetic oxygen production, energy plantation. Bio Chemical Route: Biogas production from organic wastes by anaerobic fermentation, Bio gas plants-KVIC, Janta, Deenbhandu models, factors affecting bio gas generation. Thermal gasification of

**Module-3**

**Geothermal Energy**: Forms of geothermal energy, Dry steam, wet steam, hot dry rock and magmatic chamber systems.
**Tidal Energy**: Tidal power, Site selection, Single basin and double basin systems, Advantages and disadvantages of tidal energy.
**Wind Energy**: Wind energy-Advantages and limitations, wind velocity and wind power, Basic components of wind energy conversion systems, horizontal and vertical axis wind mills, coefficient of performance of a wind mill rotor, Applications of wind energy.

**Module-4**

**Hydroelectric plants**: Advantages & disadvantages of water power, Hydrographs and flow duration curves-numericals, Storage and pondage, General layout of hydel power plants- components such as Penstock, surge tanks, spill way and draft tube and their applications, pumped storage plants, Detailed classification of hydroelectric plants, water hammer.
**Ocean Thermal Energy**: Ocean thermal energy conversion, Principle and working of Rankine cycle, Problems associated with OTEC.

**Module-5**

**NUCLEAR ENERGY** Principles of release of nuclear energy-Fusion and fission reactions. Nuclear fuels used in the reactors, Chain reaction, Moderation, breeding, Multiplication and thermal utilization factors. General components of a nuclear reactor and materials, Brief description-Pressurized water reactor, Boiling water reactor, Sodium graphite reactor, Fast Breeder reactor, Homogeneous graphite reactor and gas cooled reactor, Radiation hazards, Shielding, Nuclear waste, Radioactive waste disposal.

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

CO1: Understand the construction and working of steam generators and their accessories.

CO2: Identify renewable energy sources and their utilization.

CO3: Understand principles of energy conversion from alternate sources including wind, geothermal, ocean, biomass, nuclear, hydel and tidal.

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

| Sl | Title of the Book | Name of the | Name of the Publisher | Edition and |
|---|---|---|---|---|

| No | | Author/s | | Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Power Plant Engineering | P. K. Nag | Tata McGraw Hill Education Private Limited, New Delhi | Third Edition, 2012. |
| 2 | Power Plant Engineering | Arora and Domkundwar | Dhanpat Rai & Co. (P) Ltd. | Sixth Edition, 2012. |
| 3 | Non-conventional Sources of Energy | G.D.Rai | Khanna Publishers, New Delhi | Fifth Edition, 2015. |
| 4 | Non-conventional energy resources | B H Khan | McGraw Hill Education | 3rd Edition |
| **Reference Books** | | | | |
| 1 | Power Plant Engineering | R. K. Rajput | Laxmi publication New Delhi | |
| 2 | Principles of Energy conversion | A. W. Culp Jr | McGraw Hill | 1996 |
| 3 | Power Plant Technology | M.M. EL-Wakil | McGraw Hill International | 1994 |
| 4 | Solar Energy: principles of Thermal Collection and Storage | S.P. Sukhatme | Tata McGraw-Hill | 1984 |

**B.TECH IN MECHANICAL AND SMART MANUFACTURING**
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**SEMESTER - VIII**
**Professional Elective-4**

**Optimization Techniques**

| | | | |
|---|---|---|---|
| Course Code | **18SM821** | CIE Marks | 40 |
| Teaching Hours /Week (L:T:P) | 3:0:0 | SEE Marks | 60 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning Objectives:**

- To expose the students to techniques to optimize complex engineering problems.
- To introduce non-linear programming techniques.
- To introduce the Integer programming method.

**Module-1**

**Introduction:** Statement of optimisation problem, Design vector, Design constraints, Objective function, Classification of optimisation problems based on :constraints, nature of design variables, nature of the equations involved Single variable optimisation: Necessary and sufficient conditions, Multivariable optimization with no constraints: Necessary and sufficient conditions, Semi definite case, Saddle point, Multi variable optimization with equality constraints, Solution by direct substitution, Lagrange Multipliers, Interpretation of Lagrange multipliers, Multivariable optimization with inequality constraints: Khun Tucker conditions(concept only).

**Module-2**

**Nonlinear Programming:** One-Dimensional Minimization Methods, Introduction, Unimodal Function, Elimination methods: unrestricted search, fixed step size, accelerated step size, Exhaustive search: dichotomous search, interval halving method, Fibonacci method, golden section method, Interpolation methods: Quadratic and cubic interpolation method, direct root method, Newton method, QuasiNewton method, secant method.

**Module-3**

**Nonlinear Programming:** Direct search methods: Classification of unconstrained minimization methods, rate of convergence, scaling of design variables, random search methods, univariate methods, pattern directions, Powell's methods, Simplex method.

**Module-4**

**Nonlinear Programming:** Indirect Search (Descent) Methods: Gradient of a function, Steepest decent method, Fletcher Reeves method, Newton's method, Davidson-Fletcher-Powell method.

**Module-5**

**Integer Programming:** Introduction, Graphical representation, Gomory's cutting plane method: concept of a cutting plane, Gomory's method for all-integer programming problems, Bala's algorithm for zero–one programming, Branch-and-Bound Method.

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

CO1: Define and use optimization terminology, concepts, and understand how to classify an optimization problem.

CO2: Understand how to classify an optimization problem.

CO3: Apply the mathematical concepts formulate the problem of the systems.

CO4: Analyse the problems for optimal solution using the algorithms.

CO5: Interpret the optimum solution.

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

| Sl No | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Engineering Optimization Theory and Practice | S. S. Rao | John Wiley & Sons | Fourth Edition 2009 |
| 2 | Optimisation Concepts and Applications in Engineering | A. D. Belegundu, T.R. | Cambridge University Press | 2011 |
| **Reference Books** | | | | |
| 1 | Engineering Optimization: Methods and Applications | Ravindran, K. M. Ragsdell, | Wiley, New York | 2nd ed. 2006 |

**B.TECH IN MECHANICAL AND SMART MANUFACTURING**
**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
**SEMESTER - VIII**
**Professional Elective-4**

## Non-Destructive Testing and Evaluation

| | | | |
|---|---|---|---|
| Course Code | **18SM822** | CIE Marks | 40 |
| Teaching Hours /Week (L:T:P) | 3:0:0 | SEE Marks | 60 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning Objectives:**

- To introduce the basic principles, techniques, equipment, applications and limitations of Non Destructive Testing (NDT) methods such as Visual, Penetrant Testing, Magnetic Particle Testing, Ultrasonic Testing, Radiography, Eddy Current.
- To enable selection of appropriate NDT methods.
- To identify advantages and limitations of NDT methods
- To make aware the developments and future trends in NDT.

**Module-1**

**OVERVIEW OF NDT:** NDT Versus Mechanical testing, Overview of the Non-Destructive Testing Methods for the detection of manufacturing defects as well as material characterisation. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT. Visual inspection – Unaided and aided.

**Module-2**

**SURFACE NDT METHODS:** Liquid Penetrant Testing – Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection materials, magnetization methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

**Module-3**

**THERMOGRAPHY AND EDDY CURRENT TESTING (ET):** Thermography- Principles, Contact and non -contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation – infrared radiation and infrared detectors, Instrumentations and methods, applications. Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.

**Module-4**

**ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION (AE):** Ultrasonic Testing-Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction. Acoustic Emission Technique –Principle, AE parameters, Applications.

**Module-5**

**RADIOGRAPHY (RT):** Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films – graininess, density, speed, contrast, characteristic curves, Penetrameters, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Computed Radiography, Computed Tomography.

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

CO1: Classify various 144on-destructive testing methods.

CO2: Check different metals and alloys by visual inspection method.

CO3: Explain and perform non-destructive tests like: Liquid penetrant test, Magnetic particle test, Ultrasonic

test, X- ray and Gamma ray radiography, Leak Test, Eddy current test.

CO4: Identify defects using relevant NDT methods.

CO5: Differentiate various defect types and select the appropriate NDT methods for better evaluation.

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

| Sl No | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Practical Non-Destructive Testing | Baldev Raj, T.Jayakumar, | Narosa Publishing House | 2009 |
| 2 | Non-Destructive Testing Techniques | Ravi Prakash | New Age International Publishers | 1st revised edition2010 |
| **Reference Books** | | | | |
| 1 | ASM Metals Handbook,"NonDestructive | American Society of | Metals Park, Ohio, USA, | 2000 |
| 2 | Introduction to Nondestructive testing: a training guide | Paul E Mix, | Wiley | 2nd Edition New Jersey, 2005 |
| 3 | Handbook of Nondestructive evaluation | Charles, J. Hellie | McGraw Hill, New York | 2001 |
| ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook,Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, | | | | |

**B.TECH IN MECHANICAL AND SMART MANUFACTURING**
**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
**SEMESTER - VIII**
**Professional Elective-4**

**PROJECT MANAGEMENT**

| | | | |
|---|---|---|---|
| Course Code | **18ME823** | CIE Marks | 40 |
| Teaching Hours /Week (L:T:P) | 3:0:0 | SEE Marks | 60 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning Objectives:**

- To understand how to break down a complex project into manageable segments and use of effective project management tools and techniques to arrive at solution and ensure that the project meets its deliverables and is completed within budget and on schedule.
- To impart knowledge on various components, phases, and attributes of a project.
- To prepare students to plan, develop, lead, manage, and successfully implement and deliver projects within their chosen practice area.

**Module-1**

**Introduction:** Definition of project, characteristics of projects, understand projects, types of projects, scalability of project tools, project roles Project Selection and Prioritization – Strategic planning process, Strategic analysis, strategic objectives, portfolio alignment – identifying potential projects, methods of selecting projects, financial mode / scoring models to select projects, prioritizing projects, securing and negotiating projects.

**Module-2**

**Planning Projects:** Defining the project scope, Project scope checklist, Project priorities, Work Breakdown Structure (WBS), Integrating WBS with organisation, coding the WBS for the information system. Scheduling Projects: Purpose of a project schedule, historical development, how project schedules are limited and created, develop project schedules, uncertainty in project schedules, Gantt chart.

**Module-3**

**Resourcing Projects:** Abilities needed when resourcing projects, estimate resource needs, creating staffing management plant, project team composition issues, Budgeting Projects: Cost planning, cost estimating, cost budgeting, establishing cost control. Project Risk Planning: Risk Management Planning, risk identification, risk analysis, risk response planning, Project Quality Planning and Project Kick off: Development of quality concepts, project quality management plan, project quality tools, kick off project, baseline and communicate project management plan, using Microsoft Project for project baselines.

**Module-4**

**Performing Projects:** Project supply chain management: - Plan purchasing and acquisitions, plan contracting, contact types, project partnering and collaborations, project supply chain management. 28 Project Progress and Results: Project Balanced Scorecard Approach, Internal project, customer, financial issues, Finishing the project: Terminate project early, finish projects on time, secure customer feedback and approval, knowledge management, perform administrative and contract closure.

**Module-5**

Netw**ork Analysis:** Introduction, network construction - rules, Fulkerson's rule for numbering the events, AON and AOA diagrams; Critical path method (CPM) to find the expected completion time of a project, floats; PERTfor finding expected duration of an activity and project, determining the probability of completing a project, predicting the completion time of project; crashing of simple projects.

**Course Outcomes:** At the end of the course the student will be able to:
CO1: Understand the selection, prioritization and initiation of individual projects and strategic role of project management.
CO2: Understand the work breakdown structure by integrating it with organization.
CO3: Understand the scheduling and uncertainty in projects. CO4: Understand risk management planning using project quality tools.
CO5: Understand the activities like purchasing, acquisitions, contracting, partnering and collaborations related to performing projects.
CO6: Determine project progress and results through balanced scorecard approach
CO7: Draw the network diagram to calculate the duration of the project and reduce it using crashing.

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

| Sl No | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Project Management | Baldev Raj, T.Jayakumar, M.Thavasimuthu | Cengage Learning | Edition 2009 |
| 2 | Project Management -A systems approach to planning scheduling and controlling | Harold kerzner | CBS publication | |
| 3 | Project Management | S Choudhury | McGraw Hill Education (India) Pvt. Ltd. New Delhi | 2009 |
| **Reference Books** | | | | |
| 1 | Project Management | Pennington Lawrence | Mc Graw Hill | |
| 2 | Project Management | A Moder Joseph and Phillips New Yark | Van Nostrand Reinhold | |
| 3 | Project Management | Bhavesh M. Patal | Vikas publishing House | |

**B.TECH IN MECHANICAL AND SMART MANUFACTURING**
**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
**SEMESTER - VIII**
**Professional Elective-4**

**Industrial Safety**

| | | | |
|---|---|---|---|
| Course Code | **18SM824** | CIE Marks | 40 |
| Teaching Hours /Week (L:T:P) | 3:0:0 | SEE Marks | 60 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning Objectives:**

- The present course highlights the importance of general safety and its prevention.
- It enables students to understand about mechanical, electrical sand chemical safety.
- The Industrial safety course helps in motivating the students to understand the reason for fire
- Its Controlling of fire by various means are highlighted.
- Importance of chemical safety, labelling of chemicals, hand signals during forklift operations in industrial and aerodromes will help in to understand and apply the techniques in practical field.
  A visit to campus, various labs, workshops, local industries and fire stations helps in analyzing the importance of safety and corrective measures through case studies.

**Module-1**

Terms used: accident, safety, hazard, safe, safety devices, safety guard, security, precaution, caution, appliance, slip, trip, fall. Ladders and scaffolding. Unsafe acts, reason for accidents, MSDS (material safety data sheet), computer Aided Hazard Analysis, International acts and standards OSHA, WHO. Environment act, control and abatement of environmental pollution-Biomedical waste. Lockout and tag out procedures. Safe material handling and storage. Risk analysis quantification. Case studies: Student should identify the unsafe acts near their surroundings like housekeeping, lab as well as industrial layouts, road safety, campus layout, safety signs

**Module-2**

Introduction, toxicity of products of combustion – vapour clouds – flash fire – jet fires – pool fires – autoignition, sources of ignition . Class A, B, C, D and E fire. Fire triangle, Fire extinguishers, Fire hazard and analysis, prevention of fire. Fire protection and loss prevention, steps after occurrence of fire. notice-first aid for burns, Portable fire extinguishers. Fire detection, fire alarm and firefighting systems. Safety sign boards, instruction on portable fire extinguishers. Case studies: demonstration of fire extinguishers, visit to local fire fighting stations. Visit to fire accident sites to analyze the cause of fire and its prevention for future

**Module-3**

PPE, safety guards, Mechanical hazards, workplace hazards, Forklift hazard control Safety while working with machine tools like lathe, drill press, power and band saws, grinding machines. Safety during welding, forging and pressing. Safety while handling Material, compressed gas cylinders, corrosive substance, waste drum and containers. Case studies: Visit to machine shop, workshops, foundry lab and local industries to record the practical observation and report the same with relevant figures and comments

**Module-4**

Introduction to electrical safety, Indian standards on electrical safety, Electric hazards, effect of electric current on human body, causes of electrical accidents, prevention of electric accidents, PPE used. Protection systems: Fuse, circuit breakers and overload relays – protection against over voltage and under voltage. Electric shock. Primary and secondary electric shocks, AC and DC current shocks. Safety precautions against shocks. Safety precautions in small and residential building installations. Safety procedures in electric plant. Case studies: To visit electrical sub stations, local distribution

systems, observe and share the experience and report.

**Module-5**

Introduction to Chemical safety, Labelling of chemicals, acid hoods. Handling of acids, eye washers and showers. Safety thinking, accident investigation, safety policy of the company, safety, loss prevention and control, check list for LPG installations, safety precautions using CNG, fire prevention and safety audit, confined space entry, risk assessment. Case studies: To visit chemical laboratory of the college and other chemical industries like LPG , CNG facilities and report.

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

CO1: Understand the basic safety terms and international standards.

CO2: Identify the hazards and risk analysis around the work environment and industries.

CO3: Use the safe measures while performing work in and around the work area of the available laboratories. Able to recognize the sign boards and its application

CO4: Recognise the types of fires extinguishers and to demonstrate the portable extinguishers used for different classes of fires.

CO5: Report the case studies by sharing experience of the employees working in housekeeping, laboratories like workshops, electrical labs, machine shops, electronics and computer laboratories.

CO6: Recognise the chemical and electrical hazards for its prevention and control.

**Question paper pattern:**

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

| Sl No | Title of the Book | Name of the Author/s | Name of the Publisher | Edition and Year |
|---|---|---|---|---|
| **Textbook/s** | | | | |
| 1 | Industrial Safety and Management | L M Deshmukh | McGraw Hill Education (India) private Limited | ISBN-13: 978-0-07- 061768-1 |
| 2 | Fire Prevention Hand Book | Derek, James | Butter Worth's and Company, London | 1986 |
| 3 | Electrical Safety, fire safety and safety management | S.Rao, R K Jain and Saluja | Khanna Publishers | ISBN: 978- 81-7409- 306-6 |
| 4 | Industrial health and safety management | A.M.Sarma | Himalya publishing house | |
| 5 | Environmental engineering | Gerard Kiely | McGraw Hill Education (India) | ISBN-13: 978-0-07- 063429-9 |
| **Reference Books** | | | | |
| 1 | The Environment Act (Protection) 1986 | Commercial Law Publishers (India) | | |
| 2 | Water (Prevention and control of pollution) act 1974 | Commercial Law publishers (India) Pvt. Ltd., New Delhi. | | |

- To visit respective Institution: stores, office, housekeeping area, laboratories.
- To visit local industries, workshops, district firefighting system facility and local electrical